Report of Vermilion Snapper Otolith Aging; 1994-2000 Data Summary

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Introduction

During the years 1994 to 2000, 3582 vermilion snapper otoliths were collected along with corresponding biological data. These data were collected during 701 separate sampling sessions of Gulf of Mexico landings from Florida to Texas. The main sampling programs which collected vermilion snapper otoliths included: the trip interview program (TIP), the Beaufort head boat survey and the National Marine Fisheries Service Panama City laboratory sampling program. Biological samples were collected from private boats, charter boats, head boats, commercial boats and scientific surveys. A concentrated effort was made in 2000 to intensively sample vermilion snapper in anticipation of a stock assessment in 2001. Sagittal otoliths were sub-sampled for age determination in an effort to be as representative as possible by gear and location. For this report we present our results of age and size frequency distributions of vermilion snapper by year, fishing mode and sampling region.

Year 2000 Otolith sampling statistics

Forty-four percent of all vermilion snapper otoliths sampled from 1994 to 2000 were collected during the 2000 sampling year. Of the main sampling programs, the TIP program provided over 50% of the otoliths with a mean of 12 otoliths collected per sampling session (s.d.= 10) (Table 1) (Fig. 1A.). Five TIP port agents contributed otoliths mainly from commercial sources. The Panama City laboratory sampling program provided the next largest number of vermilion snapper otoliths with 619 (39.3%, mean otoliths per trip= 6, s.d.= 5). Three Beaufort head boat samplers collected 10.3% of the total vermilion snapper otoliths from party boats (mean otoliths per trip= 5, s.d.= 2.7).

During 2000 the majority of vermilion snapper otoliths collected from the Gulf of Mexico were from Florida landings (90.1%) followed by Louisiana (5.46%), Alabama (2.28%), Texas (1.78%) and Mississippi (0.38%) (Fig. 1B). The fishing mode recorded most frequently was commercial hook and line (48.54%) (Fig. 1C). Scientific surveys accounted for 32.55% of otoliths collected with most fish landed by hook and line with only 6 individuals collected in traps. Head boat landings represented 12.88% of vermilion snapper otoliths collected followed by charter boat landings at 6.03%. Private recreational boats were not sampled in 2000. Vermilion snapper otoliths were collected during every month of 2000. Beaufort head boat samples and charter boat samples were confined to summer and early fall months, while commercial and scientific survey samples were collected throughout the year.

Size frequency distributions

2000

We noted several differences when we compared total lengths (TL) by fishing mode for fish collected in 2000. The commercial fishery provided the greatest percentage of large individuals with a dominant size class in the 400-450 mm TL size range (Fig.2). Over 90% of all vermilion snapper collected from scientific survey were included in the 201-299 mm TL size class. This large percentage of small fish resulted because the scientific survey was conducted using relatively small hooks (1/0) but, more importantly, sampled fish under the legal size limit (10 inches, 254 mm TL). The head boat fishery included a wide array of size classes with most vermilion collected within the 251-450 mm TL size range. The charter boat fishery size distribution was similar to the head boat size distribution, but included fewer fish under 300 mm TL.

Size distributions were also compared for commercial samples obtained from Florida and Louisiana to determine if there was a difference in size distributions between the eastern and western Gulf of Mexico. The size distribution between east and west gulf was similar with the majority of vermilion snapper collected in the 351-499 mm TL size classes (Fig. 3). Recreational samples were not compared due to the relatively small number of samples from the western gulf.

1994-2000

Length frequency distributions were also generated for all vermilion snapper sampled for otoliths. Total lengths (TL) ranged from 161 to 576 mm TL . Length frequency from the commercial hook and line fishery indicated a shift to larger sizes through time with a mode in the

300-350 mm TL size class in 1994 to a mode of 400-450 mm TL in 2000 (Fig. 4). This size increase could partially be explained by an increase in the legal size limit in late 1997 from 8 inches (204 mm) to 10 inches (254 mm). Recreational length frequency distributions (i.e., head boat and charter boat landings) also indicated an increase in TL through time (Fig. 5). The modes for 1994-1996 were in the 251-299 mm TL size class and in 1999 in the 300-399 mm TL size class. The 2000 sample indicated a bi-modal distribution with modes in the 251-299 mm TL size class and the 400-450 mm TL size class. The years 1997 and 1998 also included a higher percentage of large fish however, relatively few lengths were recorded during those years.

Age determinations

We followed the processing method of Cowan et al. (1995). The sectioned otoliths were assigned an age based on the count of annuli (opaque zones observed with reflected light) and the degree of marginal edge completion. For example, otoliths were advanced a year in age after January 1st if their edge-type was a nearly complete translucent zone. Typically, marine fish in the southeastern U.S. complete annulus formation (opaque zone formation) by late-spring to early summer. Therefore an otolith with two completed annuli and a large translucent zone would be classified as age 3 if the fish was caught during spring in expectation that a 3rd (opaque) annulus would have soon formed. After June 30, when opaque zone formation is typically complete, all fish were assigned an age equal to the annulus count by convention. By this traditional method, an annual age cohort is based on a calender year rather than time since spawning (Jearld 1983).

For the year 2000 samples, 500 otoliths (32%) were randomly selected for age determinations. Otolith collections from 1994-1996 were randomly sub-sampled with 68% of the samples selected for aging. Selections were made in order to obtain a representative sample from all fishing modes and from all gulf states. Due to the relatively small number of samples collected during 1997-1999 all otoliths were aged.

Calibration and Quality Control of Aging

The first author was the principal reader of vermilion snapper otoliths at the Panama City Laboratory. Two additional readers made independent age determinations of otolith sections that were randomly selected and twenty percent of otoliths aged were read by all three readers for calibration and error determination. Approximately 8% of the sectioned otoliths were rejected due to poor preparation or to difficulty distinguishing annuli. The otolith rejection rate was higher for vermilion snapper than for red snapper (4% rejection rate) . Vermilion snapper otoliths appeared more fragile than red snapper and consequently a greater number of sections were chipped or fractured during sectioning using a Hilquist high speed saw. All three readers showed greater than 79% agreement for "1 year and 94% or higher for " 2 years. The average percent error (APE; Beamish and Fournier 1981) for all vermilion snapper aged was 8.38% as compared to an APE for red snapper of 5.24% (Allman et al. In press). Much of the disagreement between readers was due to difficulty establishing the first or core ring, which seems to be a common problem for many reef fish (Fowler 1995). Opaque zones near the core often made distinguishing the first annulus difficult (Fig.6).

Age distributions by Fishing Mode, Region and Year

There has been much disagreement in growth rate estimates for vermilion snapper from the Gulf of Mexico (Schirripa 1998). Size at age data for this study indicated large variation in size at age for all years (Fig 7). These data agree with some controversial earlier work on vermilion snapper in the Gulf of Mexico (Hood and Johnson 1999) and the South Atlantic Bight (Zhoa et al. 1997), which indicated large variation in size at age. Because vermilion snapper are more difficult to age compared to other species, in otolith workshops we discussed the degree to which reader error, as opposed to differential growth, may be contributing to the variation in the pattern of size at age. It can often be observed that there are great differences in size at age for specimens whose otoliths can be clearly read (Fig. 8). In order to determine if variation in size was due to differential growth rates, we plotted TL (mm) on otolith weight (g) for all year 2000 fish. Each age class was divided with the largest 50% of fish classified as fast growers, and the smallest 50% as slow growers (Fig.9). Previous studies have indicated that slow growing fish have relatively large otoliths compared to faster growing fish (Reznick et al.1989; Secor and Dean 1989). If reader error contributed notably to mis-assignment of ages, we expected otolith weight to be distributed haphazardly and not distinguish fast and slow growth groups. However, the otolith weight-body size relationships were distinct for the two groups. This suggests that the variation in size at age was due to differences in growth rate and cannot be merely explained by reader error.

2000

Vermilion snapper collected during 2000 were estimated to be from 2 to 21 years. The commercial fishery collected the greatest number of older individuals with 30% of the collection 10 years or older (Fig. 10). The commercial fishery was bimodal with a mode at 4 years when vermilion snapper were recruiting to the fishery and another at 10 years. The 10 year old fish could be indicative of a large 1990 year class. Both the head boat and scientific survey indicated that 4 and 5 year olds were most common with fish recruiting to the fishery by age 4. Full recruitment to the charter boat fishery was not until age 5. The age structure of the commercial fishery was fairly similar between the eastern and western gulf with the east consisting of a larger percentage of 3 and 4 year olds while the west had a slightly higher percentage of older fish (Fig. 11). However, sample size was low for this comparison.

