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Vermilion Snapper Otolith Aging: 2001-2004 Data Summary

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Introduction

This report updates vermilion snapper otolith aging completed since the last full stock assessment in 2001 (Porch and Cass-Calay, 2001). The previous otolith aging summary covered the years 1994 through 2000 (Allman et al., 2001). During the years 2001 to 2004, 9,998 vermilion snapper otoliths were collected along with corresponding morphological data. Data were collected from 682 separate sampling sessions of Gulf of Mexico landings from Florida to Texas. The main sampling programs collecting vermilion snapper were the trip interview program (TIP; 84%), fishery-independent survey (11%), cooperative fisher program (1.8%), headboat (1.0%), marine recreational fisheries statistical survey (MRFSS; 0.80%) and the recreational fish information network (RECFIN; 0.76%).

As in previous years vermilion snapper sampled during 2001 to 2004 were predominantly from the eastern Gulf of Mexico (85%). Florida landings dominated the collection followed by Louisiana, Texas, Mississippi and Alabama (Fig. 1). The fishing mode recorded most often was commercial hand-line followed by fishery-independent survey, headboat and charter boat (Fig. 2). Sampling effort was fairly evenly distributed across all four years (2001= 22%, 2002= 20%, 2003= 32% and 2004= 26%) with geographic and fishing mode trends similar among years (Table 1 & 2).

We summarized the vermilion snapper data for five key strata: region (east and west) and mode (commercial, recreational and fishery-independent (east only)). Vermilion snapper collected from Florida, Alabama and Mississippi were considered as eastern gulf and Louisiana and Texas as western gulf; vermilion snapper were classified as commercial hand-line, recreational hand-line or fishery-independent (hand-line and trap). Charter boat, headboat and private boat collections were classified together as recreational.

Size frequency distributions

Size frequency distributions of age-sampled vermilion snapper appeared similar between the commercial and recreational sectors. Over half of vermilion snapper from the commercial, charter boat and headboat fisheries were between 300 and 399 mm total length (TL) (Fig. 3). Length was significantly different between the charter boat, headboat and commercial fisheries (ANOVA, $p<0.001$). A Tukey's pairwise comparison indicated that means were different between the headboat and commercial fisheries. The smallest individuals were collected by the fishery-independent survey with fifty percent of the collection 200-249 mm TL. This large percentage of small fish was probably due to the gear used (i.e., small hooks (1/0) and fish traps), but more importantly vermilion snapper were retained under the legal size-limit of 10 inches (254 mm TL). These small fish are valuable for growth analysis.

Vermilion snapper size distributions were compared between the eastern and western Gulf of Mexico for all years combined. Commercial hand-line fish were significantly larger from the western gulf compared to the eastern gulf (ANOVA, $p<0.001$; Fig. 4A). A similar trend was noted for the recreational fishery; however, relatively few recreational fish were sampled from the western gulf (Fig. 4B) and fewer than fifty fishery-independent fish were collected from the western gulf. Length

frequency distributions were consistent across years with most modes from 300-349 mm TL for the commercial and recreational fisheries and 200-249 mm TL for the fishery-independent fish (Fig. 5, 6 & 7).

Age determinations

All vermilion snapper otoliths collected during the years 2001 to 2003 were processed and aged. Additionally, all 2004 recreational, fishery-independent and western Gulf of Mexico commercial otoliths were aged. Due to time constraints and the disproportionate number of commercial hand-line fish from the eastern Gulf of Mexico, these fish were sub-sampled for processing. The number of 2004 commercial hand-line fish selected from the eastern gulf was approximately equal to the number collected from the commercial fishery in the western gulf during 2004 (i.e., approximately 500 from each region). This decision was based on previous landings data which indicated that typically about 50% of vermilion snapper are landed in the eastern gulf (National Marine Fisheries Service[1]). Eastern gulf commercial hand-line fish were selected equally among six, two-month waves (e.g., wave one= Jan.& Feb., wave two= Mar.& Apr., etc.).

Otoliths were processed and aged by personnel from the National Marine Fisheries Service (NMFS), Panama City Laboratory (years 2001, 2002 and 2004) and the Florida Fish and Wildlife Research Institute (FWRI) (year 2003). The NMFS Laboratory used a Hilquist high-speed thin sectioning machine following the methods of Cowan et al. (1995), while the FWRI laboratory used a low-speed saw. Sectioned otoliths were assigned an age based on the count of annuli (opaque zones observed with reflected light) including partially completed annuli if detected on the margin. If the margin was translucent, the degree of translucent zone completion was also recorded (Vanderkooy and Guindon-Tisdel, 2003). For example, otoliths were advanced one 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 (Johnson, 1983; Patterson et al., 2001; Wilson and Nieland, 2001; Garcia et al., 2003). 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 calendar year rather than time since spawning (Jearld 1983).

Calibration and quality control of aging

In order to determine if aging methods between NMFS and FWRI laboratories were consistent, a reference set of 200 otoliths (100 otoliths prepared by each laboratory) was read by both laboratories, and the ages compared using average percent error (APE; Beamish and Fournier, 1981). Fifty-seven percent of age readings were in agreement and 94% were within ± 1 year. Average percent reader error (APE) was 5.17% (CV = 7.14%). Production aging laboratories generally consider an APE ≤5% as a target for

[1] National Marine Fisheries Service.2003. Fisheries Statistics and Economics Division. Website:www.nmfs.noaa.gov

moderately long-lived species with relatively difficult to read otoliths (Morison et al., 1998; Campana, 2001). Precision estimates of vermilion snapper aging have improved since the last reported comparison of vermilion ages in which APE was 8.4% (Allman et al., 2001). Typically most of the disagreement between readers is 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 make distinguishing the first annulus difficult. A total of 8,776 vermilion snapper otoliths were processed for aging; of these, 9% were rejected due to preparation flaws or indistinguishable annuli.

