

SUPPLEMENTAL MATERIAL 1

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Scofield (2013) is a student project report on the preliminary results of a life history study on gindai (*Pristipomoides zonatus*).

Age and Maturation of Gindai (*Pristipomoides zonatus*), a Hawaiian Bottomfish

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ABSTRACT

Pristipomoides zonatus, commonly known as gindai in Hawaii, is a commercially important snapper in the western tropical and subtropical Pacific, yet little is known of its life history. This study provides preliminary estimates of important life history parameters necessary for stock assessment. Age estimation using transverse otolith sections revealed the oldest fish was about 39 years for a fish near maximum recorded length (50.0 cm). Median age-at-maturity of *P. zonatus* collected from the Hawaiian Archipelago was estimated using estimates of age-at-length and length-at-maturity. Examination of histological preparations of gonads indicated that median length at maturity (L_{50}) was 29.7 ± 2.3 (95% CI) cm. A von Bertalanffy growth function was fitted to length-at-age estimates and resulted in the following growth parameters: $L_{\infty} = 45.3 \pm 2.0$ cm Fork Length, $k = 0.113 \pm 0.025 \text{ yr}^{-1}$ and $t_0 = -3.40 \pm 1.40 \text{ yr}$. Based on this relationship the median age-at-maturity (A_{50}) was approximately 6 yrs.

INTRODUCTION

A group of indigenous Hawaiian bottomfishes referred to as the *Deep 7* is an important component of commercial fisheries in the Hawaiian Islands. Reaching a peak in 1988, the main Hawaiian Islands (MHI) bottomfish fishery brought in 1.2 million pounds of fish worth 6.3 million dollars (2010 dollars; Hospital & Beavers 2011). By 1998, restrictions were set in place to manage the fisheries for sustainability (Hawaiian Bottomfish Fishery 2011). In the MHI both commercial and recreational fishing requires permits and the entire Northwestern Hawaiian Islands (NWHI) was closed to bottomfish fishing with the formation of the Papahānāmokuākea Marine National Monument (PMNM) in 2006 (PMNM 2013). During the same year that the PMNM was established, 315 thousand pounds were landed by the MHI fishery, a 73% decrease from the fishery peak in 1988 (Hospital & Beavers 2011).

Gindai (*Pristipomoides zonatus*) is one of six snappers in the *Deep 7* complex (Figure 1). This species can be found at depths of 70 to 300 m and commonly reaches 35 cm in length, but has been recorded at lengths up to 50 cm (Allen 1985). *P. zonatus* does not comprise a large percentage of the catch in Hawaii, but its importance is greater in other regions of the Indo-Pacific (Figure 2). High catch rates have been recorded in the Mariana Archipelago and other US Territories (Moffitt 1993, WPRFMC 2001). Snapper species (family Lutjanidae) in general support important fisheries both in terms of number and revenue for the western Pacific (Haight et al. 1993). Despite the importance of the *Deep 7*, life history information is incomplete for many of these fishes (Haight et al. 1993) and *P. zonatus* is no exception (WPRFMC 2001).

Few life history details are well known for deepwater snappers and prior estimates have been based on limited information. Deepwater snappers, like *P. zonatus*, are thought to be long lived and spawn repeatedly during a protracted period of year, broadly defined as April to October and over multiple years. However, the number of times that individual females spawn within and among years is generally unknown (WPRFMC 2001, Moffitt 1993). Accurate and precise information on the age and growth structure, longevity, and age at sexual maturity of this species are required for estimating sustainable yield and related life history attributes, such as potential increases in fecundity and egg quality at larger body size and greater age. Studies have shown that as fish grow and age, fecundity can increase exponentially in fishes (Schmitt & Skud 1978; Nitschke & Mather 2001; Cailliet & Andrews 2008), and egg size (offspring quality and survivorship) can increase as well (Schmitt & Skud 1978; Berkeley et al., 2004; Bobko & Berkeley 2004).

Bottomfish have very limited areal distributions in Hawaiian Archipelago because of the steep submarine slopes of the seamounts and volcanic islands (WPRFMC 2001). Hence, suitable habitat is more limited relative to other regions and the bottomfish fishery needs to be carefully monitored where fishing is still permitted. As a result of restrictions, fishing pressure has increased in the Main Hawaiian Islands. Utilizing age-validated life history parameters of *P. zonatus* will aid the bottomfish industry in establishing sustainable harvest practices.

Recent stock assessments have shown that overfishing of the *Deep 7* is becoming an issue and accurate life history information for these species is of paramount importance. Brodziak et al. (2011) predicted low to moderate overfishing of the *Deep 7* in the coming years for the MHI. The goal of this study is to provide preliminary life history information for *P. zonatus* by 1) estimating length-at-age from otoliths, 2) describing growth parameters using these length-at-age data, 3) determining length-at-maturity from gonads, and 4) estimating the age-at-maturity by combining these results. It is hypothesized that the results from this study will provide a baseline for validation of previous age estimates (WPFMC 2001, Fry et al. 2006), with additional consideration for longevity analyses (i.e. bomb radiocarbon dating; Andrews et al. 2012) and the timing of first annulus formation (daily microincrement counting to describe early growth).

MATERIALS AND METHODS

All specimens used in this study were provided by the Pacific Islands Fisheries Science Center (NOAA Fisheries, PIFSC) from Bottomfish Stock Assessment cruises. These collections were conducted throughout the Hawaiian Archipelago during the period of June 2007 to September 2011. Mentoring on fish age estimation and gonadal maturation was provided by Drs. Allen Andrews and Edward DeMartini, respectively.

Specimens

P. zonatus specimens were selected from both NWHI and MHI collections, with the MHI emphasized. Collections in the MHI were made at Kaula Rock, Ni'ihau, Kaua'i, off Kaena Point on O'ahu, and off the Kona coast of Hawaii Island. For each specimen, the depth of capture (fm), whole body weight (kg), and length (FL) were recorded and are available via the original collection ID number. Gonads were extracted and weighed (g) at time of collection and fixed in 10% formalin. Focus was placed on specimens collected during the April-October spawning period of eteline snappers (DeMartini & Lau 1999) and a total of 152 *P. zonatus* were available; including 139 females with intact gonads and both sagittal otoliths.

A total of 49 specimens were collected in the MHI; larger fish only were available from most of these MHI sites. Additional smaller specimens were therefore considered from other locations that might include immature individuals. This required using fish collected farther abroad in the NWHI (Necker Island, East and West Twin Banks, Maro Reef, Nihoa and West Nihoa Islands), for a total of 90 individuals collected during the defined spawning season.

Otoliths and Age Estimation

Age-reading is the process of estimating age by counting growth zones in sections of otoliths (ear stones) or other hard parts of fishes. Using otolith sections to estimate age

requires specialized training from an experienced age-reader. A. Andrews provided expertise on the methods of sagittae sectioning and interpretation of growth zones in the otolith sections during joint sessions with the senior author. Sagittal otoliths were selected from 80 fish that ranged from smallest to largest in fish length to presumably cover the potential age range. Both sagittae from each of the 80 fish were weighed (± 0.001 g). For consistency, the left sagitta was chosen to be processed for age estimation. Each otolith was thin-sectioned with a low-speed, diamond blade saw (Buehler Isomet) crosswise through the center (transverse section). Each otolith section was mounted on a glass microscope slide using a clear mounting medium (Richard-Allan Scientific Cytoseal™ 60) and allowed to harden. Once hardened, each section was examined under a dissecting scope to determine the best orientation for reading and if any polishing was necessary. Select samples that were difficult to read or contained imperfections were ground down with 600-grit wet-dry sandpaper and polished to enhance age-reading of growth zones visible in the section (Choat et al. 2003).

During the age-reading sessions, slides were viewed using transmitted light on a Leica S8 APO stereomicroscope with a DFC295 digital camera. Various magnifications were used for initial age-reading interpretations. The 11 transverse sections with the most well defined growth zones were selected to reveal a consistent growth structure and pattern that could be used to develop criteria in counting less defined otolith sections. After becoming familiarized with the growth patterns and developing counting criteria, the 80 sections were aged by a series of three blind reads (separated by several days to a week) and a final read to resolve a final age. The precision of age reading was evaluated by calculating an Average Percent Error (APE) and Coefficient of Variation (CV) (Beamish and Fournier 1981, Chang 1982). Mean otolith weight was regressed as a predictor of fish age for a minor subset of examined specimens to predict the age of individual fish that were not aged (see Linking Age and Maturity, below). A von Bertalanffy growth function (VBGF) was fitted to length-at-age estimates to estimate growth parameters.

Gonads and Maturity

Maturity was determined by preparing histological sections of each gonad specimen and scoring each using a predetermined maturity key to assign developmental stage, provided by E. DeMartini. All gonad specimens were weighed prior to sectioning to determine the formalin-fixed weight (g), which was used to determine the gonosomatic index ($GSI = 100 \% [\text{gonad weight}/\text{somatic weight}]$). A section was extracted from the middle of one lobe of each of the 74 gonads and placed in histology cassettes in preparation for processing. These specimens were sent to the John A. Burns School of Medicine's Histology & Imaging Core for histological preparation. At the Histology & Imaging Core the specimens were dehydrated and embedded in paraffin. Samples were cut in a series of 6- μm sections that were mounted on glass slides and stained with Harris's hematoxylin and counter-stained with eosin (Hunter & Macewicz 1985).

Histological slides were examined with an Olympus BX51 compound binocular microscope to determine the ovarian and testicular developmental stage and maturation state of each *P. zonatus*. Maturity was determined based on the maturity key mentioned above. This key utilized characteristics of *P. zonatus* gonads, including the yolk development of oocytes, the presence of hydrated oocytes, postovulatory follicles, tailed sperm and sperm ducts and, if necessary, the median diameter of the largest viable oocytes present. Median body size at maturity (FL₅₀) of both sexes pooled was estimated using nonlinear regression to fit a logistic curve using PC SAS 9.2 and SigmaPlot 12.0 (DeMartini and Lau 1999; DeMartini et al. 2010).

