PACIFIC ISLANDS FISHERIES SCIENCE CENTER

Status of Life History Sampling Conducted through the Commercial Fisheries Bio-sampling Programs in the Western Pacific Territories of American Samoa and Guam and in the Commonwealth of the Northern Mariana Islands

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INTRODUCTION

The 2006 re-authorization of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) was amended by Congress (Federal Register, Vol. 74, No.11, Jan 16, 2009) to require the development of annual catch limits (ACL) by 2011 for fish stocks designated as management unit species (MUS) under federal fisheries (or ecosystem) management plans. This ACL mandate applied to both data-rich and data-limited stocks. Typically, data-limited stocks include those where catch and other fisheries data are often lumped into species complexes or other broad categories. This makes it difficult to characterize the species composition of the fishery, which can be especially important for assessment when good abundance indices are lacking. When species-specific information is not available, estimating life history parameters of individual species is not possible. Age and growth as well as size and age at 50% maturity (L_{M50} & t_{M50}) can be particularly important for management consideration. Within the regional jurisdiction of the Pacific Islands Fisheries Science Center (PIFSC), such data-limited situations are exemplified by the coral reef and bottomfish fisheries that harvest large numbers of species within the western Pacific territories of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI).

The fisheries conducted within these territories are predominantly small scale, of modest commercial value, and target a diverse array of species. The coral reef and bottomfish fisheries in these regions are managed by the Western Pacific Regional Fishery Management Council (the Council) under Fishery Ecosystem Plans (FEPs), (Council, 2008). The Council is responsible for the implementation and management of these plans, which incorporate the regulatory mechanisms of the MSA. The PIFSC is responsible for providing the scientific information and analysis to develop stock assessments that include the bottomfish and coral reef stocks of American Samoa, Guam, and CNMI.

Accurate biological information on life history processes (growth, longevity, $L_{M50,}$ & t_{M50}) of harvested bottomfish and coral reef fish species is scarce in these regions. Local resource agencies have limited capacity to acquire adequate catch and effort statistics and fisher and dealer participation is voluntary, thus restricting the quantity, accessibility, and type of data available for analysis.

As part of a national effort to improve information gathering on data-limited fisheries and to achieve the ACL mandate for all managed stocks, the National Marine Fisheries Service (NMFS) developed and funded the Commercial Fisheries Bio-Sampling (CFBS) Program in 2009. The CFBS Program provided financial support to each of the six NMFS Science Centers to enhance their ability to improve data collections. For PIFSC, this involved contracting and training bio-sampling teams to conduct this work in each of the western Pacific territories, working with the support of their respective marine resource agencies (Department of Marine and Wildlife Resources (DMWR) in American Samoa, Department of Fish and Wildlife (DFW) in CNMI Saipan, and Division of Aquatic and Wildlife Resources (DAWR) in Guam). Each agency agreed to acquire length/weight metrics and collect biological samples (otoliths, gonads, and fin clips) from fish species deemed important to their respective territories. In each region, the bio-sampling teams implemented standardized sampling techniques outlined by the PIFSC.

The primary effort was to establish cooperative relations with as many local fish markets, fishermen, and vendors as possible to acquire length and weight metrics by species as well as collect any available supplementary catch and effort data. This would provide species composition and size-frequency data to support the development of stock assessments, provide information on species productivity and susceptibility, and refine ACLs for MUS in these territories.

Secondarily, to support life history studies, 6-10 target species were subsampled for hardparts and tissues. Otoliths, gonads, and fin clips were extracted from target species to be used to determine growth rate, longevity, L_{M50}, t_{M50}, and to validate species identifications. Building the capacity, facilities, and expertise in these territories to conduct life history studies on their own will take time. Meanwhile, the Life History Program (LHP) within the PIFSC Fisheries Research & Monitoring Division has both the facilities and expertise for this work and is collaborating with the territories to accomplish it. In each region, choosing species desirable for life history sampling involved consideration of several factors. Initially, the Council created a list of "Risk Ranked Species" during a National Scientific and Statistical Committee meeting in November 2008 that guided selection of priority species for life history bio-sampling. However, when sampling began, many of the "Risk Ranked Species" were rarely available at local markets. Taking into account the importance of the species as a food fish, its commercial value, and the availability of fish throughout the year in a wide range of sizes, an updated list was created with guidance from the regional bio-sampling teams, resident fishermen, and local agencies. As life histories were documented and specimen collections grew, the list of priority species was modified.

The focus of this report will be to document the methodologies implemented by each western Pacific regional bio-sampling team to collect biological samples from target coral reef and bottomfish species, species-specific length and weight metrics, and fisheries data and summarizes the sampling results achieved from the programs' inception through December 2014.

METHODOLOGY

In August 2009, the PIFSC and the Council organized a bio-sampling workshop at the Guam Fisherman's Co-op Association (GFCA) in Hagåtña, Guam. The workshop familiarized CFBS Program affiliates with the bio-sampling protocols and procedures routinely conducted by the PIFSC LHP. To demonstrate fish processing and bio-sampling techniques, hands-on activities were incorporated. Assigning unique IDs (fish sample identification numbers) and effectively labeling, preserving, and archiving specimens was also discussed. In an October 2010 workshop organized and held by the PIFSC in Hawaii, additional guidance was provided on methods used to accurately identify species and individualize bio-sampling activities and protocols. CFBS Program team members and marine resource agency staff from Guam, CNMI, and American Samoa attended both workshops.

The CFBS Program participants modified the PIFSC procedures and protocols to best fit their sampling environment and launched independent bio-sampling programs in their own territories.

Guam established routine bio-sampling activities on available reef fish and bottomfish at the GFCA in August 2009. Bio-samplers in American Samoa began regular sampling of reef and bottom fish in October 2010 at the Fagatogo Marketplace (Marketplace) in Pago Pago.The CNMI Saipan bio-samplers began regularly sampling reef fish at various vendor establishments in December 2010 and bottomfish species in September 2012.

All bio-sampling supplies, training, technical support, contracts for local fishermen, and external support for processing collected specimens (otoliths, gonads, and fin clips) were provided by the PIFSC.

Due to diverse fishing practices, combination of partners involved, and availability of resources, bio-sampling methods varied by territory. Some invariant procedures and protocols, however, did exist. Most bio-sampling events took place at a centralized fish market, at vendor establishments during catch offload, or in a designated lab. All fish lengths and weights were obtained using a 75 cm fish measuring board, 1 m calipers or 150 cm tape measure (when needed for larger fish), and a digital bench scale. Most of the bio-sampling effort was geared towards documenting species composition and collecting length and weight measurements of the entire catch brought to market by individual fishers. Information on fishing effort was also collected to assist in development of catch-per-unit effort (CPUE) relative abundance indices. When sufficient data adequate to construct reliable length-weight relationships were obtained for a particular species, weight was no longer measured in the field. Instead, individual fish weight was calculated from measured length using a standard linear regression generated by the Bio-Sampling Database (Database). The calculated weights allow a total to be provided for all catch sampled. The Database was specifically tailored for the western Pacific territories for data entry and management. The PIFSC and Western Pacific Fisheries Information Network (WPacFIN) maintained and updated the specialized Database, providing training and ongoing support for its use in the territories.

To allow for easy acquisition of data for fish subsampled for otoliths and tissues, two separate data sets were created in the Database. They were called “Field” and “Lab”. On sampling days, the entire commercial catch brought to market by individual fishers was measured to provide an unbiased sample of the size distribution of the catch. These were categorized as “Field” fish. In all territories, Field fishes were identified to the species level, fork length (to the nearest 0.1 cm) and body weight (g) were recorded.The moon phase, details about the seller, and fishing information (general area fished, start and end time, hours fished, trip type, fishing method, and fished date) were documented. The vendor or market selling the fishes recorded additional information (the number of pieces caught to the group level (reef fish, bottomfish, and pelagics), the price paid to the fishermen per pound, the total weight of each group of fish, and the total value of the catch) onto a Commercial Sales Receipt developed by WPacFIN.

After the entire commercial catch for each fisherman was measured, fishes identified as a priority for life history research were purchased or processed for otoliths and tissues. This subsample of fish was categorized as “Lab” fish and data associated with Lab fish were stored in the Lab and Field data sets. The Lab dataset was created to provide a convenient compendium of the data on fish subsampled for otoliths and gonads.

Information on the vendor, fisherman, fishing method, fishing effort, date caught, and capture location can be found in both data sets (Lab and Field). Additional data collected from Lab fish included visual determination of sex obtained from extracted gonads, gonad weight, and the number of otoliths extracted. Unlike Field fish, each fish processed for life history studies (Lab fish) was assigned a sample identification number. Field fish were not assigned a sample identification number, but the associated collection data (vendor, fisherman, fishing method, fishing effort, date caught, and capture location) occur in both data sets.

The collection protocol for Lab fish was to obtain 10-20 fish of each target species in a size-stratified, randomly sampled manner in 5-10 cm size bins per month. For each targeted species, Lab fish sampling was intended to cover the range of lengths found in Field fish. Size-stratified random sampling across most of the size distributions was typically achievable except for the smallest and largest size classes. Collection of Lab fish for the difficult to obtain smallest and largest size classes were augmented through opportunistic sampling to achieve a minimum sample size (n=10).

The fish sample identification number was created for all Lab fish by concatenating the first letter of the territory (A, G, or C) with the initials of the sampling technician (first, middle, and last name) and the sequential number of specimens sampled by that technician. The fish sample identification number was a unique identifier linking physical specimens (otoliths, gonads, and fin clips) extracted from Lab fish to other associated data (species, body length, body weight, gonad weight, sex, number of otoliths extracted, vendor, fisherman, fishing method, fishing effort, date caught, and capture location).

Labeling, preservation, and archival protocols for extracted gonads and otoliths collected from Lab fish were consistent throughout the Territories. Depending on size, either a cross-section of or the entire gonad was placed into a histological cassette. Immature gonads were often small enough to place into cassettes uncut. With pencil, the fish sample identification number was written on the front and the date of collection on the side of the cassette. Gonad samples were fixed and stored in 10% Formalin. Macroscopic identification of sex was recorded and fresh gonad weight (in grams) was obtained prior to fixation. The sagittal otoliths were extracted, cleaned, and archived. The number of otoliths extracted was documented using the following notation: 2.0 (2 whole sagittae, both cores intact), 1.5 (1 whole sagitta, 1 broken, both otolith cores intact), 1.0 (1 whole sagitta, 1 broken, 1 core intact), 0.5 (both sagittae broken, but at least 1 otolith core intact), 0.1 (no usable pieces, no cores intact), and 0 (no otoliths extracted). Extracted otolith and gonad specimens were subsequently transported to PIFSC for further processing.

Non-invasive bio-sampling techniques (otolith extraction through the fish's gills and external identification of sex in sexually dimorphic species) were conducted opportunistically, but this mode of sampling was uncommon.

Fin clips were collected from the fish's dorsal or pectoral fin, appropriately labeled with the fish sample identification number, and stored in 95% ethanol. Extracted fin clips were archived for future mtDNA sequencing to verify the accuracy of species identifications made in the field and provide input to the Fish Barcode of Life Initiative (FISH-BOL) (http://www.fishbol.org).

When available, whole fish were purchased and stored frozen with the intention of being voucher specimens. When five of each species documented in a region was obtained, collection of voucher specimens ceased. Specimens from Guam and Saipan were sent to the University of Guam to be archived and specimens from American Samoa were stored in the DMWR laboratory.

PIFSC LHP staff analyzed the data from both Lab and Field data sets using Microsoft Excel 2010 and the 2013 R Foundation for Statistical Computing, version 3.0.2. Length-frequency histograms of both Lab and Field data sets were created for species subsampled as Lab fishes in each Pacific territory. Viewing the data this way has been helpful to ensure Lab fish sampling occurred over the range of sizes reflected in the Field data. In each Pacific territory, additional species were measured and identified during collection of Field data, however, only information for Lab species was included as this report focused on life history activities of the CFBS Program. Ten species from American Samoa, six species from CNMI, and six species from Guam were selected as Lab fish. Species-specific, monthly, length frequency histograms of the Field data for these fishes were also created.

American Samoa-specific Methodology

Before April 2010, a centralized fish market did not exist in American Samoa. Bio-samplers did not have transportation to visit the numerous small-scale markets and roadside stands scattered across the island selling locally caught fish. Tracking down fish before they were sold was challenging and DMWR staff was unable to consistently measure or sample fish otoliths and gonads. When the Marketplace in Pago Pago was established in 2010, collaborating fishermen brought their catch to the Marketplace or bio-samplers transported fish from the fishermen's home to the Marketplace. Bio-samplers were able to measure a fishermen's catch before it was sold and would purchase target species as Lab specimens. A different protocol was used, however, for sampling Lab fish from available Field fish. Instead of measuring the entire catch then selecting fish for life history sampling (Lab fish), select fish were segregated from the total catch for Lab sampling, then the rest of the catch was measured. Therefore, Field sampling of the remaining catch did not include fish set aside for Lab sampling.

As of 2014, most fishermen no longer brought their catch directly to the Marketplace; instead, bio-samplers received fish at the DMWR laboratory located across the street from the Marketplace. After the bio-sampling team purchased fish chosen for specimen extractions and fish lengths and weights were obtained, fishermen could sell their catch at the Marketplace or elsewhere.

The spear fishery harvests the majority of coral reef species landed at the Marketplace and collection of length and weight measurements (Field data) occurred two times a week on Wednesdays and Saturdays from 5:30 a.m. to 8:00 a.m. (Ochavillo, 2012), either at the Marketplace (2009-2013) or the DMWR (2014). Fish subsampled for otoliths and tissues were purchased opportunistically by the CFBS Program and processed at the DMWR lab. The bottomfish fishery was unpredictable, but bottomfish fishermen maintained good communication with bio-samplers, alerting them when their catch was to be offloaded. When notified, bio-samplers would meet with bottomfish fishermen to measure their catch and sample or purchase target species. There were typically 3-5 technicians present to assist with bio-sampling activities, but a total of seven technicians were trained in bio-sampling procedures. Fish were separated according to fisherman then grouped by species. Length-weight data from fish brought in during the designated sampling times was recorded using an Olympus® hands-free voice recorder. Fishermen were paid 25 cents for each fish measured as an incentive to participate in the CFBS Program. Fin clips were collected at the Marketplace for the FISH-BOL project and photographs were taken of unidentified fish. As of October 2014, fin clip collection had ceased. No whole fish were retained as voucher specimens. Otoliths from Lab fish were cleaned and placed into 30 mL scintillation vials labeled with their associated fish sample identification number. All gonad histological cassettes were stored in 10% formalin in the DMWR laboratory. Species targeted for Lab sampling were: *Lethrinus xanthochilus, Lutjanus gibbus, Lutjanus rufolineatus, Myripristis amaena, Myripristis berndti, Myripristis murdjan, Naso unicornis, Sargocentron spiniferum, Sargocentron tiere,* and *Scarus rubroviolaceus*. Two designated bio-sampling technicians transcribed Field data and entered Lab data into the Database as time allowed; however, the protocol set forth by PIFSC for data entry was altered. Lengths and weights for life history sampling (Lab fish) only occurred in the Lab dataset. To obtain the total set of fish measurements and amend the Field dataset, both Lab and Field data sets had to be queried and their records combined.

CNMI-specific Methodology

Micronesian Environmental Services (MES), a private consultant, was contracted to conduct CFBS Program activities in Saipan. MES cultivated close ties with a number of mobile fish vendors, which provided pre-sale, vendor home access to the catch for sampling and collection of length-weight measurements. On designated sampling days, which were guided by the business operations of the vendor, MES staff would measure every fish from an individual catch before they were sold in the early morning hours (before 8:00 a.m.) at the MES lab or the vendors home; partial catches were not measured. When funding allowed, whole fish of target species and unidentified fish were purchased as Lab specimens. Ice was provided to fishermen by MES as an incentive to participate in bio-sampling activities.

If fish were measured at the vendor's home, a workstation composed of a bench scale and measuring board was set up after interactions between vendor and fisherman concluded, otherwise fish were measured in the MES lab. There were usually 3-4 technicians involved in Field sampling events at the vendor's home, one person identified the species and obtained length-weight measurements using the fish measuring board and scale. Fork length (0.1 cm), body weight (g), and any comments related to that fish were called out to a data recorder, whom recorded the data onto customized data sheets. A 3rd (and sometimes-4th) person helped with species identifications. All Lab fish were processed at the MES laboratory and all technicians participated in the processing (extraction of otoliths and gonads) of these fish.

Species targeted for Lab sampling were *Lethrinus atkinsoni, Lethrinus obsoletus, Mulloidichthys flavolineatus, Naso unicornis*, *Parupeneus barberinus*, and *Siganus argenteus*. As of June 2014, *L. atkinsoni* and *P. barberinus* were no longer purchased or sampled as Lab fish because sufficient specimens from the whole range of sizes needed for a complete life history study had been collected. From this date onwards, only opportunistic sampling of minimum and maximum sizes attained by *N. unicornis* were collected as Lab samples since samples of other intermediate sizes were sufficient.

Lab fishes purchased for life history sampling were brought to the MES lab in Garapan, Saipan and stored in re-sealable plastic bags on ice until technicians were able to extract otoliths and gonads. A hand-written tag containing the fork length (0.1 cm), body weight (g), date caught, 4-letter species code (first two letters of the genus and species), area fished, and the vendor name were placed in the bag with the specimen.

Extracted otoliths were cleaned with water using a paintbrush, dried on paper towels, and stored in 1 mL cryogenic vials. A printed tag containing the fish sample identification number was placed into the vial and that number was written on the cap or the side of the vial. Until 2013, vials were organized by sampler and date and stored in small re-sealable, plastic bags. After 2013, they were organized in cryogenic storage racks by sampler (for convenience, not for cold storage). Histological cassettes of gonads were stored by species in 2-liter jugs containing 10% Formalin. Information collected from voucher specimens were recorded on supplementary data sheets containing the fished date, fishing location, species, total length (0.1 cm), fork length (0.1 cm), weight (g), fish sample identification number, and comments. Pre-printed tags for voucher specimens allowed for easy identification of the number of fish remaining to be collected. As of early 2013, the collection of voucher specimens for mtDNA sequencing was suspended due to lack of funds.

The MES data specialist was responsible for the entry and safekeeping of all collected data. Biological samplers did not have access to the Database.

GUAM-specific Methodology

Most fishermen brought their catch directly to the GFCA to be sold. A contract with the GFCA was established to allow bio-samplers access to their facilities to collect length-weight metrics and purchase Lab fish. Bio-sampling technicians trained GFCA staff to identify fish to the species level and taught them how to collect fish lengths and weights utilizing standardized protocols. Initially, a hands-free Olympus® digital voice recorder was used during sampling events, but now, data are handwritten onto customized bio-sampling forms. Species targeted for Lab sampling were *Etelis coruscans, Pristipomoides zonatus*, *Cheilinus undulatus, Hipposcarus longiceps, Monotaxis grandoculis,* and *Variola louti*. Co-op staff extracted gonads and otoliths from bottomfish species (*E. coruscans* and *P. zonatus*) and notified bio-samplers when these specimens (gonads and otoliths) were ready for pick-up. PIFSC staff extracted otoliths and gonads from reef fish species. Specimen availability was unpredictable and employing GFCA staff was an efficient means to monitor, measure, and collect length-weight metrics from Field fish from a fishermen's catch or sample target species (Lab fish) offloaded intermittently throughout the day. PIFSC staff was on-call during the business hours of the GFCA (10:00 a.m.-7:00 p.m.) seven days a week. Sampling by PIFSC staff usually occurred from 10:00 a.m.- 2:00 p.m., 3-5 days per week, however, no set sampling schedule existed. Field and Lab sampling opportunities were entirely dependent on fishermen submitting their catch to the GFCA. Typically, the entire catch was measured (collection of Field data). On rare occasions, measuring the entire catch was not possible because a few fish were sold to customers before PIFSC bio-samplers arrived.When this happened, the remaining catch was measured.

Otoliths and gonads extracted at the GFCA by PIFSC biosamplers or GFCA staff were placed into 6”x 6” re-sealable, plastic bags. The fisherman’s name, fishing location, fork length to the nearest 0.1 cm, weight (g or lbs.), and date was written on the front of the bag with a permanent marker. Whole fish needing to be sampled and specimens extracted at the GFCA were brought back to a makeshift workspace at the DAWR for further processing. In February 2014, a permanent PIFSC lab independent of the DAWR was established in Guam to process these specimens.

Sagittal otoliths were cleaned in a cap of water using a fine-bristled paintbrush, placed into 30 mL scintillation vials, and labeled appropriately. A cotton ball was placed in the vial after otoliths were dried and vials were archived in boxes at the PIFSC Honolulu lab. Fin clips were collected from unidentified fish and stored in 95% ethanol.

Specimens were purchased as voucher specimens for mtDNA sequencing. As these specimens were obtained, they were labeled with a fish sample identification number and stored in freezers at the DAWR until transferred to the University of Guam (UoG). At the UoG, the fish’s length and weight were re-measured, assigned an official FISH-BOL voucher identification number, preserved whole in 95% ethanol, and archived by species. As of early 2014, the collection of voucher specimens for mtDNA sequencing was suspended due to lack of funds.

Field and Lab data was entered into the Database by bio-samplers as time permitted.

RESULTS

The CFBS Program teams were successful in selecting Lab fish that were representative samples of Field fish (Figs. 1−4). Total number of fish measured in the Field and subsampled as Lab fish is noted in Table 1. In each territory, most size classes of species selected for life history sampling (Lab fish) were available each month by size-stratified random sampling of the landed catches (Field fish) (Figs. 5−70). Median length of Field data varied by month for most fishes (Tables 2−4, Figs. 5−70). Histograms of fork length frequencies exhibit normal distribution for all fish except *Cheilinus undulatus*, *Naso unicornis, Sargocentron spiniferum, Lethrinus atkinsoni*, and *Myripristis murdjan* (Figs. 1-4). Otoliths and gonads were successfully extracted from most Lab fish in all three regions (Table 5). Large fish for all species except for *Myripristis murdjan* and *Lutjanus rufolineatus* in American Samoa were not readily available to collect as Lab fish because they were seldom brought in (Figs. 1-4).

Table 1.--Total number of fish measured in the markets (Field fish) and the number of fish purchased or sampled as Lab fish in each territory August 2009 through December 2014. The number of Field fish, which for CNMI and Guam is interchangeable with Total Number of Fish, is included in this table to show the total number of fish measured in American Samoa, they selected and removed Lab fish form the entire catch before collection of Field data occurred. In Guam, there are more Lab fish than Field fish for Etelis coruscans because GFCA staff collected otoliths and gonads from this species before the CFBS Program was created and information on the entire catch was not recorded.

Species	Territory	Number of Lab Fish	Number of Field Fish	Total Number of Fish Measured
Lethrinus xanthochilus	American Samoa	358	1923	2281
Lutjanus gibbus	American Samoa	427	2088	2515
Lutjanus rufolineatus	American Samoa	233	533	766
Myripristis amaena	American Samoa	320	1967	2287
Myripristis berndti	American Samoa	619	2834	3453
Myripristis murdjan	American Samoa	291	1599	1890
Naso unicornis	American Samoa	481	4183	4664
Sargocentron spiniferum	American Samoa	243	545	788
Sargocentron tiere	American Samoa	681	5959	6640
Scarus rubroviolaceus	American Samoa	365	3626	3991
Lethrinus atkinsoni	CNMI	876	4353	4353
Lethrinus obsoletus	CNMI	791	3713	3713
Mulloidichthys flavolineatus	CNMI	804	9655	9655
Naso unicornis	CNMI	2177	8512	8512
Parupeneus barberinus	CNMI	1224	7673	7673
Siganus argenteus	CNMI	888	12006	12006
Cheilinus undulatus	Guam	83	90	90
Etelis coruscans	Guam	298	280	298
Hipposcarus longiceps	Guam	228	2800	2800
Monotaxis grandoculis	Guam	196	2151	2151
Pristipomoides zonatus	Guam	101	293	293
Variola louti	Guam	157	883	883

Table 2.--Monthly sample size, median length, and minimum and maximum body size (Range (cm)) for the 10 species selected for life history research in American Samoa collected October 2010 through December 2014.