Age distribution by fishing mode, region and year

Vermilion snapper collected from 2001 to 2004 ranged from 1 to 26 years for the commercial hand-line fishery, 2 to 13 years for the charter boat and headboat fisheries and 1 to 25 years for the fishery-independent survey (Fig.8). Age distributions from the commercial hand-line and recreational fisheries indicated that fish recruit by age 4 and age 5 respectively. Charter boat, headboat and commercial ages were significantly different (ANOVA, $p<0.001$). A Tukey's pairwise comparison indicated that means were different between the headboat and commercial fisheries and the charter boat and commercial fisheries. This was contrary to the findings of the previous reporting period (1994 to 2000) in which commercially caught vermilion snapper were on average older than those from the recreational fishery (Allman et al., 2001). Few individuals beyond 10 years were recorded from any sector (2-4%).

Regional differences were apparent in both the commercial and recreational age distributions (Fig. 9 A&B). Commercial hand-line vermilion snapper from the western gulf were significantly older than those from the eastern gulf (ANOVA, $p<0.001$). On average western gulf fish were 1 year older than eastern gulf fish for the commercial fishery and 0.3 years older for the recreational fishery. A similar pattern was noted for the commercial fishery during 1994 to 2000 (Allman, et al. 2001) and as in previous years, few ages were available from the western gulf recreational fishery.

An examination of the commercial hand-line age distribution by year suggested the influence of a strong 1999 year class which was visible beginning in 2002 as age 3 fish, in 2003 as age 4 fish and in 2004 as age 5 fish (Fig. 10). This strong year class was also noted in the recreational fishery with large number of age 4 fish in 2003 and age 5 fish in 2004 (Fig. 11). This pattern was observed in both the eastern and western commercial hand-line fishery. The only indication of a strong 1999 year class in the fishery-independent collection was a large proportion of age 3 fish (30%) in 2002 (Fig. 12). However, caution must be used interpreting fishery-independent data since these data were collected using different methods for different purposes and were sampled over a smaller area.

Total length at age plots indicated large variation in size-at-age (Fig.13). This was consistent with previous studies on vermilion snapper (Allman et al., 2001; Hood and Johnson, 1999; Zhao et al., 1997).

Ongoing work and recommendations

Due in part to the large variation in size-at-age of vermilion snapper, the last stock assessment (Porch and Cass-Calay, 2001) used a non-age-based production model. Preliminary sampling conducted in northwest Florida waters suggests that differences in growth rates may vary greatly over relatively small distances (i.e., tens of kilometers). These small scale demographic differences could be due to habitat type/quality. The NMFS Panama City Laboratory is currently sampling vermilion snapper using hook and line and traps at reef sites off northwest Florida and with a cooperator off southwest Florida. Habitat type will be examined using ROV and diver surveys. Growth and reproductive parameters are being compared on a small scale (i.e., reef sites <50 km apart) and between northwest and southwest Florida. Finally, better regional representation in sampling is recommended from the western Gulf of Mexico especially in the recreational sector.

Acknowledgements

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Literature cited

Allman, R.J., G.R. Fitzhugh and W.A. Fable. 2001. Report of vermilion snapper otolith aging: 1994-2000 data summary. National Marine Fisheries Service, Panama City Laboratory Contribution Series 01-1. 23 p.

Beamish, R.J. and D.A. Fournier. 1981. A method for comparing the precision of a set of age determinations. Can. J. Fish. Aquat. Sci. 38: 982-983.

Campana, S.E. 2001. Accuracy, precision and quality control in age determination, including a review of the use and abuse of age validation methods. Jour. Fish Bio. 59: 197-242.

Cowan, J.H., R.L. Shipp, H.K. Bailey, and D.W. Hawick. 1995. Procedure for rapid processing of large otoliths. Trans. Am. Fish. Soc. 124: 280-282.

Fowler, A.J. 1995. Annulus formation in otoliths of coral reef fish-a review. pages 45-63. *In* Secor, D.H., J.M. Dean, and S.E. Campana (eds.), Recent developments in fish otoliths research. The Belle W. Baruch Library in Marine Science No. 19. University of South Carolina Press, Columbia, SC.

Garcia, E.R., J.C. Potts, R.A. Rulifson and C.S. Manooch III. 2003. Age and growth of yellowtail snapper, *Ocyurus chrysurus*, from the Southeastern United States. Bull. Mar. Sci. 72: 909-921.

Hood, P.B. and A.K. Johnson. 1999. Age, growth, mortality, and reproduction of vermilion snapper, *Rhomboplites aurorubens*, from the eastern Gulf of Mexico. Fish. Bull. 97: 828-841.

Jearld, A. Jr. 1983. Age determination. pages 301-324 *In*: L.A. Nielsen and D.L. Johnson (eds.), Fisheries Techniques, American Fisheries Society, Bethesada MD.

Johnson, A.G. 1983. Age and growth of yellowtail snapper from South Florida. Trans. Am. Fish. Soc. 112: 173-177.

Morison, A.K., S.G. Robertson, and D.G. Smith. 1998. An integrated system for production fish aging: image analysis and quality assurance. *North American Journal of* Fish. Manage. 18: 587-598.