1994-2000

During 1994-2000 vermilion snapper ages ranged from 1 to 21 years. Age distributions from the commercial hook and line fishery indicated that fish fully recruited to the fishery by age 5 during 1994 and 1995 and by age 3 or 4 during 1996, 1998 and 2000 (Fig. 12). There was also some evidence of a strong 1995 year class with 3 year olds making up nearly 50% of the ages in 1998. Age distributions from the recreational fishery indicated that recruitment to the fishery generally occurred by age 3 or 4 (Fig. 13). Overall the recreational fishery included fewer fish beyond 8 years compared to the commercial fishery. There was some evidence of a strong 1990 year class starting in 1994 with a large percentage of 4 year old fish followed by 5, 6 and 7 year old fish in 1995, 1996 and 1997. Again, caution must be used when interpreting year class strength due to low sample size coupled with possible reader error.

Future work

While we feel that the high variance in vermilion snapper size-at-age is real and is a robust phenomenon, reader error may have obscured patterns of year class strength (e.g., see Beamish and McFarlane 1995). Important future work remains to increase reader accuracy by establishing the first annuli through chemical marking experiments. Specifically, age 0 and age 1 (or older) individuals should be chemically marked and sampled while reared throughout a season of annulus formation in order to compare pattern of formation. Also, a higher resolution study of marginal increment formation may be useful to assign stages of completion of marginal increments. Since opaque zone banding can be diffuse, we plan to examine banding patterns using a combination of subjective (stage assignment by eye) and objective criteria such as luminescence patterns measured with imaging software. Finally, better regional representation in sampling is needed from the western Gulf of Mexico and also greater sampling effort from the recreational private sector.

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Figure 1. Percent composition of total 2000 vermilion snapper otolith collection (n=1574) by A. sampling program, B. state, C. fishing mode.

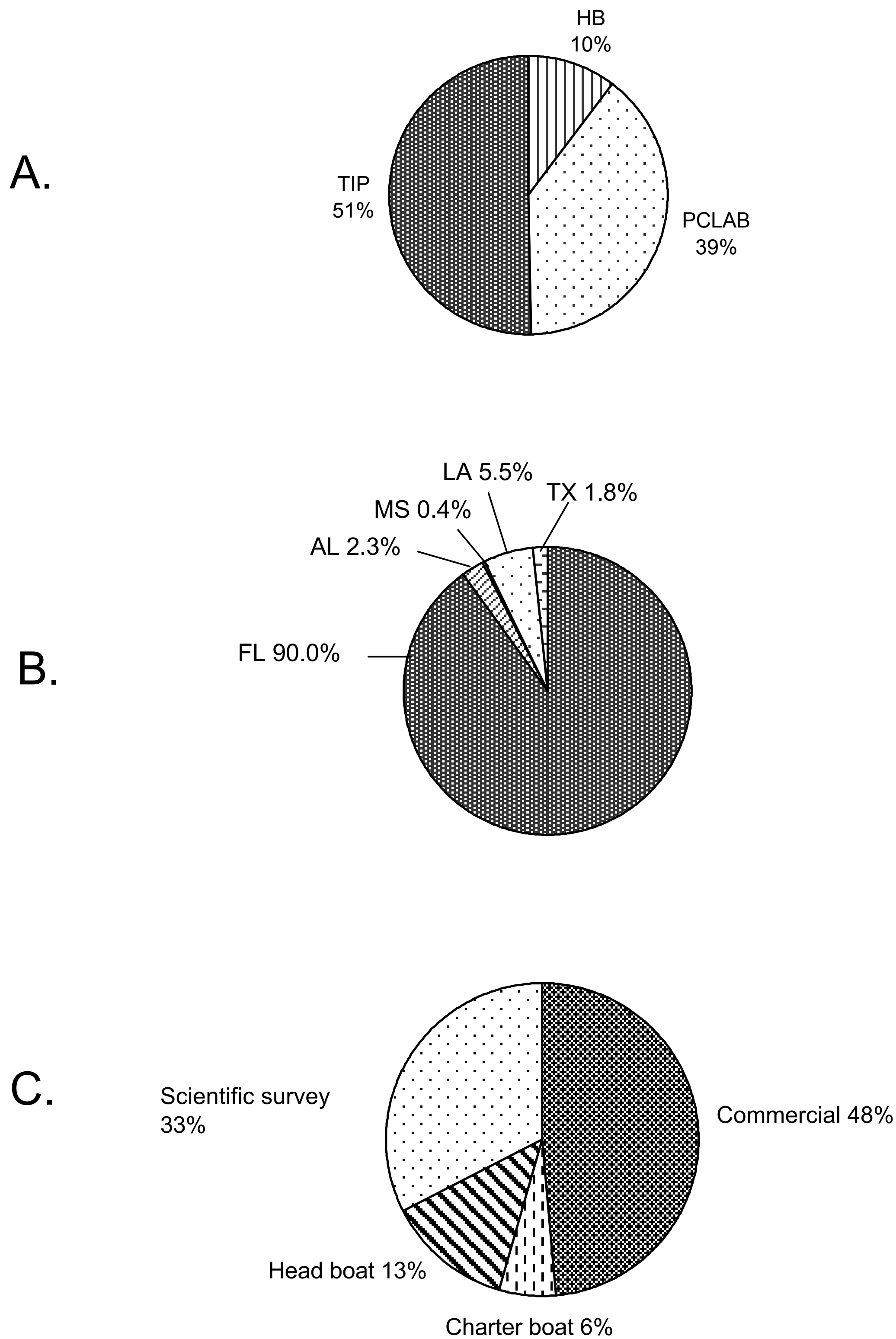


Figure 2. Length frequency distribution for 2000 by fishing mode for all available samples.