Linking Age and Maturity

The von Bertalanffy Growth Function (VBGF) generated from length-at-age estimates (n = 80) was coupled with maturity status to estimate age-at-maturity for this species. Using the otolith weight-age regression, age was predicted for specimens that were unaged but for which gonadal maturation was described (n=7). The predicted age data will provide input to drive a more extensive study using additional *P. zonatus* samples from the Hawaiian Islands and perhaps other regions of the insular Pacific.

RESULTS & DISCUSSION

Age Estimation

The analysis of *P. zonatus* otolith sectioning, age reading, and structural observations led to an age estimation protocol. All transverse sections were viewed at a fixed magnification (12.5x) to maintain the otolith section proportion and avoid magnification-induced inconsistencies. Age reading was made with the sulcus facing upwards and away from the reader for consistency and because light transmission was best through the sections in this orientation (e.g. fewer edge effects). Growth zones were visible as coupled opaque and translucent zones in the transverse section. The dorsal side of the transverse section was used for age reading because growth zone clarity was most consistent in this part of the otolith. These measures created a consistent view for developing growth zone search patterns for the age reader.

Otolith sections were examined from the smallest to largest fish to provide information on growth patterns through ontogeny (Figure 3). As expected from other studies of otolith growth, the growth patterns observed in *P. zonatus* otoliths began with broad growth zones in early years that became progressively compressed in otoliths from the largest fish. Many sub-annual zones were present in areas of the otolith that represented the earliest growth up through late teen ages. This factor made the early year zones more difficult to interpret. Because of this, the first year of growth was measured for each fish to ensure a consistent starting point for each reading. Based on observed changes in the otolith structure for the smallest otoliths (i.e. consistent location of proximal surface indentations and inflection points; Figure 3a), the first year of growth was estimated to be 6.4 mm across the core of the section (Figure 4). However, it is

recommended that the use of daily growth increment counting be used to validate the formation of the first annual growth zone. In addition to the complicated structure within the first few years of growth (i.e. additional zones that could be quantified but were not counted), several otoliths had structured bundles of crystalized knobs on the dorsal end of the section (Figure 3b, c). Despite potential complications, four blind reads resulted in a within-reader APE of 5.2% and a CV of 7.0%, signifying good precision in age interpretation using the transverse sections.

The age estimates of otoliths from *P. zonatus* provide a preliminary look at the age and growth and age range of *P. zonatus* across its size range in the Hawaiian Islands. The smallest fish at 15.9 cm FL was aged at 1 year and the resolved age for the largest fish at 48.2 cm FL (mean otolith weight 0.8185g) was 32 years old (Table 1). A slightly smaller specimen (43.2 cm FL, mean otolith weight 0.7853g) was aged at 39 years (Figure 5). The latter specimen was estimated to be the oldest of the 80 fish that were aged, with a length about 10 cm greater than the mean fish length of the population (35 cm FL), although considerably less than reported maximum length (50 cm FL) for the species. The age estimate findings, coupled with known maximum size of *P. zonatus* indicate it is likely *P. zonatus* lives for more than 40 years.

Resolved fish age and mean sagittal otolith weight were used to create relationships to describe length-at-age and age prediction from otolith weight. Nonlinear regression of length on age resulted in a good fit ($R^2 = 0.89$) to the VBGF. Growth parameters of the VBGF were: $L_\infty = 45.3 \pm 2.02$ cm FL, $k = 0.113 \pm 0.025$ yr⁻¹, $t_0 = -3.40 \pm 1.40$ yr (\pm CI 95%; Figure 6). The regression of otolith weight on estimated age was linear and precise ($r^2 = 0.87$; Figure 7). The data set for resolved ages was fairly complete, but there were few specimens with otolith weight data greater than 0.7 g (Fig. 7). Further investigation of ages from smaller and larger otoliths in size classes that are not well represented will provide a more complete relationship.

Maturity

Data provided by histology offered insight otherwise unobtainable about the actual gender of each *P. zonatus* specimen. Using histological preparations of the 74 *P. zonatus* specimens available, 43 fish were determined to be female (Table 2). Over one third of the large *P. zonatus* (40 – 46.5 cm FL) recorded as female were actually male despite the considerable size and weight difference between ovaries and testes (Appendix 2). The large number of testes assumed to be ovaries from large, mature *P. zonatus* demonstrates the need for improved macroscopic sexing. The 31 males were included in estimating median body size at maturity after noting no discernible differences in length-at-maturity between males and females. Further inquiry into the maturity of males is needed to determine possible sexual differences in length-at-maturity.

Histological preparation of gonads proved necessary to sex *P. zonatus* from smaller size classes. The smaller fish allowed for a more comprehensive evaluation of median age at maturity that included immature *P. zonatus* of both sexes. Smaller gonad

samples had less definitive structures making the determination of sex difficult. The hydrated oocyte stage was the most imminent (ready to spawn) developmental stage observed for females. Ovaries containing post-ovulatory follicles were not encountered. The ovaries of several specimens contained atretic oocytes, signifying that these females had already spawned for the season and were regressing to a resting stage until the next spawning season.

Median body size at maturity was coupled with age estimates to estimate length- and age-at-maturity of *P. zonatus*. Median body length-at-maturity (L_{50}) was estimated to be 29.7 ± 2.3 cm ($\pm 95\%$ CI) FL (Figure 8) and a preliminary estimate of median age-at-maturity based on the VBGF was calculated ($A_{50} = 6.0 \pm 0.44$ yr; Figure 9). This information will provide useful management information for estimating sustainable harvest rates that improve the accuracy of predicting risks of exploitation. Ideally, further investigation of maturity of *P. zonatus* from the Hawaiian Islands would require additional immature and female specimens to more thoroughly describe length-and age-at-maturity relations.

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FIGURES

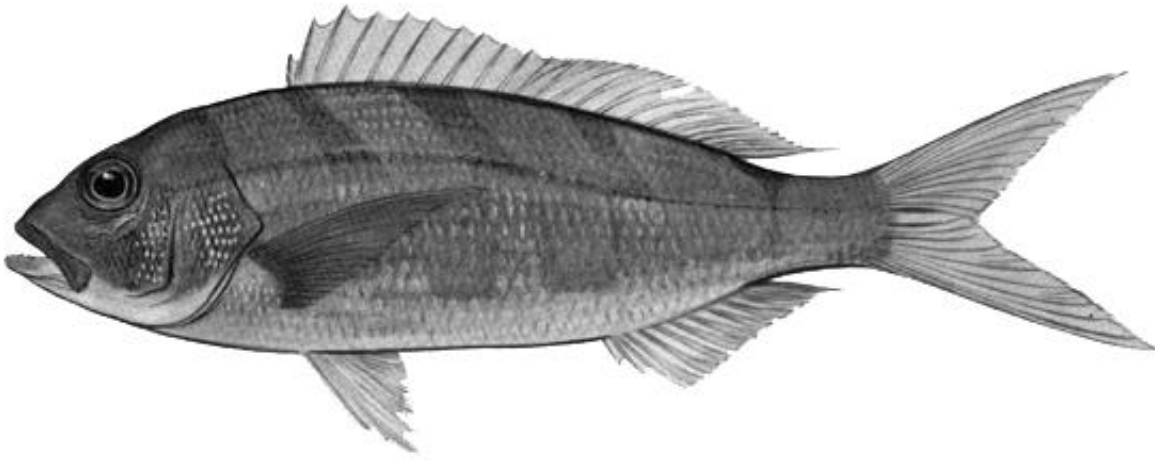


Figure 1. *Pristimoides zonatus* (Valenciennes, 1830), commonly known as gindai in the Hawaiian Islands (from Snappers of the world, FAO, Allen 1985)