Patterson, W.F. III, J.H. Cowan, Jr., C.A. Wilson, and R.L. Shipp. 2001. Age and growth of red snapper, *Lutjanus campechanus*, from an artificial reef area off Alabama in the northern Gulf of Mexico. Fish. Bull. 99: 617-627.

Porch, C.E., and S.L. Cass-Calay. 2001. Status of the vermilion snapper fishery in the Gulf of Mexico assessment 5.0. NOAA/NOAA Fisheries/SEFSC/Sustainable Fisheries Division Contrib. NO. SFD-01/02-129 p.

Vanderkooy, S. and K. Guindon-Tisdel (eds.). 2003. A practical handbook for determining the ages of Gulf of Mexico fishes. Gulf States Marine Fisheries Commission, Publication Number 111.

Wilson, C.A. and D.L. Nieland. 2001. Age and growth of red snapper, *Lutjanus campechanus*, from the northern Gulf of Mexico off Louisiana. Fish. Bull. 99: 653-664.

Zhao, B., J.C. McGovern, and P.J. Harris. 1997. Age, growth, and temporal change in size at age of the vermilion snapper from the South Atlantic Bight. Trans. Am. Fish. Soc. 126: 181-193.

Table 1. Number of vermilion snapper otoliths collected by year and state.

State	2001	2002	2003	2004
AL	44	4	23	34
FL	1959	1853	2439	1936
LA	134	75	490	402
MS	76	55	42	36
TX	28		201	167
Total	2241	1987	3195	2575

Table 2. Number of vermilion snapper otoliths collected by year and fishing mode.

Fishing mode	2001	2002	2003	2004
Commercial	1522	1491	3040	2419
Charter boat	21	196	45	77
Headboat	130	91	43	49
Fishery-indep.	568	209	55	25
Private			12	5
Total	2241	1987	3195	2575

Figure 1. Gulf of Mexico vermilion snapper collected 2001-2004 by state.

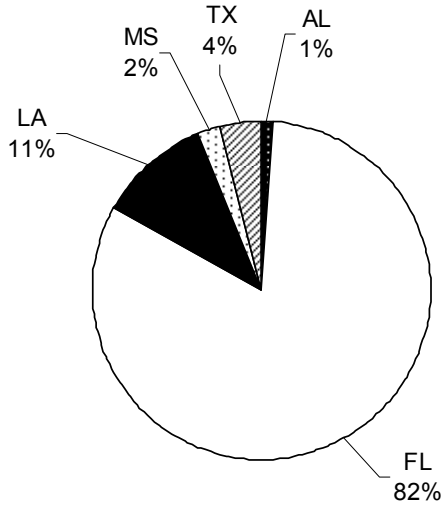


Figure 2. Gulf of Mexico vermilion snapper collected 2001-2004 by fishing mode.

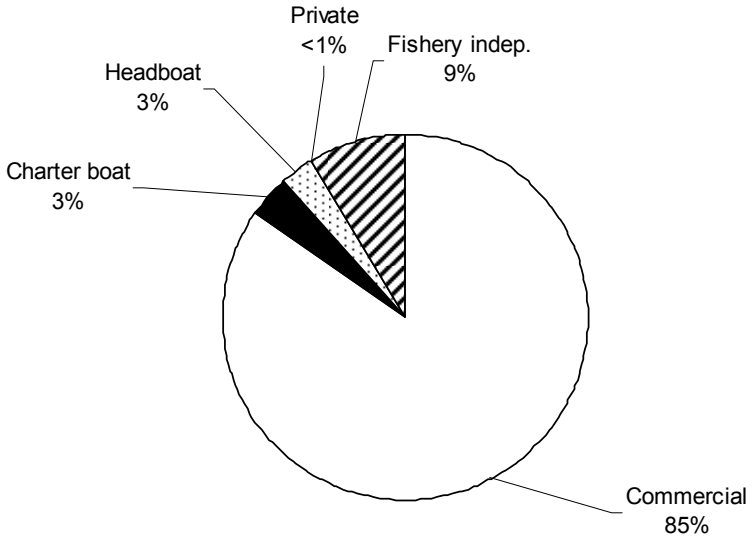
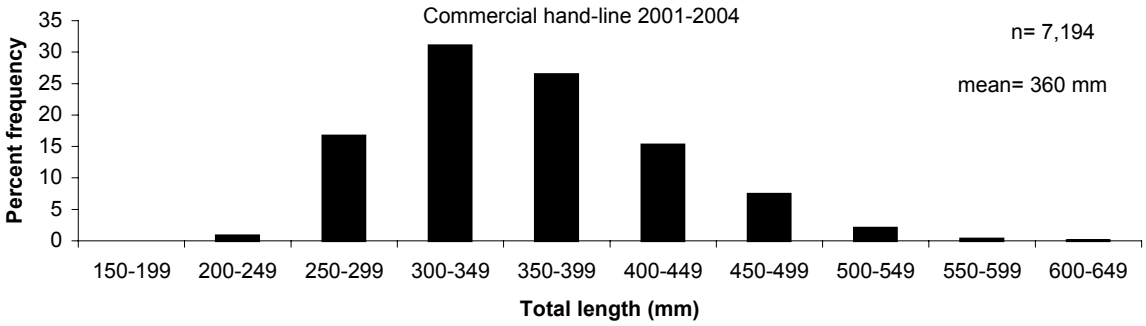
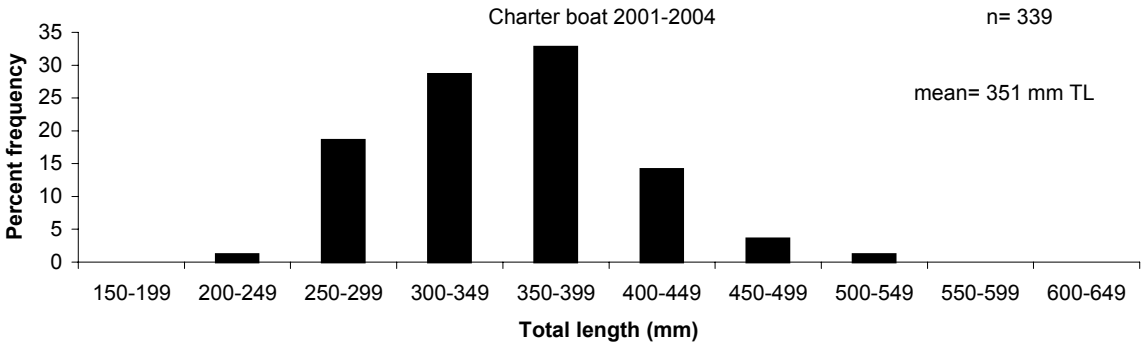
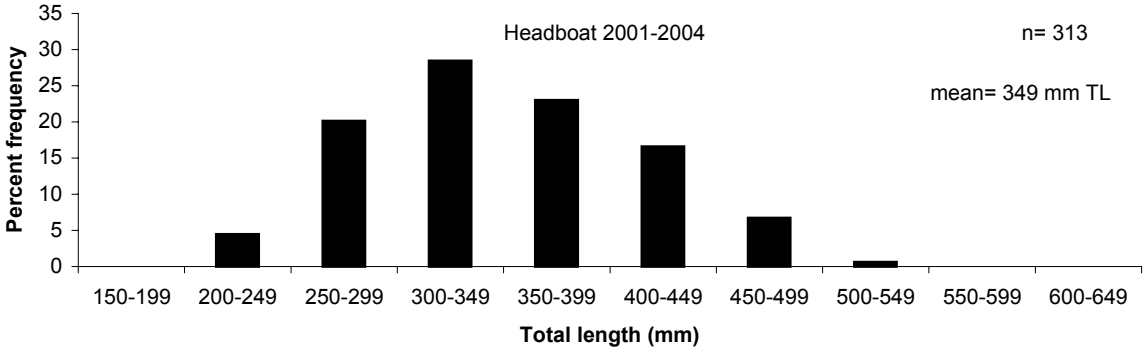