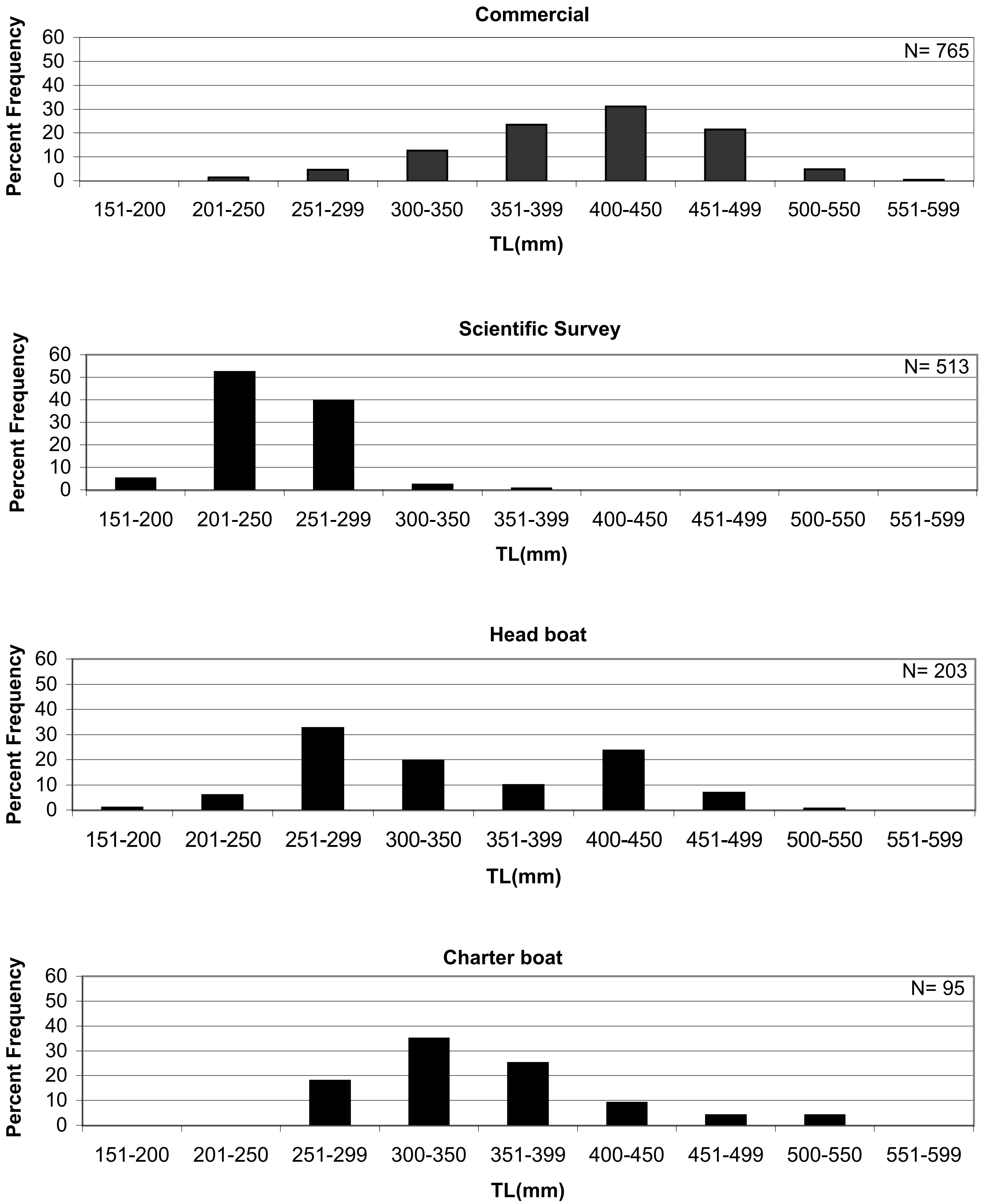
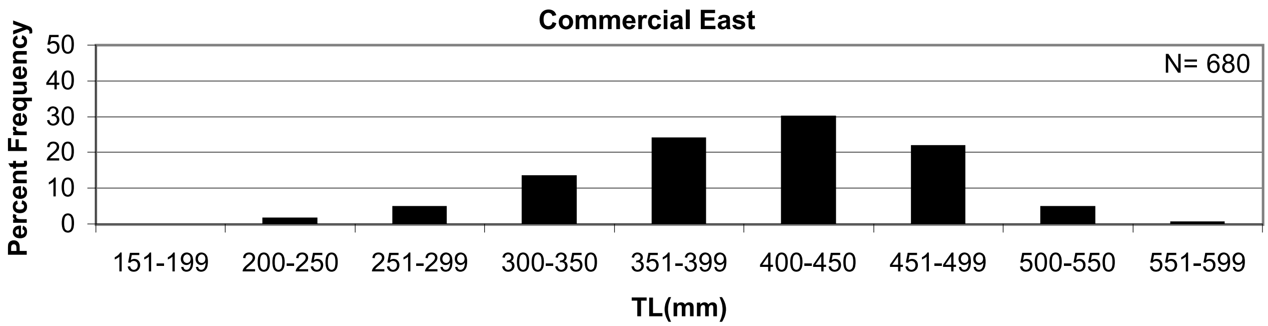


Figure 3. Length frequency distribution from the commercial fishery east (FL landings) and west (LA landings) for 2000 for all available samples.



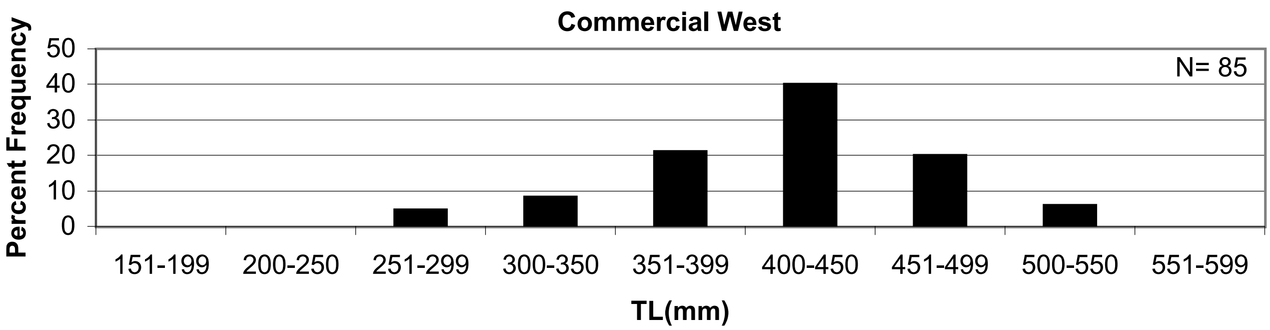


Figure 4. Size frequency distribution for all commercial hook and line samples.

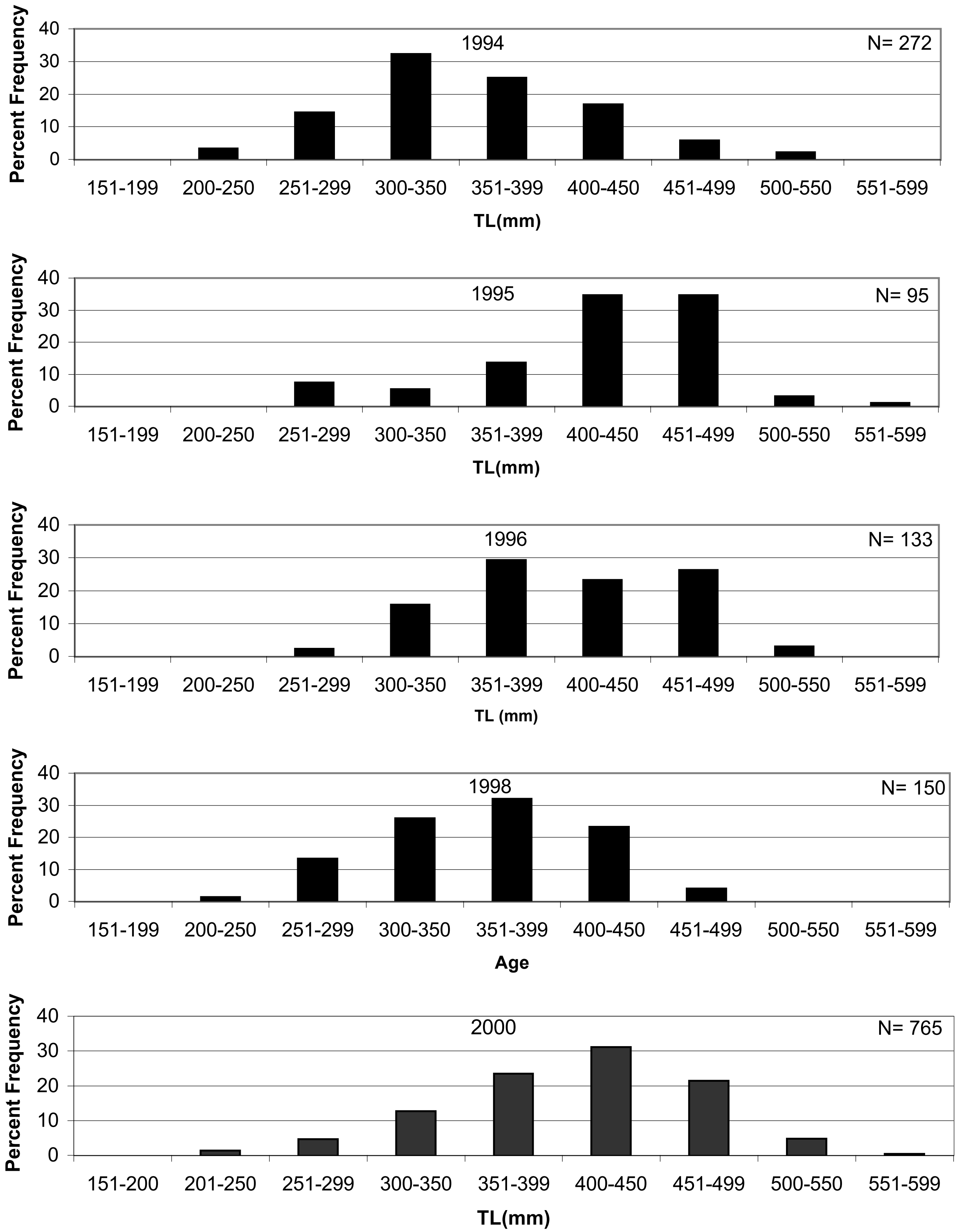


Figure 5. Size frequency distribution for all recreational (charter boat and head boat) samples.