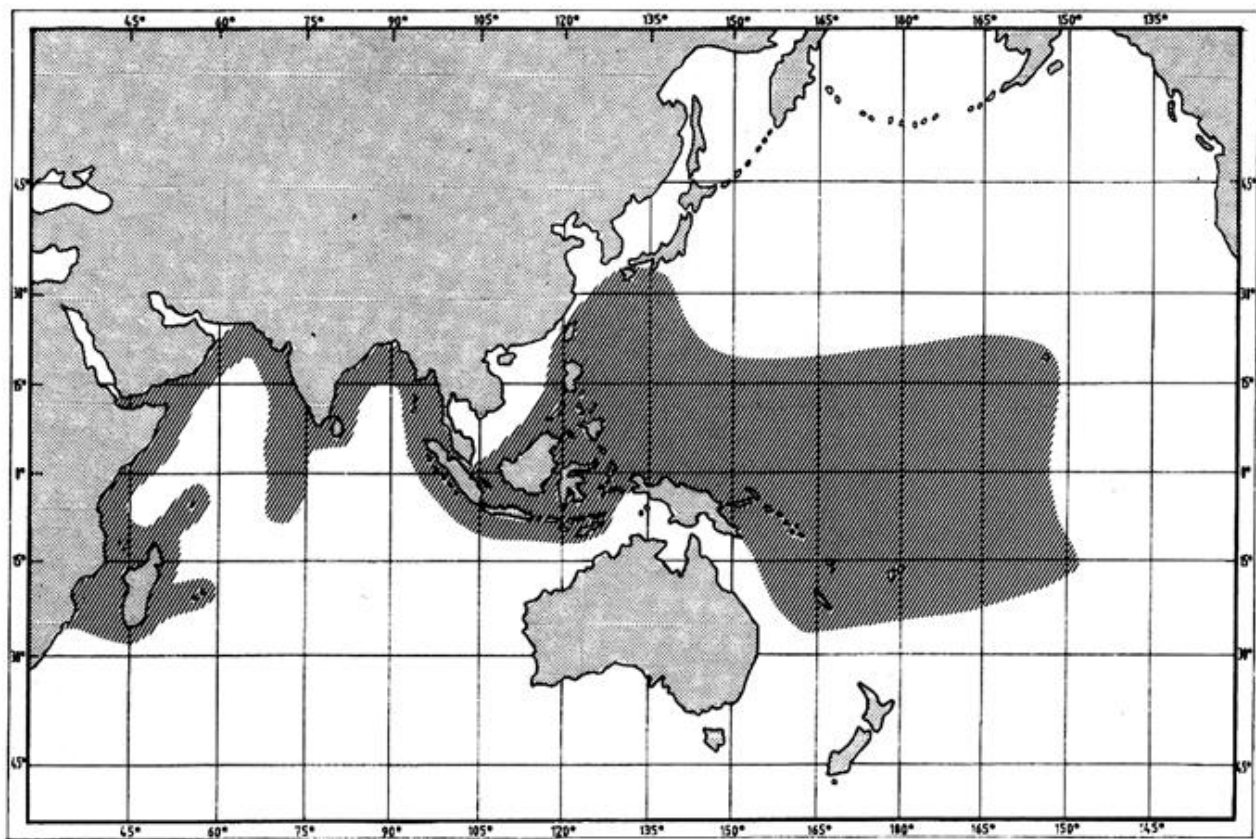


Figure 2. Known distribution of *P. zonatus* (Snappers of the world, FAO, Allen 1985)

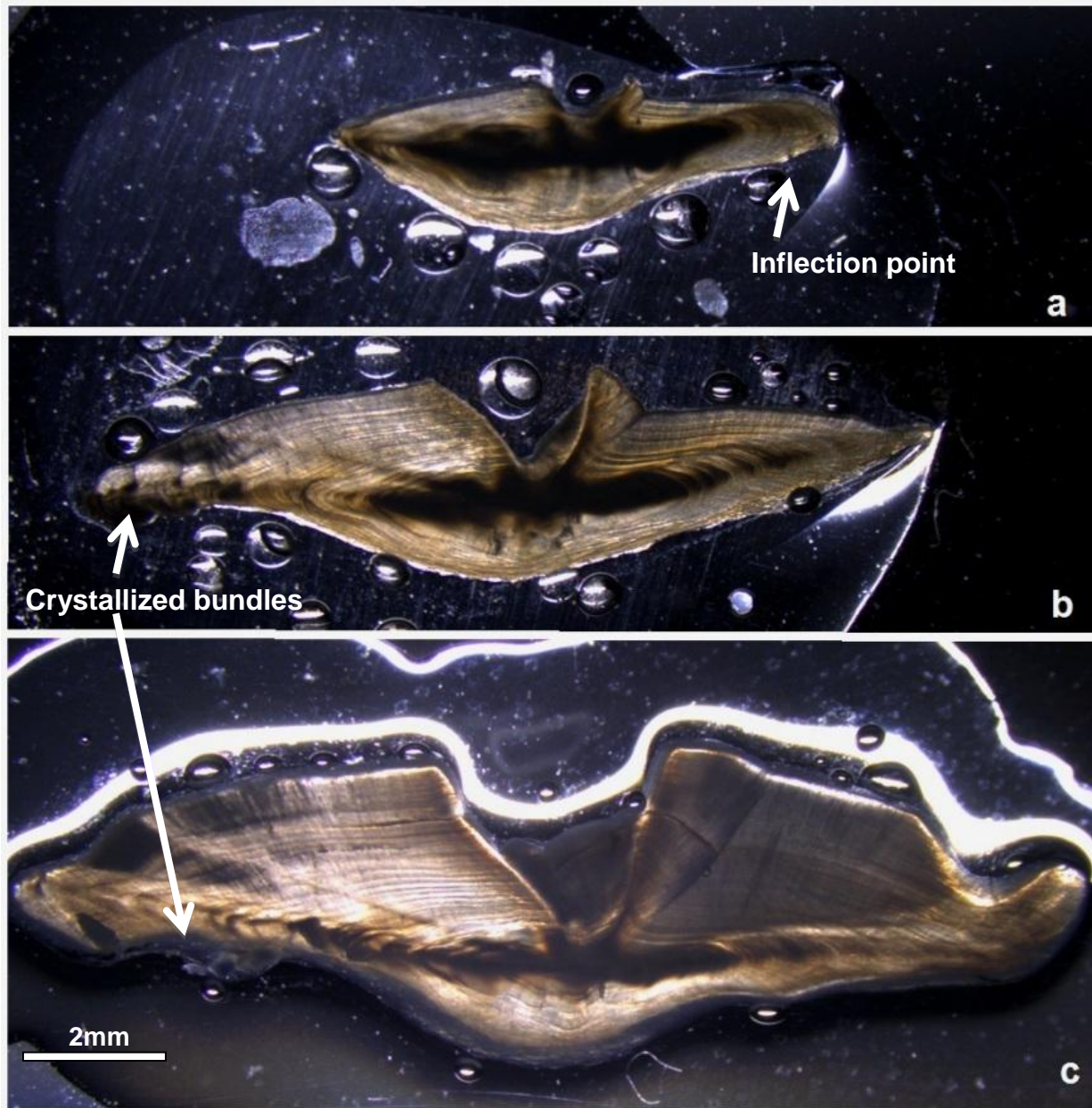


Figure 3. Series of otolith sections from three different *P. zonatus* specimens. The series ranges from the smallest to the largest fish with an intermediate otolith to display ontogenetic changes in growth structure. Specimen PZ 1 was aged at 1 years (a). Specimen PZ 27 was aged at 12 years (b). Specimen PZ 40 was aged at 33 years (c). This series demonstrates the amount of interpretation required in estimating the ages of younger *P. zonatus* specimens (i.e inflection points and surface indentations).

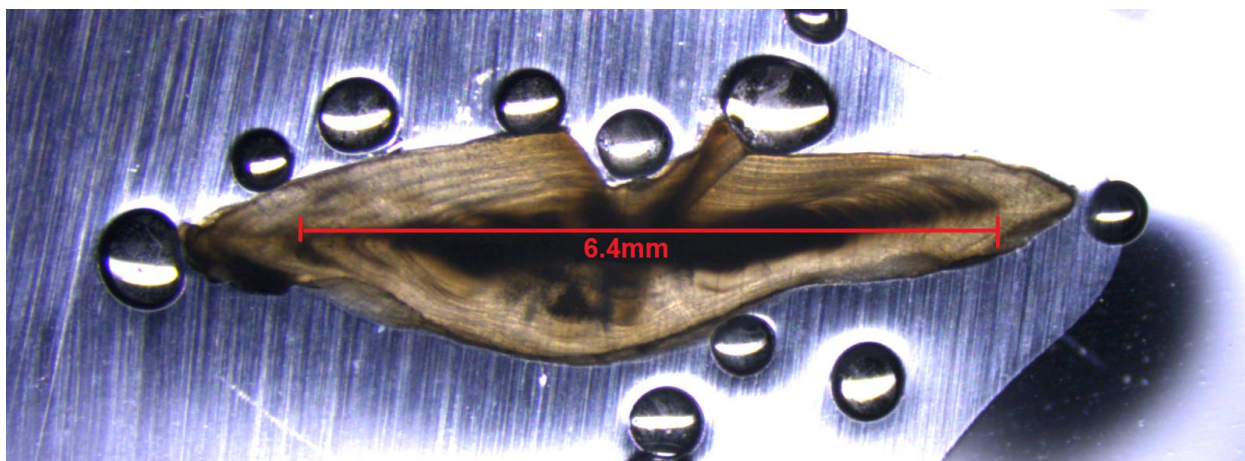


Figure 4. The first year of growth was estimated using the youngest *P. zonatus* specimen (PZ 01, 1 year), in concert with other structural observations in otoliths of older individuals was measured to be approximately 6.4mm along the dorso-ventral axis. This measurement was used as a standard in locating the first annulus in other sections and was part of the age estimation criteria.

Note: Scale bar not accurate because it was not calibrated at the time.