Figure 3. Vermilion snapper length frequency distributions of age samples by fishing mode 2001 to 2004.







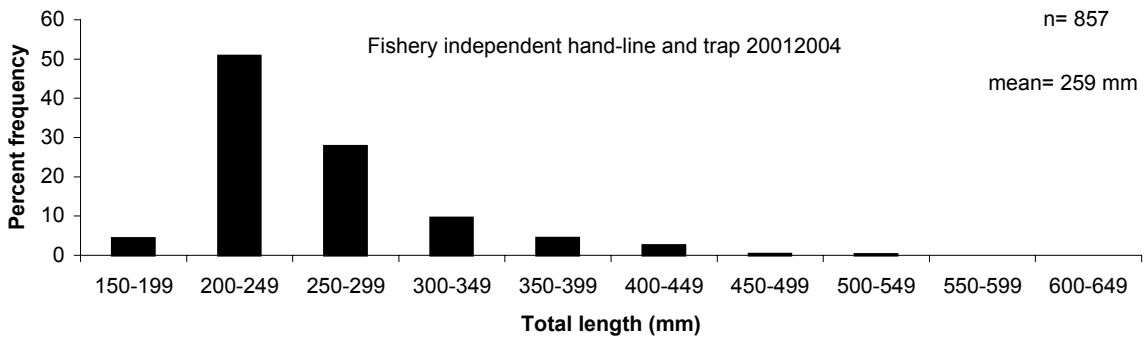
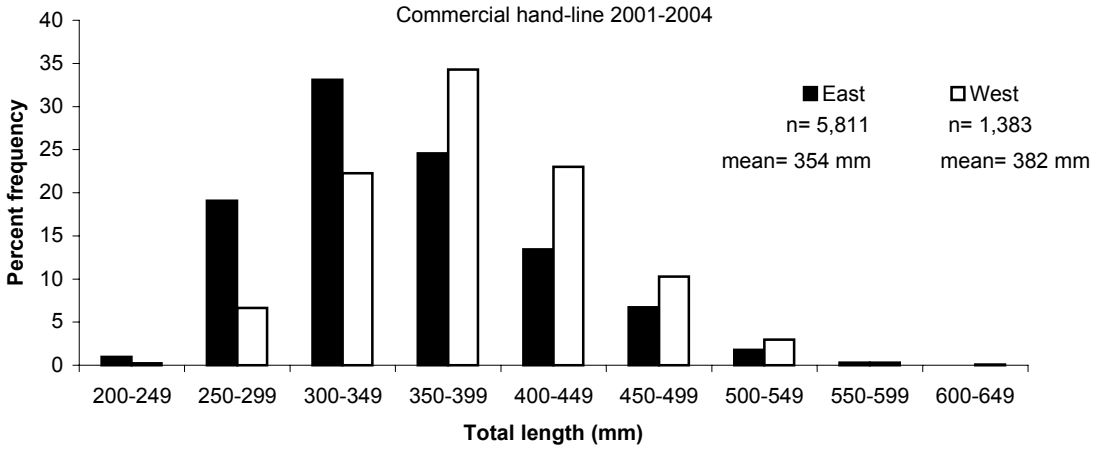


Figure 4. Vermilion snapper length frequency distribution of age samples by fishing mode and region.