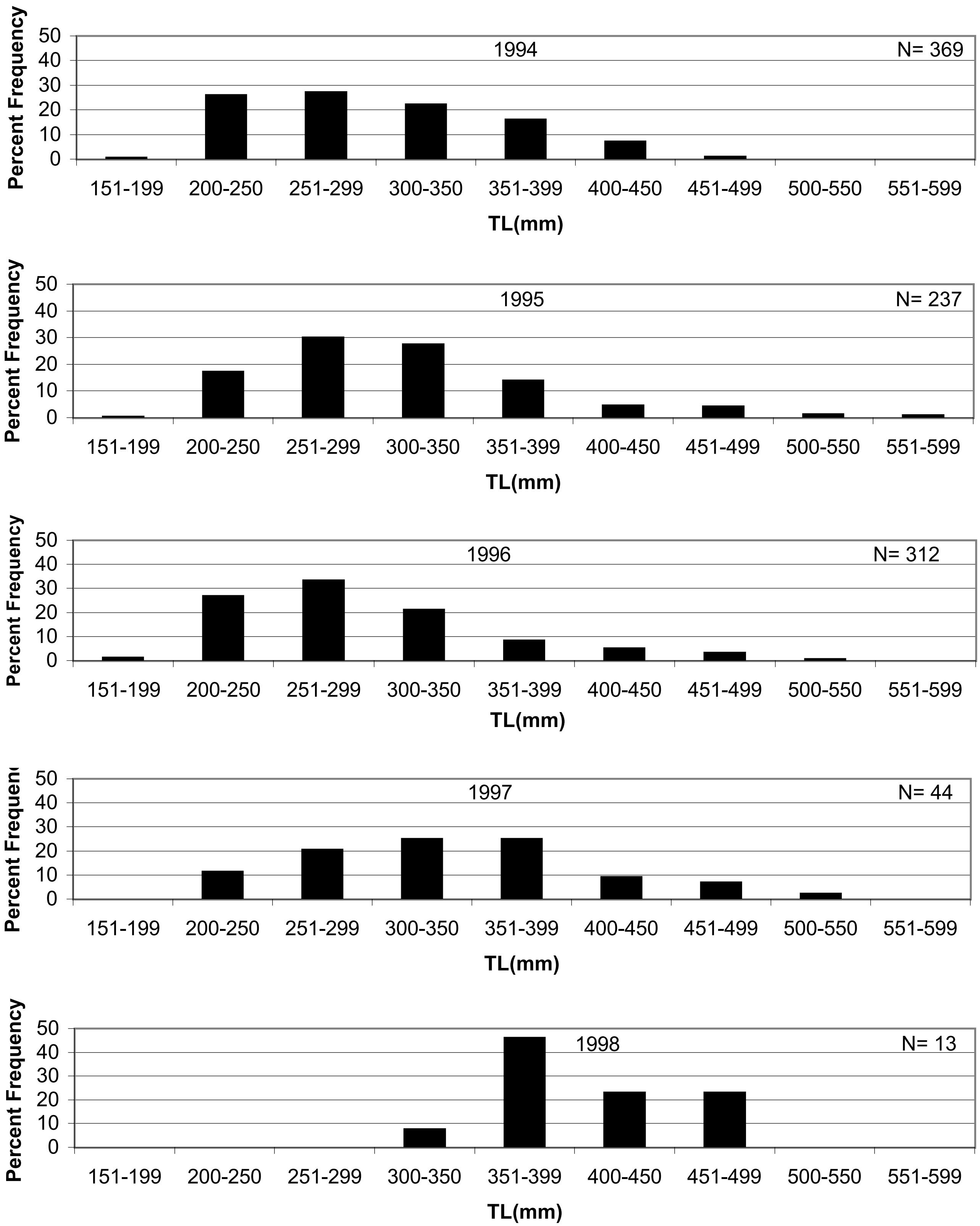
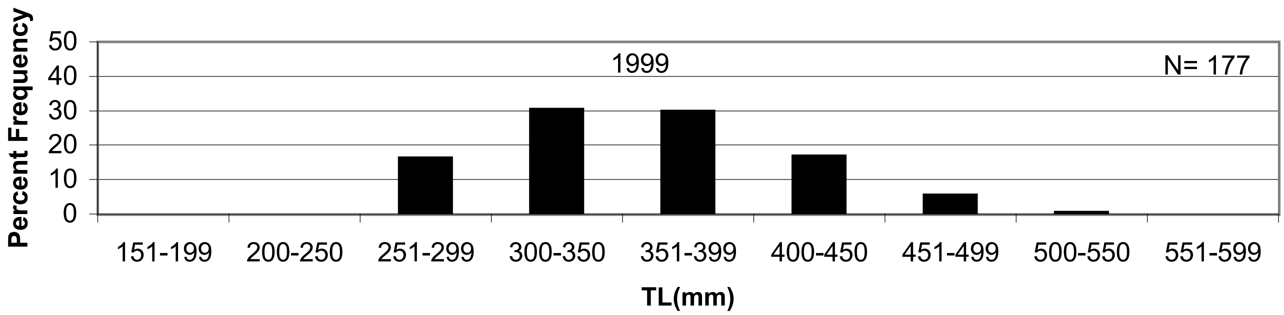


Figure 5. Continued



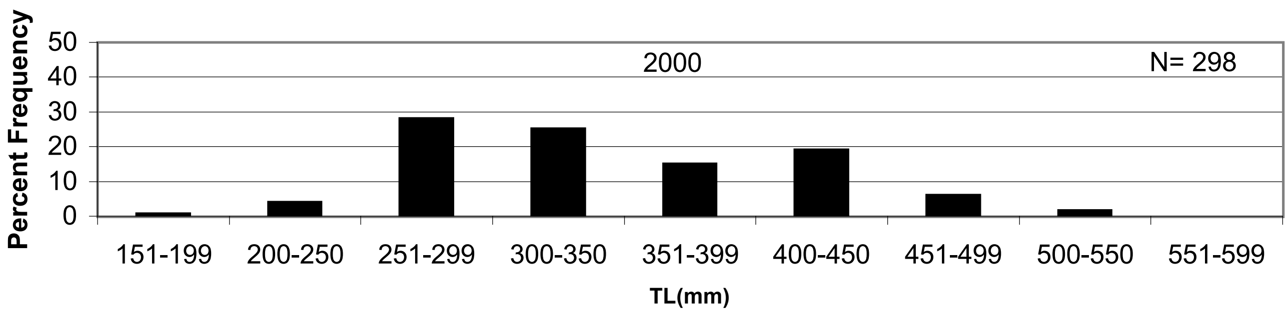


Figure 6. Sagittal section (50X) from vermilion snapper with annuli (1-7) and opaque zones.