AMERICAN SAMOA	JAN			FEB			MARCH			APRIL			MAY			JUNE		
Species	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range (cm)
Lethrinus xanthochilus	266	37.2	20.7-42.5	393	37.2	20.7-53.7	447	37.0	21.6-45.5	141	35.7	27.0-44.5	223	37.6	25.5-43.7	62	36.8	30.0-43.3
Lutjanus gibbus	290	30.6	21.0-56.8	156	31.2	17.2-53.5	451	30.2	17.5-56.7	155	28.6	17.0-38.0	230	29.3	23.1-43.9	179	28.0	18.5-47.4
Lutjanus rufolineatus	112	21.6	14.9-41.9	105	22.0	16.5-26.5	110	21.8	15.9-43.3	9	21.6	20.0-26.1	27	23.5	19.5-27.3	10	22.2	21.8-23.4
Myripristis amaena	234	17.0	12.5-20.5	220	16.8	13.0-20.1	196	17.0	13.0-21.0	163	17.0	9.6-21.0	90	16.9	14.3-20.2	141	17.0	14.0-21.0
Myripristis berndti	260	18.3	14.0-32.5	404	18.4	11.1-30.6	389	18.0	13.0-23.8	283	17.6	12.5-27.2	186	17.2	13.4-23.2	159	17.0	13.9-23.9
Myripristis murdjan	155	16.9	13.2-26.8	249	16.5	12.5-26.5	218	16.7	14.0-27.5	112	16.9	9.3-26.5	52	16.5	13.3-26.9	79	16.2	13.1-23.4
Naso unicornis	309	32.0	18.1-52.5	551	31.0	17.2-52.2	554	30.4	18.5-52.3	483	32.7	17.2-52.3	473	30.4	18.3-52.2	332	33.0	18.4-54.7
Sargocentron spiniferum	58	28.5	15.0-34.2	63	24.3	15.2-34.0	49	26.0	15.1-34.5	43	23.0	13.0-37.5	80	20.0	14.9-36.0	45	21.1	14.2-30.2
Sargocentron tiere	631	17.6	13.4-25.5	566	17.6	13.5-23.4	767	17.7	13.4-31.6	462	18.0	10.3-23.4	439	17.8	12.9-23.4	396	18.4	6.1-25.2
Scarus rubroviolaceus	324	37.2	19.1-53.9	484	36.8	19.0-50.5	360	35.2	18.3-51.5	355	35.2	17.5-51.2	310	35.5	18.9-51.8	318	33.8	18.1-54.5

AMERICAN SAMOA	JULY			AUG			SEPT			OCT			NOV			DEC		
Species	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range (cm)
Lethrinus xanthochilus	62	37.2	31.0-45.9	85	37.1	23.9-41.6	96	37.3	27.4-54.2	166	37.2	22.5-54.0	170	37.0	19.5-44.7	172	36.7	19.0-50.4
Lutjanus gibbus	38	30.8	17.6-38.2	137	29.2	14.6-39.4	115	29.5	22.0-48.8	165	29.7	20.7-50.0	218	28.7	21.1-51.5	382	30.4	17.4-42.2
Lutjanus rufolineatus	20	20.2	17.8-25.5	65	22.0	17.1-27.0	36	21.8	18.3-24.0	135	22.0	17.9-26.0	105	21.5	17.6-27.5	32	21.9	17.3-26.5
Myripristis amaena	134	16.8	13.8-22.0	320	17.0	13.0-20.9	179	17.0	13.8-21.5	172	17.0	14.0-21.8	169	16.5	13.8-20.6	269	17.0	13.4-22.5
Myripristis berndti	134	17.2	14.0-22.7	309	17.1	13.5-27.9	262	17.6	12.5-23.2	307	17.3	13.4-26.4	345	18.2	14.0-23.9	415	17.3	12.5-23.2
Myripristis murdjan	73	16.5	14.0-19.5	195	16.1	13.2-26.5	122	16.5	13.7-26.7	220	16.2	14.2-26.0	165	16.7	13.4-26.4	251	16.4	13.1-24.5
Naso unicornis	290	28.7	17.0-50.8	388	29.4	18.4-51.0	222	31.7	18.5-53.5	344	29.6	12.4-50.5	377	30.5	17.5-52.5	340	27.3	16.4-55.0
Sargocentron spiniferum	25	21.8	17.7-31.7	90	21.6	13.1-36.0	105	26.2	12.7-34.4	49	24.3	14.9-32.7	76	28.1	14.7-38.6	104	21.6	10.2-32.6
Sargocentron tiere	365	18.0	14.0-24.6	778	18.0	12.7-26.0	385	18.0	14.0-22.5	762	17.5	12.9-26.6	414	17.7	12.5-29.9	674	17.5	13.0-22.5
Scarus rubroviolaceus	168	32.2	17.9-49.5	345	33.0	18.8-52.0	305	34.1	18.0-51.7	384	34.2	17.2-54.0	424	36.5	19.2-51.6	208	36.0	19.0-53.5

Table 3.--Monthly sample size, median length, and minimum and maximum body size (Range (cm)) for the 6 species selected for life history research in CNMI collected December 2010 through December 2014.

CNMI	JAN			FEB			MARCH			APRIL			MAY			JUNE		
Species	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range
Lethrinus atkinsoni	320	18.2	12.4 - 32.8	290	18.1	14.5 - 32.8	568	17.7	13.2 - 34.0	485	19.4	13.7 - 35.1	475	20.5	12.4 -35.1	389	20.2	15.6 - 33.7
Lethrinus obsoletus	370	19.2	15.1 - 27.2	347	19.6	145 - 28.0	731	20.1	15.3 - 27.1	332	21.2	13.5 - 27.7	260	21.2	14.9 - 27.1	265	21.4	15.8 - 27.5
Mulloidichthys flavolineatus	1237	14.7	8.4 - 30.6	761	16.3	9.2 - 29.7	1577	15.8	10.3 - 30.5	835	16.2	11.3 - 33.2	793	17.6	12.8 - 28.5	589	17.7	12.4 - 30.5
Naso unicornis	715	24.4	13.7 - 53.6	392	24.2	16.3 - 49.2	1068	23.6	15.2 - 48.5	830	25.7	10.8 - 49.0	1036	27.4	12.9 - 51.5	628	27.0	19.3 - 50.3
Parupeneus barberinus	711	20.0	9.3 - 34.9	492	20.0	10.9 - 33.5	1164	19.4	11.3 - 33.7	730	20.0	13.1 - 33.9	569	19.9	11.7 - 35.6	672	20.0	13.2 - 34.5
Sarganus argenteus	982	18.8	11.6 - 32.7	828	18.6	11.6 - 32.8	1721	18.3	10.0 - 34.1	1009	19.2	11.8 - 33.4	1005	21.0	13.0 - 33.4	1136	20.8	13.1 - 33.2

CNMI	JULY			AUG			SEPT			OCT			NOV			DEC		
Species	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range
Lethrinus atkinsoni	326	21.0	15.0 - 34.0	268	20.1	14.9 - 33.0	375	19.8	13.2 -31.8	229	19.0	14.0 - 30.3	220	18.4	14.0 - 28.7	408	19.0	13.8 - 30.2
Lethrinus obsoletus	198	21.1	16.5 - 27.4	122	21.8	15.9 - 29.0	274	21.1	12.2 - 28.6	192	19.6	15.1 - 26.8	260	20.7	16.2 - 31.2	362	21.0	15.9 - 27.6
Mulloidichthys flavolineatus	289	18.6	10.2 - 27.7	309	19	10.5 - 28.2	661	18.4	9.1 - 29.7	711	18.2	8.3 - 31.4	805	16.2	8.5 - 30.1	1088	15.5	8.5 - 28.2
Naso unicornis	883	28.5	18.3 - 51.0	671	26.9	18.5 - 53.2	445	25.7	18.7 - 51.3	560	24.7	18.1 - 45.8	533	23.8	13.2 - 49.9	751	24.6	13.3 - 47.5
Parupeneus barberinus	322	20.2	14.1 - 34.4	433	20.7	14.2 - 36.0	567	21.4	8.2 - 37.1	730	20.4	13.5 - 35.5	533	20.5	13.5 - 33.3	750	21.4	11.0 - 37.3
Siganus argenteus	772	22.7	13.0 - 33.1	758	20.5	13.0 - 31.0	631	21.0	12.6 - 30.8	1052	16.9	11.4 - 28.9	1150	17.0	11.7 - 32.7	966	20.3	12.2 - 33.3

Table 4.--Monthly sample size, median length, and minimum and maximum body size (Range (cm)) for the 6 species selected for life history research in Guam collected August 2009 through December 2014.

GUAM	JAN			FEB			MARCH			APRIL			MAY			JUNE		
Species	Sample Size (n)	Median Length (cm)	Range (cm)	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range
Cheilinus undulatus	4	54.2	41.1 - 73.8	2	85.6	63.7 - 107.6	7	66.5	31.5 - 119.4	5	55.5	31.6 - 126.5	11	81.8	34.2 - 130.4	12	108.2	45.4 - 134.3
Etelis coruscans	0			4	69.8	62.4 - 84.6	5	64.8	52.5 - 71.4	19	70.5	53.2 - 85.0	36	65.0	36.3 - 79.7	44	73.6	50.1 - 89.5
Hipposcarus longiceps	140	36.7	22.2 - 51.0	122	36	22.7 - 49.0	126	35.7	23.4 - 49.1	144	38.0	21.8 - 51.0	280	37.8	24.8 - 49.5	374	37.6	23.3 - 49.4
Monotaxis grandoculis	150	28.8	20.0 - 44.5	109	30.1	20.0 - 48.0	104	28.0	19.2 - 47.0	149	29.6	19.7 - 48.9	197	27.5	15.0 - 42.4	215	28.5	19.8 - 43.3
Pristipomoides zonatus	0			0			0			29	26.3	21.5 - 38.0	37	29.8	22.5 - 35.1	65	27.9	19.0 - 37.2
Variola louti	44	34.7	27.4 - 49.0	33	32.3	25.6 - 42.0	30	35.0	27.5 - 44.6	86	34.1	24.5 - 48.6	106	33.7	22.5 - 45.0	103	34.7	22.0 - 48.0

GUAM	JULY			AUG			SEPT			OCT			NOV			DEC		
Species	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range	Sample Size (n)	Median Length (cm)	Range
Cheilinus undulatus	8	93.5	77.7 - 122.5	16	76.5	44.4 - 133.7	10	99.7	40.1 - 130.2	7	76.3	40.0 - 105.2	2	44.0	34.0 - 54.0	6	46.2	35.0 - 82.5
Etelis coruscans	19	76.4	61.0 - 96	46	72.9	29.5 - 95.0	74	73.2	34.0 - 95.0	17	72.0	53.2 - 91.5	0			3	77.8	74.5 - 78.1
Hipposcarus longiceps	294	39.5	25.5 - 50.4	460	39.2	24.2 - 51.0	264	38.5	28.5 - 50.9	181	38.0	24.5 - 50.0	110	34.5	23.5 - 49.8	305	37.5	23.5 - 50.3
Monotaxis grandoculis	196	27.4	20.2 - 46.7	309	27.5	19.0 - 42.1	244	27.5	18.6 - 40.7	192	28.3	19.0 - 39.3	120	29.9	19.4 - 44.0	166	28.5	20.0 - 43.1
Pristipomoides zonatus	40	26.3	20.9 - 36.4	43	28.4	18.5 - 36.0	38	26.7	20.8 - 44.5	17	28.5	18.4 - 34.5	11	28.5	18.0 - 35.7	13	24.7	19.5 - 36.5
Variola louti	117	33.7	20.3 - 47.5	94	36.8	24.2 - 48.2	102	33.4	19.8 - 48.5	59	34.5	21.9 - 53.6	37	35.2	24.1 - 46.4	72	35.0	23.1 - 45.5

Table 5: Number of specimens (gonads and otoliths) collected from Lab fish in each territory. Number of otoliths refers to the total number of whole otoliths extracted, archived, and available for ageing for each species in each territory. Number of gonads refers to the number of gonads extracted, preserved, and available for reproductive studies for each species in each territory. Sample dates are from August 2009 through December 2014.

Species Targeted for Life History Research (Lab)	Number of Specimens Collected from Lab Fish in CNMI		Number of Specimens Collected from Lab Fish in Guam		Number of Specimens Collected from Lab Fish in Amer. Samoa	
	Gonads	Otoliths	Gonads	Otoliths	Gonads	Otoliths
Cheilinus undulatus	18	18	70	66	0	0
Etelis coruscans	0	0	295	294	0	0
Hipposcarus longiceps	0	0	226	224	0	0
Lethrinus atkinsoni	876	860	7	7	0	0
Lethrinus obsoletus	679	673	42	44	0	0
Lethrinus xanthochilus	0	0	2	2	360	359
Lutjanus gibbus	0	0	2	4	428	426
Lutjanus rufolineatus	0	0	0	0	233	232
Monotaxis grandoculis	0	0	164	187	0	0
Mulloidichthys flavolineatus	804	786	0	0	0	0
Myripristis amaena	0	0	0	0	319	320
Myripristis berndti	0	0	6	6	610	617
Myripristis murdjan	0	0	0	0	288	292
Naso unicornis	2177	2132	15	30	477	474
Parupeneus barberinus	1224	1192	0	0	0	0
Pristipomoides zonatus	0	0	90	99	0	0
Sargocentron spiniferum	0	0	0	2	240	241
Sargocentron tiere	0	0	2	4	634	679
Scarus rubroviolaceus	0	0	0	0	359	349
Siganus argenteus	888	848	0	0	0	0
Variola louti	0	0	156	154	0	0

American Samoa

From 71 fishing areas around Tutuila, American Samoa, 29,275 fish were measured and 4,018 of those fish were purchased or sampled as Lab fish (Table 1) from October 2010 through December 2014*Sargocentron tiere (*22.4%*)*, *N. unicornis* (14.3%), and *Scarus rubroviolaceus* (12.4%) were the species most frequently seen at the Market (Table 1, Figs. 1−2 & 5−34). All ten species were available year round, but *Lutjanus rufolineatus* and *Sargocentron spiniferum* were either not often caught or were not brought into the Market as frequently as the other 8 species (Fig. 1-2, 5−34).

CNMI

From 36 different fishing areas around Saipan, Rota, and Tinian, 45,912 fish were measured and 6,760 of those fish were purchased or sampled as Lab fish (Table 1) from December 2010 through December 2014. All 6 species chosen for life history sampling (Lab fish) were frequently encountered and measured at various vendors and markets year round (Figs. 3, 35−52). *Siganus argenteus* (26.2%), *Mulloidichthys flavolineatus* (21.0%), and *Naso unicornis* (18.5%) were the species most frequently brought into the markets and mobile fish vendors (Table 1, Figs. 3, 35−52).

Guam

From 49 different fishing locales around Guam, 6,497 fish were measured and 1,063 of those fish were purchased or sampled as Lab fish (Table 1) from 49 different fishing locales around Guam from August 2009 through December 2014. *Hipposcarus longiceps* (36.6%) and *Monotaxis grandoculis* (28.4%) were the species most often brought to the GFCA by fishermen and *Cheilinus undulatus* (2.1%) and *Pristipomoides zonatus* (4.8%) were brought in the least frequently (Table 1, Figs. 4, 53−70).

DISCUSSION

The objectives of the CFBS Program were: to collect biological data from coral reef and bottomfish MUS deemed important within each community based on knowledge of resident fishermen and local agencies, to develop methods to adequately sample regions without a centralized fish market, to manage data using a BioSampling Database, and to determine which fish would be good candidates for supplemental life history studies (accessible year round, available in a wide range of sizes, and available for extraction of otoliths, gonads, and tissues). All these objectives were met.

Prior to the creation of the CFBS Program, short-term collection of biological data from fish markets and vendors in the Pacific territories had been undertaken, but not on a sustained level. Creel surveys targeted fishers, which typically didn't involve collection of species-specific biological data or extraction of biological samples for life history studies, and fishery-based catch and fish size information for the very important spearfish fishery was rarely collected. Other studies conducted by PIFSC (Resources Assessment Investigation of the Mariana Archipelago 1980-1985 (Polovina, et al., 1985) and the Reef Assessment and Monitoring Program of the Coral Reef Ecosystem Division 2002-2015 (Williams, et al., 2012)) focused on bottomfish fishing operations and visual surveys, often concentrating efforts in the more remote areas within the Pacific territories.

Routine collection of biological data year round through on-going bio-sampling programs is important to identify size distributions, catch composition, and their variation and trends. Through the CFBS Program, biological samples are routinely collected from fishes deemed important within local communities to enhance life history research.Fish size and fishery-based catch information for the spearfish fishery is now better documented, and sampling is conducted on locally caught fish.

Future endeavors made possible by the efforts of the CFBS regional bio-sampling programs include: age distributions and growth information derived from otoliths, fishery selectivity and mortality estimation from fish size- and age-frequency distributions, exploration of geographic variation in life history, identification and resolution of sampling gaps, development of more rapid life history proxies utilizing gonadal somatic indices (GSI) to infer median size at maturity, and using histology to verify sex and more accurately identify maturation stage.

To provide the data needed to determine annual catch limits and assess stock status, it is critical to sample stocks throughout their distribution. In addition to improving estimates of catch and fishing mortality for each region, with the CFBS Program in place, it is now possible to evaluate whether or not the life history traits of a species vary with location. Each species may exhibit unique age and growth characteristics (i.e. natural mortality, longevity, size at maturity, etc.) relative to its zoogeography (Brown, 1995).

For example, sex-specific estimates of median lengths at sexual maturity have been completed for the Hawaiian Archipelago populations of *Naso unicornis* (DeMartini, et. al., 2014). *N. unicornis* is a valuable food fish throughout the Pacific. A life history study using the bio-sampling data collected from the Northern Mariana Islands and American Samoa stocks will allow for comparison of vital rates of *N. unicornis* from three distinct regions. Understanding this could help identify external influences (fishing intensity, environment) on the reproductive characteristics and growth rate of this species. Similar studies could be conducted for species found in all three western Pacific Territories and Hawaii.

Analysis of length frequency histograms (Figs. 1−70) shows fishes brought to market to be sold and chosen for life history sampling were not available in a complete range of sizes, and fish reaching maximum lengths known for each species were rarely encountered. These truncated size ranges can be an indication of size-selective fishing practices. Estimates of life history and other characteristics across the entire size range of a species are less reliable when such fish are not available for sampling. The smallest and largest sized fish are critical in determining early growth rate and longevity, respectively. The PIFSC Life History Program has had some success obtaining hardto catch specimens (very small and very large fish) in Hawaii through private contracts with commercial fishermen and through scientific sampling conducted by PIFSC staff. Utilizing external contracts to implement similar strategies to collect valuable fish not normally available in the fishery will be beneficial to the western Pacific Territories.

In the summer of 2014, a NOAA research vessel bio-sampling project took place in the Northern Mariana Islands and Guam, which provided an opportunity to target large and small-sized fish and species rarely available at the markets. Bottomfishers and spear fishers conducted sampling operations around eight of the Northern Mariana Islands and the island of Guam, collecting target species in a wide range of sizes from generally inaccessible regions. Future sampling projects involving NOAA research vessels in CNMI, Guam, and American Samoa will also contribute to the collection of hard-to-obtain specimens.

Gonad weights and gonad-somatic indices (gonad wt./somatic wt. × 100) derived from Lab fish were plotted against length and body weight in an attempt to develop life history proxies for length at 50% reproductive maturity (L_{M50}). GSI plots (not shown here) were created using collected gonad weight (g), body length (FL (cm)), body weight (g), and sex data. An expected bias for over-classifying immature fish was confirmed and further analysis is necessary to identify the cause of this bias (DeMartini, personal communication, 2015). Various measures of maximum length (L_{max}) are also being evaluated to determine its feasibility as a predictor of L_{M50}.

Histological examination of gonadal tissues is the most reliable method for determining the reproductive phase and L_{M50} of a species, but is also the most time consuming. To evaluate the reliability of the proxies developed using GSIs, life history staff identified the sex and maturation stage using mounted, stained, and thin-sectioned histological preparations of gonadal tissue onto glass slides prepared by the University of Hawaii (UH). Fish were categorized as immature or mature using the histological features and reproductive phases outlined in Brown-Peterson et al., 2011. This analysis will provide insight on how to alleviate the bias towards over-classifying resting mature fish as immature and determine L_{M50}, an important biological parameter for management designed to sustain spawning biomass.

Although the establishment of the CFBS Program regional bio-sampling projects was hugely successful, it was not without its complications. Ongoing obstacles include addressing the overall lack of resources in each Territory, building local capacity to process and analyze collected specimens, standardizing data collection and specimen archival procedures, and conducting frequent data quality control checks.

Capacity building in the territories is a high priority. The LHP is a small group of biologists responsible for conducting life history studies on numerous marine species throughout the Pacific. The LHP alone cannot comprehensively examine all species of interest; external help will be required. Participants from Guam and CNMI are currently being trained in histological staging techniques and the preparation of sectioned otoliths for age determination through enumeration of daily and annual growth marks. Acquiring the appropriate equipment and outfitting the labs in these Territories is currently underway.

Deciphering the methods used for data entry in one of the territories was challenging. Protocols set forth by the PIFSC to collect and manage data associated with Lab and Field fish were altered, which compromised the integrity of the data. LHP staff also identified issues with archival procedures during analysis and processing of extracted specimens (otoliths and gonads). Additional training on accurate labeling procedures and storage of specimens will need to be conducted and data quality control checks will need to be performed more frequently to alleviate data entry errors and mislabeling of physical specimens.

The CFBS Program participants will continue to collect valuable biological information from fish deemed important within their communities. Their efforts will help create species-specific management tools and provide insight on how to focus future bio-sampling endeavors. The target species list will continue to evolve as life histories are documented and as resources allow.

LITERATURE CITED

Brown, J.H. 1995. Brown, J.H.
1995. *Macroecology*. University of Chicago Press. ISBN 0-226-07614-8.

Brown-Peterson, N.J., et. al.
2011. A Standardized Terminology for Describing Reproductive Development in Fishes, Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science, 3:1, 52-70.

Council.
December 2008. Fishery Ecosystem Plan for the American Samoa Archipelago. Western Pacific Regional Fishery Management Council, Honolulu, HI. http://www.wpcouncil.org/fishery-plans-policies-reports/american_samoa_fep/

Council.
December 2008. Fishery Ecosystem Plan for the Mariana Archipelago. Western Pacific Regional Fishery Management Council, Honolulu, HI. http://www.wpcouncil.org/fishery-plans-policies-reports/marianas-fishery-ecosystem-plan/

DeMartini, E.E., Ross, C.L., & Eble, J.A.
2014. Spawning seasonality and body sizes at sexual maturity in the Bluespine Unicornfish, Naso unicornis (Acanthuridae). Ichthyological Research, Volume 61, Issue 3, pp. 243-251.

Federal Register, Vol. 74, No.11.
January 16, 2009. Magnuson-Stevens Act Provisions; Annual Catch Limits; National Standard Guidelines.

International Barcode of Life, FISH-BOL, www.fishbol.org.

Ochavillo, D. et al.
2012. Commercial fisheries bio-sampling programme in American Samoa. SPC Fisheries Newsletter #139, September/December.

Polovina JJ, Moffitt RB, Ralston S, Shiota PM.
1985. Results of the resource assessment investigation of the Mariana Archipelago, 1985. Southwest Fisheries Science Center Administrative Report H-85-07, 22 p.

Williams, I., J. Zamzow, K. Lino, M. Ferguson, and E. Donham.
2012. Status of coral reef fish assemblages and benthic condition around Guam: a report based on underwater visual surveys in Guam and the Mariana Archipelago, April-June 2011. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-33, 22 p. + Appendices.

FIGURES

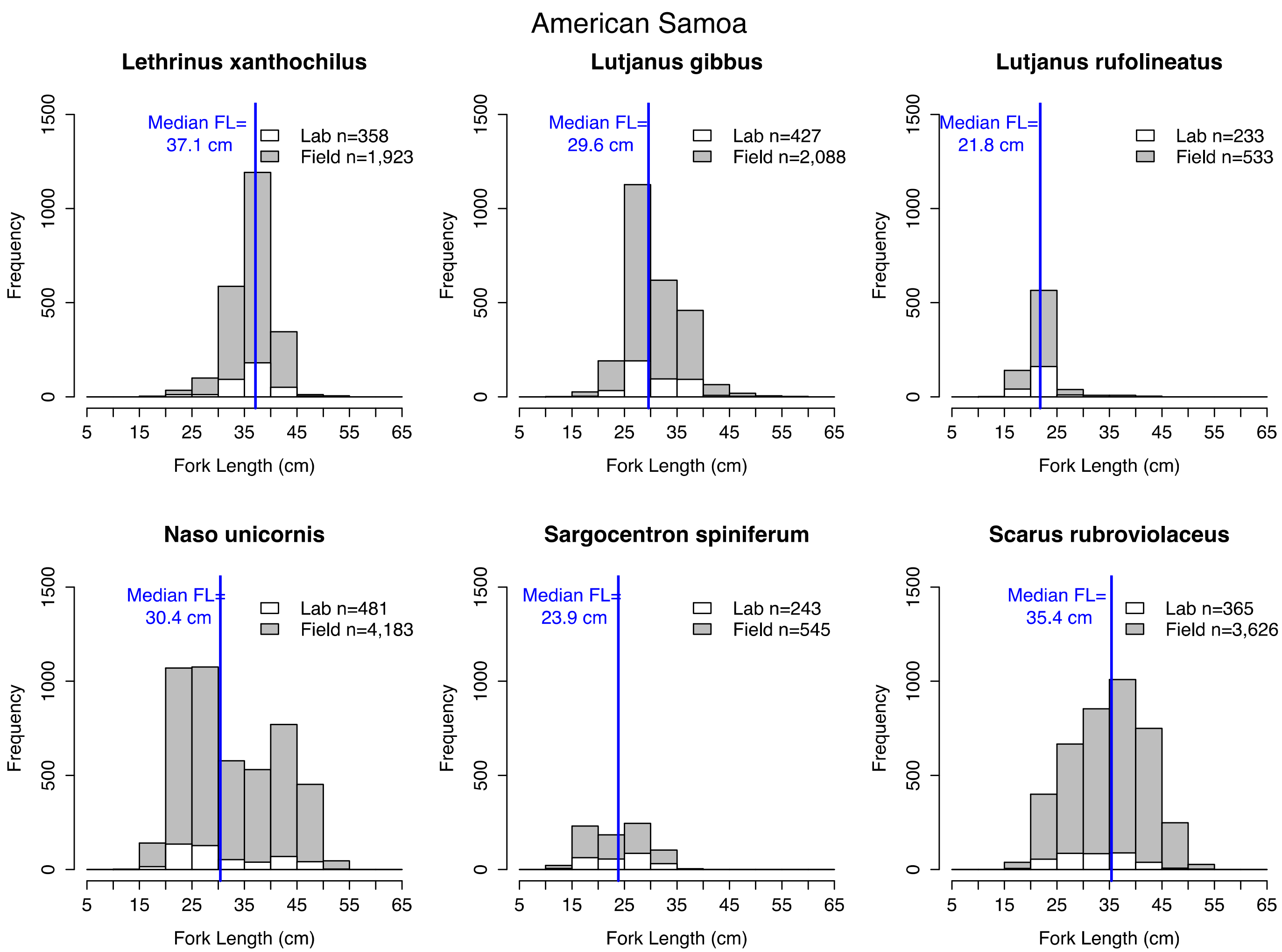

Figure 1.--Cumulative fork length frequency histograms of species targeted by the American Samoan Commercial Fisheries Biosampling Program for life history research from December 2010 through December 2014. Fish with fisheries data and length and weight measurements (Field fish) are shown in gray, and fish with extracted specimens (otoliths and/or gonads) in addition to fisheries data are shown in white (Lab fish); median fork length for each species is displayed.