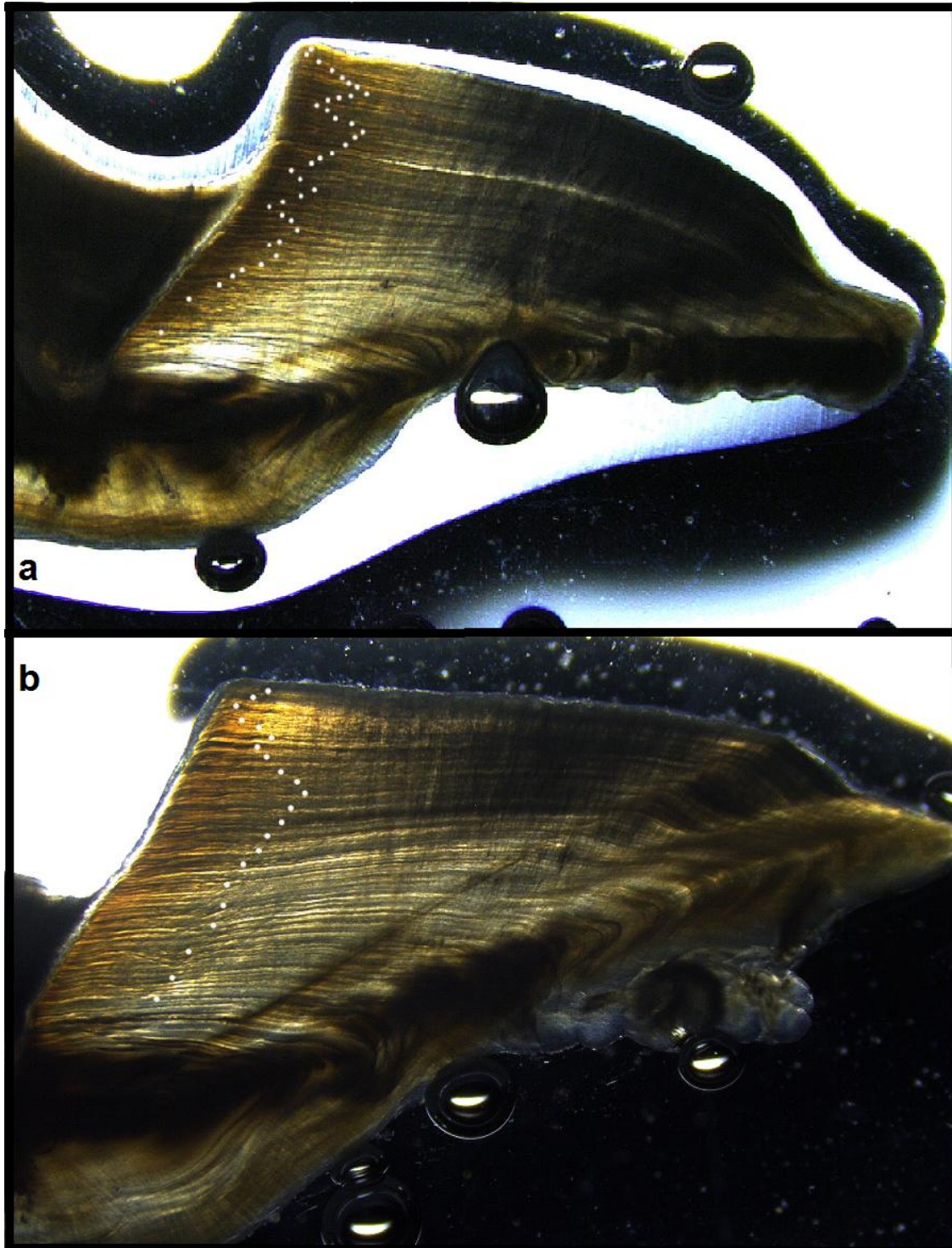


Figure 5. Pictured is a *P. zonatus* transverse otolith section from specimen PZ 90 (a) that was aged at 39 years. The zones counted are marked in this cross section image with white dots. The estimated annual growth zone counting and growth patterns were well defined in the more compressed bands than the early, lesser defined growth. Another section from specimen PZ 70 (b) was aged at 22 years. Growth patterns were well defined in both earlier and later, more compressed bands of growth. This definition was not typical for all specimens' otolith sections. Age-reading criteria, however, were defined using sections like this one.

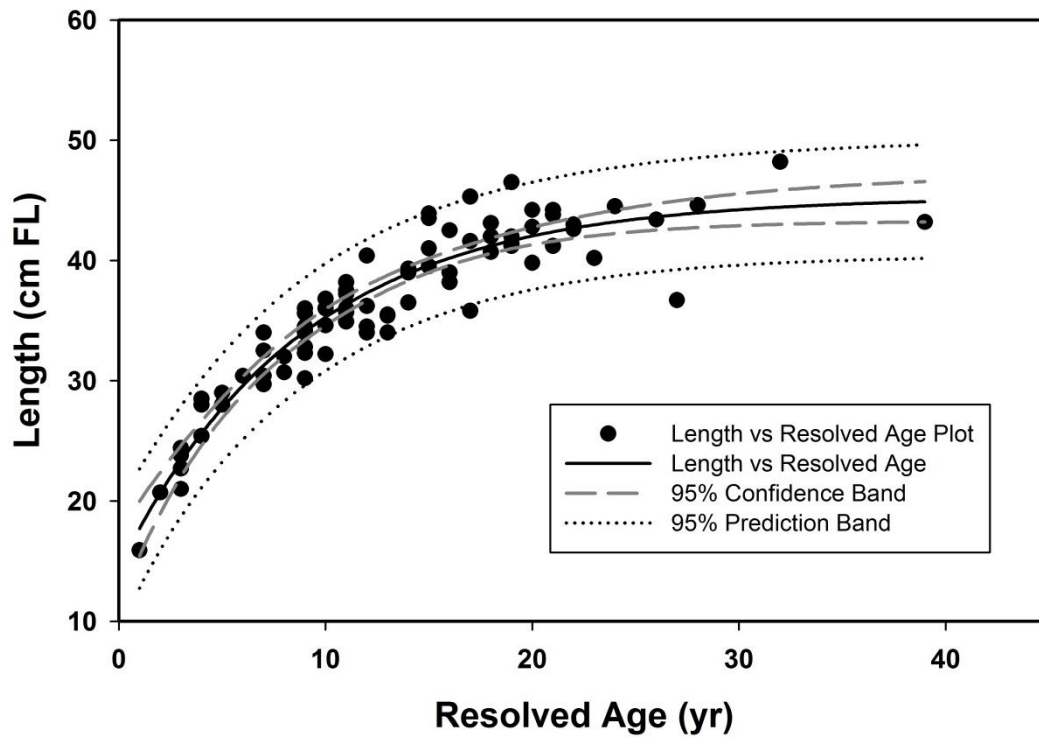


Figure 6. A length-at-age plot for *P. zonatus* from otolith section age estimates with a von Bertalanffy Growth Function fitted to those data ($L_{\infty} = 45.3$ cm FL, $k = 0.113 \text{ yr}^{-1}$, $t_0 = -3.40$ yr). The 95% confidence intervals were 0.025 yr^{-1} and ± 2.02 cm FL for k and L_{∞} , respectively.

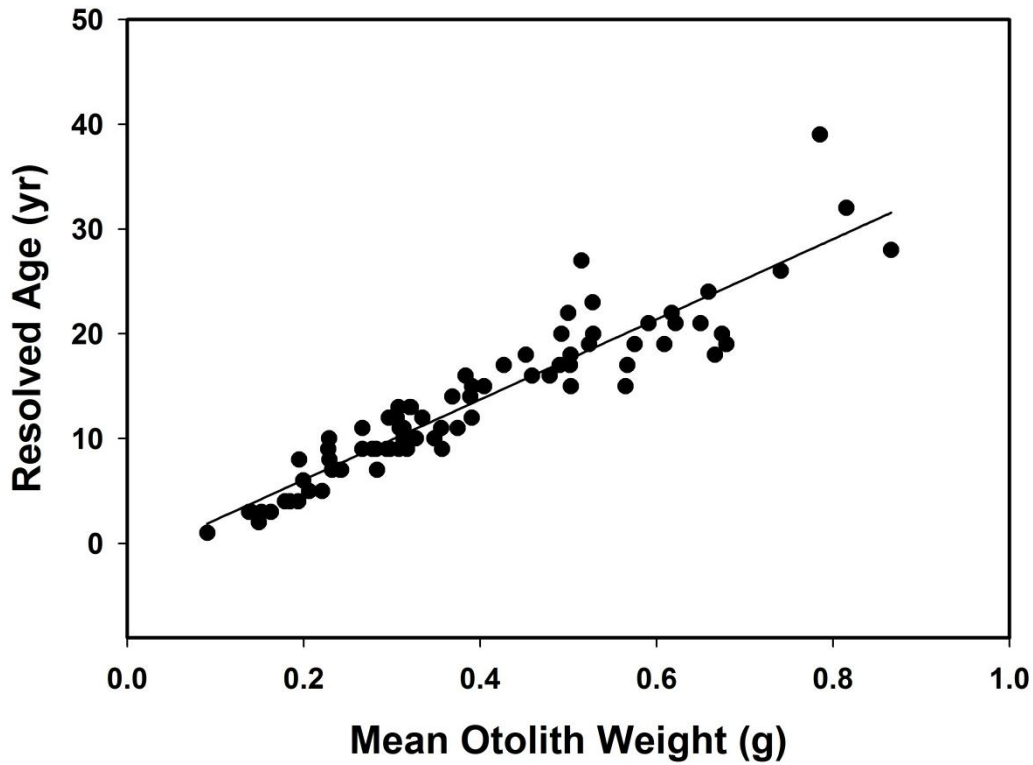


Figure 7. Regression of sagittal otolith weight as a predictor of estimated age for *P. zonatus* ($r^2 = 0.87$, $n = 80$). This relationship was used to estimate age for unaged fish specimens for which gonadal maturity was described.

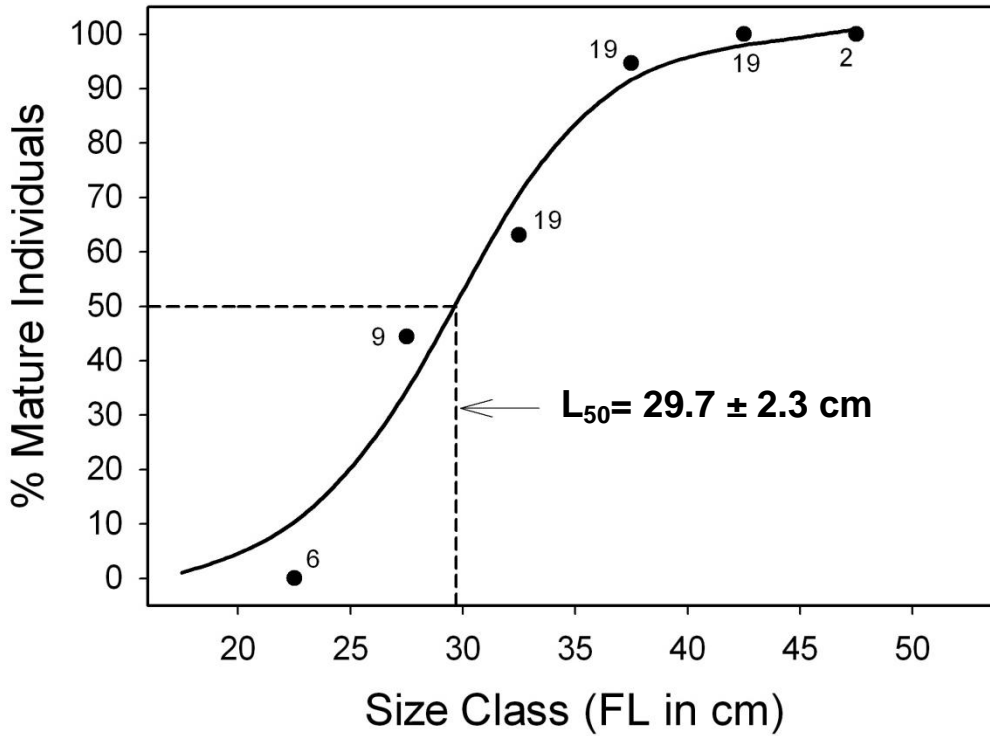


Figure 8. Mean body size at maturity (L_{50}) of pooled sexes (43 female, 31 male) for *P. zonatus* ($n=74$) was estimated to be 29.7 ± 2.3 cm FL. Numbers next to symbols represent the total number of fish in each size class (5 cm bins).