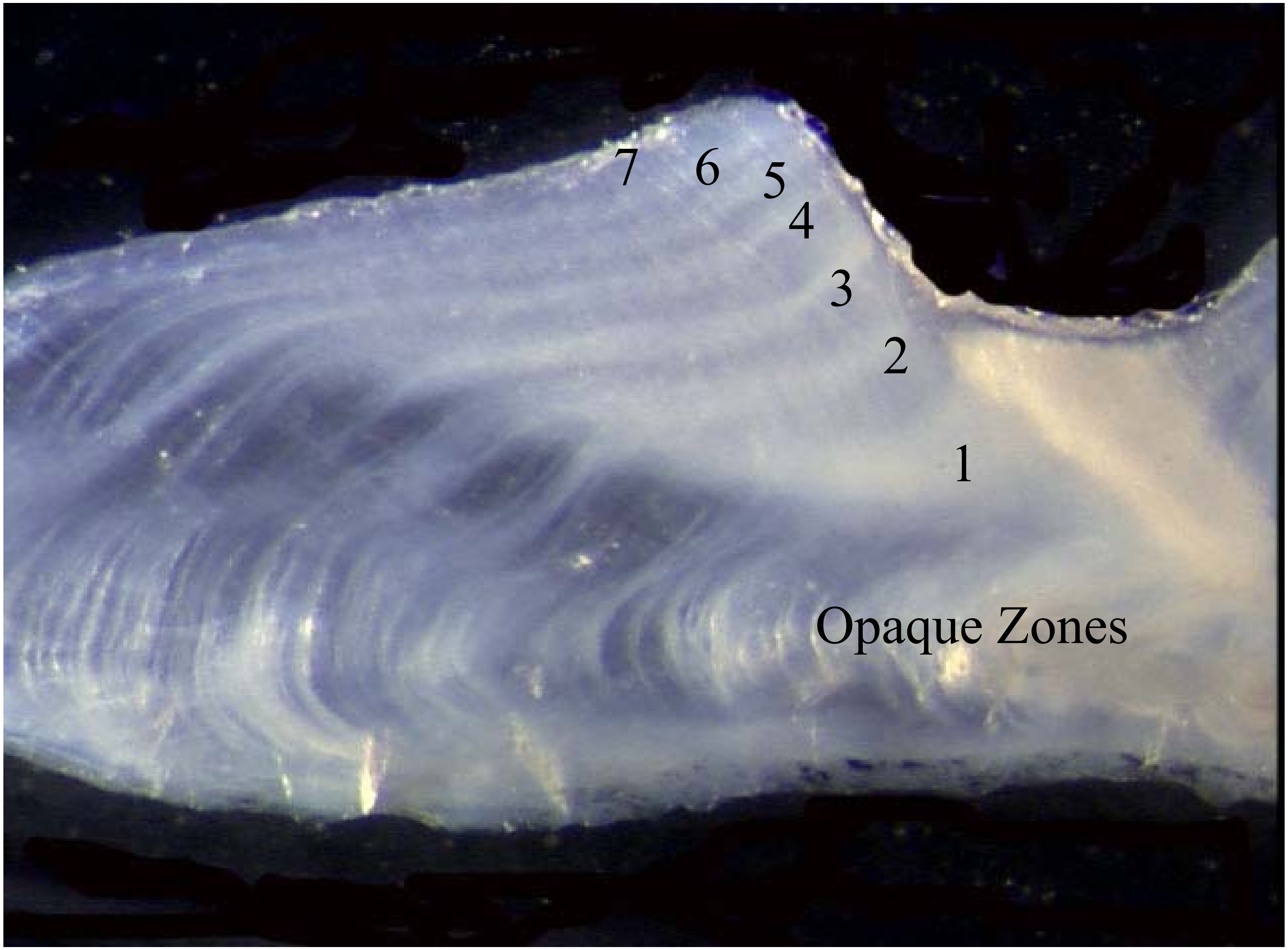


Figure 7. Total length TL (mm) on age.

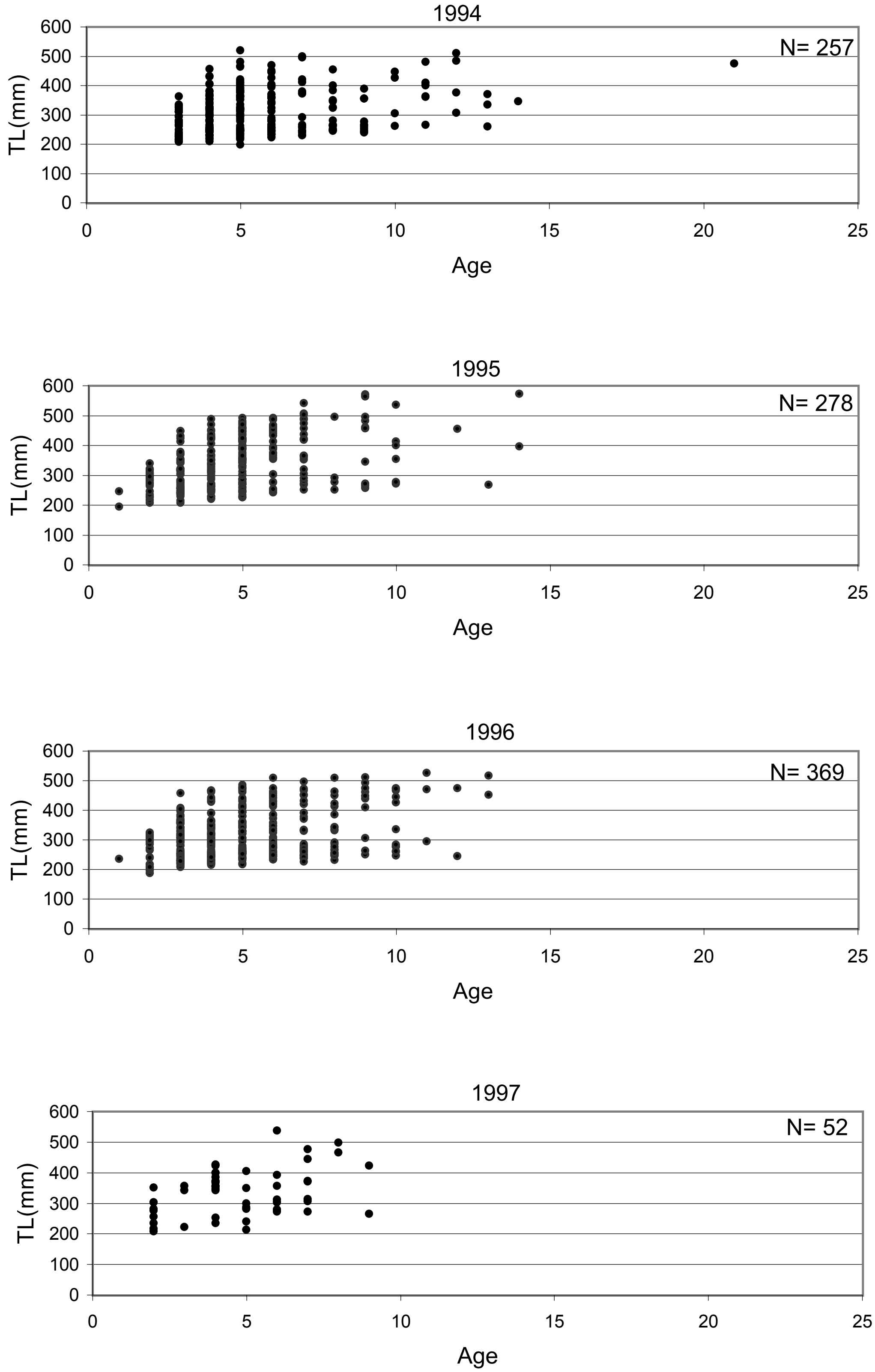
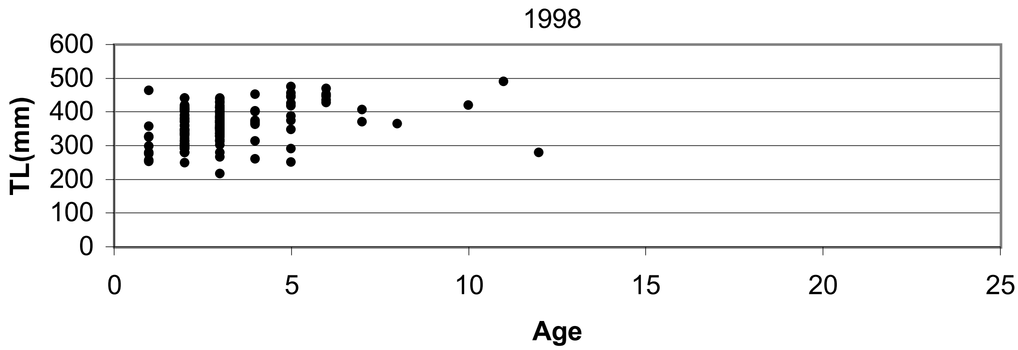
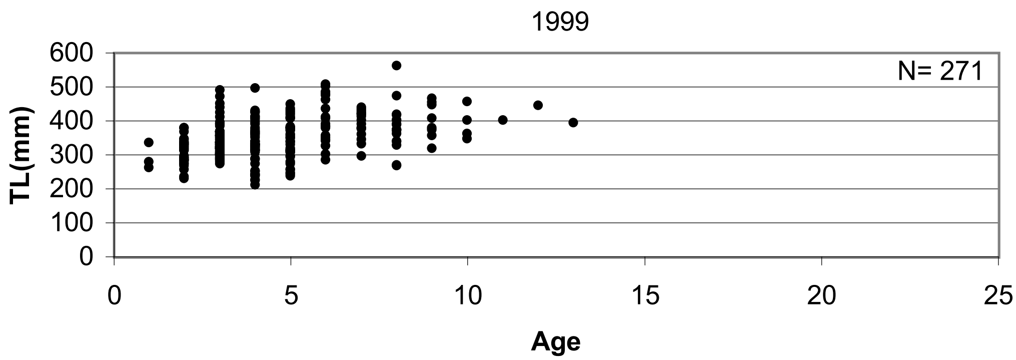


Figure 7. Continued.