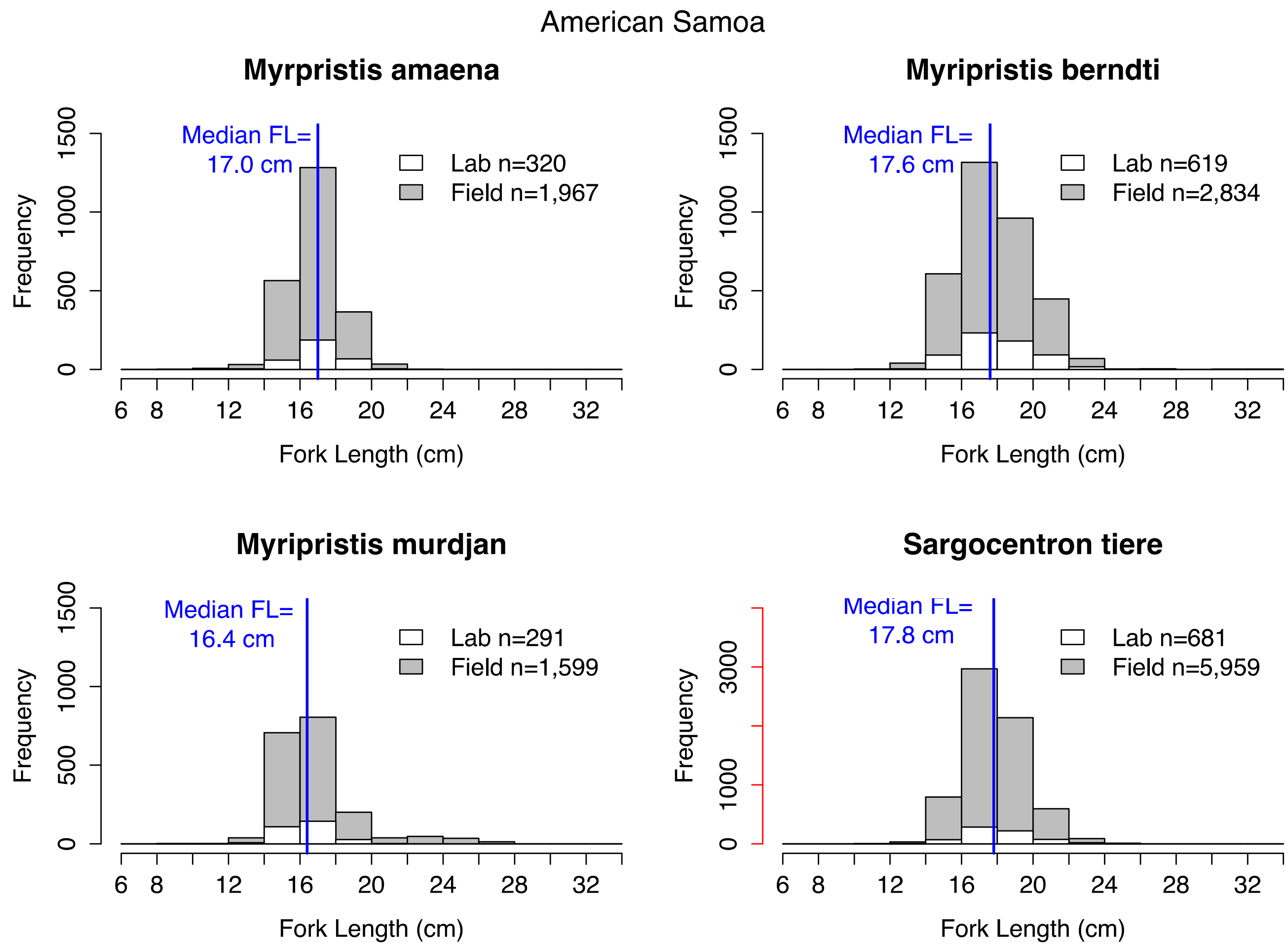

Figure 2.--Cumulative fork length frequency histograms of species targeted by the American Samoan Commercial Fisheries Biosampling Program for life history research from December 2010 through December 2014. Fish with fisheries data and length and weight measurements (Field fish) are shown in gray, and fish with extracted specimens (otoliths and/or gonads) in addition to fisheries data are shown in white (Lab fish); median fork length for each species is displayed.

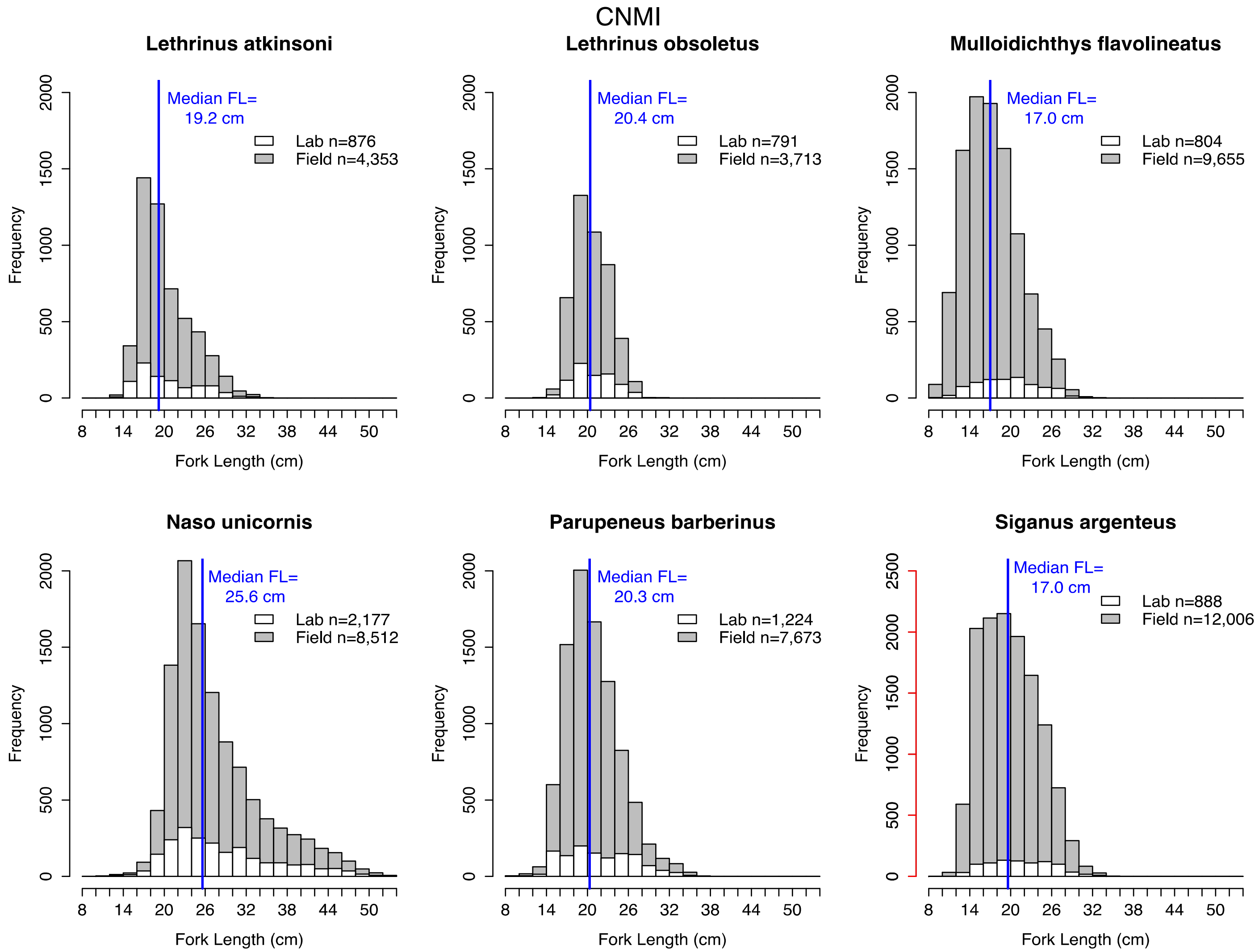

Figure 3.--Cumulative fork length frequency histograms of species targeted by the CNMI Commercial Fisheries Biosampling Program for life history research from December 2010 through December 2014. Fish with fisheries data and length and weight measurements (Field fish) are shown in gray, and fish with extracted specimens (otoliths and/or gonads) in addition to fisheries data are shown in white (Lab fish); median fork length for each species is displayed.

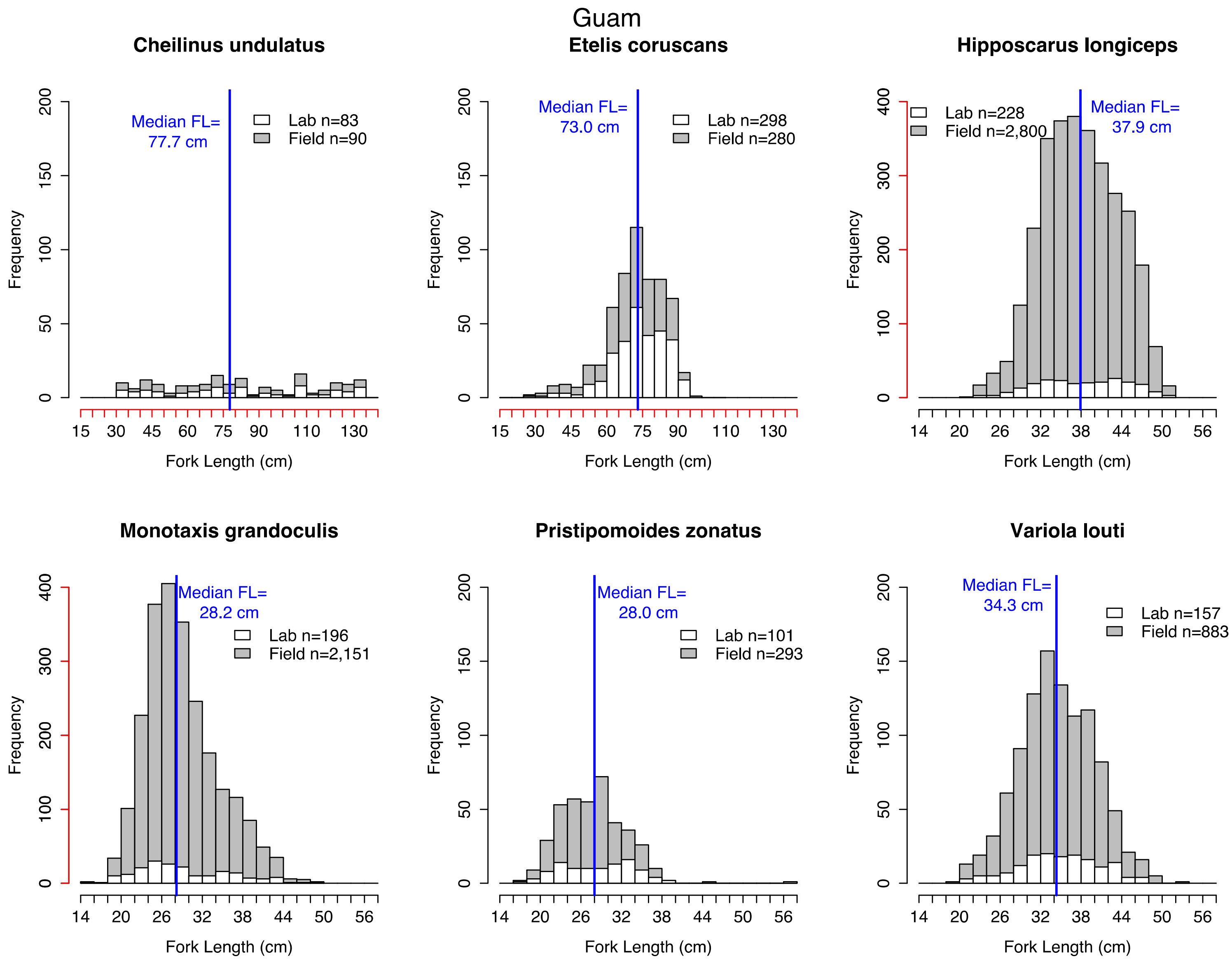

Figure 4.--Cumulative fork length frequency histograms of species targeted by the Guam Commercial Fisheries Biosampling Program for life history research from December 2010 through December 2014. Fish with fisheries data and length and weight measurements (Field fish) are shown in gray, and fish with extracted specimens (otoliths and/or gonads) in addition to fisheries data are shown in white (Lab fish); median fork length for each species is displayed.

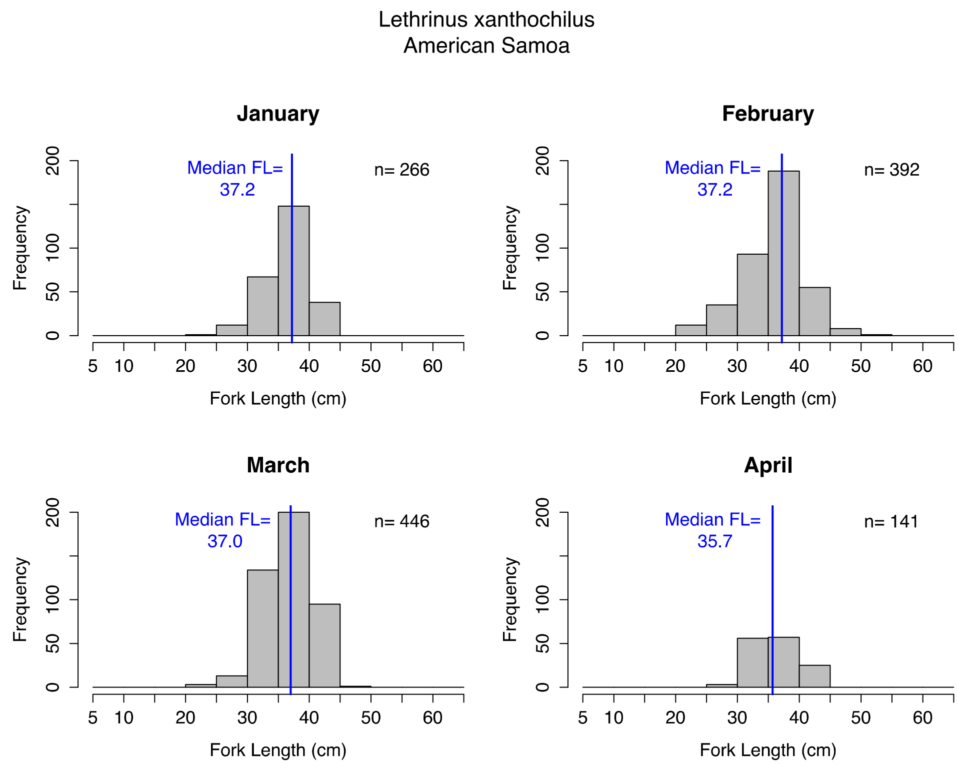

Figure 5.--Monthly fork length frequency histograms of *Lethrinus xanthochilus* measured in American Samoa January–April, all years. Median length and total number of fish measured each month is displayed.

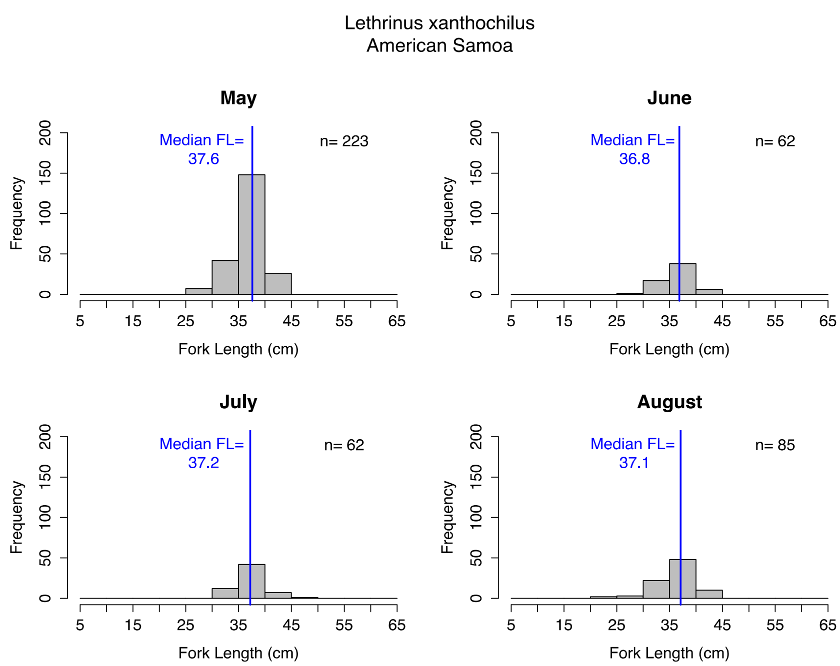

Figure 6.--Monthly fork length frequency histograms of *Lethrinus xanthochilus* measured in American Samoa May–August, all years. Median length and total number of fish measured each month is displayed.

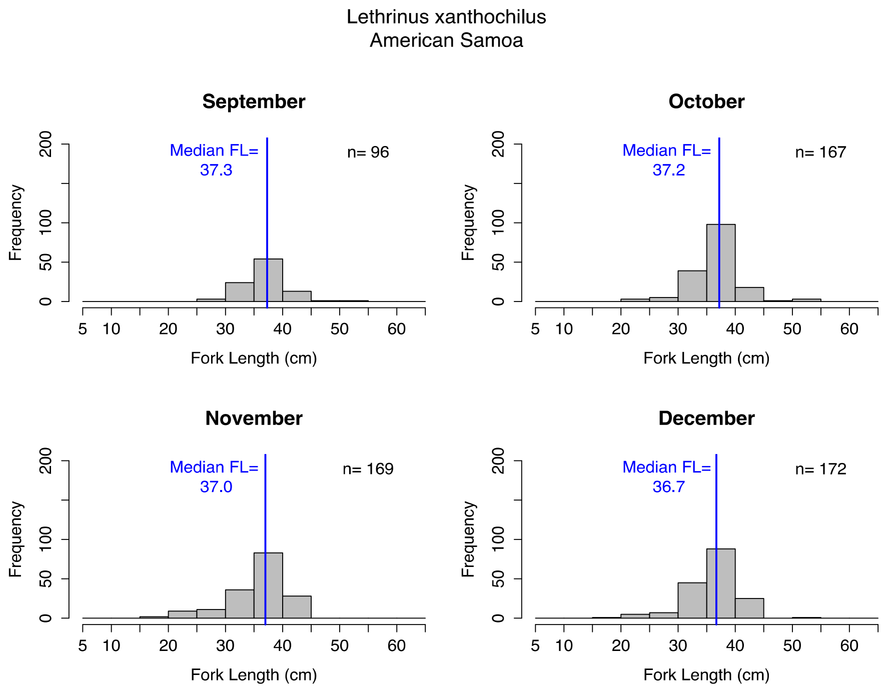

Figure 7.--Monthly fork length frequency histograms of *Lethrinus xanthochilus* measured in American Samoa September–December, all years. Median length and total number of fish measured each month is displayed.

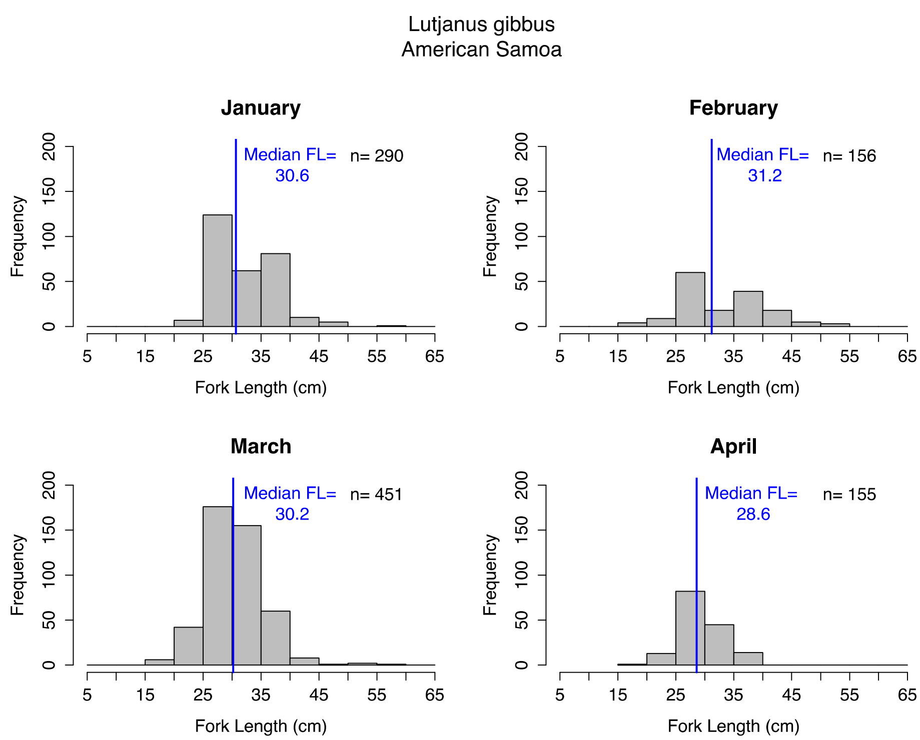

Figure 8.--Monthly fork length frequency histograms of *Lutjanus gibbus* measured in American Samoa January–April, all years. Median length and total number of fish measured each month is displayed.

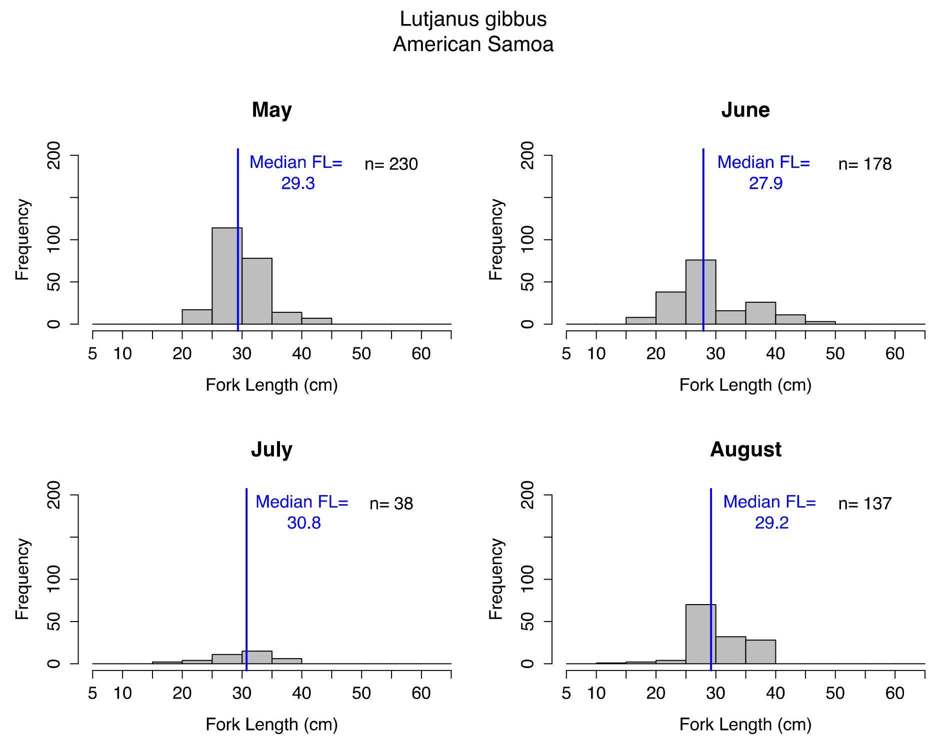

Figure 9.--Monthly fork length frequency histograms of *Lutjanus gibbus* measured in American Samoa May–August, all years. Median length and total number of fish measured each month is displayed.