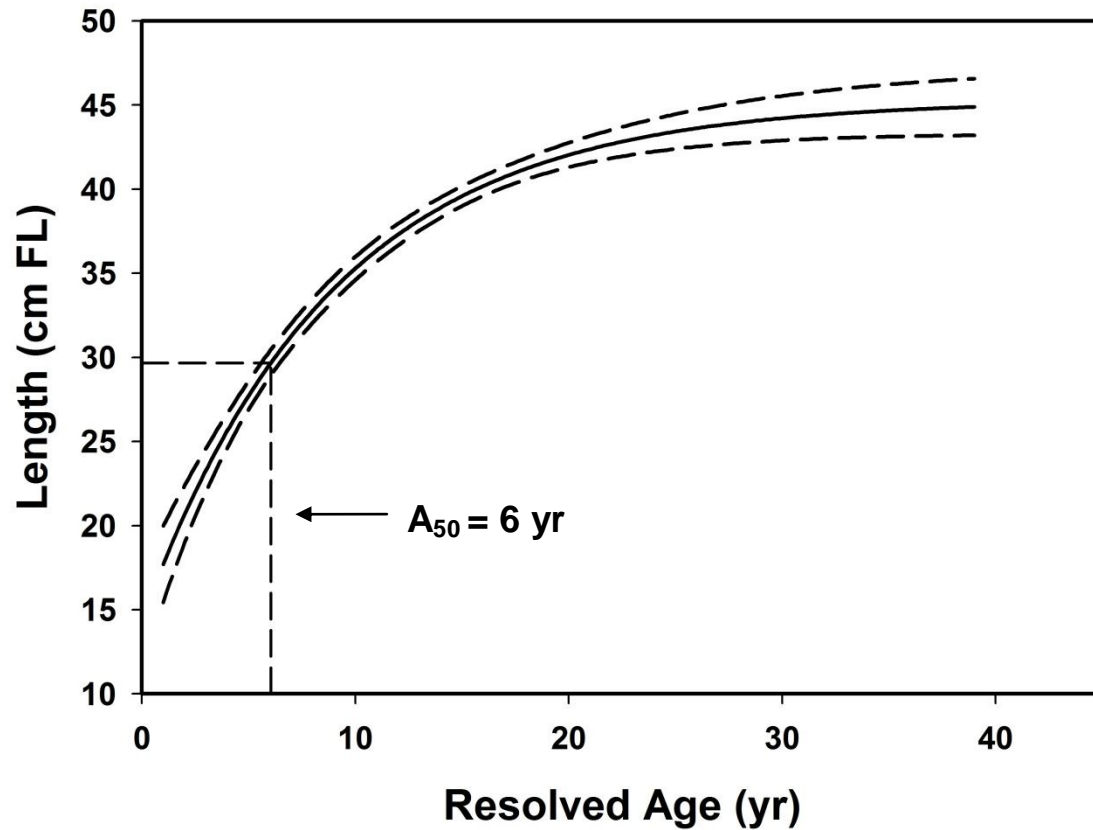


Figure 9. Plot of the VBGF for *P.zonatus* from all aged samples ($n=80$) with confidence interval of $\pm 0.025 \text{ yr}^{-1}$ and $\pm 2.02 \text{ cm FL}$, for k and L_{∞} , respectively. Arrow indicates the estimated median age-at-maturity (A_{50} , $6.0 \pm 0.44 \text{ yr}$) corresponding to the median length-at-maturity (L_{50} , $29.7 \pm 2.3 \text{ cm FL}$).

TABLES

Table 1. Age estimates for all 80 *P. zonatus* specimens for which both fork length and mean otolith weight data were available.

| ID | Fish Length (cm) | Mean Otolith Weight (g) | Estimated Age (yr) |
|-----------|-----------------------------|------------------------------------|-------------------------------|
| PZ 01 | 15.9 | 0.0908 | 1 |
| PZ 02 | 20.7 | 0.1491 | 2 |
| PZ 03 | 21.0 | 0.1383 | 3 |
| PZ 04 | 22.7 | 0.1404 | 3 |
| PZ 05 | 23.8 | 0.1523 | 3 |
| PZ 06 | 24.4 | 0.1628 | 3 |
| PZ 07 | 25.4 | 0.1844 | 4 |
| PZ 08 | 28.0 | 0.2210 | 5 |
| PZ 09 | 28.0 | 0.1787 | 4 |
| PZ 10 | 28.5 | 0.1937 | 4 |
| PZ 11 | 29.0 | 0.2064 | 5 |
| PZ 12 | 29.7 | 0.2415 | 7 |
| PZ 13 | 30.2 | 0.2278 | 9 |
| PZ 14 | 30.4 | 0.1994 | 6 |
| PZ 15 | 30.4 | 0.2320 | 7 |
| PZ 16 | 30.7 | 0.1947 | 8 |
| PZ 17 | 32.0 | 0.2294 | 8 |
| PZ 18 | 32.2 | 0.2288 | 10 |
| PZ 19 | 32.3 | 0.2821 | 9 |
| PZ 20 | 32.5 | 0.2424 | 7 |
| PZ 21 | 32.8 | 0.2979 | 9 |
| PZ 22 | 34.0 | 0.3171 | 9 |
| PZ 48 | 34.0 | 0.2832 | 7 |
| PZ 49 | 34.0 | 0.32145 | 13 |
| PZ 50 | 34.0 | 0.3054 | 12 |
| PZ 51 | 34.2 | 0.26645 | 9 |
| PZ 47 | 34.5 | 0.29655 | 12 |
| PZ 52 | 34.5 | 0.27795 | 9 |
| PZ 23 | 34.6 | 0.3131 | 10 |
| PZ 24 | 34.9 | 0.3128 | 11 |
| PZ 77 | 35.4 | 0.30745 | 13 |
| PZ 78 | 35.5 | 0.32005 | 13 |
| PZ 25 | 35.6 | 0.3570 | 9 |
| PZ 79 | 35.7 | 0.26655 | 11 |
| PZ 80 | 35.8 | 0.4269 | 17 |
| PZ 26 | 36.0 | 0.3078 | 9 |
| PZ 55 | 36.0 | 0.3088 | 11 |
| PZ 56 | 36.0 | 0.3482 | 10 |
| PZ 57 | 36.0 | 0.29405 | 9 |
| PZ 27 | 36.2 | 0.3345 | 12 |
| PZ 81 | 36.5 | 0.38875 | 14 |
| PZ 82 | 36.7 | 0.51465 | 27 |
| PZ 58 | 36.8 | 0.32705 | 10 |

| | | | |
|-------|------|---------|----|
| PZ 59 | 37.2 | 0.313 | 11 |
| PZ 83 | 37.5 | 0.3557 | 11 |
| PZ 28 | 38.2 | 0.3745 | 11 |
| PZ 60 | 38.2 | 0.3834 | 16 |
| PZ 29 | 39.0 | 0.3886 | 14 |
| PZ 61 | 39.0 | 0.45885 | 16 |
| PZ 84 | 39.3 | 0.36855 | 14 |
| PZ 62 | 39.5 | 0.3906 | 15 |
| PZ 30 | 39.8 | 0.4922 | 20 |
| PZ 85 | 40.2 | 0.52745 | 23 |
| PZ 86 | 40.4 | 0.3904 | 12 |
| PZ 64 | 40.7 | 0.4517 | 18 |
| PZ 31 | 41.0 | 0.4044 | 15 |
| PZ 65 | 41.2 | 0.64985 | 21 |
| PZ 87 | 41.2 | 0.6089 | 19 |
| PZ 66 | 41.4 | 0.52345 | 19 |
| PZ 88 | 41.6 | 0.49005 | 17 |
| PZ 89 | 41.6 | 0.5019 | 17 |
| PZ 32 | 42.0 | 0.5025 | 18 |
| PZ 68 | 42.0 | 0.57515 | 19 |
| PZ 69 | 42.5 | 0.4788 | 16 |
| PZ 70 | 42.6 | 0.61735 | 22 |
| PZ 33 | 42.8 | 0.5283 | 20 |
| PZ 71 | 43.0 | 0.49985 | 22 |
| PZ 34 | 43.1 | 0.6662 | 18 |
| PZ 90 | 43.2 | 0.78525 | 39 |
| PZ 35 | 43.4 | 0.7406 | 26 |
| PZ 36 | 43.5 | 0.5029 | 15 |
| PZ 72 | 43.8 | 0.59085 | 21 |
| PZ 73 | 43.9 | 0.56485 | 15 |
| PZ 37 | 44.2 | 0.6215 | 21 |
| PZ 74 | 44.2 | 0.67415 | 20 |
| PZ 75 | 44.5 | 0.6589 | 24 |
| PZ 38 | 44.6 | 0.8658 | 28 |
| PZ 76 | 45.3 | 0.56675 | 17 |
| PZ 39 | 46.5 | 0.6790 | 19 |
| PZ 40 | 48.2 | 0.8151 | 32 |