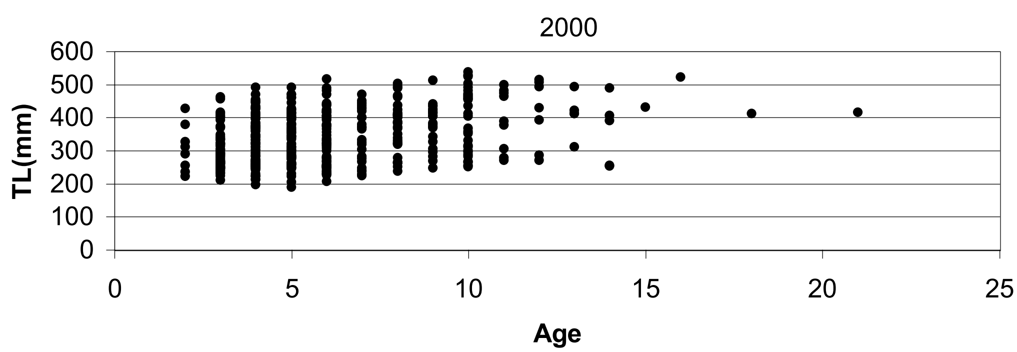


Figure 8. Sagittal sections (50X) from two 4 year old vermilion snapper; Total length= 210 mm (top section), 457 mm (bottom section).

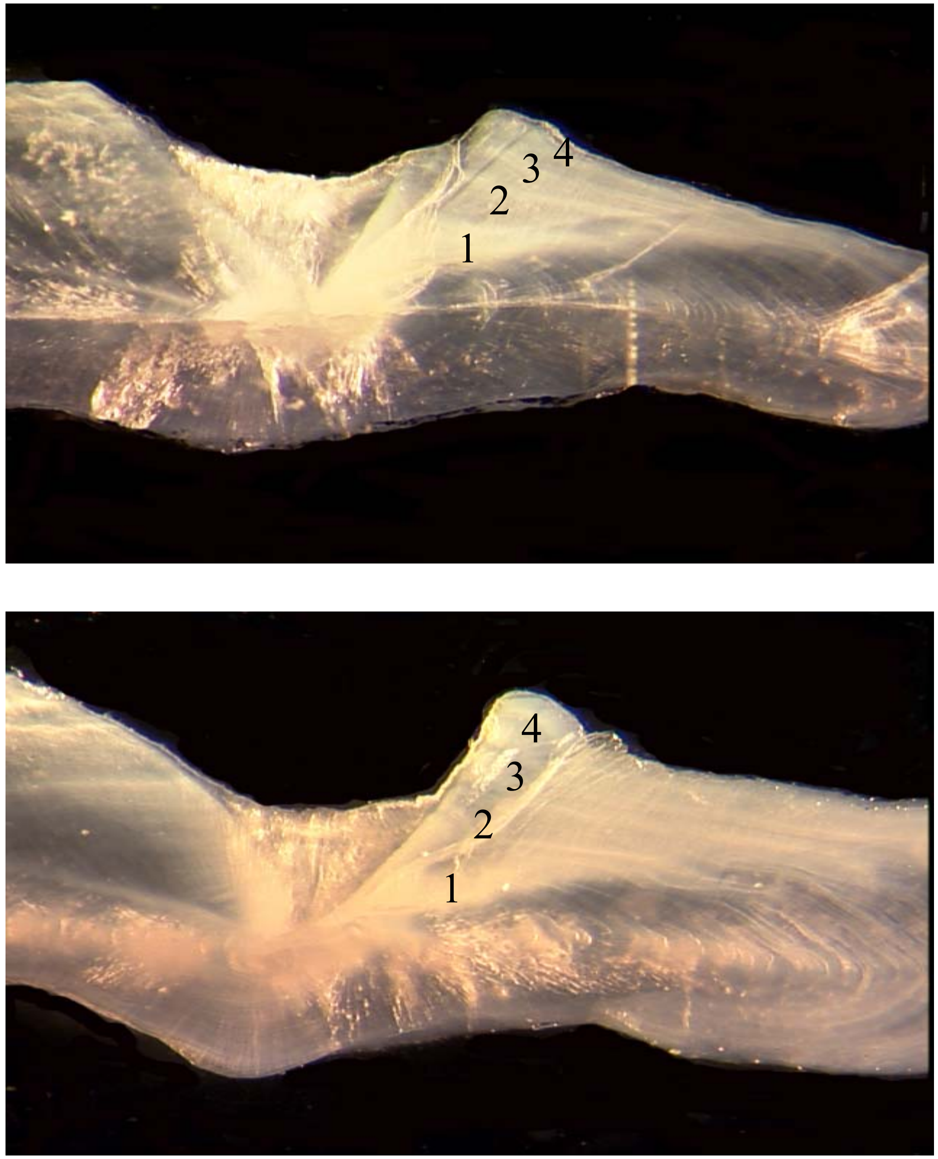


Figure 9. Total length TL(mm) on otolith weight(g) for 50% fastest and slowest growing fish in each age class for 2000.