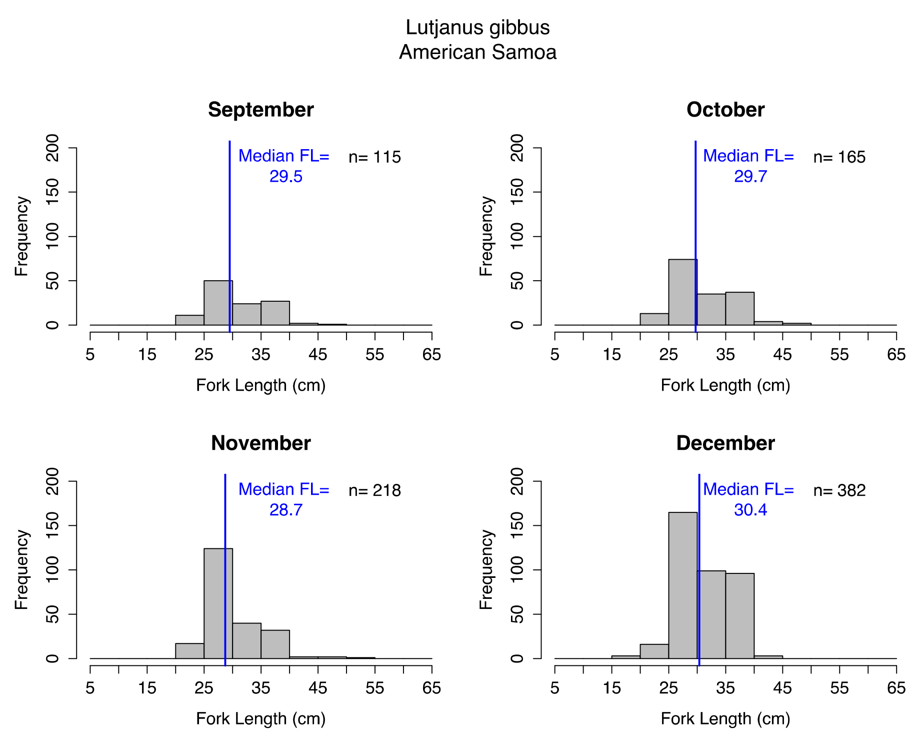

Figure 10.--Monthly fork length frequency histograms of *Lutjanus gibbus* measured in American Samoa September–December, all years. Median length and total number of fish measured each month is displayed.

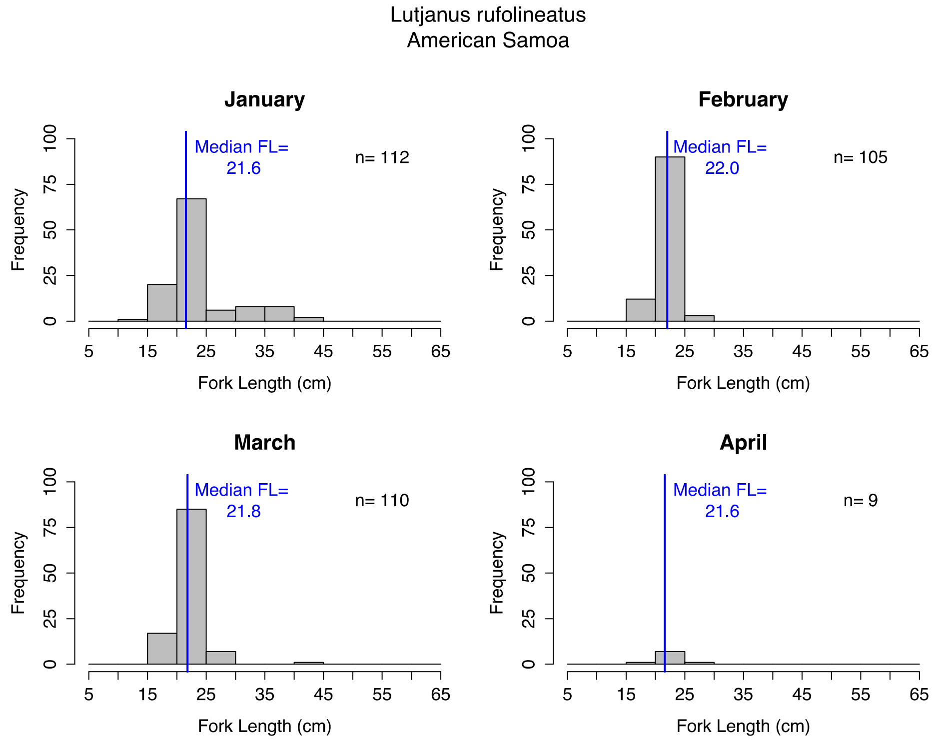

Figure 11.--Monthly fork length frequency histograms of *Lutjanus rufolineatus* measured in American Samoa January–April, all years. Median length and total number of fish measured each month is displayed.

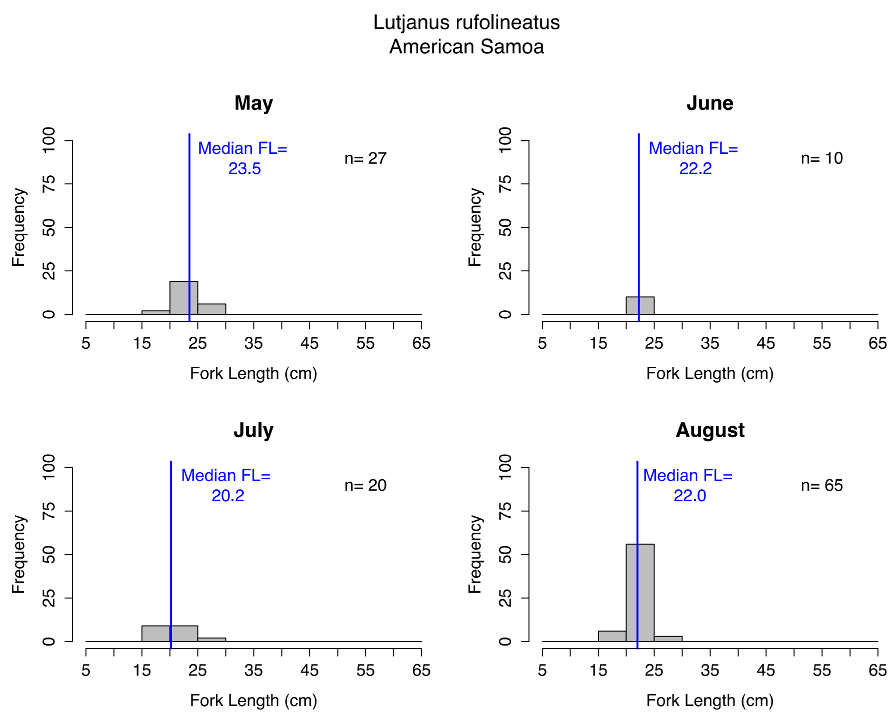

Figure 12.--Monthly fork length frequency histograms of *Lutjanus rufolineatus* measured in American Samoa May–August, all years. Median length and total number of fish measured each month is displayed.

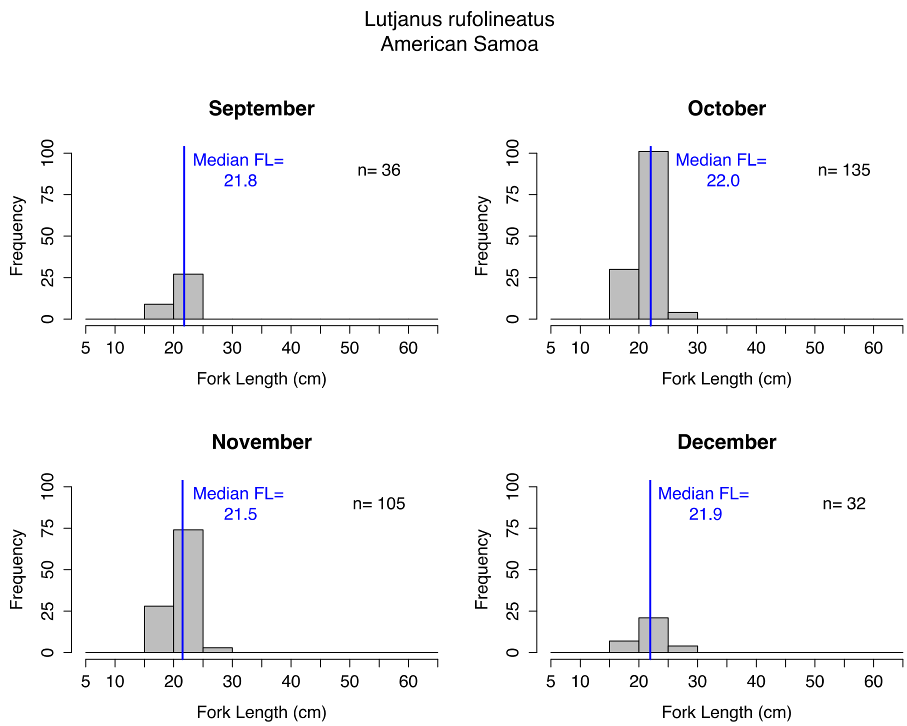

Figure 13.--Monthly fork length frequency histograms of *Lutjanus rufolineatus* measured in American Samoa September-December, all years. Median length and total number of fish measured each month is displayed.

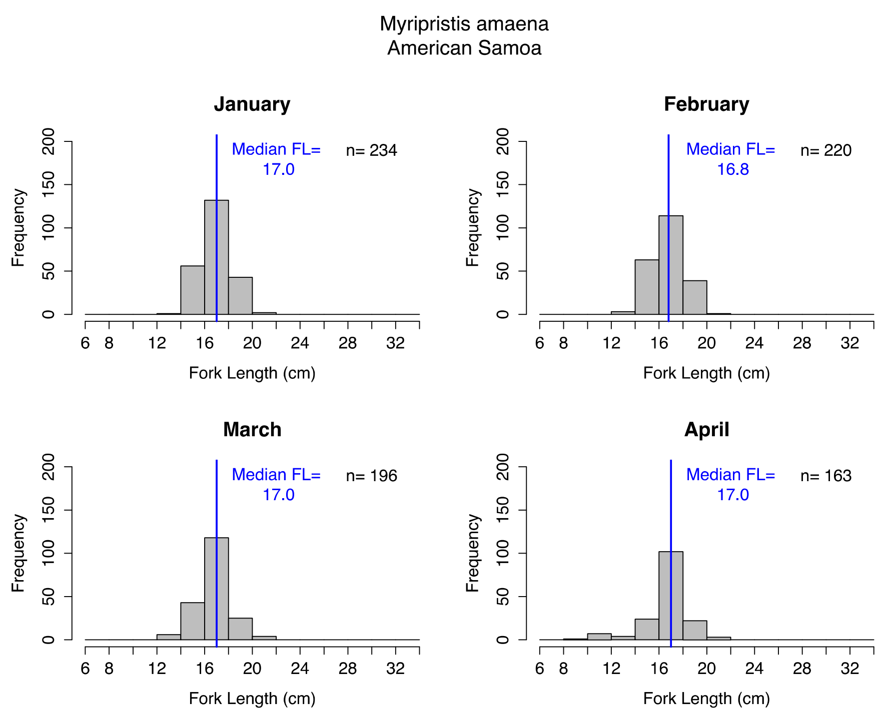

Figure 14.--Monthly fork length frequency histograms of *Myripristis amaena* measured in American Samoa January–April, all years. Median length and total number of fish measured each month is displayed.

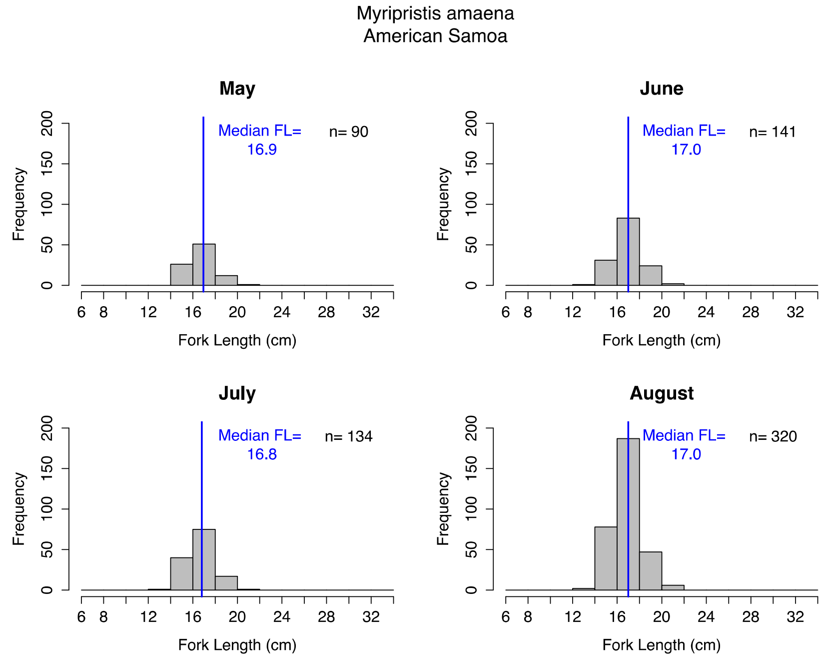

Figure 15.--Monthly fork length frequency histograms of *Myripristis amaena* measured in American Samoa May–August, all years. Median length and total number of fish measured each month is displayed.

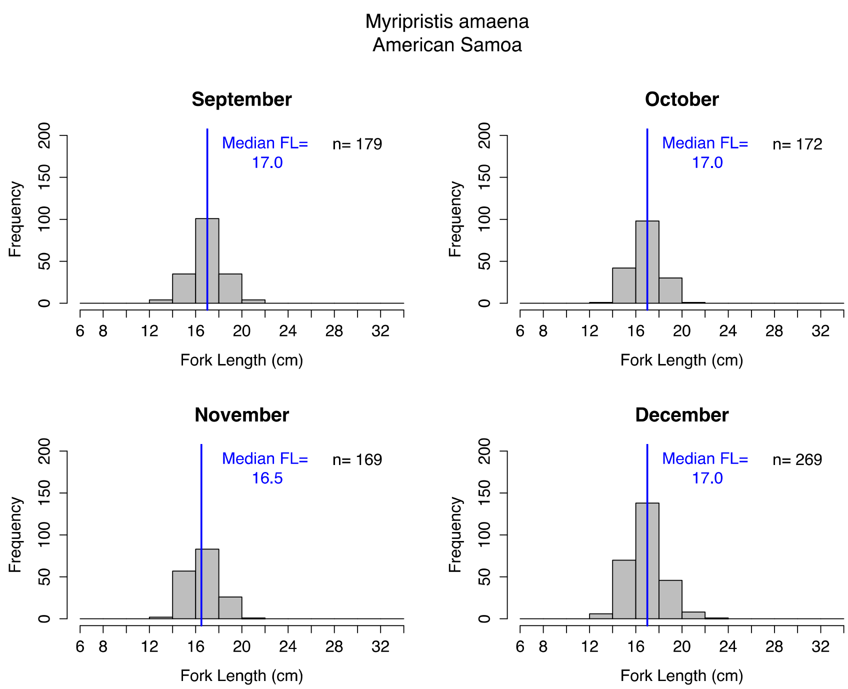

Figure 16.--Monthly fork length frequency histograms of *Myripristis amaena* measured in American Samoa September–December, all years. Median length and total number of fish measured each month is displayed.

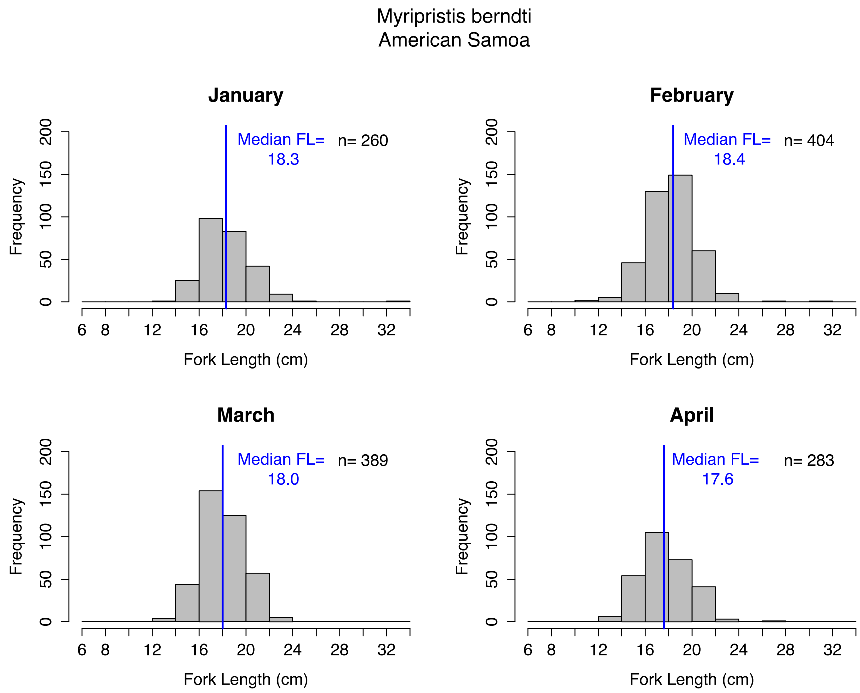

Figure 17.--Monthly fork length frequency histograms of *Myripristis berndti* measured in American Samoa January–April, all years. Median length and total number of fish measured each month is displayed.

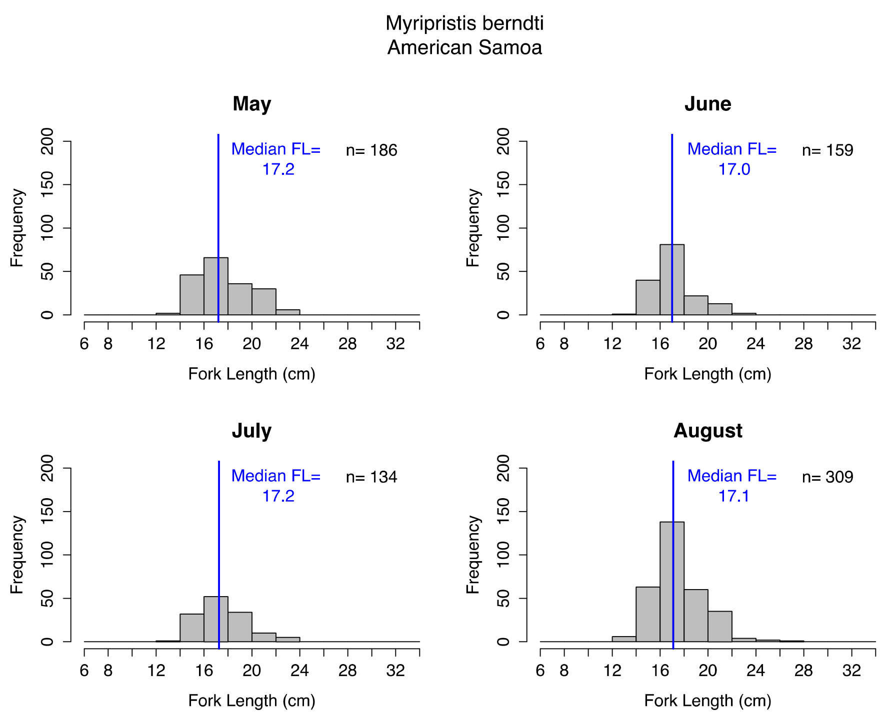

Figure 18.--Monthly fork length frequency histograms of *Myripristis berndti* measured in American Samoa May–August, all years. Median length and total number of fish measured each month is displayed.

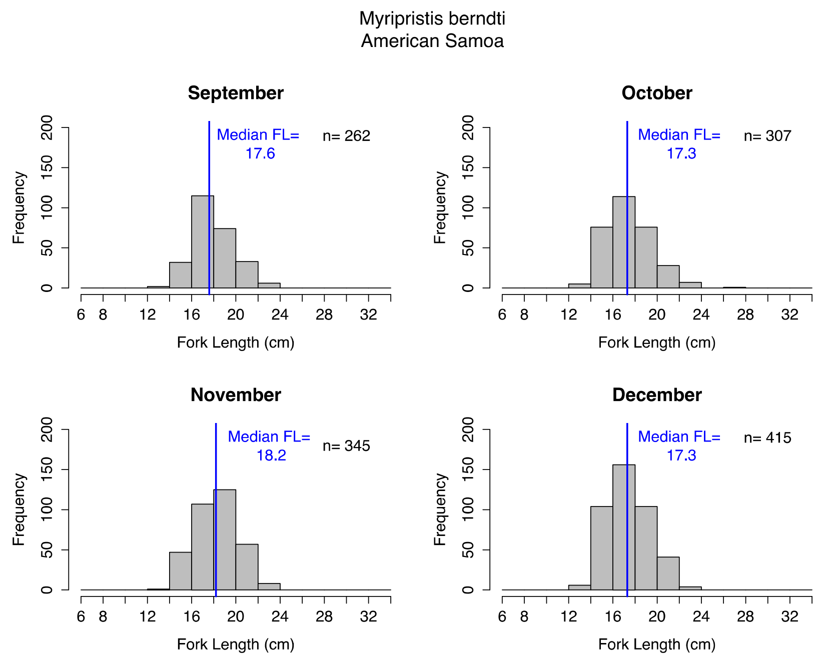

Figure 19.--Monthly fork length frequency histograms of *Myripristis berndti* measured in American Samoa September–December, all years. Median length and total number of fish measured each month is displayed.

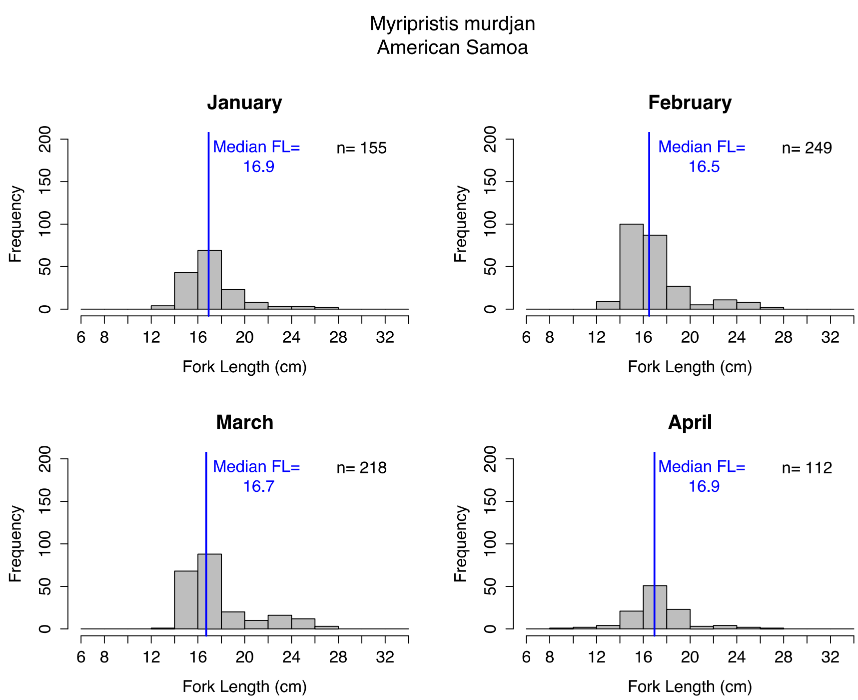

Figure 20.--Monthly fork length frequency histograms of *Myripristis murdjan* measured in American Samoa January–April, all years. Median length and total number of fish measured each month is displayed.

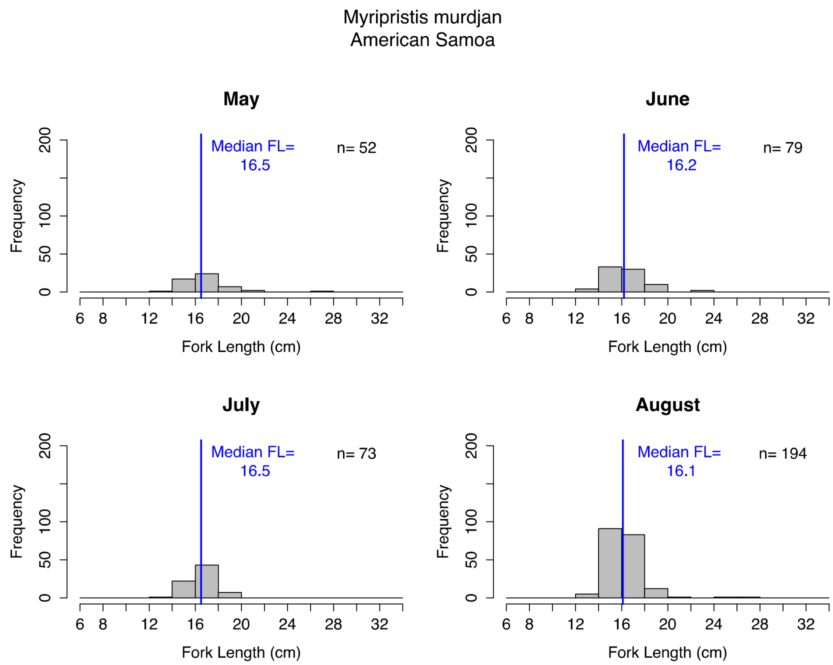

Figure 21.--Monthly fork length frequency histograms of *Myripristis murdjan* measured in American Samoa May–August, all years. Median length and total number of fish measured each month is displayed.