Table 2. Gonad data of N=74 *P. zonatus* specimens sorted by fish length. Age estimates with asterisks were predicted using the age-otolith weight relationship. Collection month, maturity (imm = immature and MAT = mature), and gonosomatic index (GSI) are provided.

| ID | Fish Length (cm) | Collection | Sex | Maturity | GSI | Estimated Age (yr) |
|-------|------------------|------------|-----|----------|-------|--------------------|
| PZ 01 | 15.9 | November | F | Imm | 0.071 | 1 |
| PZ 02 | 20.7 | June | M | Imm | 0.035 | 2 |
| PZ 03 | 21.0 | November | F | Imm | 0.065 | 3 |
| PZ 04 | 22.7 | April | F | Imm | 0.065 | 3 |
| PZ 05 | 23.8 | April | F | Imm | 0.278 | 3 |
| PZ 06 | 24.4 | September | F | Imm | 0.244 | 3 |
| PZ 07 | 25.4 | June | M | Imm | 0.036 | 4 |
| PZ 41 | 25.5 | June | M | Imm | 0.023 | 7* |
| PZ 08 | 28.0 | June | M | Imm | 0.175 | 5 |
| PZ 09 | 28.0 | April | M | M | 0.014 | 4 |
| PZ 42 | 28.4 | April | F | Imm | 0.010 | 5* |
| PZ 11 | 29.0 | April | M | M | 0.005 | 5 |
| PZ 12 | 29.7 | September | F | M | 0.418 | 7 |
| PZ 43 | 30.0 | April | F | M | 0.008 | 7* |
| PZ 44 | 30.0 | April | M | Imm | 0.135 | 8* |
| PZ 13 | 30.2 | September | F | M | 4.194 | 9 |
| PZ 45 | 30.2 | April | F | M | 0.122 | 6* |
| PZ 14 | 30.4 | April | F | Imm | 0.144 | 6 |
| PZ 15 | 30.4 | April | F | Imm | 0.205 | 7 |
| PZ 16 | 30.7 | June | M | Imm | 0.019 | 8 |
| PZ 17 | 32.0 | April | F | M | 0.018 | 8 |
| PZ 46 | 32.2 | November | F | M | 5.121 | 9* |
| PZ 19 | 32.3 | August | F | M | 5.435 | 9 |
| PZ 20 | 32.5 | September | M | M | 0.107 | 7 |
| PZ 21 | 32.8 | June | F | Imm | 0.793 | 9 |
| PZ 22 | 34.0 | April | F | Imm | 0.418 | 9 |
| PZ 47 | 34.0 | April | M | M | 0.034 | 12 |
| PZ 48 | 34.0 | April | M | M | 0.010 | 7 |
| PZ 49 | 34.0 | April | F | M | 0.580 | 13 |
| PZ 50 | 34.0 | April | F | Imm | 0.380 | 12 |
| PZ 51 | 34.2 | April | M | M | 0.086 | 9 |
| PZ 52 | 34.5 | April | F | Imm | 0.509 | 9 |
| PZ 23 | 34.6 | August | F | M | 3.742 | 10 |
| PZ 24 | 34.9 | August | F | M | 1.917 | 11 |
| PZ 77 | 35.4 | September | F | M | 1.080 | 13 |
| PZ 78 | 35.5 | September | F | M | 1.930 | 13 |
| PZ 25 | 35.6 | September | F | M | 0.962 | 9 |
| PZ 26 | 36.0 | April | M | M | 1.592 | 9 |
| PZ 55 | 36.0 | April | M | M | 0.041 | 11 |
| PZ 56 | 36.0 | April | M | M | 0.025 | 10 |
| PZ 57 | 36.0 | April | F | M | 0.032 | 9 |
| PZ 27 | 36.2 | April | M | M | - | 12 |
| PZ 58 | 36.8 | April | F | M | 1.443 | 10 |
| PZ 59 | 37.2 | April | F | M | 1.458 | 11 |

| | | | | | | |
|-------|------|-----------|---|-----|-------|-----|
| PZ 83 | 37.5 | December | F | M | 0.603 | 11 |
| PZ 28 | 38.2 | June | M | M | 0.050 | 11 |
| PZ 60 | 38.2 | April | F | M | 2.238 | 16 |
| PZ 29 | 39.0 | April | F | M | 4.438 | 14 |
| PZ 61 | 39.0 | September | F | M | 4.990 | 16 |
| PZ 84 | 39.3 | December | M | Imm | 0.034 | 14 |
| PZ 62 | 39.5 | June | M | M | 0.040 | 15 |
| PZ 63 | 39.6 | June | M | M | 0.139 | - |
| PZ 30 | 39.8 | September | F | M | 3.709 | 20 |
| PZ 64 | 40.7 | September | F | M | 3.421 | 18 |
| PZ 31 | 41.0 | April | M | M | 0.122 | 15 |
| PZ 65 | 41.2 | April | F | M | 6.215 | 21 |
| PZ 66 | 41.4 | September | F | M | 4.440 | 19 |
| PZ 67 | 41.6 | September | M | M | 0.160 | 17* |
| PZ 32 | 42.0 | November | F | M | 0.105 | 18 |
| PZ 68 | 42.0 | June | M | M | 4.428 | 19 |
| PZ 69 | 42.5 | April | M | M | 0.097 | 16 |
| PZ 70 | 42.6 | September | F | M | 3.190 | 22 |
| PZ 33 | 42.8 | September | M | M | 0.183 | 20 |
| PZ 71 | 43.0 | August | F | M | 3.877 | 22 |
| PZ 34 | 43.1 | June | F | M | 6.330 | 18 |
| PZ 35 | 43.4 | September | F | M | 3.981 | 26 |
| PZ 36 | 43.5 | September | M | M | 0.143 | 15 |
| PZ 72 | 43.8 | September | F | M | 3.199 | 21 |
| PZ 73 | 43.9 | September | M | M | 0.180 | 15 |
| PZ 74 | 44.2 | October | M | M | 0.136 | 20 |
| PZ 75 | 44.5 | May | M | M | 0.100 | 24 |
| PZ 38 | 44.6 | September | F | M | 3.256 | 28 |
| PZ 76 | 45.3 | September | M | M | 0.157 | 17 |
| PZ 39 | 46.5 | October | M | M | 0.089 | 19 |

Appendix A: *P. zonatus* otolith data sorted based on fish length (fork length). Capture date, location and depth, fish length (fork length), mean otolith weight, age estimates and sex (M = male and F = female) are provided. *P. zonatus* used for both age estimation and gonad histology are indicated with an X.

| Fish Data Number | Capture Date | FL (cm) | Location | Depth (Fm) | Mean Otolith Wt. (g) | Resolved Age | Sex | Gonad Histology |
|------------------|--------------|---------|-------------|------------|----------------------|--------------|-----|-----------------|
| OES2-1 | 11/28/08 | 15.9 | Kona | 164 | 0.0908 | 1 | F | X |
| IM7-7-3-407 | 06/17/08 | 20.7 | Necker | 100 | 0.1491 | 2 | M | - |
| OES2-14 | 11/22/08 | 21.0 | Kona | 139 | 0.1383 | 3 | F | X |
| OES3-24 | 04/25/09 | 22.7 | Kona | 93 | 0.1404 | 3 | F | X |
| OES3-23 | 04/25/09 | 23.8 | Kona | 87 | 0.1523 | 3 | F | X |
| OES-11-06-8 | 09/09/11 | 24.4 | Kona | 75 | 0.1628 | 3 | F | X |
| IM7-7-7-433 | 06/18/08 | 25.4 | Necker | 100 | 0.1844 | 4 | M | - |
| IM7-7-4-408 | 06/17/08 | 28.0 | Necker | 100 | 0.2210 | 4 | M | - |
| OES3-22 | 04/25/09 | 28.0 | Kona | 87 | 0.1787 | 4 | M | - |
| OES3-3 | 04/21/09 | 28.5 | Kona | 28.5 | 0.1937 | 4 | F | - |
| OES3-28 | 04/26/09 | 29.0 | Kona | 114 | 0.2064 | 5 | M | - |
| OES-11-06-5 | 09/08/11 | 29.7 | Kona | 91.6 | 0.2415 | 6 | F | X |
| OES-11-06-1 | 09/04/11 | 30.2 | Kona | 76 | 0.2278 | 6 | F | X |
| OES3-27 | 04/26/09 | 30.4 | Kona | 119.6 | 0.2320 | 5 | F | X |
| OES3-26 | 04/26/09 | 30.4 | Kona | 79.4 | 0.1994 | 5 | F | X |
| IM7-7-9-435 | 06/18/08 | 30.7 | Necker | 100 | 0.1947 | 6 | M | X |
| OES3-18 | 04/24/09 | 32.0 | Kona | 108 | 0.2294 | 6 | F | X |
| IM7-7-1-376 | 06/17/08 | 32.2 | Necker | 100 | 0.2288 | 7 | F | - |
| EE1-1 | 08/31/11 | 32.3 | Kaena Point | 107 | 0.2821 | 7 | F | X |
| OES-11-06-2 | 09/06/11 | 32.5 | Kona | 89 | 0.2424 | 7 | M | - |
| IM7-8-1-437 | 06/18/08 | 32.8 | Necker | 100 | 0.2979 | 7 | F | X |
| OES3-34 | 04/28/09 | 34.0 | Kona | 120 | 0.3171 | 8 | F | X |
| EE1-3 | 08/31/11 | 34.6 | Kaena Point | 107 | 0.3131 | 8 | F | X |
| SB1-3 | 08/31/10 | 34.9 | Oahu | 85.2 | 0.3128 | 8 | F | X |
| OES-11-06-9 | 09/10/11 | 35.6 | Kona | 90 | 0.3570 | 9 | F | X |
| OES3-33 | 04/28/09 | 36.0 | Kona | 120 | 0.3078 | 9 | M | - |
| OES3-9 | 04/23/09 | 36.2 | Kona | 81 | 0.3345 | 11 | F | - |
| IM7-7-6-427 | 06/18/08 | 38.2 | Necker | 90 | 0.3745 | 12 | M | - |
| OES3-13 | 04/24/09 | 39.0 | Kona | 110 | 0.3886 | 15 | F | X |
| KP3-5-10-219 | 09/10/07 | 39.8 | E. Twin | 112 | 0.4922 | 20 | F | X |