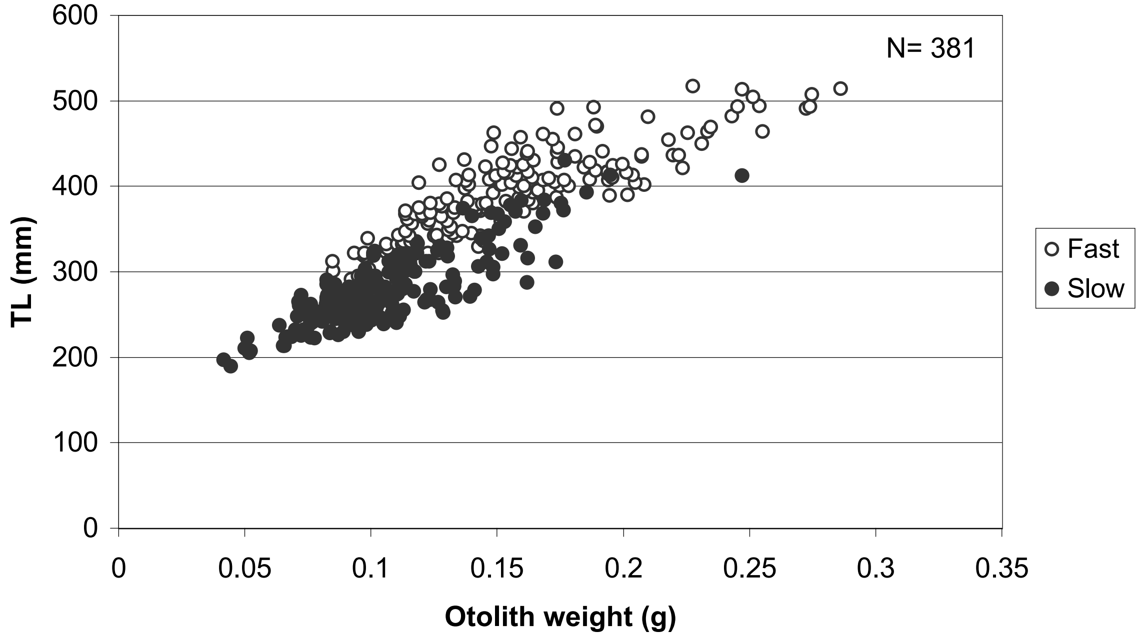
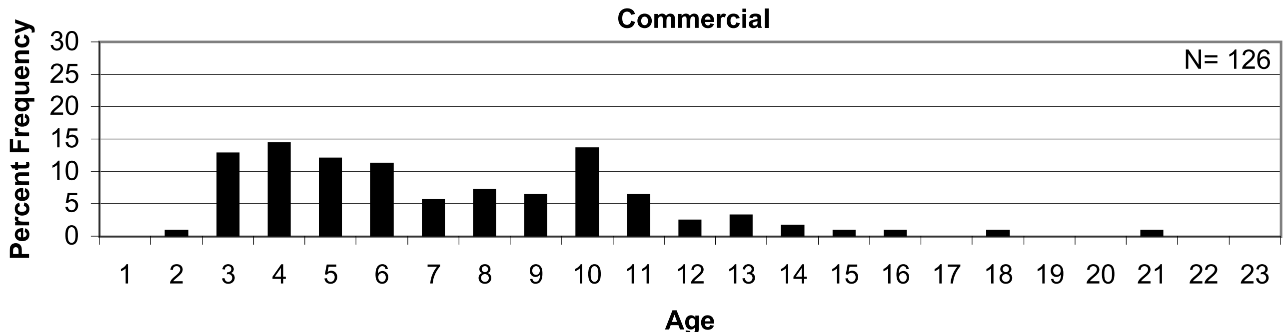
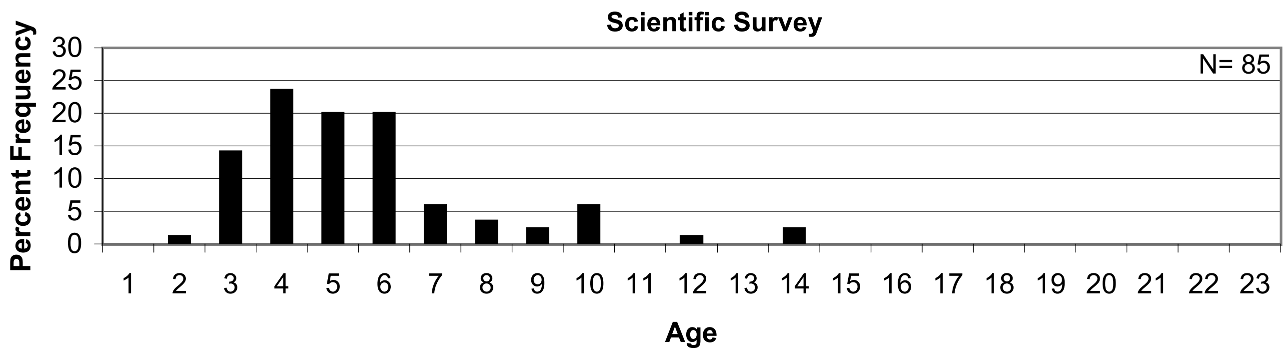
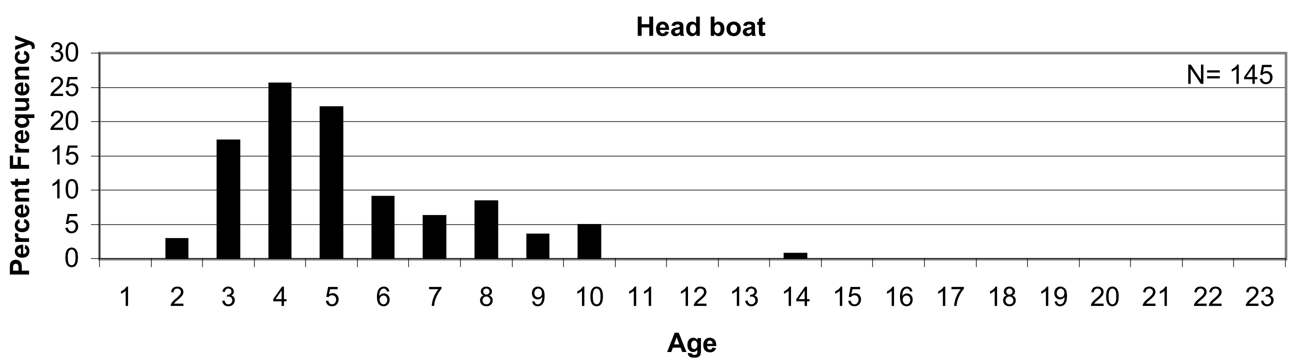


Figure 10. Age frequency distribution for 2000 by fishing mode.







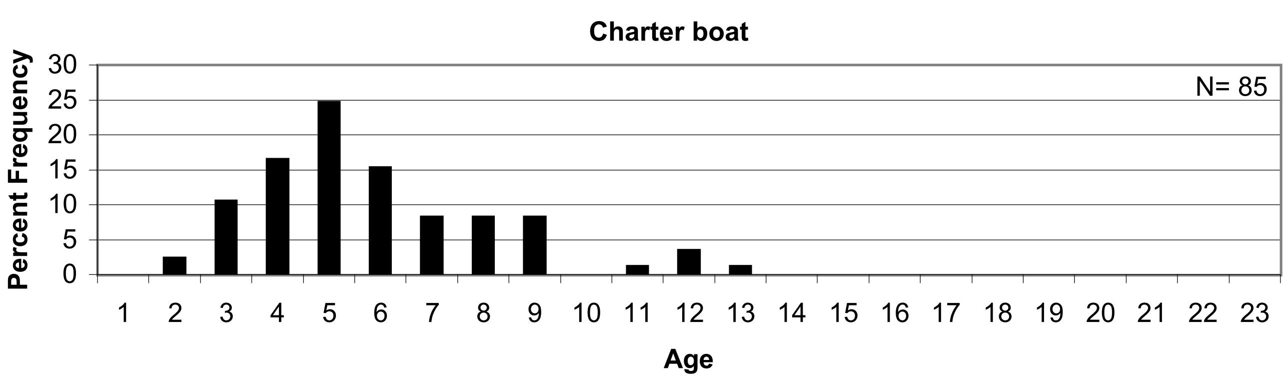


Figure 11. Age frequency distribution from the commercial fishery east (FL landings) and west (LA landi
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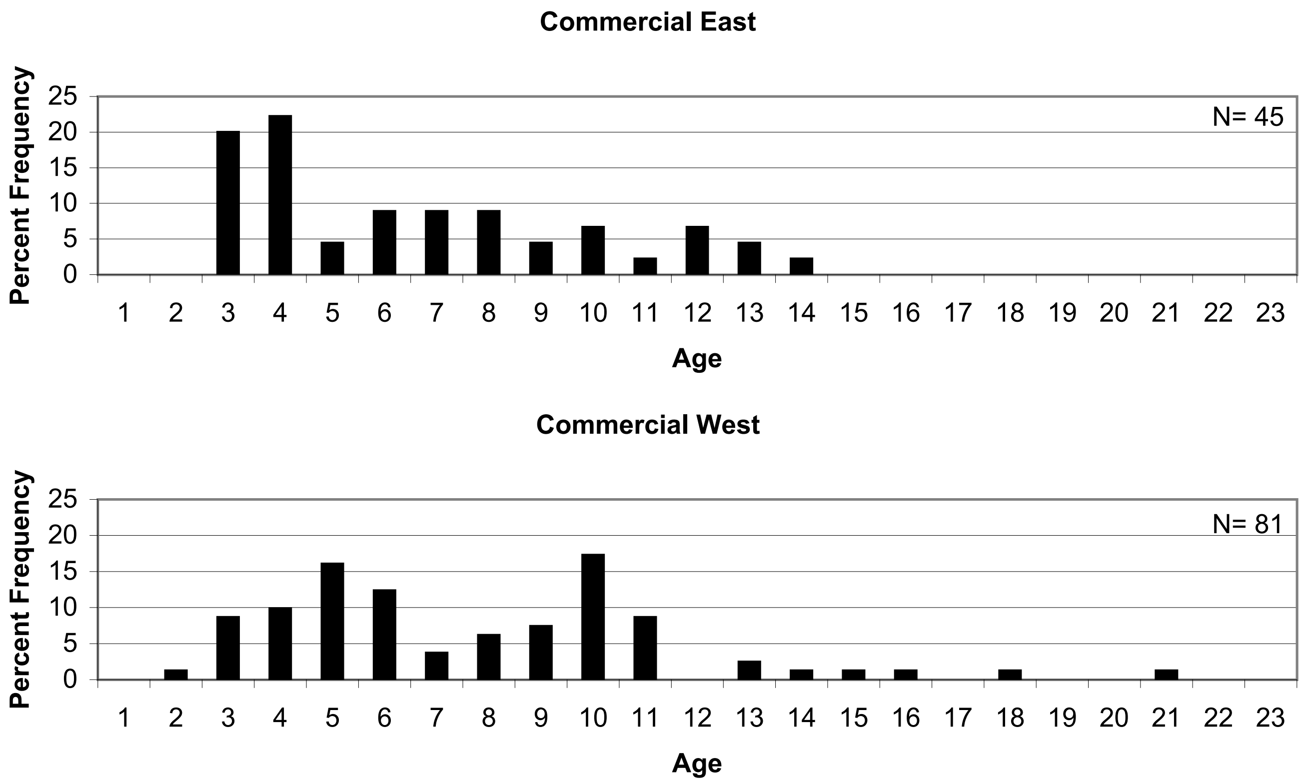

Figure 12. Age frequency distribution for commercial hook and line samples.