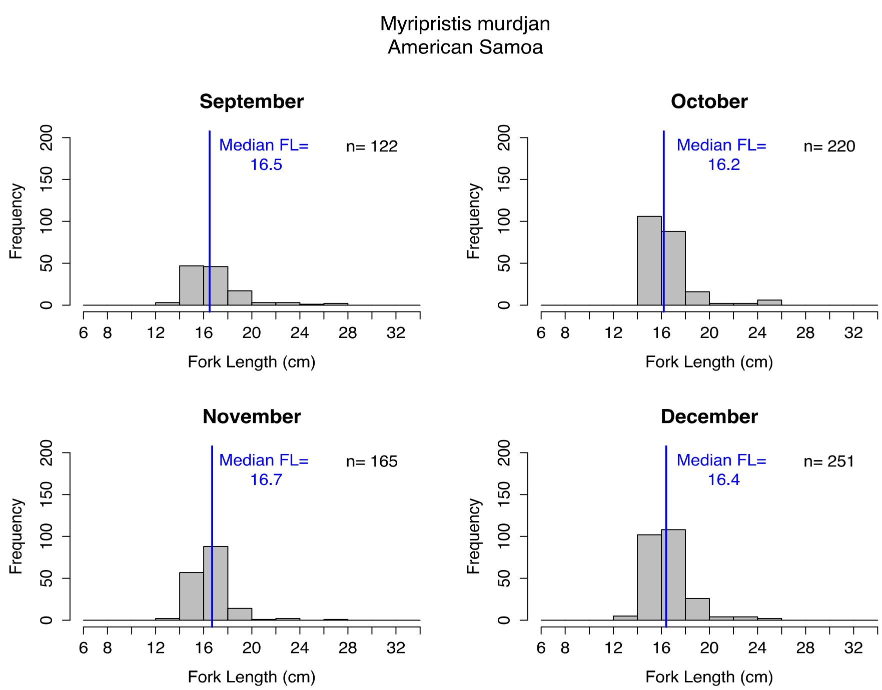

Figure 22.--Monthly fork length frequency histograms of *Myripristis murdjan* measured in American Samoa September–December, all years. Median length and total number of fish measured each month is displayed.

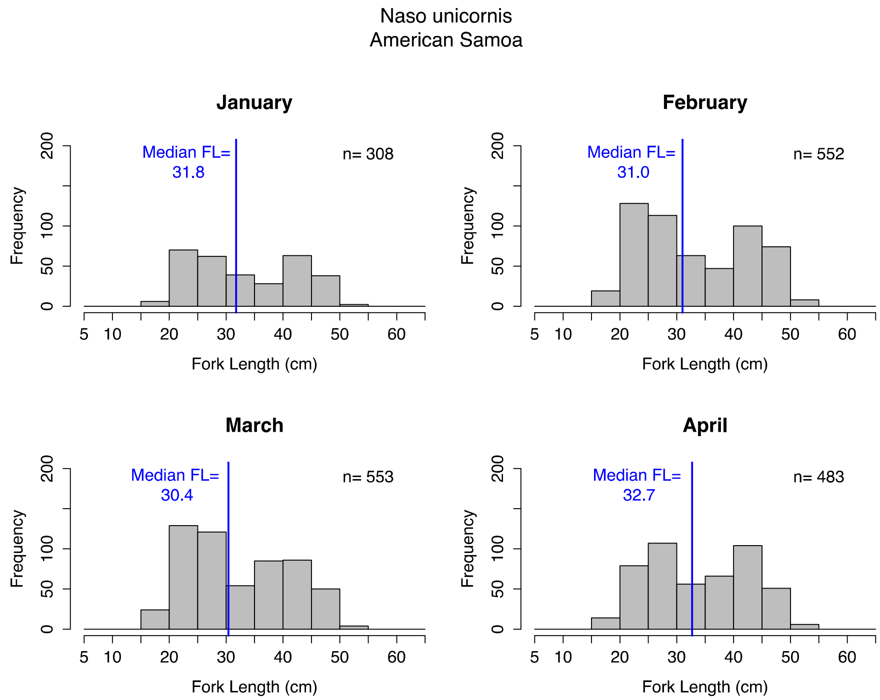

Figure 23.--Monthly fork length frequency histograms *Naso unicornis* measured in American Samoa January–April, all years. Median length and total number of fish measured each month is displayed.

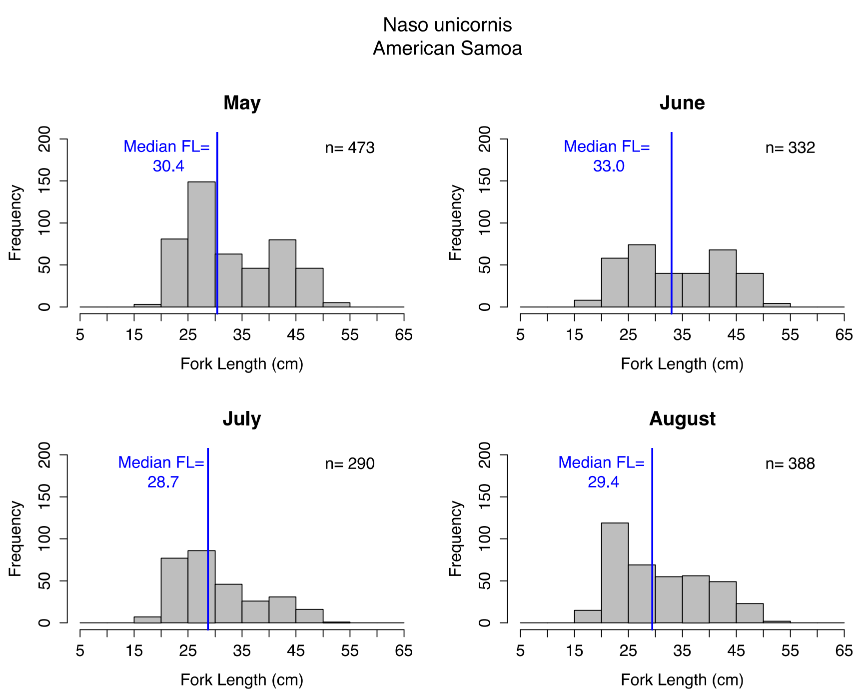

Figure 24.--Monthly fork length frequency histograms of *Naso unicornis* measured in American Samoa May–August, all years. Median length and total number of fish measured each month is displayed.

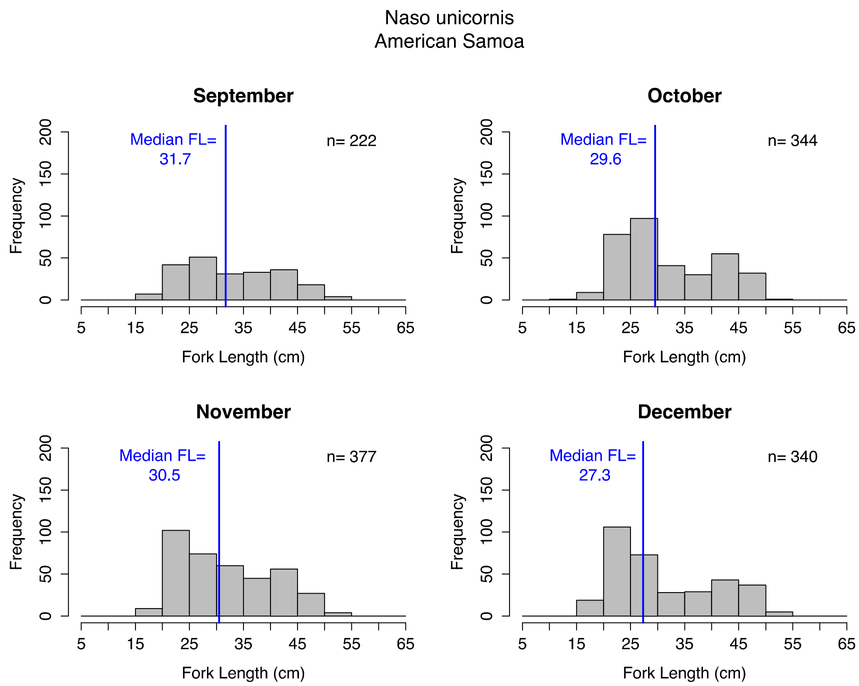

Figure 25.--Monthly fork length frequency histograms of *Naso unicornis* measured in American Samoa September–December, all years. Median length and total number of fish measured each month is displayed.

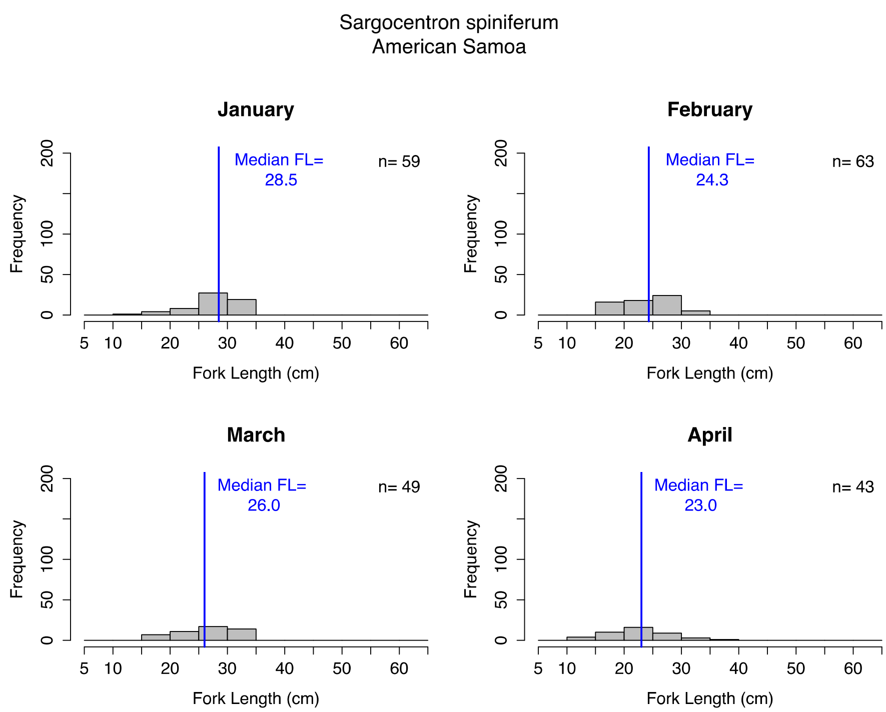

Figure 26.--Monthly fork length frequency histograms of *Sargocentron spiniferum* measured in American Samoa January–April, all years. Median length and total number of fish measured each month is displayed.

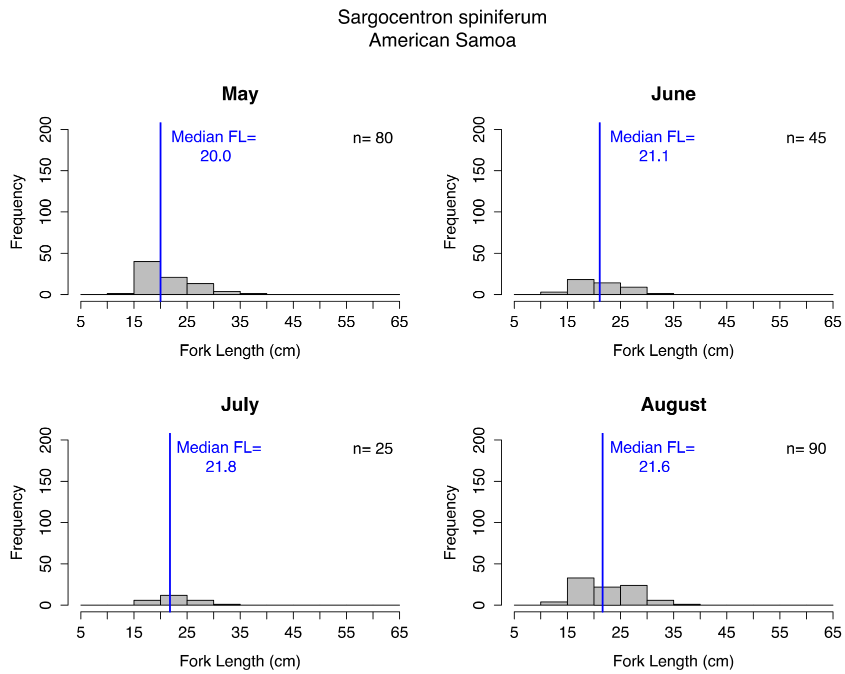

Figure 27.--Monthly fork length frequency histograms of *Sargocentron spiniferum* measured in American Samoa May–August, all years. Median length and total number of fish measured each month is displayed.

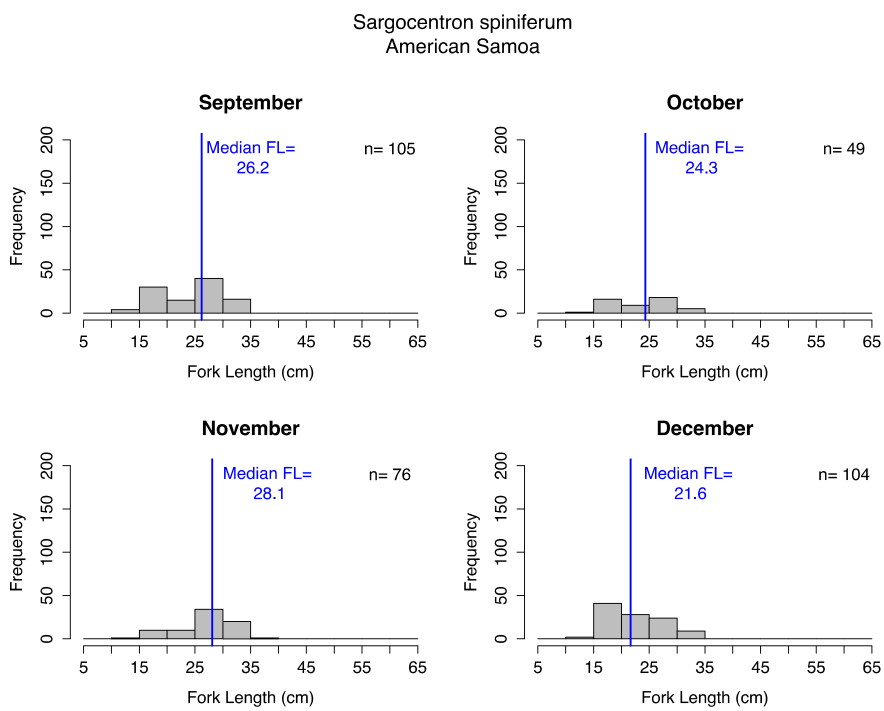

Figure 28.--Monthly fork length frequency histograms of *Sargocentron spiniferum* measured in American Samoa September–December, all years. Median length and total number of fish measured each month is displayed.

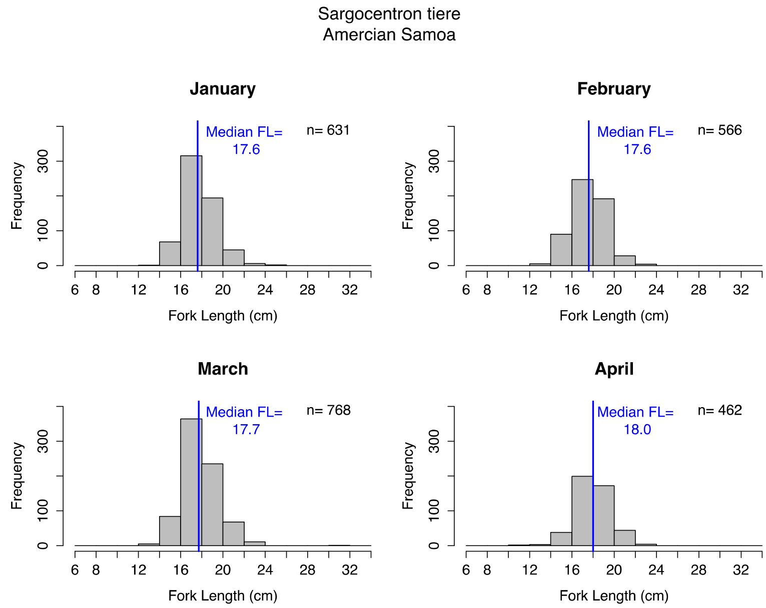

Figure 29.--Monthly fork length frequency histograms of *Sargocentron tiere* measured in American Samoa January–April, all years. Median length and total number of fish measured each month is displayed.

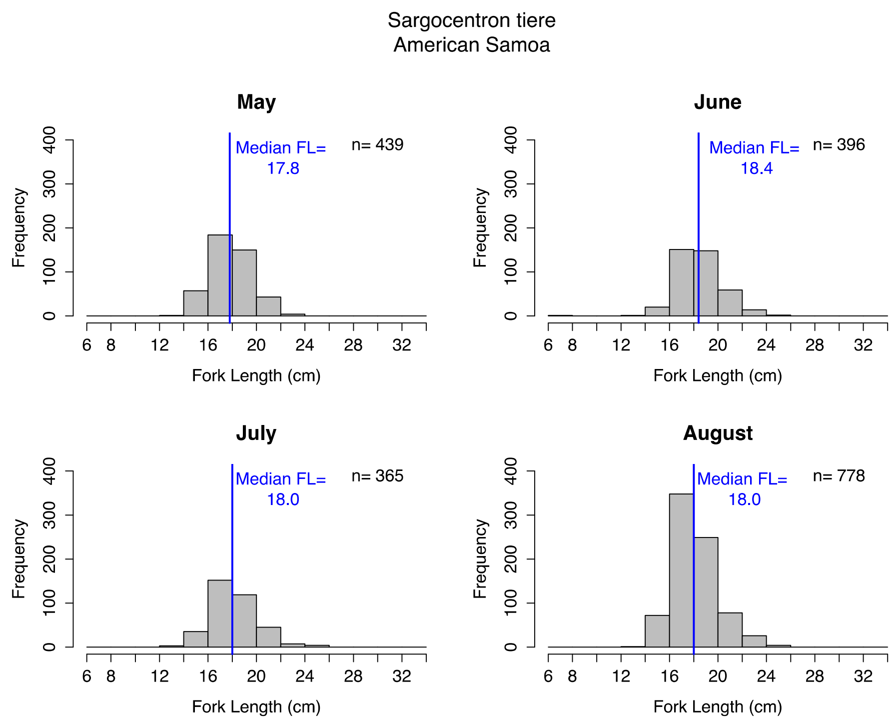

Figure 30.--Monthly fork length frequency histograms of *Sargocentron tiere* measured in American Samoa May–August, all years. Median length and total number of fish measured each month is displayed.

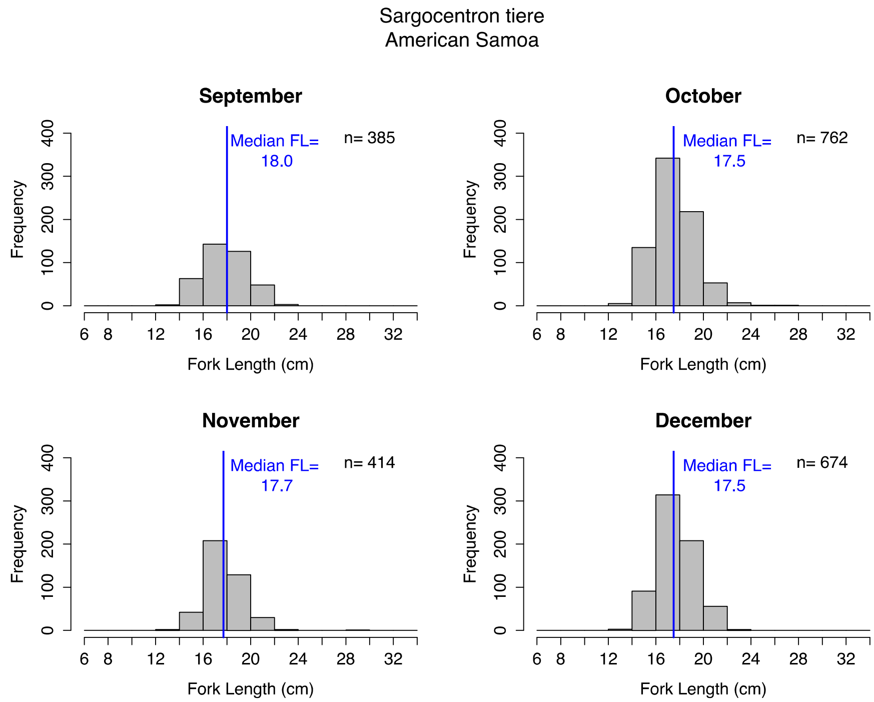

Figure 31.--Monthly fork length frequency histograms of *Sargocentron tiere* measured in American Samoa September–December, all years. Median length and total number of fish measured each month is displayed.

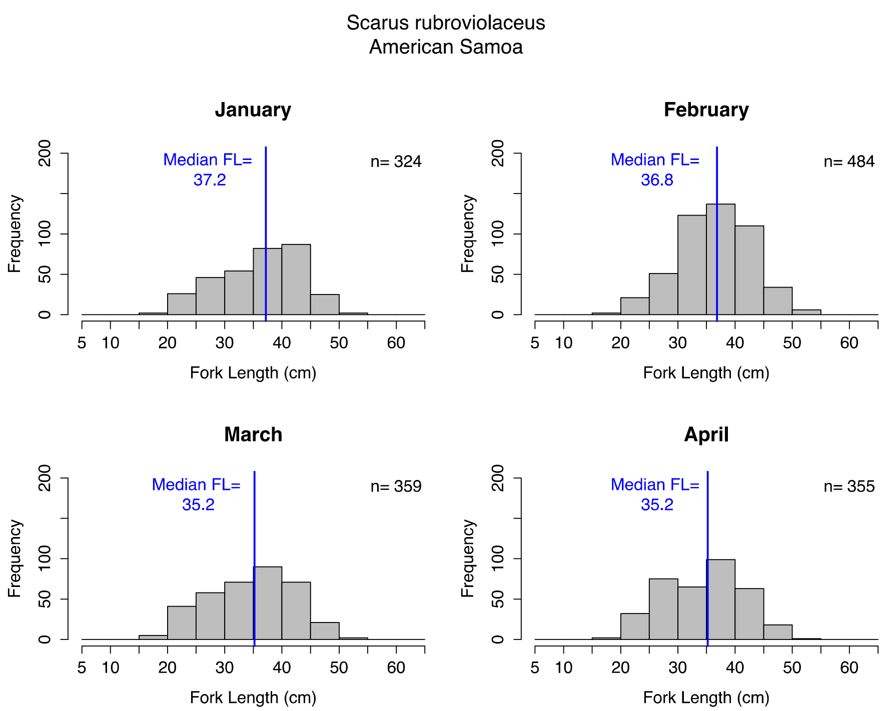

Figure 32.--Monthly fork length frequency histograms of *Scarus rubroviolaceus* measured in American Samoa January–April, all years. Median length and total number of fish measured each month is displayed.

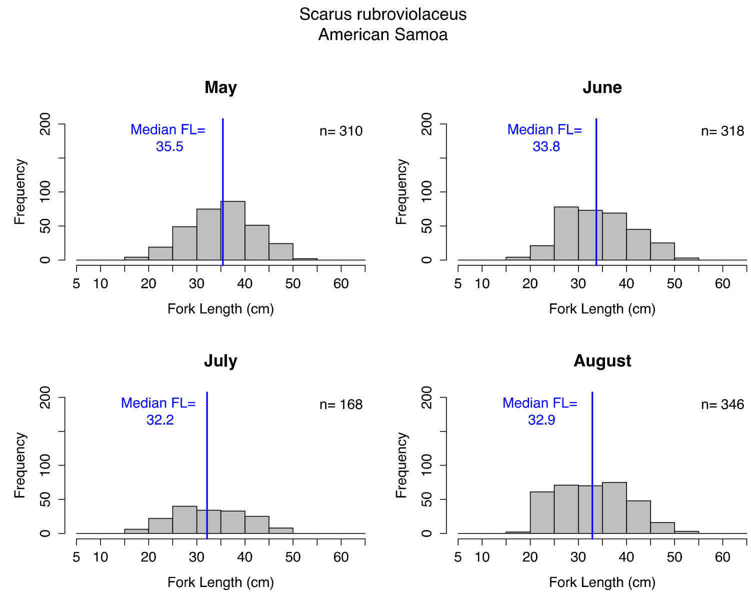

Figure 33.--Monthly fork length frequency histograms of *Scarus rubroviolaceus* measured in American Samoa May–August, all years. Median length and total number of fish measured each month is displayed.