| | | | | | | | | |
|---------------|----------|------|----------|-------|---------|----|---|---|
| OES3-11 | 04/24/09 | 41.0 | Kona | 110 | 0.4044 | 16 | M | - |
| KP3-6-5-267 | 09/11/07 | 42.0 | E. Twin | 119 | 0.5025 | 19 | F | - |
| KP3-6-3-241 | 09/11/07 | 42.8 | E. Twin | 128 | 0.5283 | 21 | M | - |
| KP3-6-6-270 | 09/11/07 | 43.1 | E. Twin | 119 | 0.6662 | 20 | F | X |
| KP4-4-3-359 | 10/20/07 | 43.4 | W. Twin | 118 | 0.7406 | 23 | F | X |
| OES-11-06-4 | 09/08/11 | 43.5 | Kona | 100 | 0.5029 | 19 | M | - |
| KP3-5-8-217 | 09/10/07 | 44.2 | E. Twin | 104 | 0.6215 | 23 | F | - |
| KP3-5-7-211 | 09/10/07 | 44.6 | E. Twin | 120 | 0.8658 | 32 | F | X |
| KP4-4-2-358 | 10/20/07 | 46.5 | W. Twin | 110 | 0.6790 | 22 | M | - |
| OES1-11-8-108 | 06/27/07 | 48.2 | Necker | 147 | 0.8151 | 31 | F | - |
| OES3-31 | 04/28/09 | 34.0 | Kona | 93 | 0.30575 | | M | - |
| OES3-21 | 04/25/09 | 34.0 | Kona | 117.8 | 0.2832 | | M | X |
| OES3-14 | 04/24/09 | 34.0 | Kona | 115 | 0.32145 | | M | X |
| OES3-32 | 04/28/09 | 34.0 | Kona | 93 | 0.3054 | | F | X |
| OES3-30 | 04/27/09 | 34.2 | Kona | 112.7 | 0.26645 | | F | X |
| OES3-16 | 04/24/09 | 34.5 | Kona | 118 | 0.27795 | | M | X |
| OES3-35 | 04/28/09 | 36.0 | Kona | - | 0.3088 | | F | X |
| OES3-37 | 04/28/09 | 36.0 | Kona | 143 | 0.3482 | | M | X |
| OES3-17 | 04/24/09 | 36.0 | Kona | 122 | 0.29405 | | M | X |
| OES3-19 | 04/24/09 | 36.8 | Kona | 138 | 0.32705 | | F | X |
| OES3-29 | 04/26/09 | 37.2 | Kona | 76.5 | 0.313 | | F | X |
| OES3-12 | 04/24/09 | 38.2 | Kona | 110 | 0.3834 | | F | X |
| KP4-4-4-353 | 10/20/07 | 39.0 | W. Twin | 112 | 0.45885 | | F | X |
| IM7-7-5-423 | 06/18/08 | 39.5 | Necker | 90 | 0.3906 | | F | X |
| KP9-1-4-567 | 05/17/08 | 40.7 | E. Twin | 117 | 0.4517 | | M | X |
| KP3-6-1-228 | 09/11/07 | 41.2 | E. Twin | 133 | 0.64985 | | F | X |
| KP3-6-7-272 | 09/11/07 | 41.4 | E. Twin | 108 | 0.52345 | | F | X |
| KP10-1-4-469 | 06/18/08 | 42.0 | W. Nihoa | 135 | 0.57515 | | F | X |
| OES3-15 | 04/24/09 | 42.5 | Kona | 131 | 0.4788 | | M | X |
| KP3-5-6-207 | 09/10/07 | 42.6 | E. Twin | 116 | 0.61735 | | M | X |
| KP3-6-4-263 | 09/11/07 | 43.0 | E. Twin | 121 | 0.49985 | | F | X |
| KP4-4-5-332 | 10/18/07 | 43.8 | E. Twin | 120 | 0.59085 | | F | X |
| KP3-5-9-218 | 09/10/07 | 43.9 | E. Twin | 112 | 0.56485 | | F | X |
| KP4-4-1-275 | 10/18/07 | 44.2 | E. Twin | 120 | 0.67415 | | M | X |
| KP9-1-5-561 | 05/17/08 | 44.5 | E. Twin | 96 | 0.6589 | | M | X |
| KP3-6-2-229 | 09/11/07 | 45.3 | E. Twin | 140 | 0.56675 | | M | X |

| | | | | | | | |
|---------------|----------|------|--------|-----|---------|---|---|
| OES-11-06-7 | 09/08/11 | 35.4 | Kona | 110 | 0.30745 | M | X |
| OES-11-06-10 | 09/10/11 | 35.5 | Kona | 90 | 0.32005 | F | X |
| OES3-10 | 04/23/09 | 35.7 | Kona | 81 | 0.26655 | F | X |
| OES1-7-4-64 | 06/22/07 | 35.8 | Maro | - | 0.4269 | F | - |
| OES1-1-7-7 | 06/20/07 | 36.5 | Maro | 114 | 0.38875 | F | - |
| OES1-7-3-63 | 06/22/07 | 36.7 | Maro | - | 0.51465 | F | - |
| OES2-52 | 12/01/08 | 37.5 | Kona | 85 | 0.3557 | F | X |
| OES2-44 | 12/01/04 | 39.3 | Kona | 86 | 0.36855 | M | X |
| OES1-7-7-67 | 06/25/07 | 40.2 | Necker | 150 | 0.52745 | F | - |
| OES3-42 | 04/28/09 | 40.4 | Kona | 105 | 0.3904 | F | - |
| OES1-5-8-48 | 06/21/07 | 41.2 | Maro | 109 | 0.6089 | F | - |
| OES-11-06-6 | 09/08/11 | 41.6 | Kona | 94 | 0.49005 | M | - |
| OES1-11-4-104 | 06/27/07 | 41.6 | Necker | 114 | 0.5019 | M | X |
| OES1-1-8-8 | 06/20/07 | 43.2 | Maro | 114 | 0.78525 | F | - |

Appendix B: Gonad histology data sorted based on fish length (fork length). Collection date, location and depth, fish length, gonad weight, sex, maturity (Imm = immature and M = mature), gonosomatic index (GSI), gonad stage, atretic stage and atretic score are provided. Gonad weights in bold were estimated using SAS. *P. zonatus* used in both age estimation and for histology are indicated with an X.