A.



B.

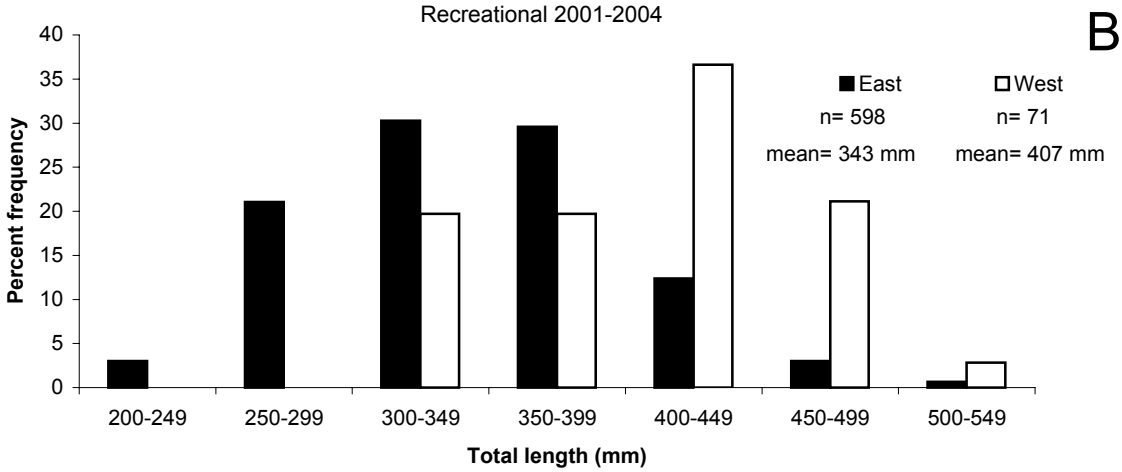


Figure 5. Vermilion snapper length frequency distribution of age samples for the commercial hand-line fishery by year.

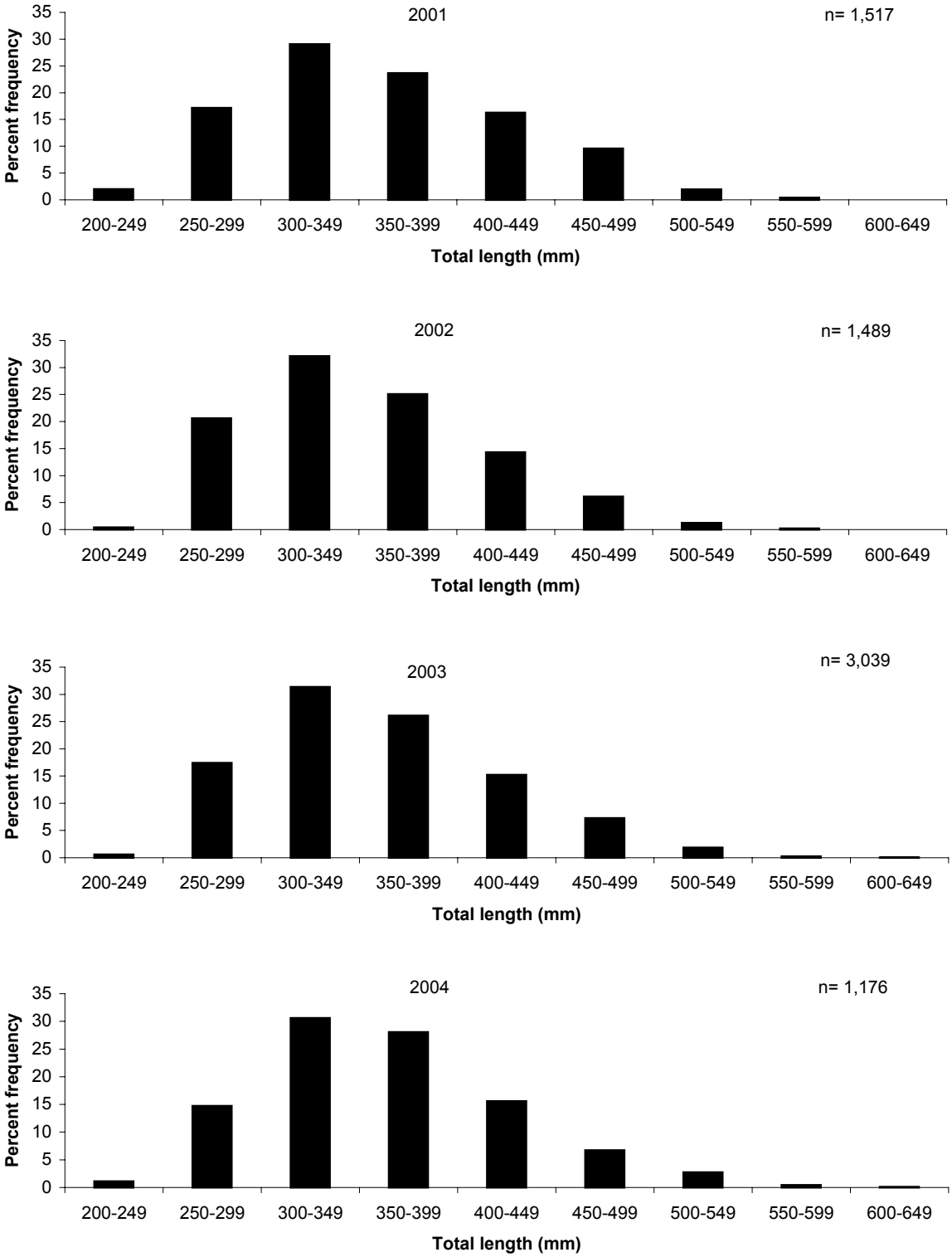


Figure 6. Vermilion snapper length frequency distribution of age samples for the recreational fishery by year.