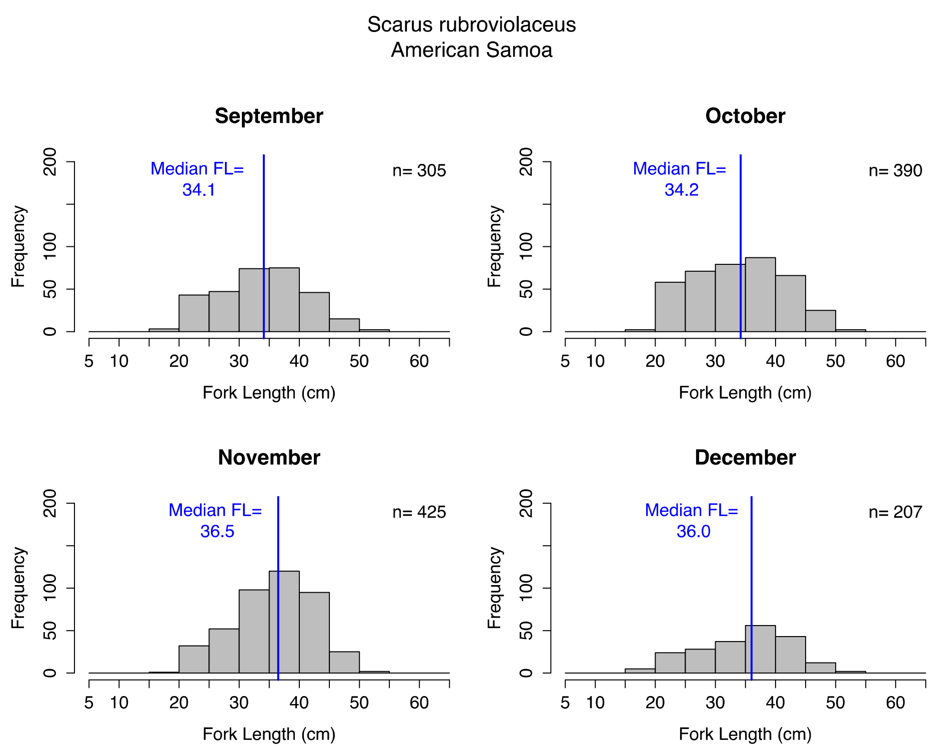

Figure 34.--Monthly fork length frequency histograms of *Scarus rubroviolaceus* measured in American Samoa September–December, all years.

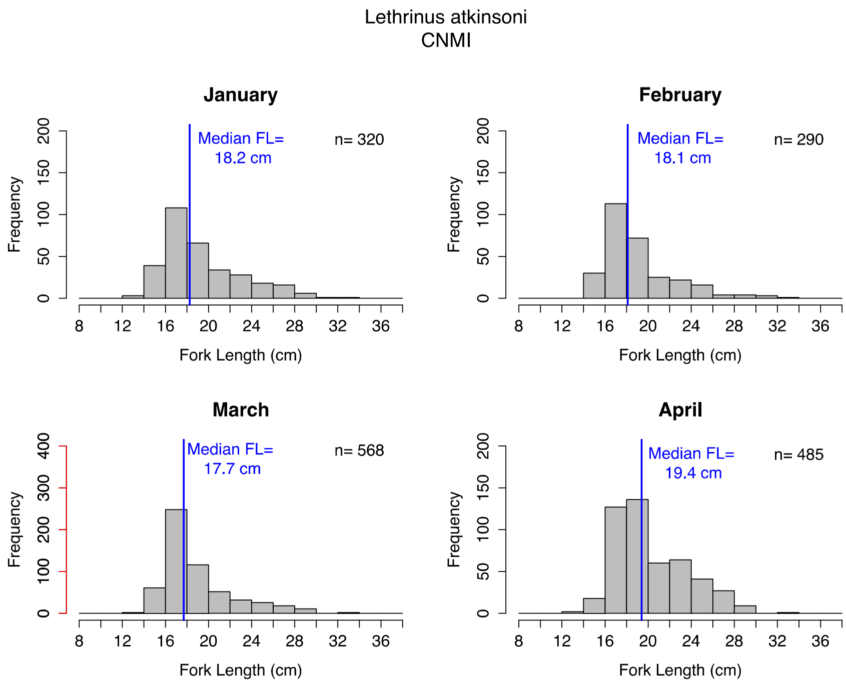

Figure 35.--Monthly fork length frequency histograms of *Lethrinus atkinsoni* measured in CNMI January–April, all years. Median length and total number of fish measured each month is displayed.

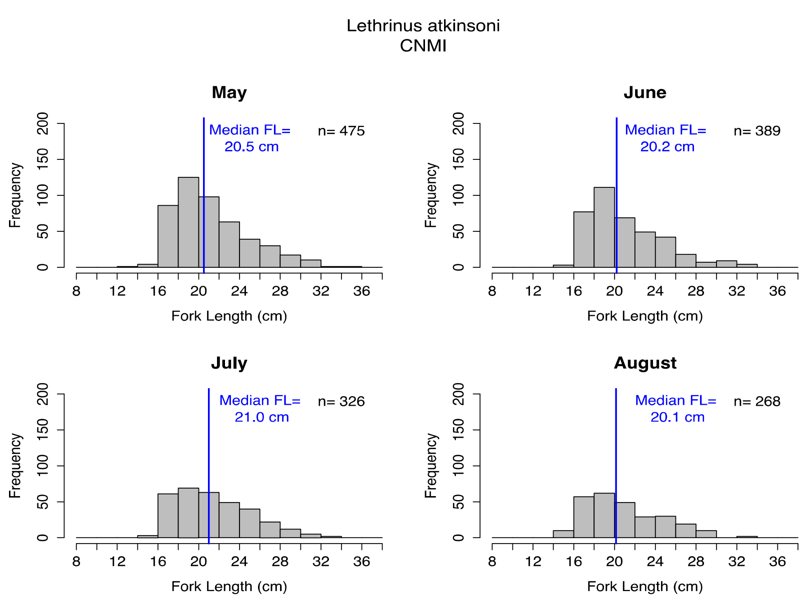

Figure 36.--Monthly fork length frequency histograms of *Lethrinus atkinsoni* measured in CNMI May–August, all years. Median length and total number of fish measured each month is displayed.

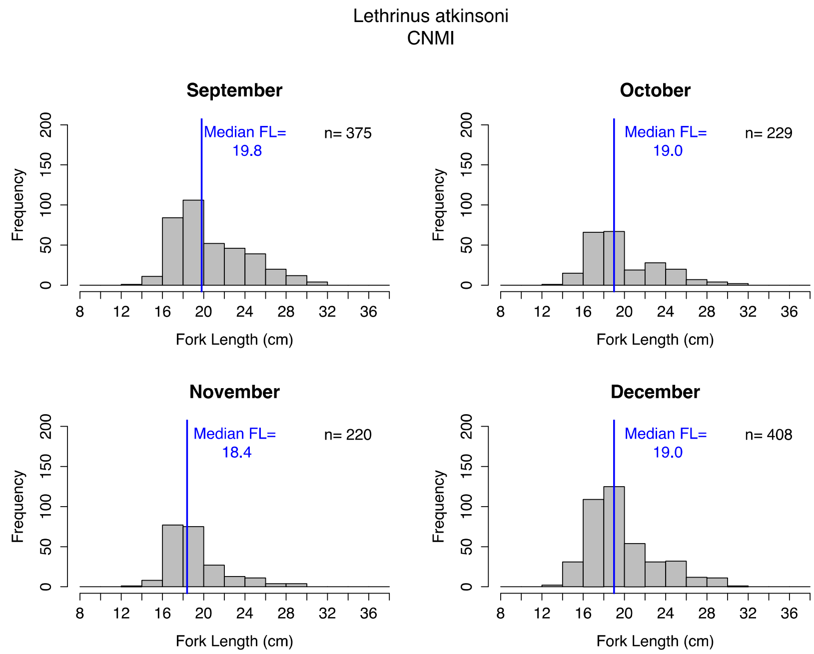

Figure 37.--Monthly fork length frequency histograms of *Lethrinus atkinsoni* measured in CNMI September–December, all years. Median length and total number of fish measured each month is displayed.

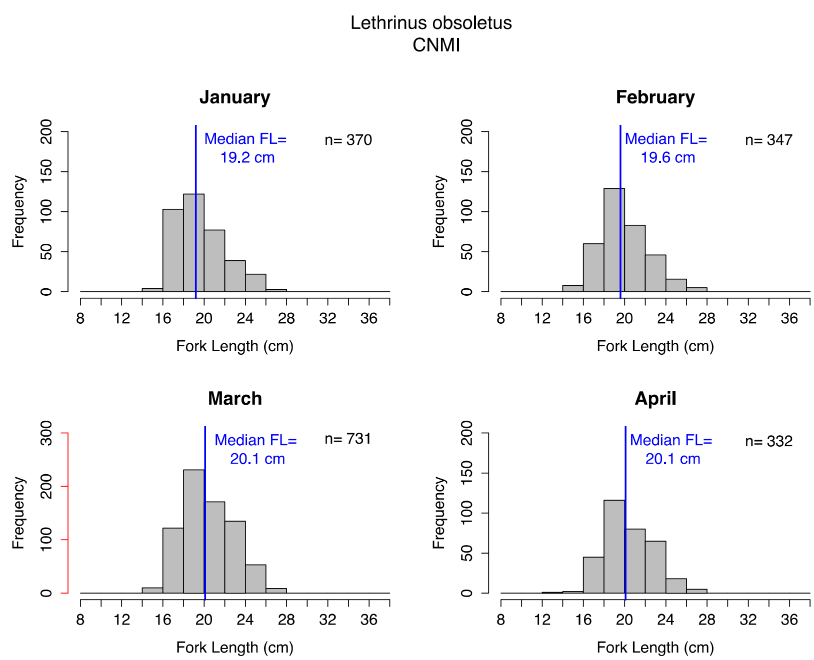

Figure 38.--Monthly fork length frequency histograms of *Lethrinus obsoletus* measured in CNMI January–March, all years. Median length and total number of fish measured each month is displayed.

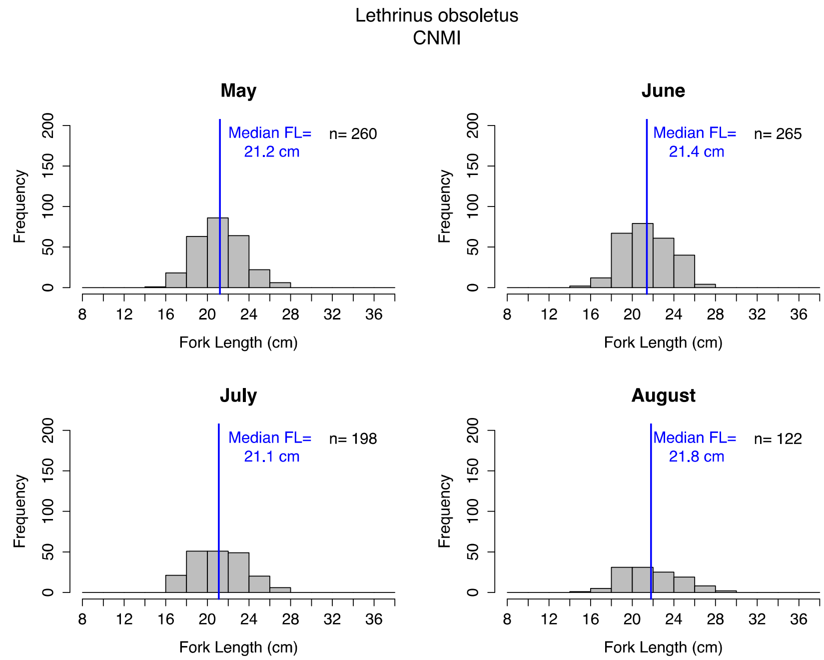

Figure 39.--Monthly fork length frequency histograms of *Lethrinus obsoletus* measured in CNMI May–August, all years. Median length and total number of fish measured each month is displayed.

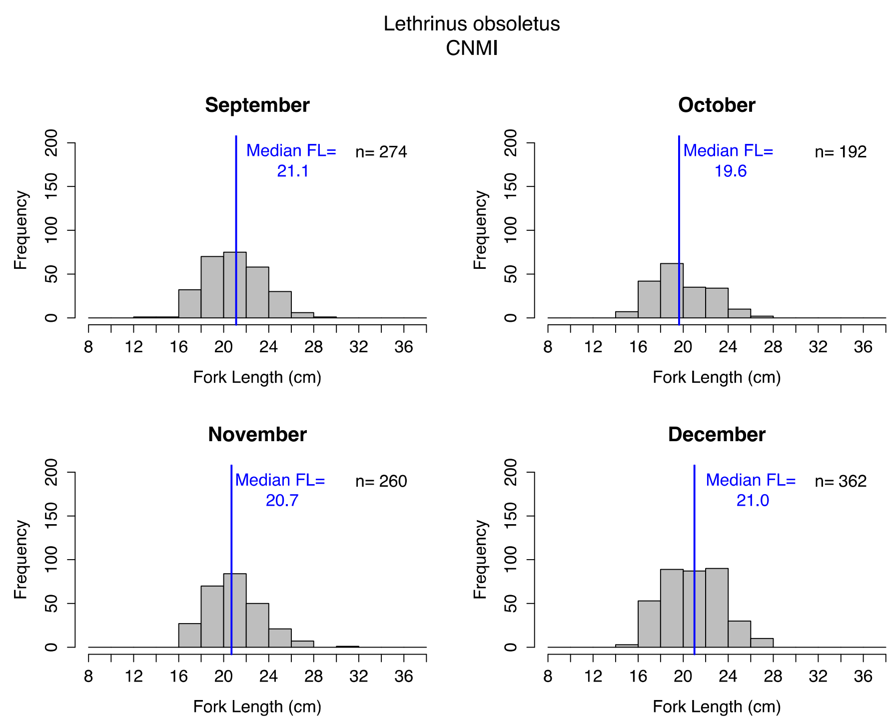

Figure 40.--Monthly fork length frequency histograms of *Lethrinus obsoletus* measured in CNMI September–December, all years. Median length and total number of fish measured each month is displayed.

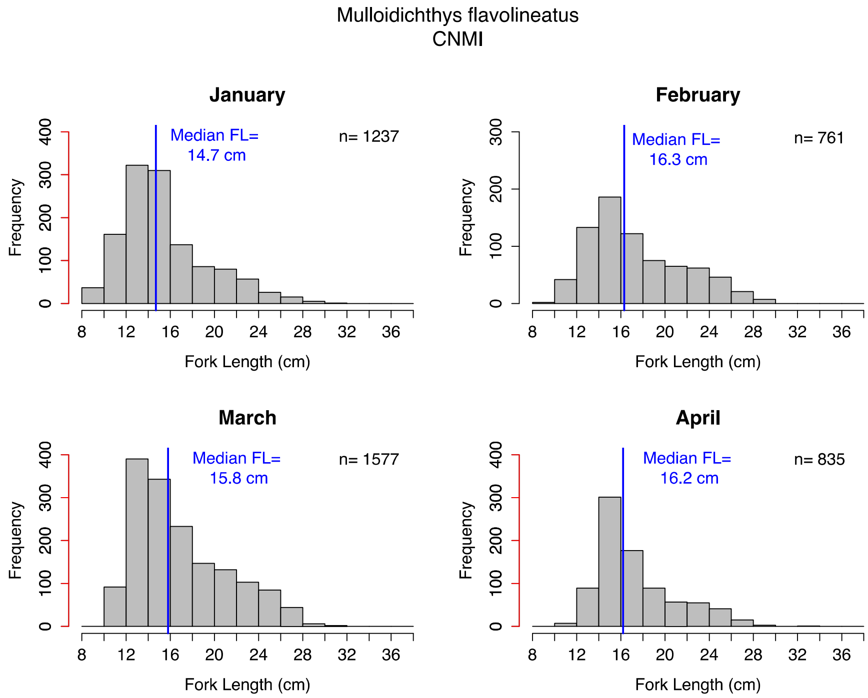

Figure 41.--Monthly fork length frequency histograms of *Mulloidichthys flavolineatus* measured in CNMI January–April, all years. Median length and total number of fish measured each month is displayed.

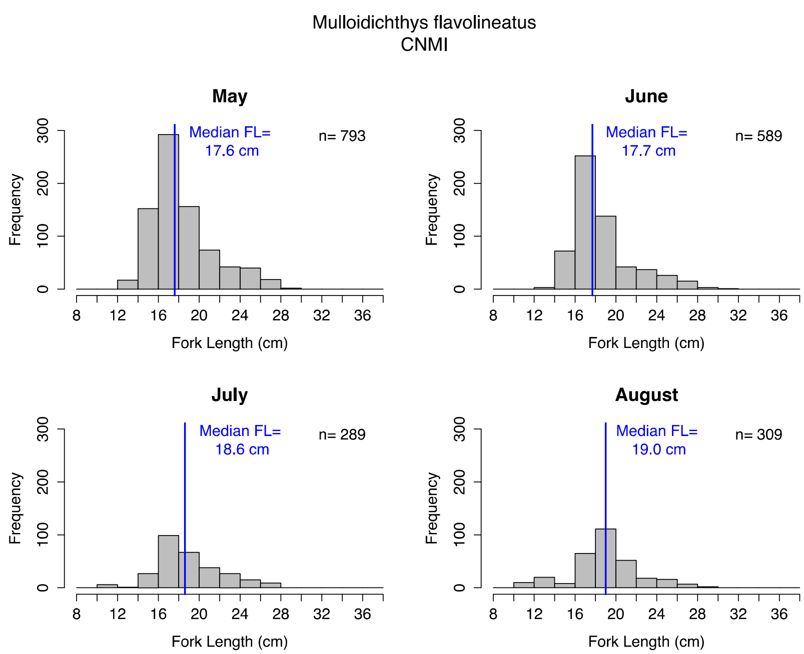

Figure 42.--Monthly fork length frequency histograms of *Mulloidichthys flavolineatus* measured in CNMI May–August, all years. Median length and total number of fish measured each month is displayed.

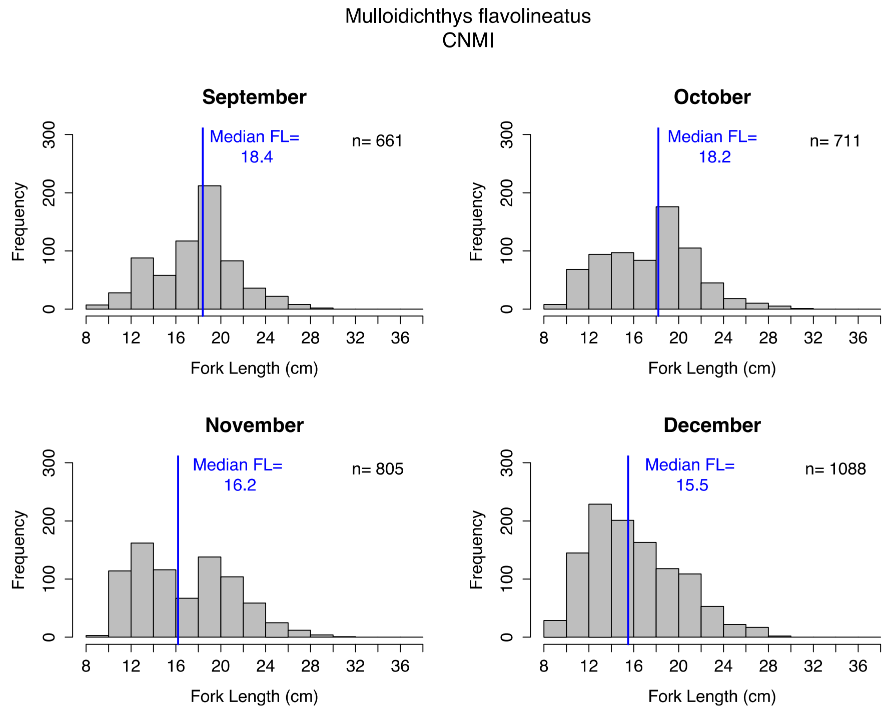

Figure 43.--Monthly fork length frequency histograms of *Mulloidichthys flavolineatus* caught measured in CNMI September-December, all years. Median length and total number of fish measured each month is displayed.

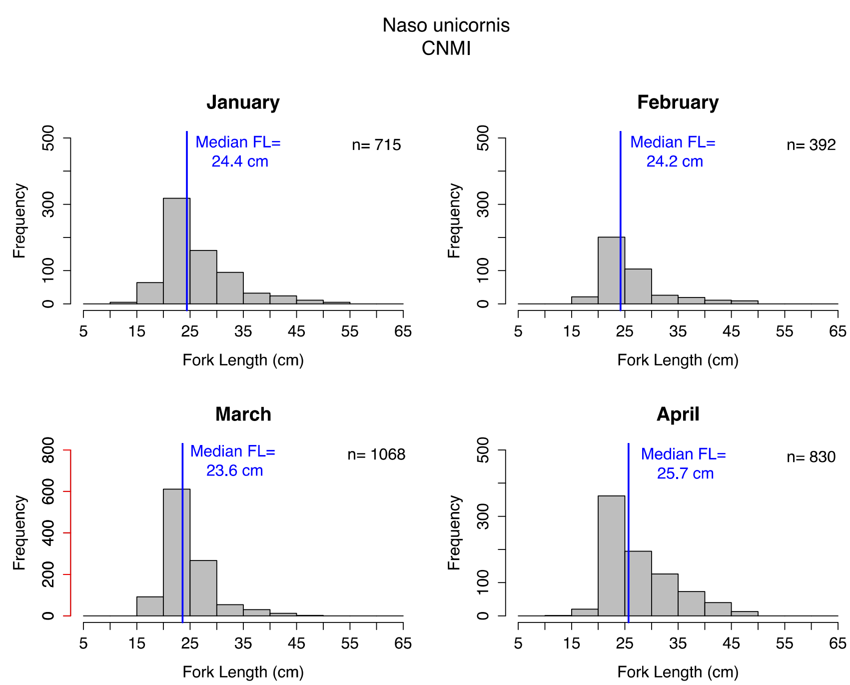

Figure 44.--Monthly fork length frequency histograms of *Naso unicornis* measured in CNMI January–April, all years. Median length and total number of fish measured each month is displayed.

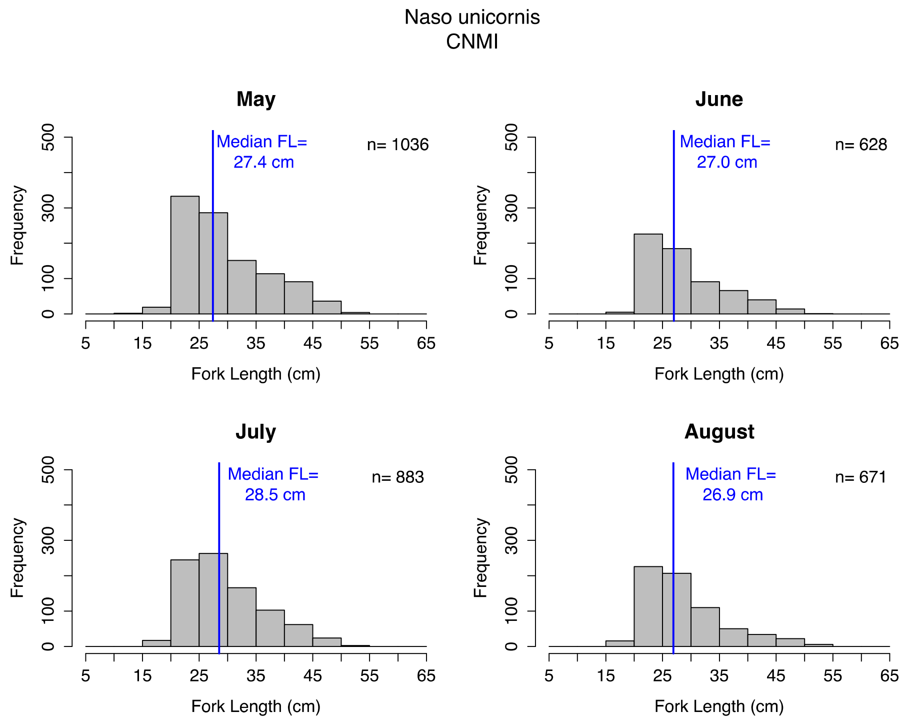

Figure 45.--Monthly fork length frequency histograms of *Naso unicornis* measured in CNMI May–August, all years. Median length and total number of fish measured each month is displayed.

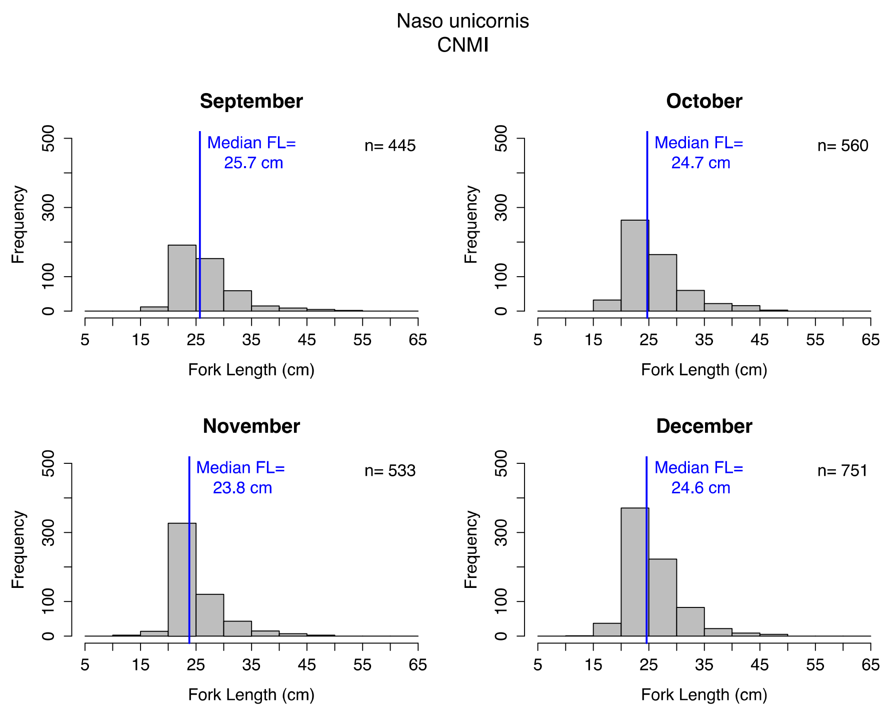

Figure 46.--Monthly fork length frequency histograms of *Naso unicornis* measured in CNMI September–December, all years. Median length and total number of fish measured each month is displayed.