| Fish Data Number | Date Caught | Location | Depth (Fm) | FL (cm) | Gonad Weight (g) | GSI | Sex | Maturity | Gonad Stage | Atretic Stage | Atretic Score | Age Estimation |
|------------------|-------------|-------------|------------|---------|------------------|-------|-----|----------|-------------|---------------|---------------|----------------|
| OES2-1 | 11/28/2008 | Kona | 164 | 15.9 | 0.05 | 0.071 | F | Imm | 1 | - | 0 | X |
| IM7-7-3-407 | 6/17/2008 | Necker | 100 | 20.7 | 0.08 | 0.035 | M | Imm | 1.1 | - | - | X |
| OES2-14 | 11/22/2008 | Kona | 139 | 21.0 | 0.44 | 0.065 | F | Imm | 1 | - | 0 | X |
| OES3-24 | 4/25/2009 | Kona | 93 | 22.7 | 0.28 | 0.065 | F | Imm | 2.1 | - | 0 | X |
| OES3-23 | 4/25/2009 | Kona | 87 | 23.8 | 0.64 | 0.278 | F | Imm | 2.2 | - | 0 | X |
| OES-11-06-8 | 9/9/2011 | Kona | 75 | 24.4 | 0.61 | 0.244 | F | Imm | 2.1 | - | 0 | X |
| IM7-7-7-433 | 6/18/2008 | Necker | 100 | 25.4 | 0.14 | 0.036 | M | Imm | 1.1 | - | - | X |
| IM7-7-2-405 | 6/17/2008 | Necker | 90 | 25.5 | 0.10 | 0.023 | M | Imm | 1.1 | - | - | - |
| OES3-22 | 4/25/2009 | Kona | 87 | 28.0 | 0.09 | 0.175 | M | M | 2 | - | - | X |
| IM7-7-4-408 | 6/17/2008 | Necker | 100 | 28.0 | 0.91 | 0.014 | M | Imm | 1.1 | - | - | X |
| OES3-20 | 4/25/2009 | Kona | 80.3 | 28.4 | 0.09 | 0.010 | F | Imm | 0 | - | 0 | - |
| OES3-28 | 4/26/2009 | Kona | 114 | 29.0 | 0.08 | 0.005 | M | M | 3 | - | - | X |
| OES-11-06-5 | 9/8/2011 | Kona | 91.6 | 29.7 | 2.09 | 0.418 | F | M | 6.2.1 | 3 | 1 | X |
| OES3-39 | 4/28/2009 | Kona | 85.2 | 30.0 | 0.14 | 0.008 | M | Imm | 1.1 | - | - | - |
| OES3-40 | 4/28/2009 | Kona | 90.1 | 30.0 | 2.61 | 0.135 | F | M | 6.2.1 | 4 | 1 | - |
| OES-11-06-1 | 9/4/2011 | Kona | 76 | 30.2 | 20.97 | 4.194 | F | M | 5.2 | - | 0 | X |
| OES3-25 | 4/25/2009 | Kona | - | 30.2 | 2.07 | 0.122 | F | M | 6.3 | 3 | 1 | - |
| OES3-27 | 4/26/2009 | Kona | 119.6 | 30.4 | 3.41 | 0.144 | F | Imm | 2.2 | - | 0 | X |
| OES3-26 | 4/26/2009 | Kona | 79.4 | 30.4 | 2.90 | 0.205 | F | Imm | 3 | - | 0 | X |
| IM7-7-9-435 | 6/18/2008 | Necker | 100 | 30.7 | 0.12 | 0.019 | M | Imm | 1.1 | - | - | X |
| OES3-18 | 4/24/2009 | Kona | 108 | 32.0 | 3.23 | 0.018 | F | M | 6.2.2 | 2 | 2 | X |
| SB1-1 | 11/22/2008 | Kona | 139 | 32.2 | 96.27 | 5.121 | F | M | 5.15 | - | 0 | - |
| EE1-1 | 8/31/2011 | Kaena Point | 107 | 32.3 | 41.85 | 5.435 | F | M | 5.15 | - | 0 | X |
| OES-11-06-2 | 9/6/2011 | Kona | 89 | 32.5 | 0.80 | 0.107 | M | M | 2 | - | - | X |
| IM7-8-1-437 | 6/18/2008 | Necker | 100 | 32.8 | 6.82 | 0.793 | F | Imm | 3 | - | 0 | X |
| OES3-34 | 4/28/2009 | Kona | 120 | 34.0 | 7.67 | 0.418 | F | Imm | 2.2 | - | 0 | X |
| OES3-31 | 4/28/2009 | Kona | 93 | 34.0 | 0.20 | 0.034 | M | M | 2 | - | - | X |
| OES3-21 | 4/25/2009 | Kona | 117.8 | 34.0 | 0.43 | 0.010 | M | M | 3 | - | - | X |
| OES3-14 | 4/24/2009 | Kona | 115 | 34.0 | 7.44 | 0.580 | F | M | 6.3 | 3 | 1 | X |

| | | | | | | | | | | | | |
|--------------|------------|-------------|-------|------|--------------|-------|---|-----|-------|---|---|---|
| OES3-32 | 4/28/2009 | Kona | 93 | 34.0 | 8.76 | 0.380 | F | Imm | 2.2 | - | 0 | X |
| OES3-30 | 4/27/2009 | Kona | 112.7 | 34.2 | 0.43 | 0.086 | M | M | 3 | - | - | X |
| OES3-16 | 4/24/2009 | Kona | 118 | 34.5 | 5.09 | 0.509 | F | Imm | 2.2 | - | 0 | X |
| EE1-3 | 8/31/2011 | Kaena Point | 107 | 34.6 | 34.05 | 3.742 | F | M | 5.2 | - | 0 | X |
| SB1-3 | 8/31/2010 | Oahu | 85.2 | 34.9 | 33.54 | 1.917 | F | M | 6.4 | 4 | 1 | X |
| OES-11-06-7 | 9/8/2011 | Kona | 110 | 35.4 | 10.80 | 1.080 | F | M | 5.1 | - | 0 | X |
| OES-11-06-10 | 9/10/2011 | Kona | 90 | 35.5 | 19.30 | 1.930 | F | M | 5.1 | - | 0 | X |
| OES-11-06-9 | 9/10/2011 | Kona | 90 | 35.6 | 9.62 | 0.962 | F | M | 5.1 | - | 0 | X |
| OES3-33 | 4/28/2009 | Kona | 120 | 36.0 | 0.41 | 1.592 | M | M | 3 | - | - | X |
| OES3-35 | 4/28/2009 | Kona | - | 36.0 | 0.31 | 0.041 | M | M | 2 | - | - | X |
| OES3-37 | 4/28/2009 | Kona | 143 | 36.0 | 0.38 | 0.025 | M | M | 2 | - | - | X |
| OES3-17 | 4/24/2009 | Kona | 122 | 36.0 | 3.98 | 0.032 | F | M | 6.2.2 | 2 | 2 | X |
| OES3-9 | 4/23/2009 | Kona | 81 | 36.2 | 0.72 | - | M | M | 3 | - | - | X |
| OES3-19 | 4/24/2009 | Kona | 138 | 36.8 | 10.82 | 1.443 | F | M | 6.2.2 | 2 | 1 | X |
| OES3-29 | 4/26/2009 | Kona | 76.5 | 37.2 | 21.87 | 1.458 | F | M | 6.2.2 | 3 | 1 | X |
| OES2-52 | 12/1/2004 | Kona | 85 | 37.5 | 13.56 | 0.603 | F | M | 6.21 | 4 | 2 | X |
| OES3-12 | 4/24/2009 | Kona | 110 | 38.2 | 13.43 | 0.050 | F | M | 6.3 | 3 | 1 | X |
| IM7-7-6-427 | 6/18/2008 | Necker | 90 | 38.2 | 0.71 | 2.238 | M | M | 2 | - | - | X |
| KP4-4-4-353 | 9/10/2007 | E. Twin | 120 | 39.0 | 55.92 | 4.438 | F | M | 4 | - | 0 | X |
| OES3-13 | 4/24/2009 | Kona | 110 | 39.0 | 24.95 | 4.990 | F | M | 4 | - | 0 | X |
| OES2-44 | 12/1/2004 | Kona | 86 | 39.3 | 0.95 | 0.034 | M | Imm | 1.1 | - | - | X |
| IM7-7-5-423 | 6/18/2008 | Necker | 90 | 39.5 | 0.57 | 0.040 | M | M | 2 | - | - | X |
| IM7-7-10-436 | 6/18/2008 | Necker | 100 | 39.6 | 2.05 | 0.139 | M | M | 3 | - | - | - |
| KP3-5-10-219 | 9/10/2007 | E. Twin | 116 | 39.8 | 51.93 | 3.709 | F | M | 4 | - | 0 | X |
| KP9-1-4-567 | 9/10/2007 | E. Twin | 112 | 40.7 | 51.65 | 3.421 | F | M | 5.1 | - | 0 | X |
| OES3-11 | 4/24/2009 | Kona | 110 | 41.0 | 0.73 | 0.122 | M | M | 3 | - | - | X |
| KP3-6-1-228 | 4/21/2009 | Kona | 28.5 | 41.2 | 105.66 | 6.215 | F | M | 5.15 | - | 0 | - |
| KP3-6-7-272 | 9/11/2007 | E. Twin | 119 | 41.4 | 72.82 | 4.440 | F | M | 5.1 | - | 0 | X |
| OES-11-06-6 | 9/8/2011 | Kona | 94 | 41.6 | 2.40 | 0.160 | M | M | 2 | - | - | - |
| KP3-6-5-267 | 11/28/2008 | Kona | 164 | 42.0 | 77.94 | 0.105 | F | M | 5.1 | - | 0 | - |
| KP10-1-4-469 | 6/18/2008 | W. Nihoa | 135 | 42.0 | 1.74 | 4.428 | M | M | 2 | - | - | X |
| OES3-15 | 4/24/2009 | Kona | 131 | 42.5 | 0.97 | 0.097 | M | M | 3 | - | - | X |
| KP3-5-6-207 | 9/11/2007 | E. Twin | 121 | 42.6 | 57.42 | 3.190 | F | M | 4 | - | 0 | X |
| KP3-6-3-241 | 9/11/2007 | E. Twin | 128 | 42.8 | 3.04 | 0.183 | M | M | 2 | - | - | X |
| KP3-6-4-263 | 8/23/2010 | Oahu | 100 | 43.0 | 66.68 | 3.877 | F | M | 4 | - | 0 | X |
| KP3-6-6-270 | 6/17/2008 | Necker | 100 | 43.1 | 119.06 | 6.330 | F | M | 5.1 | - | 0 | X |

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|-------------|------------|---------|-----|------|--------------|-------|---|---|-----|---|---|---|
| KP4-4-3-359 | 9/11/2007 | E. Twin | 133 | 43.4 | 70.86 | 3.981 | F | M | 4 | - | 0 | X |
| OES-11-06-4 | 9/8/2011 | Kona | 100 | 43.5 | 2.51 | 0.143 | M | M | 3 | - | - | X |
| KP4-4-5-332 | 9/11/2007 | E. Twin | 108 | 43.8 | 62.70 | 3.199 | F | M | 5.1 | - | 0 | X |
| KP3-5-9-218 | 9/10/2007 | E. Twin | 112 | 43.9 | 3.42 | 0.180 | M | M | 3 | - | - | X |
| KP4-4-1-275 | 10/18/2007 | E. Twin | 120 | 44.2 | 2.55 | 0.136 | M | M | 2 | - | - | X |
| KP9-1-5-561 | 5/17/2008 | E. Twin | 96 | 44.5 | 2.02 | 0.100 | M | M | 3 | - | - | X |
| KP3-5-7-211 | 9/11/2007 | E. Twin | 119 | 44.6 | 63.16 | 3.256 | F | M | 5.1 | - | 0 | X |
| KP3-6-2-229 | 9/11/2007 | E. Twin | 140 | 45.3 | 3.18 | 0.157 | M | M | 3 | - | - | X |
| KP4-4-2-358 | 10/20/2007 | W. Twin | 110 | 46.5 | 1.87 | 0.089 | M | M | 3 | - | - | X |