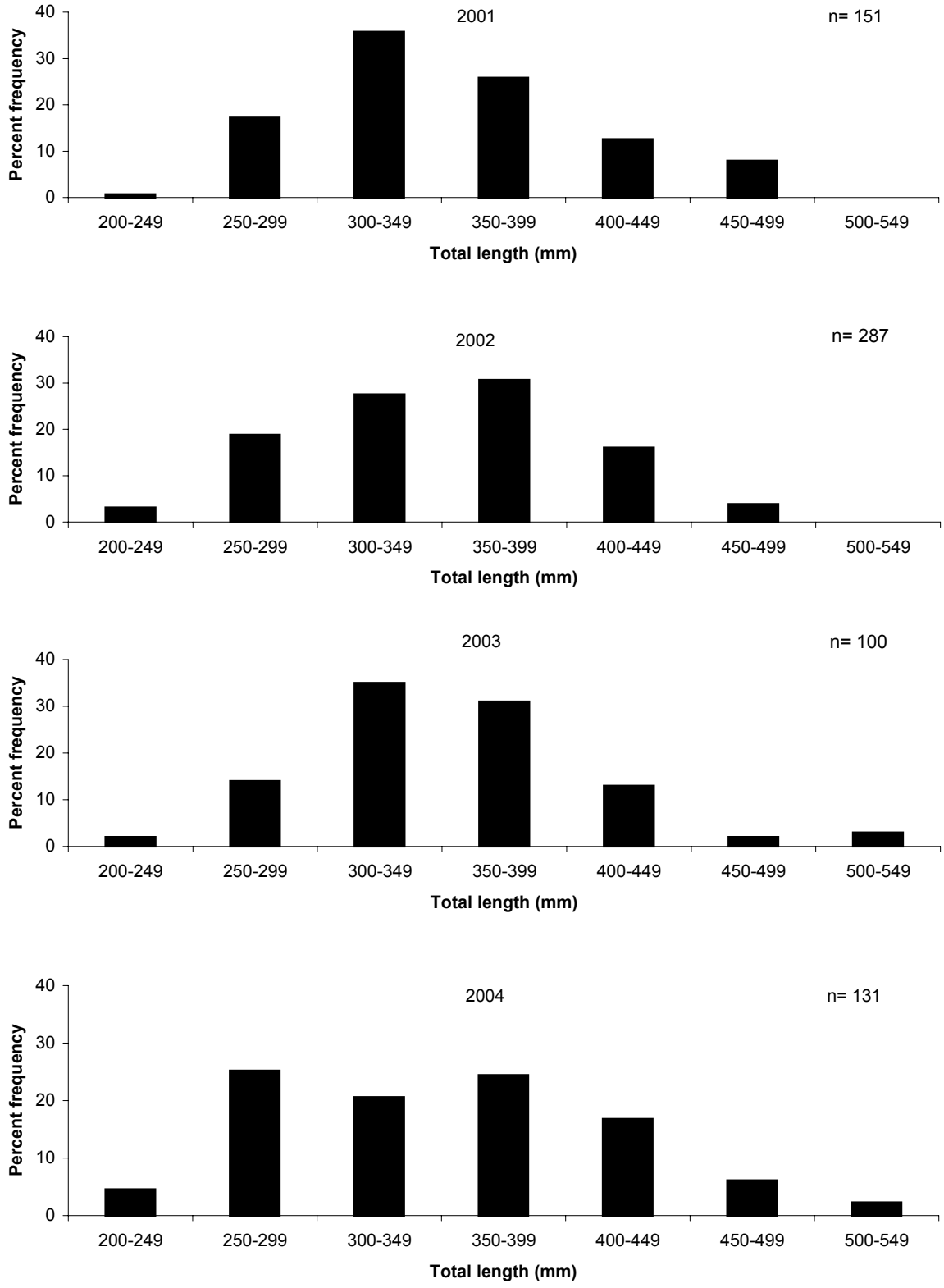
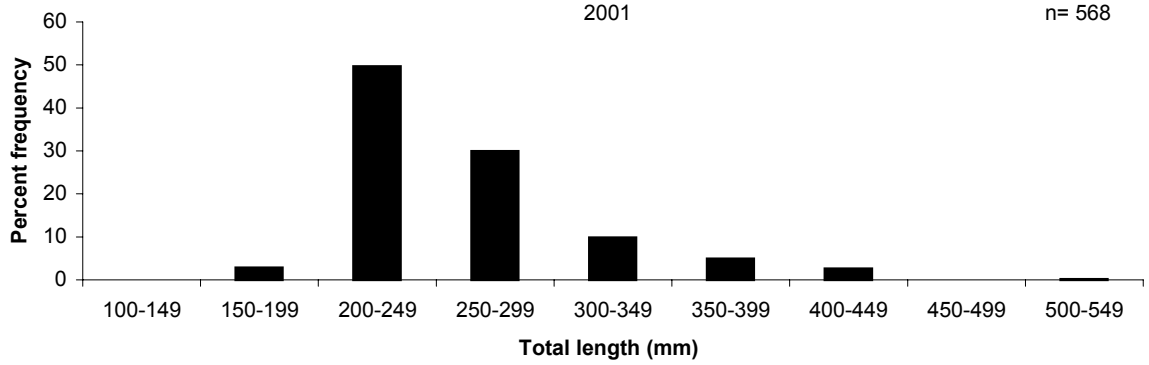
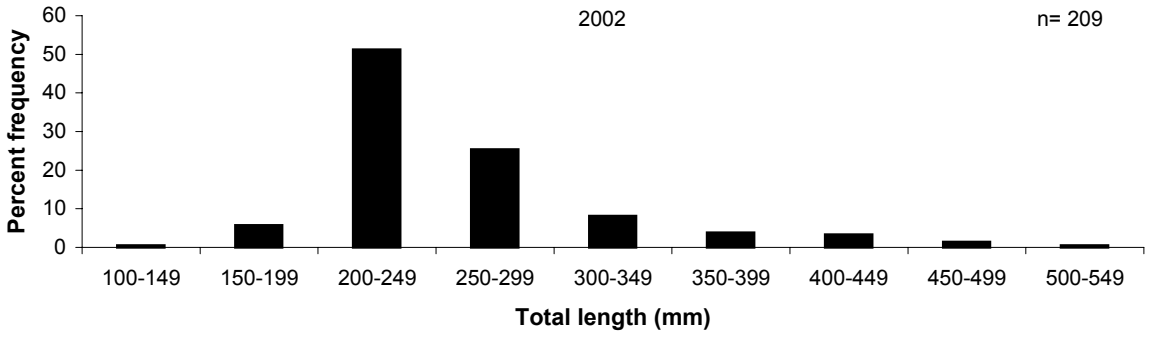