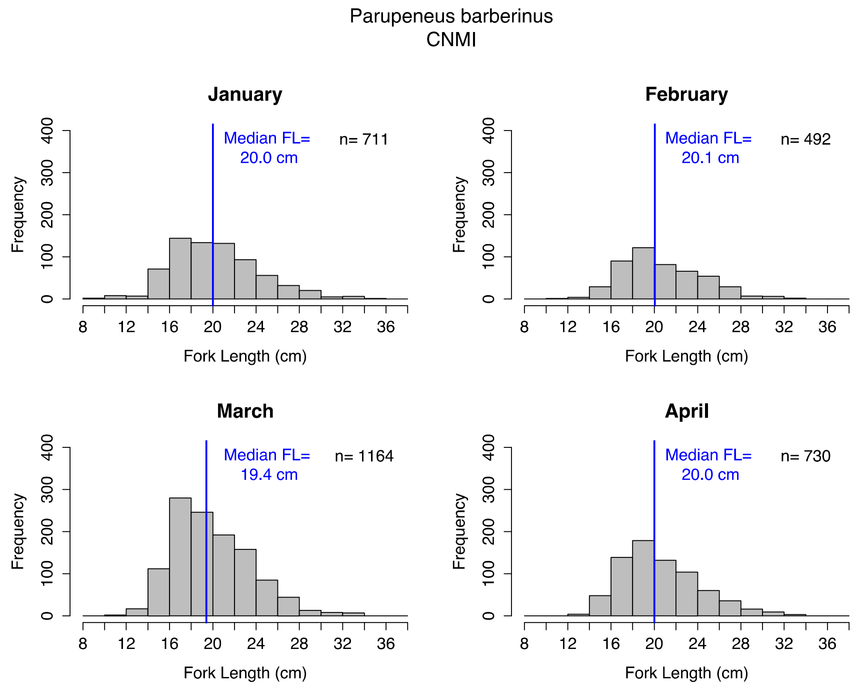

Figure 47.--Monthly fork length frequency histograms of *Parupeneus barberinus* measured in CNMI January–April, all years. Median length and total number of fish measured each month is displayed.

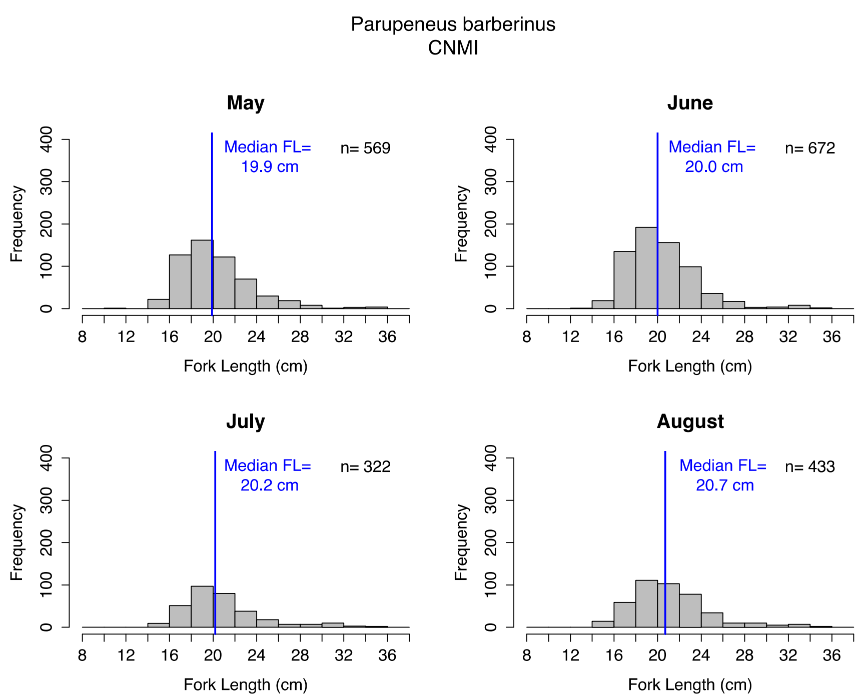

Figure 48.--Monthly fork length frequency histograms of *Parupeneus barberinus* measured in CNMI May–August, all years. Median length and total number of fish measured each month is displayed.

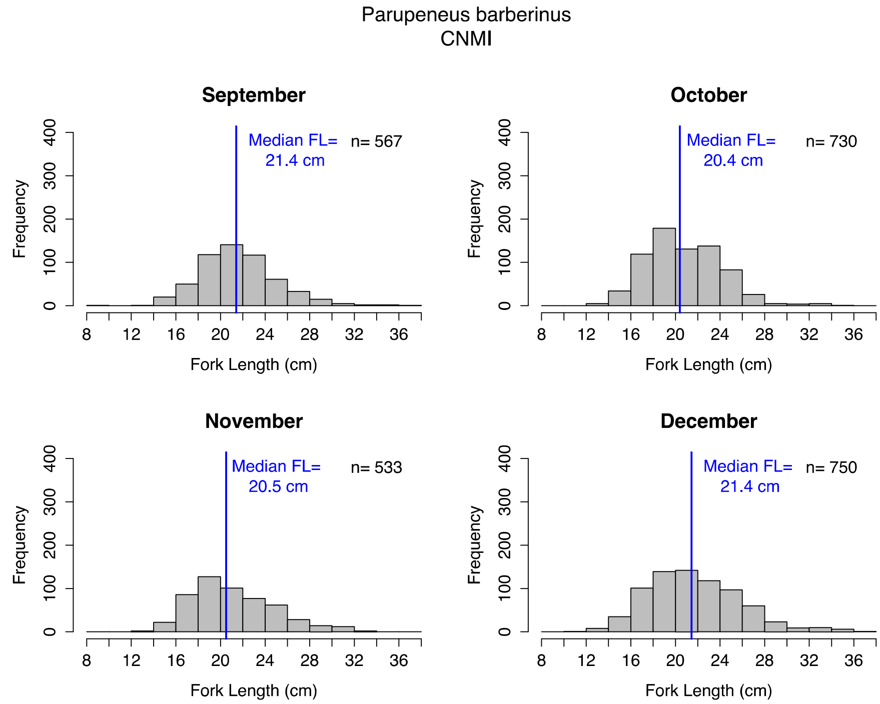

Figure 49.--Monthly fork length frequency histograms of *Parupeneus barberinus* measured in CNMI September–December, all years. Median length and total number of fish measured each month is displayed.

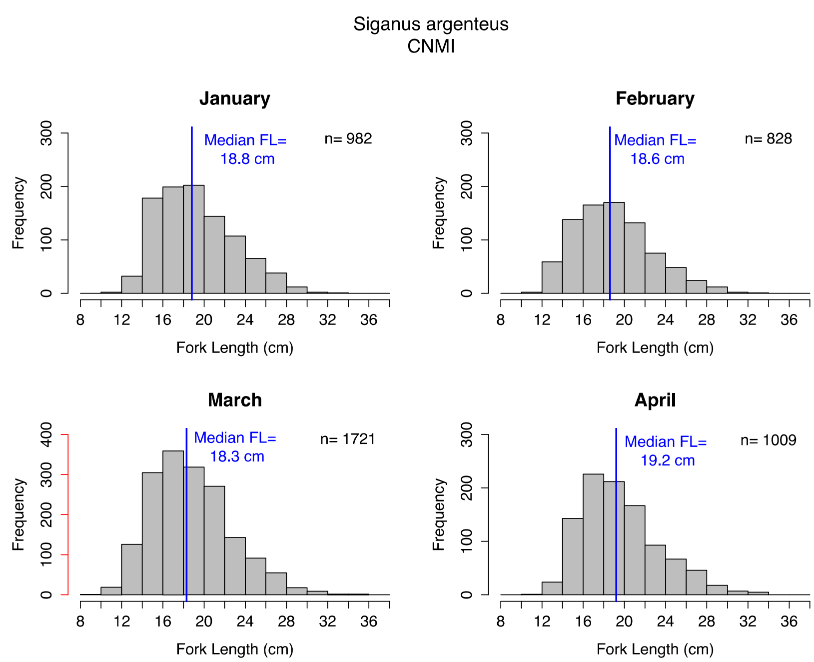

Figure 50.--Monthly fork length frequency histograms of *Siganus argenteus* measured in CNMI January–April, all years. Median length and total number of fish measured each month is displayed.

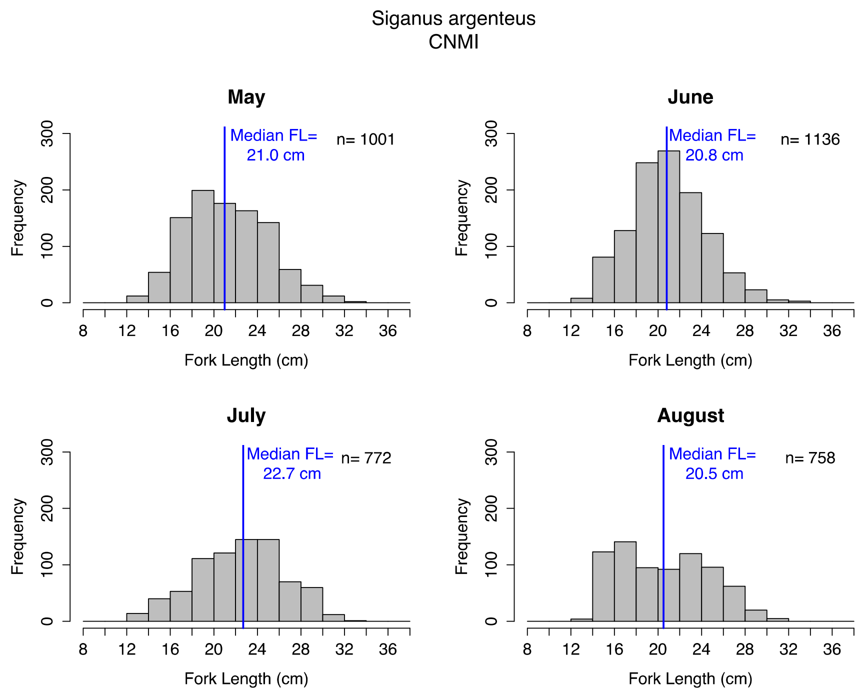

Figure 51.--Monthly fork length frequency histograms of *Siganus argenteus* measured in CNMI May–August, all years. Median length and total number of fish measured each month is displayed.

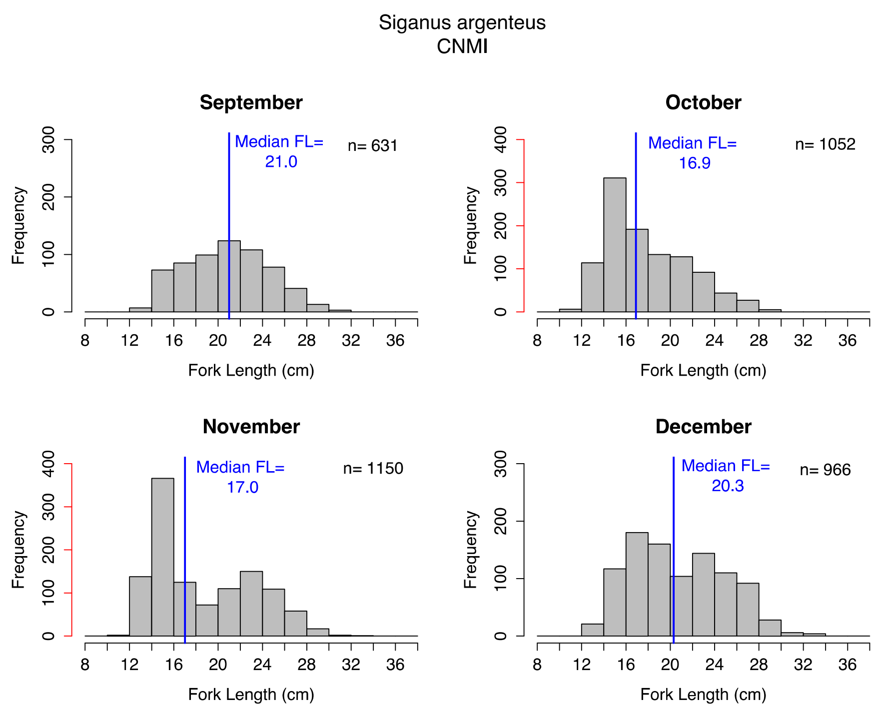

Figure 52.--Monthly fork length frequency histograms of *Siganus argenteus* measured in CNMI September–December, all years. Median length and total number of fish measured each month is displayed.

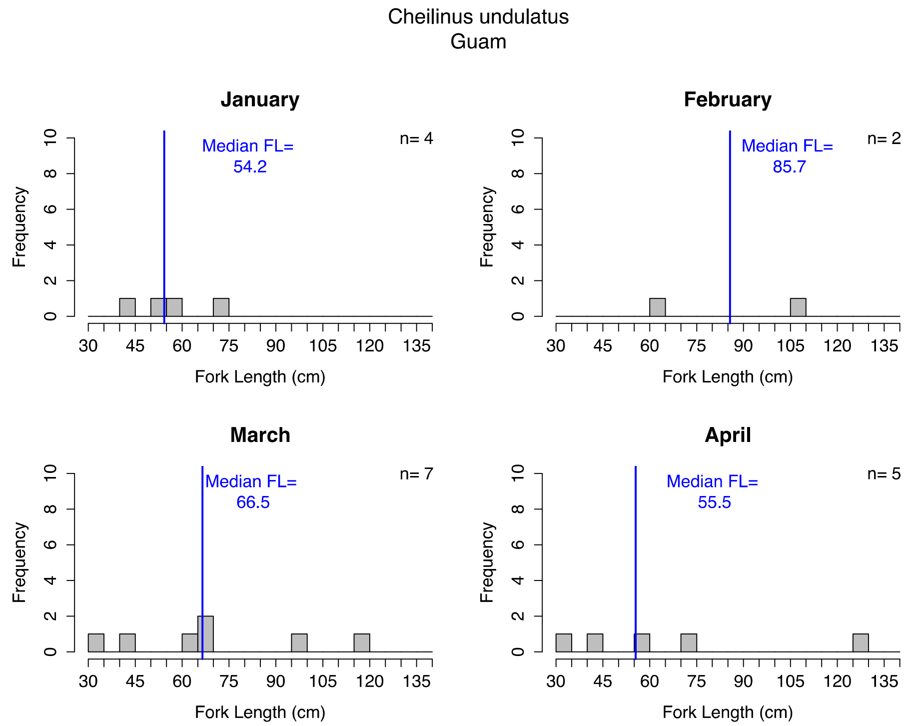

Figure 53.--Monthly fork length frequency histograms of *Cheilinus undulatus* measured in Guam

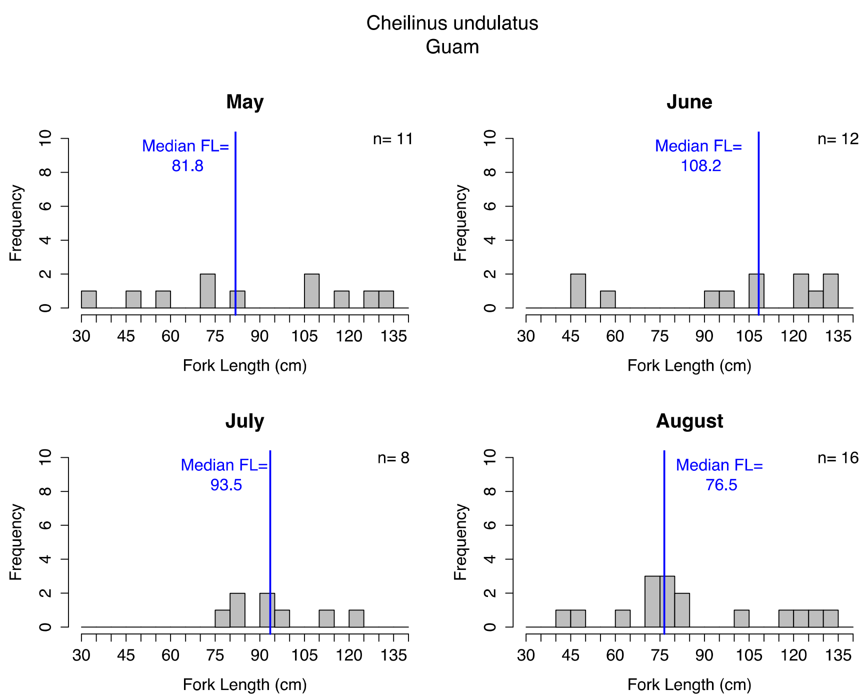

Figure 54.--Monthly fork length frequency histograms of *Cheilinus undulatus* measured in Guam May–August, all years. Median length and total number of fish measured each month is displayed.

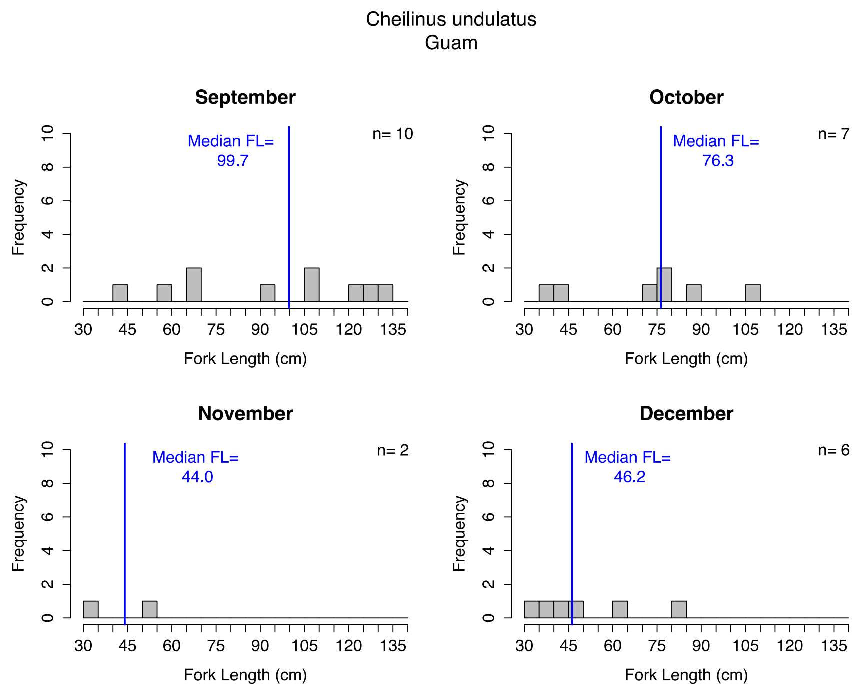

Figure 55.--Monthly fork length frequency histograms of *Cheilinus undulatus* measured in Guam September–December, all years. Median length and total number of fish measured each month is displayed.

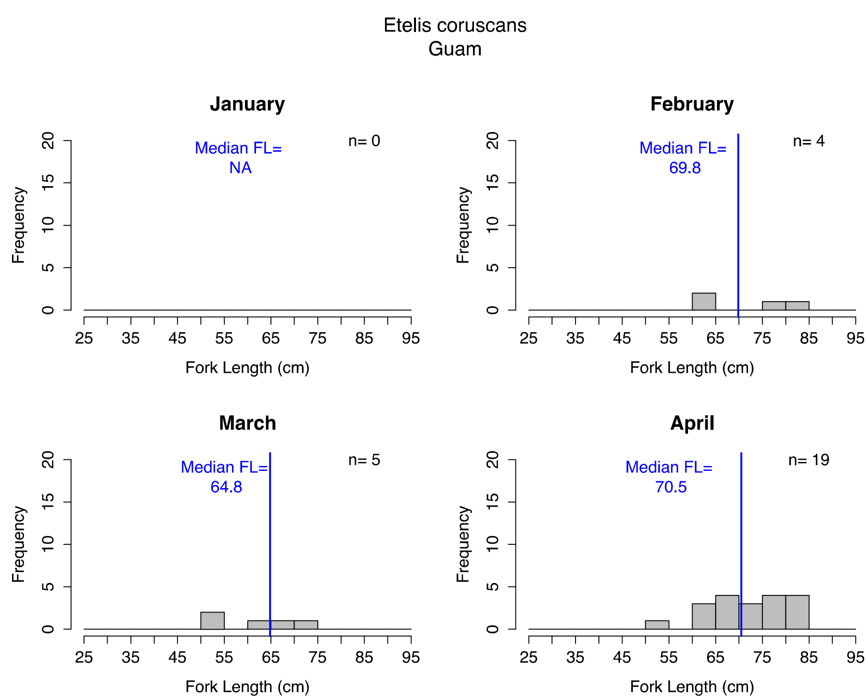

Figure 56.--Monthly fork length frequency histograms of *Etelis coruscans* measured in Guam January–April, all years. Median length and total number of fish measured each month is displayed.

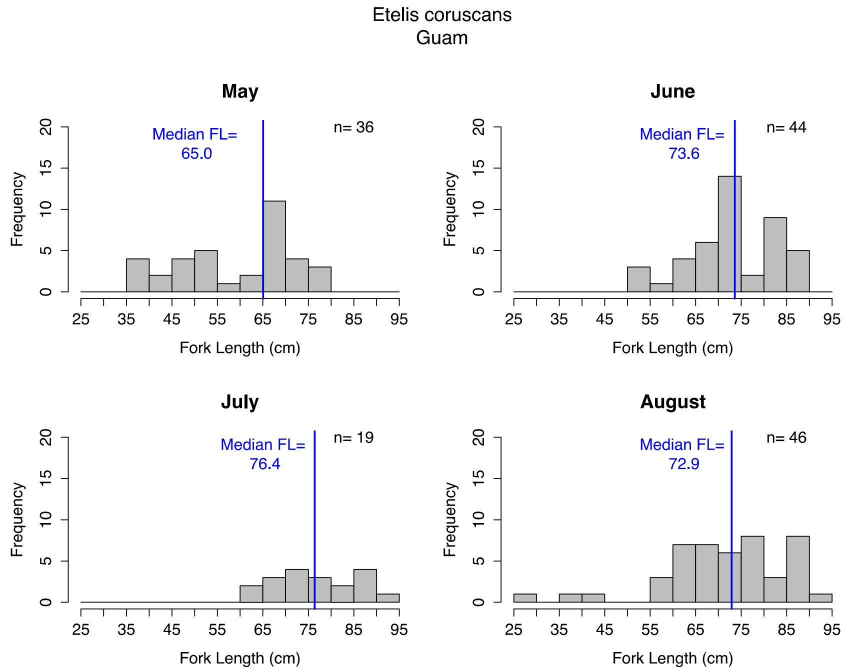

Figure 57.--Monthly fork length frequency histograms of *Etelis coruscans* measured in Guam May–August, all years. Median length and total number of fish measured each month is displayed.

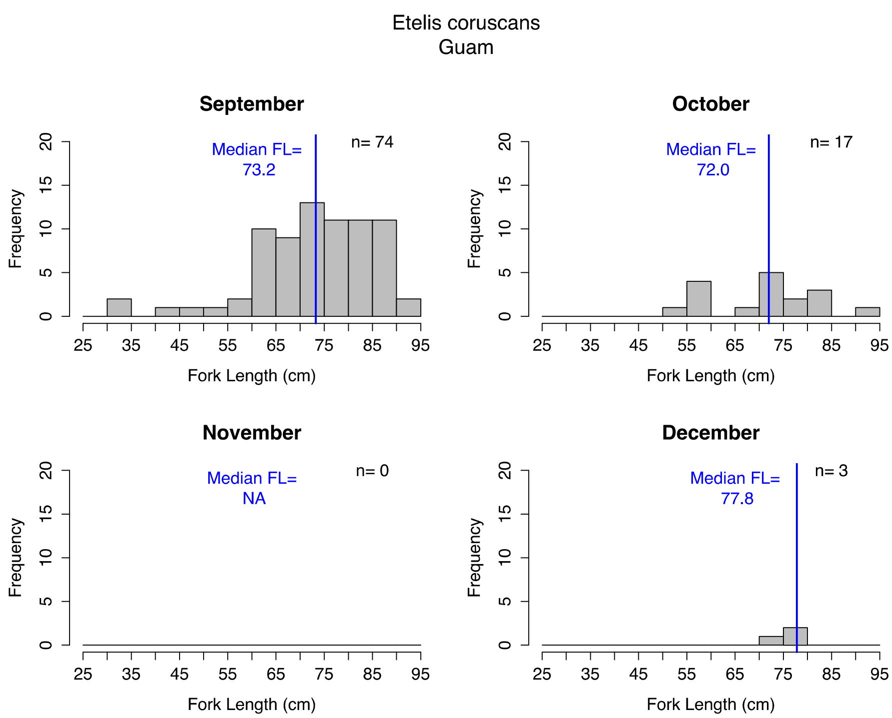

Figure 58.--Monthly fork length frequency histograms of *Etelis coruscans* measured in Guam September–December, all years. Median length and total number of fish measured each month is displayed.