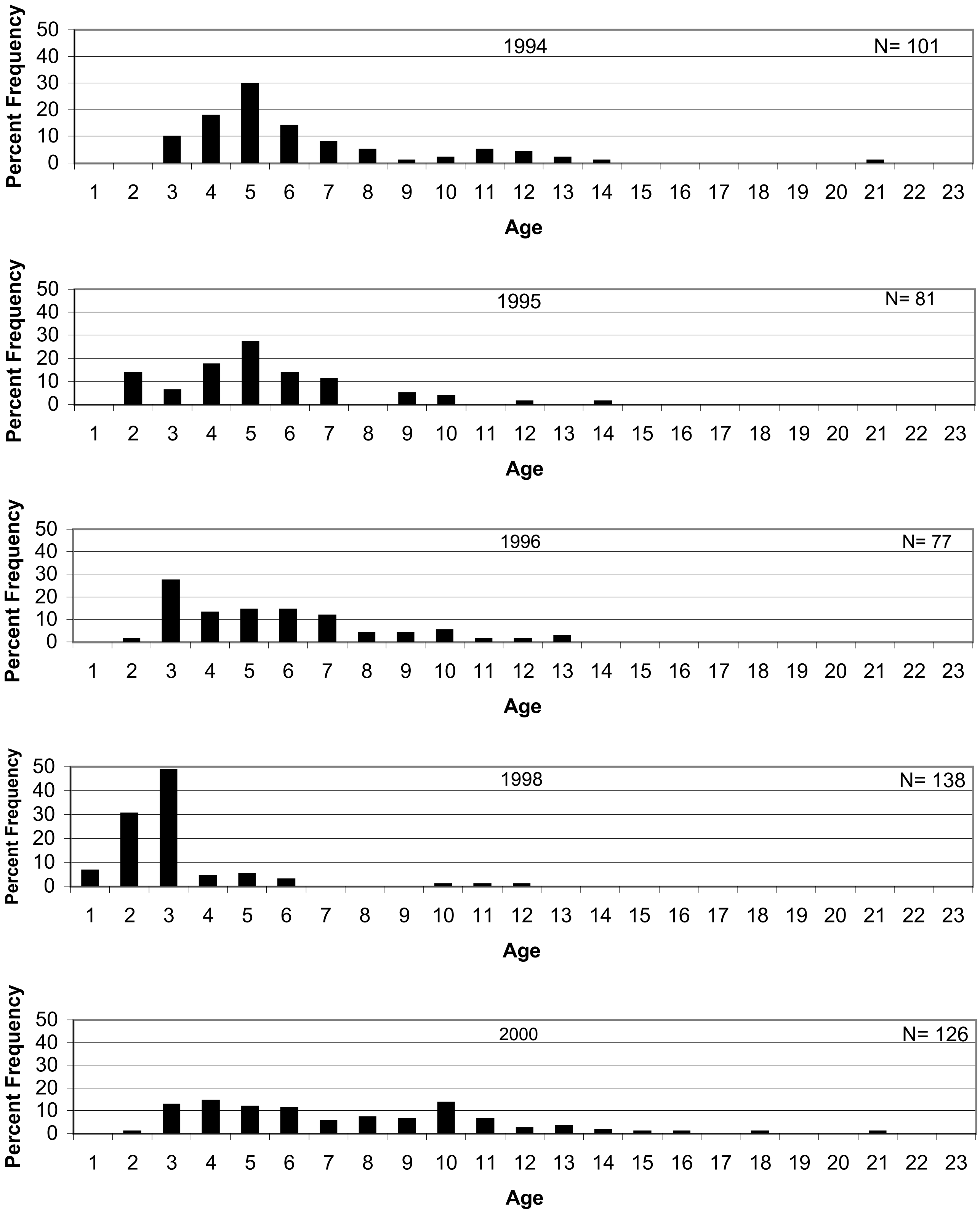

Figure 13. Age frequency distribution for recreational (charter boat and head boat) samples.

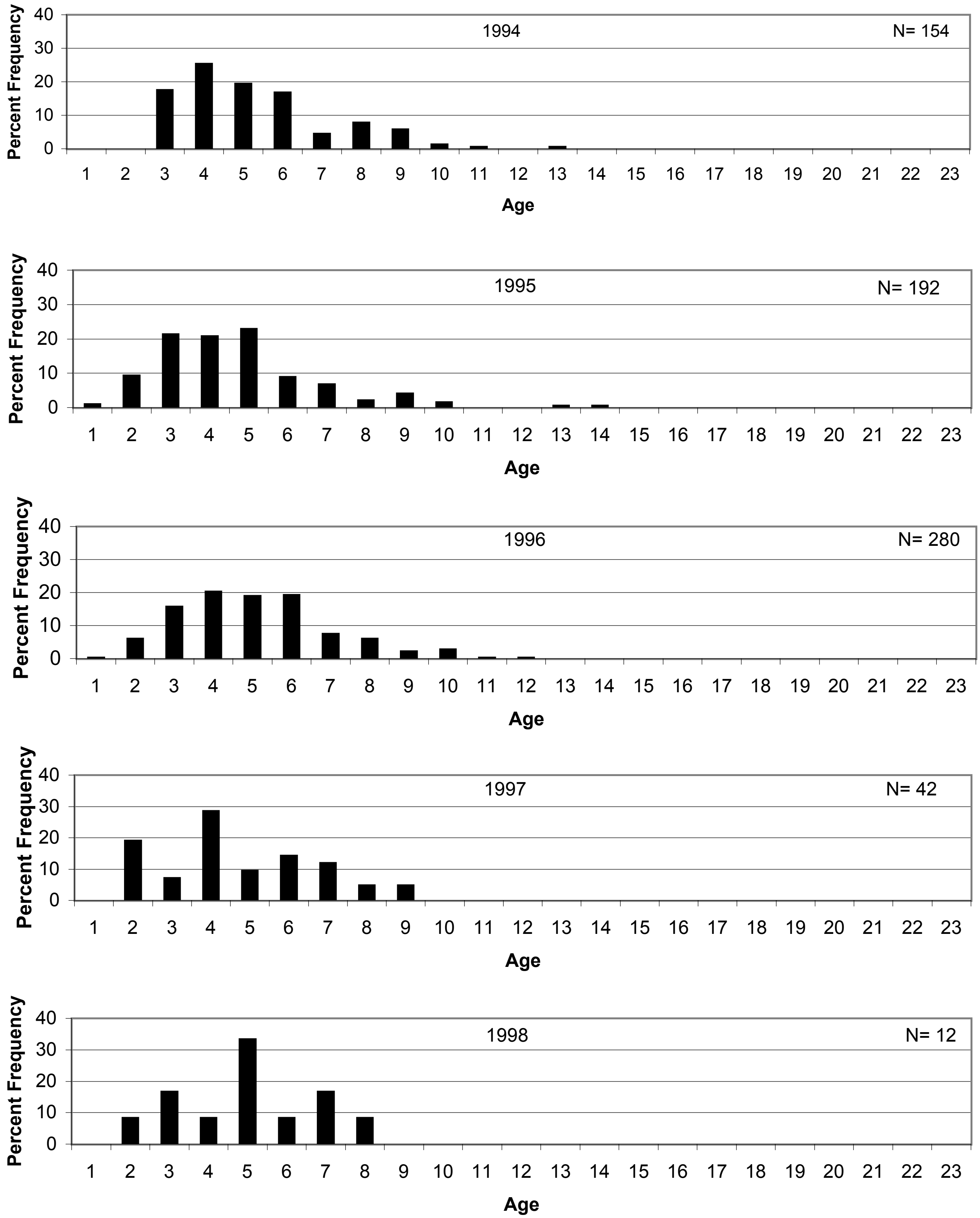

Figure 13. Continued