Figure 7. Vermilion snapper length frequency distribution of age samples for fishery-independent survey by year.





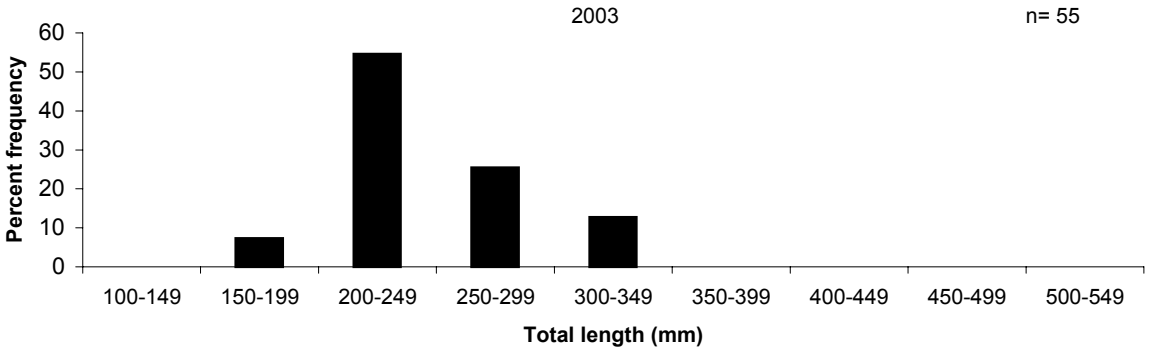
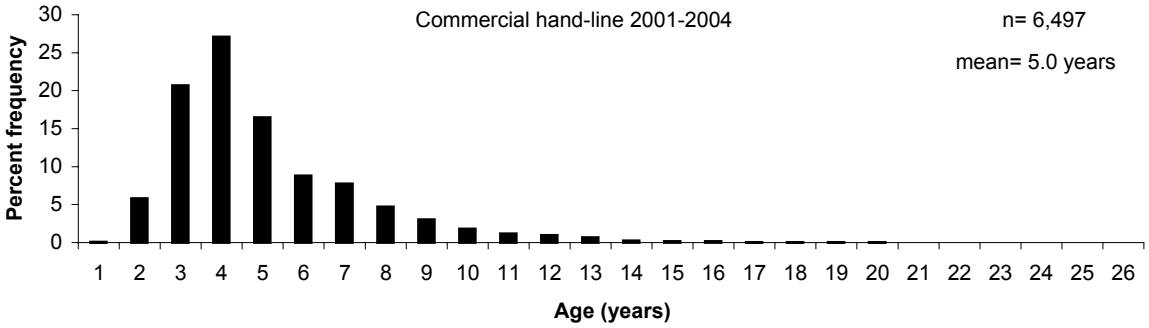
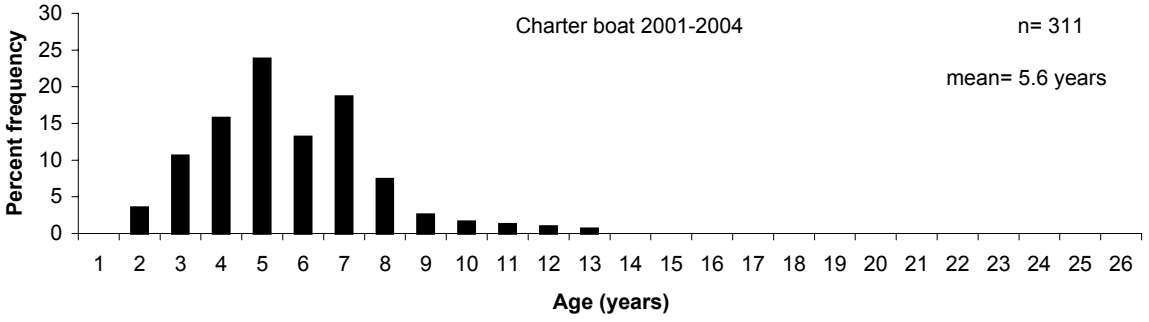


Figure 8. Vermilion snapper length frequency distribution of age samples by fishing mode 2001-2004.