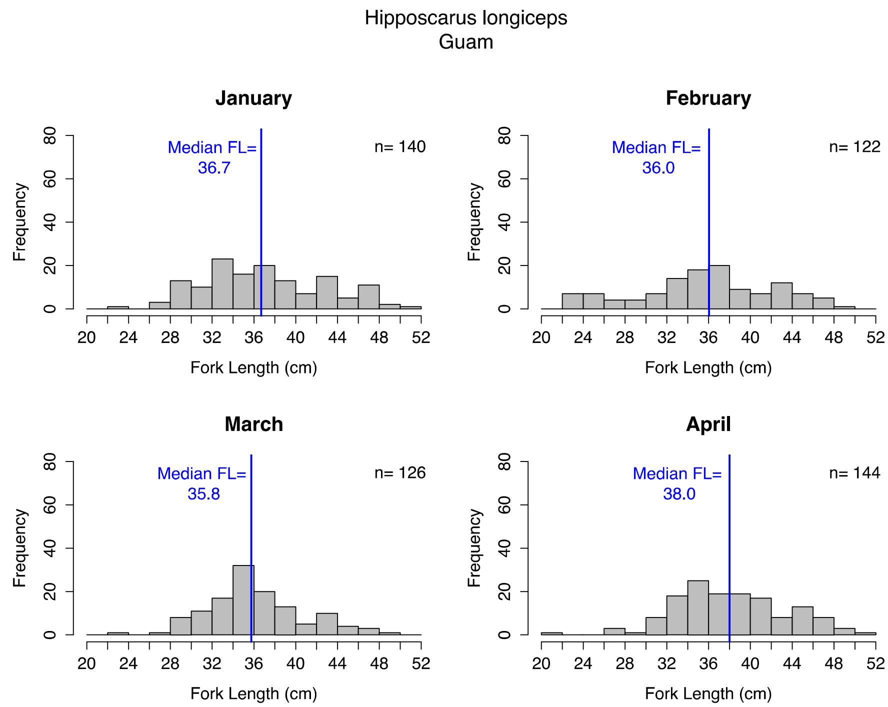

Figure 59.--Monthly fork length frequency histograms of *Hipposcarus longiceps* measured in Guam January–April, all years. Median length and total number of fish measured each month is displayed.

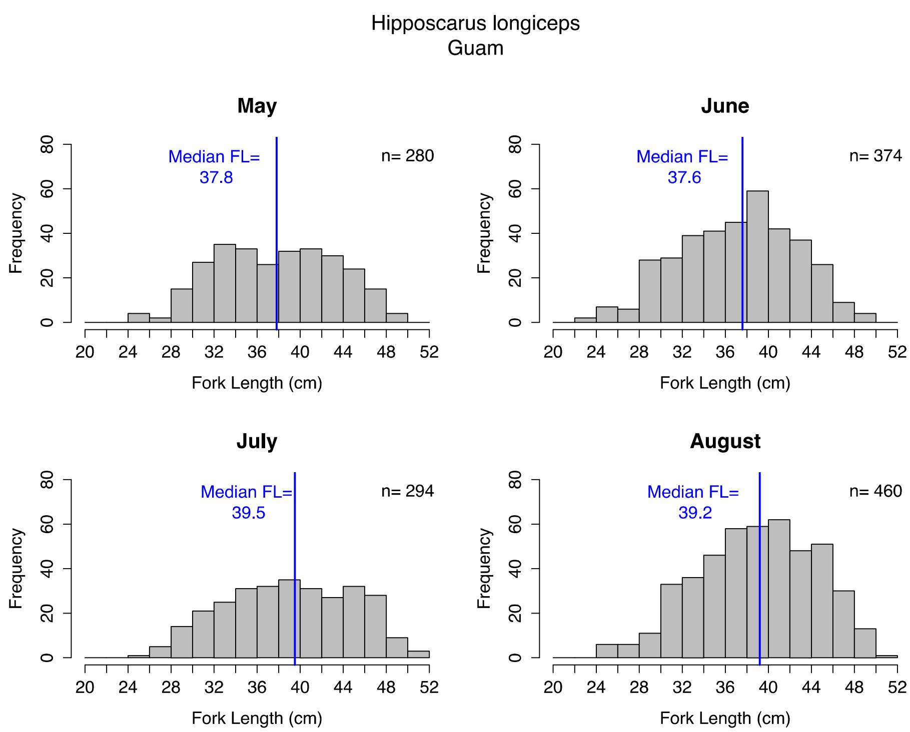

Figure 60.--Monthly fork length frequency histograms of *Hipposcarus longiceps* measured in Guam May–August, all years. Median length and total number of fish measured each month is displayed.

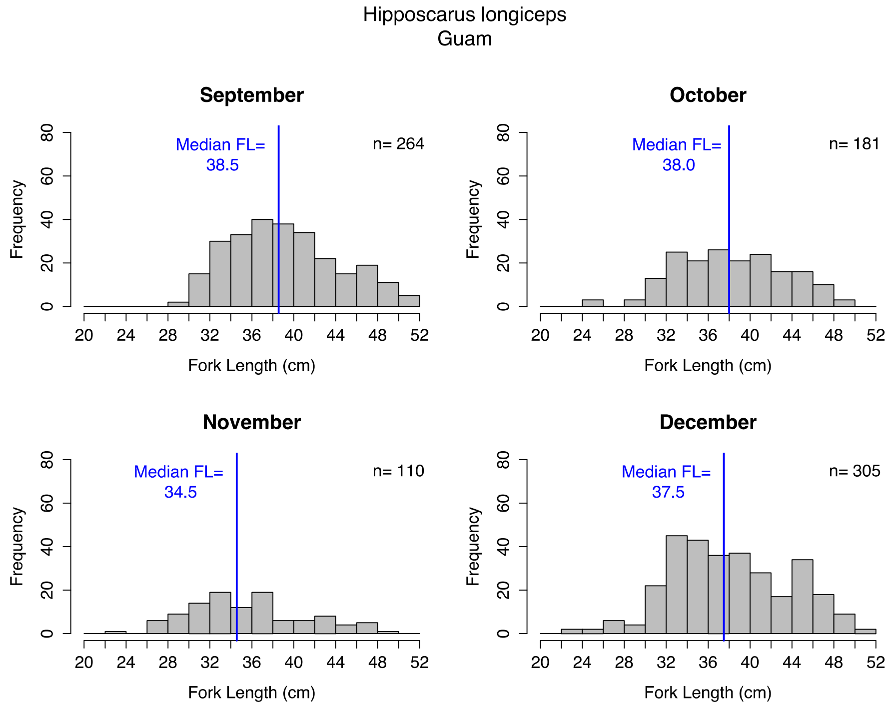

Figure 61.--Monthly fork length frequency histograms of *Hipposcarus longiceps* measured in Guam September–December, all years. Median length and total number of fish measured each month is displayed.

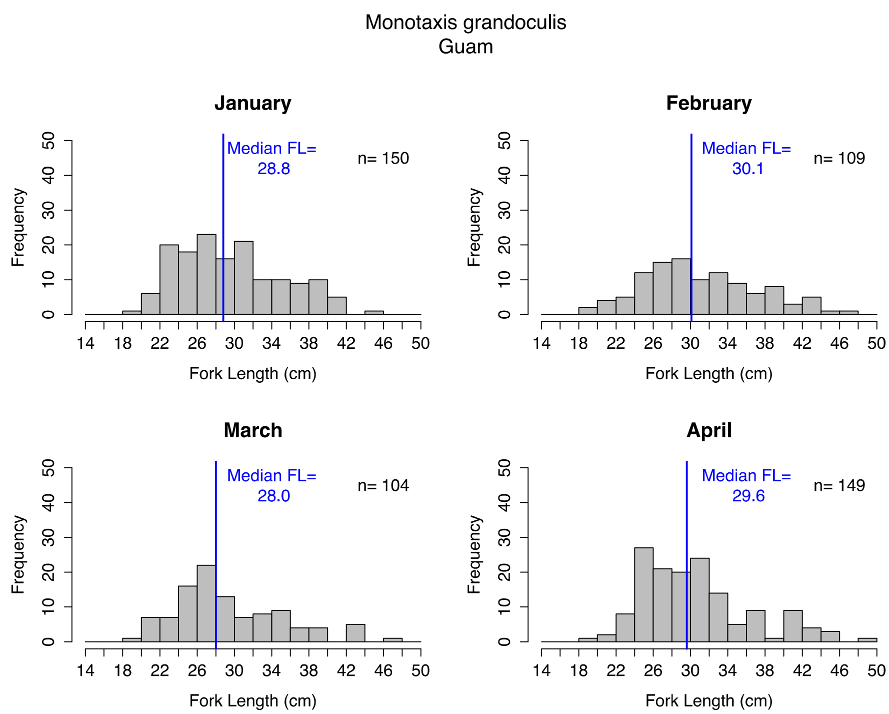

Figure 62.--Monthly fork length frequency histograms of *Monotaxis grandoculis* measured in Guam January–April, all years. Median length and total number of fish measured each month is displayed.

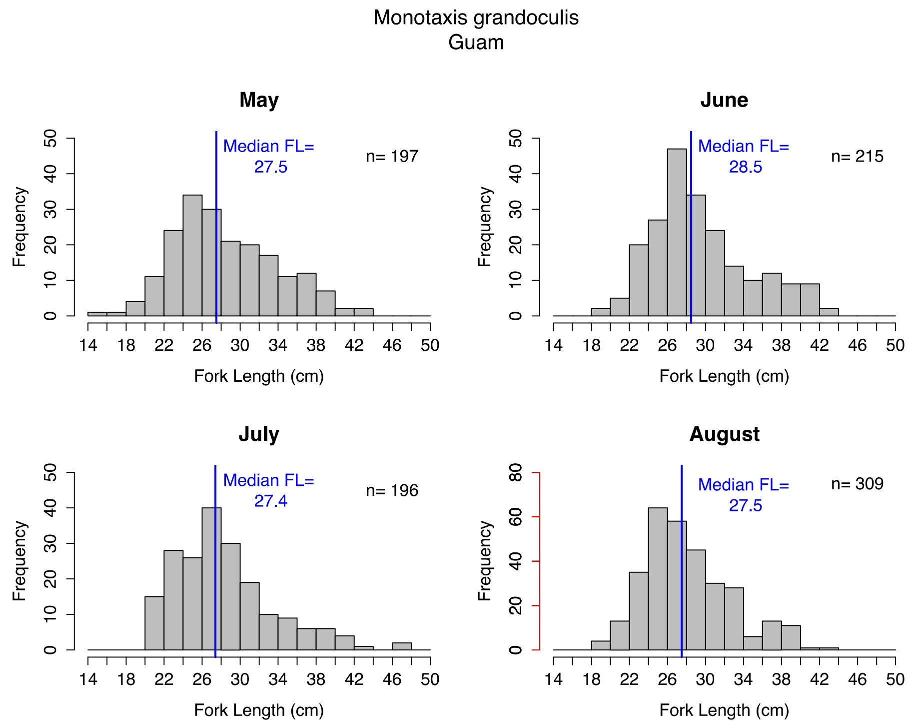

Figure 63.--Monthly fork length frequency histograms of *Monotaxis grandoculis* measured in Guam May–August, all years. Median length and total number of fish measured each month is displayed.

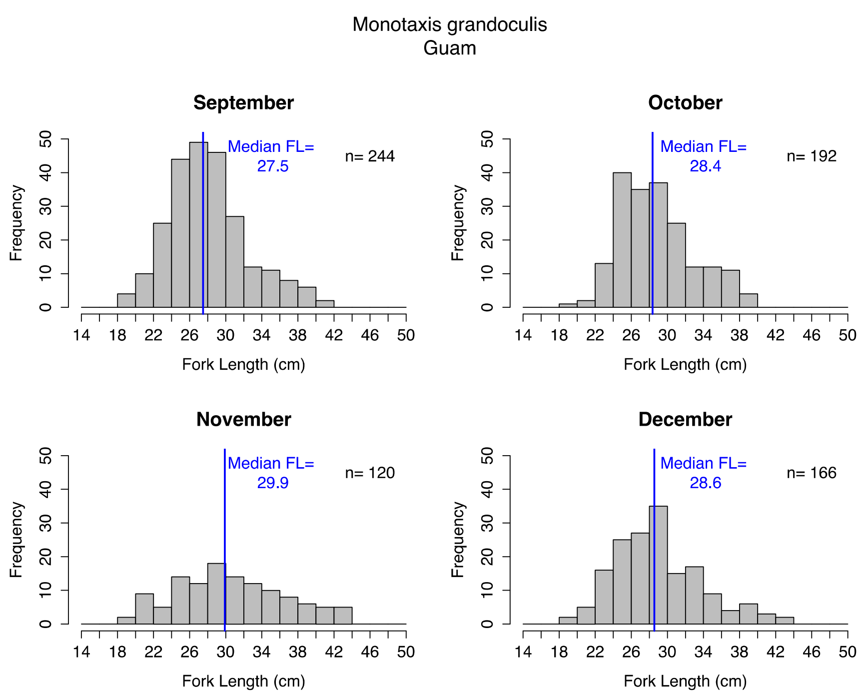

Figure 64.--Monthly fork length frequency histograms of *Monotaxis grandoculis* measured in Guam September–December, all years. Median length and total number of fish measured each month is displayed.

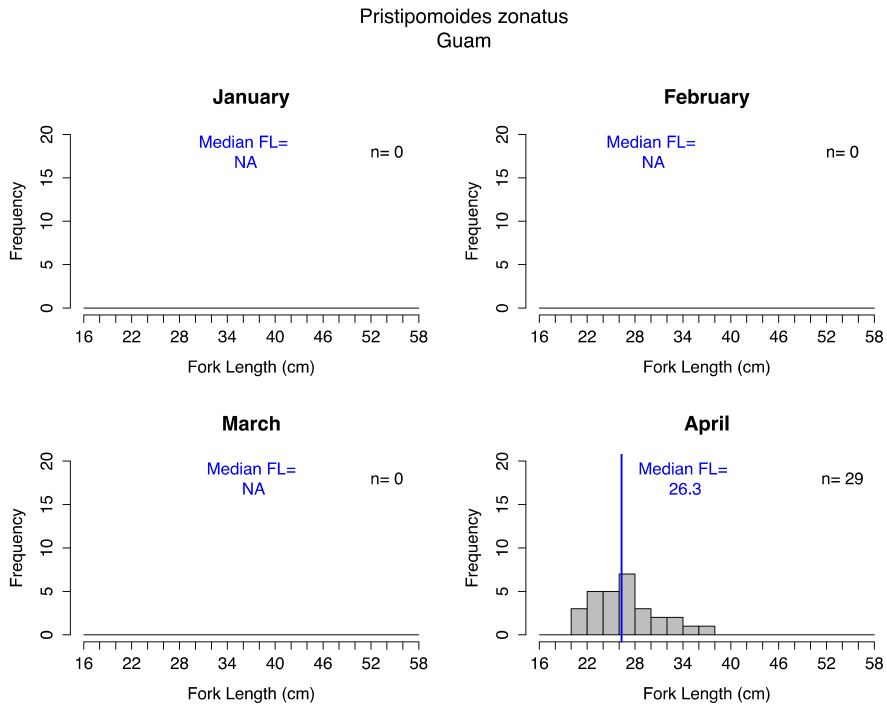

Figure 65.--Monthly fork length frequency histograms of *Pristipomoides zonatus* measured in Guam January–April, all years. Median length and total number of fish measured each month is displayed.

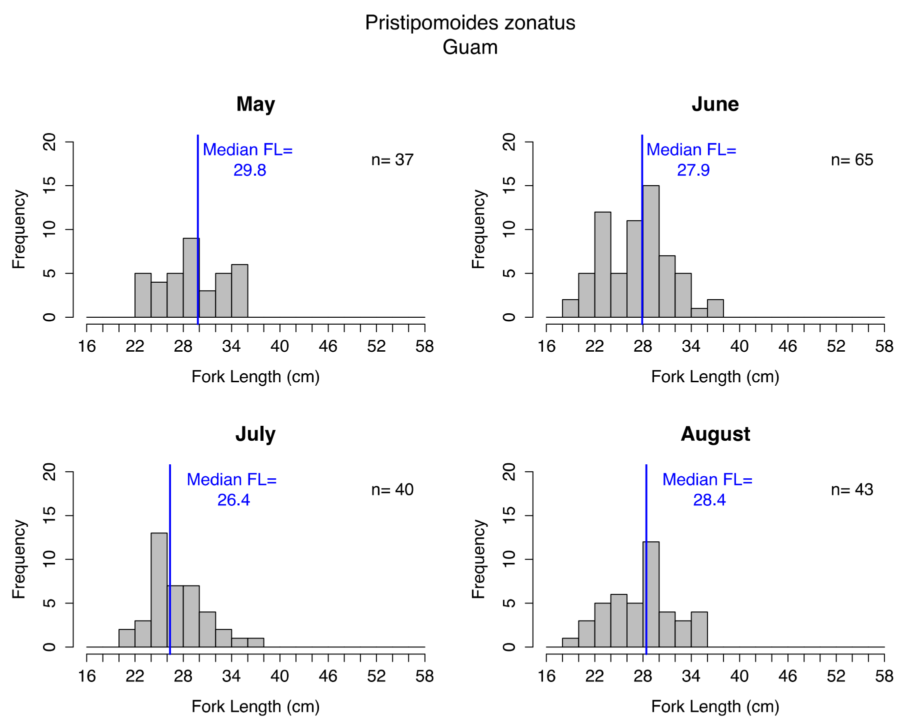

Figure 66.--Monthly fork length frequency histograms of *Pristipomoides zonatus* measured in Guam May–August, all years. Median length and total number of fish measured each month is displayed.

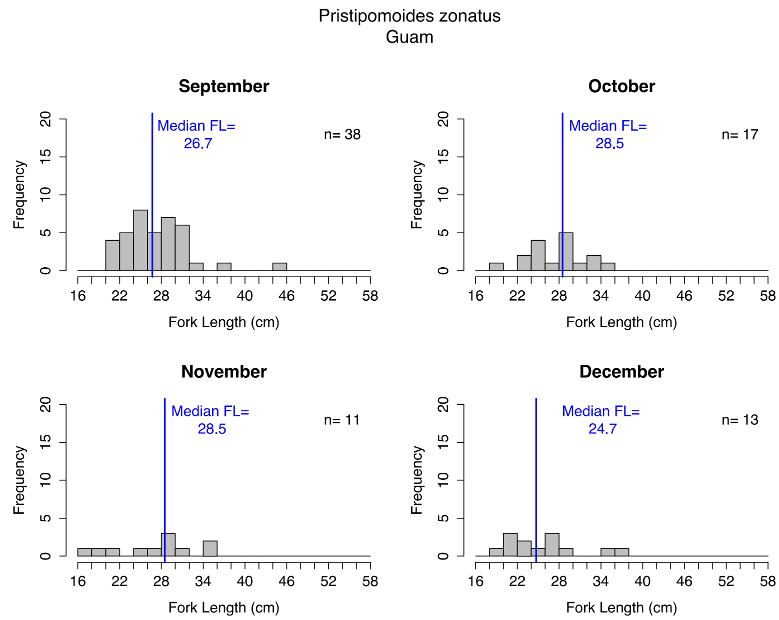

Figure 67.--Monthly fork length frequency histograms of *Pristipomoides zonatus* measured in Guam September–December, all years. Median length and total number of fish measured each month is displayed.

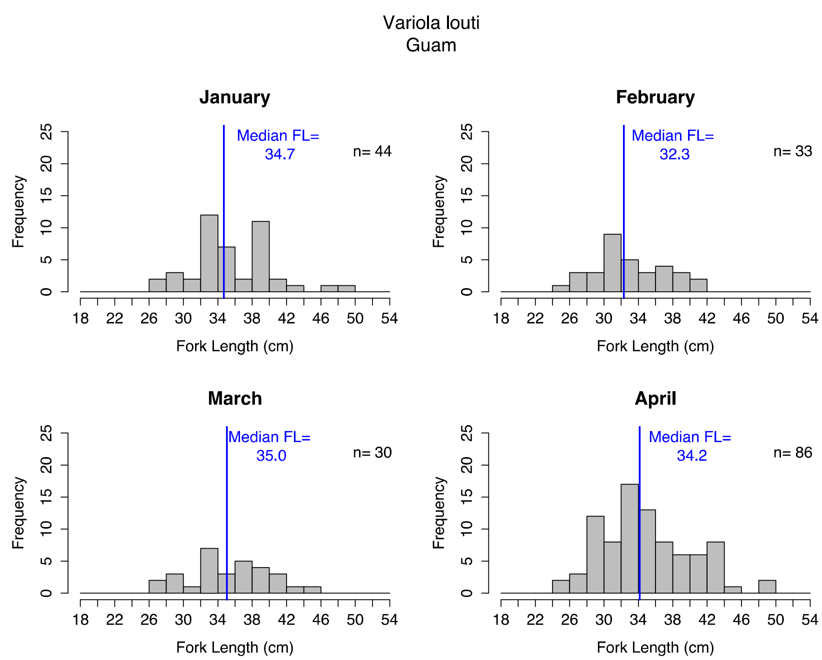

Figure 68.--Monthly fork length frequency histograms of *Variola louti* measured in Guam January–April, all years. Median length and total number of fish measured each month is displayed.

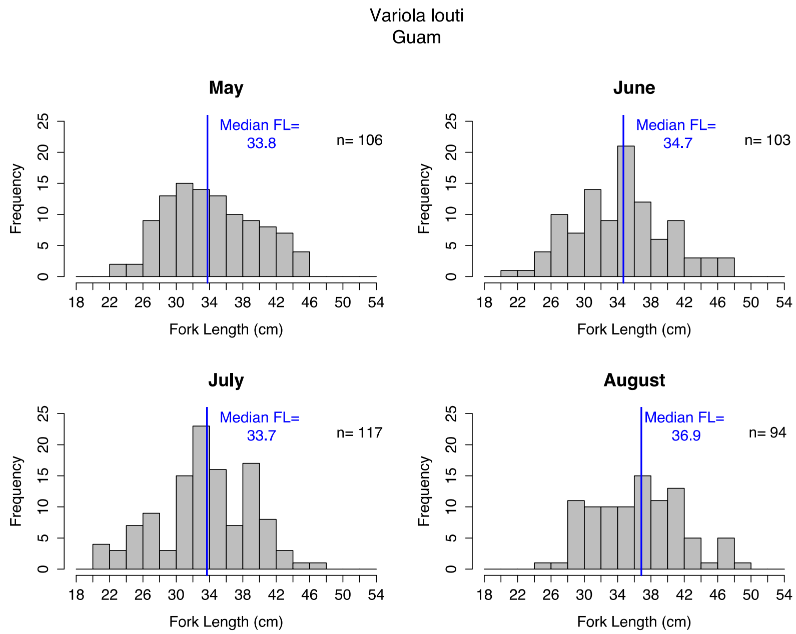

Figure 69.--Monthly fork length frequency histograms of *Variola louti* measured in Guam May-August, all years. Median length and total number of fish measured each month is displayed.

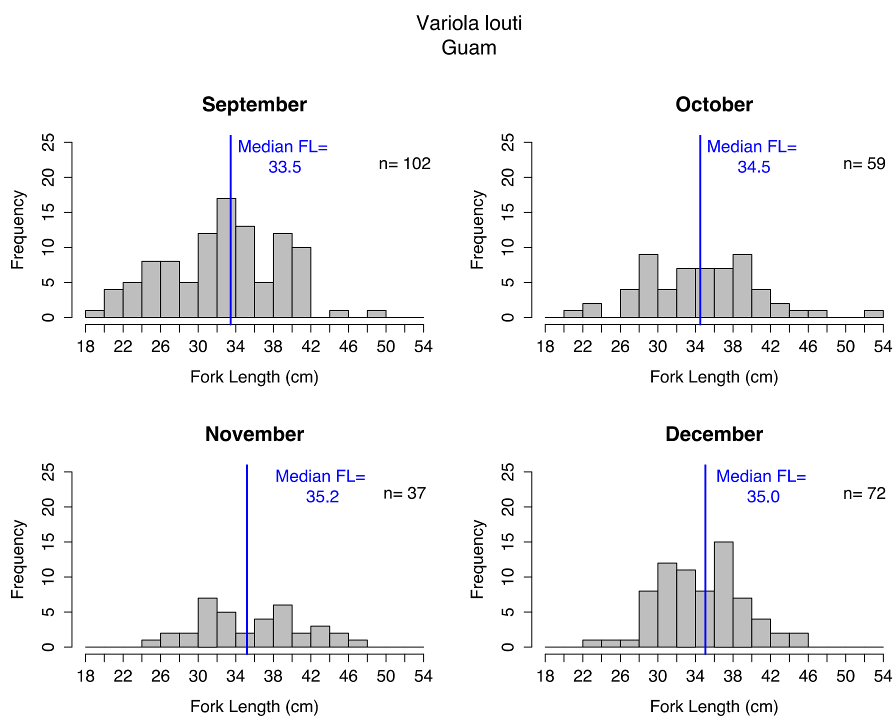

Figure 70.--Monthly fork length frequency histograms of *Variola louti* measured in Guam September–December, all years. Median length and total number of fish measured each month is displayed.