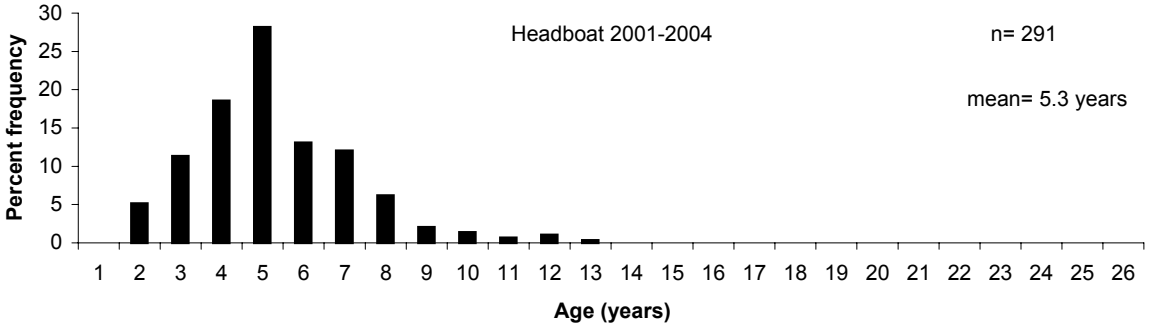


Figure 9. Vermilion snapper age frequency distribution of age samples by fishing mode and region 2001-2004.

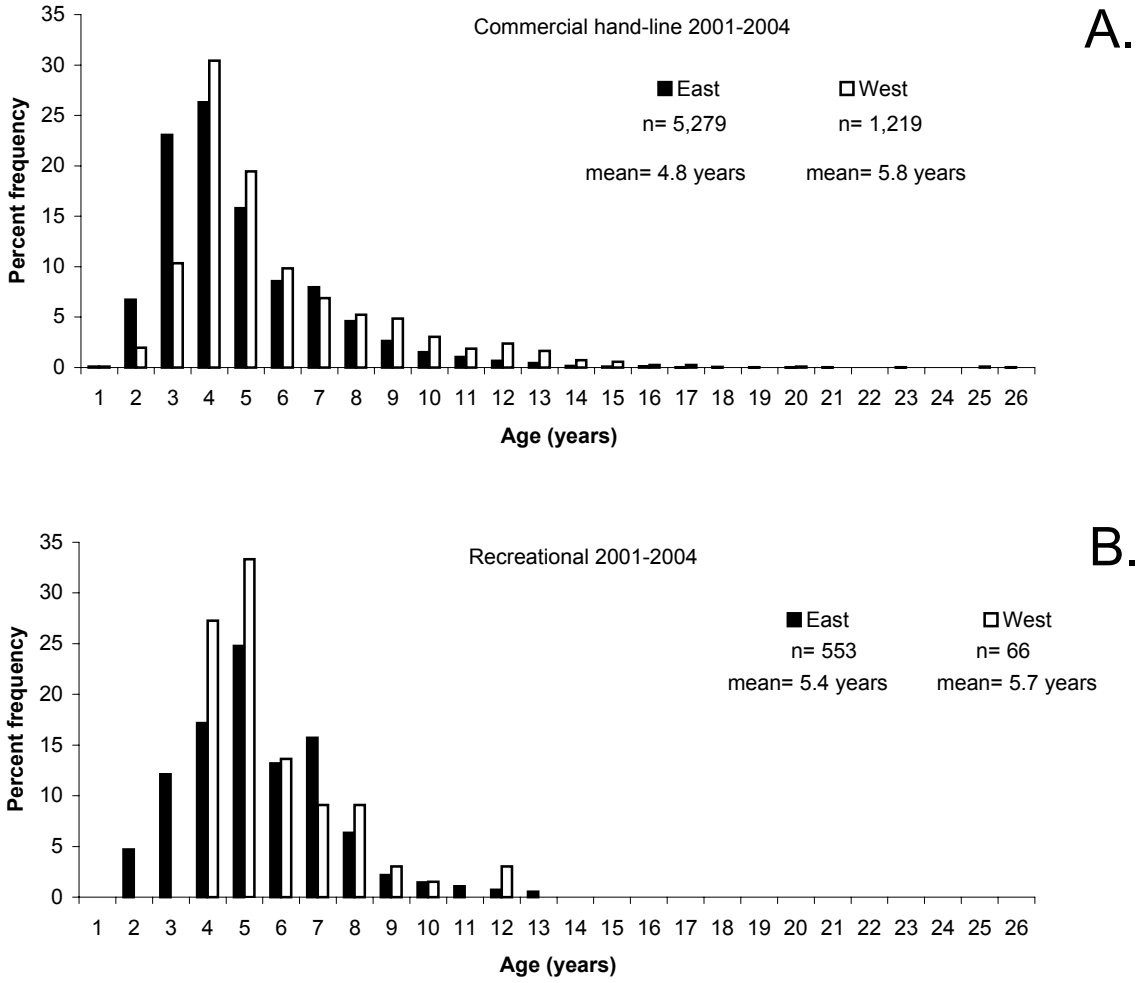


Figure 10. Vermilion snapper age frequency distribution for the commercial hand-line fishery by year.

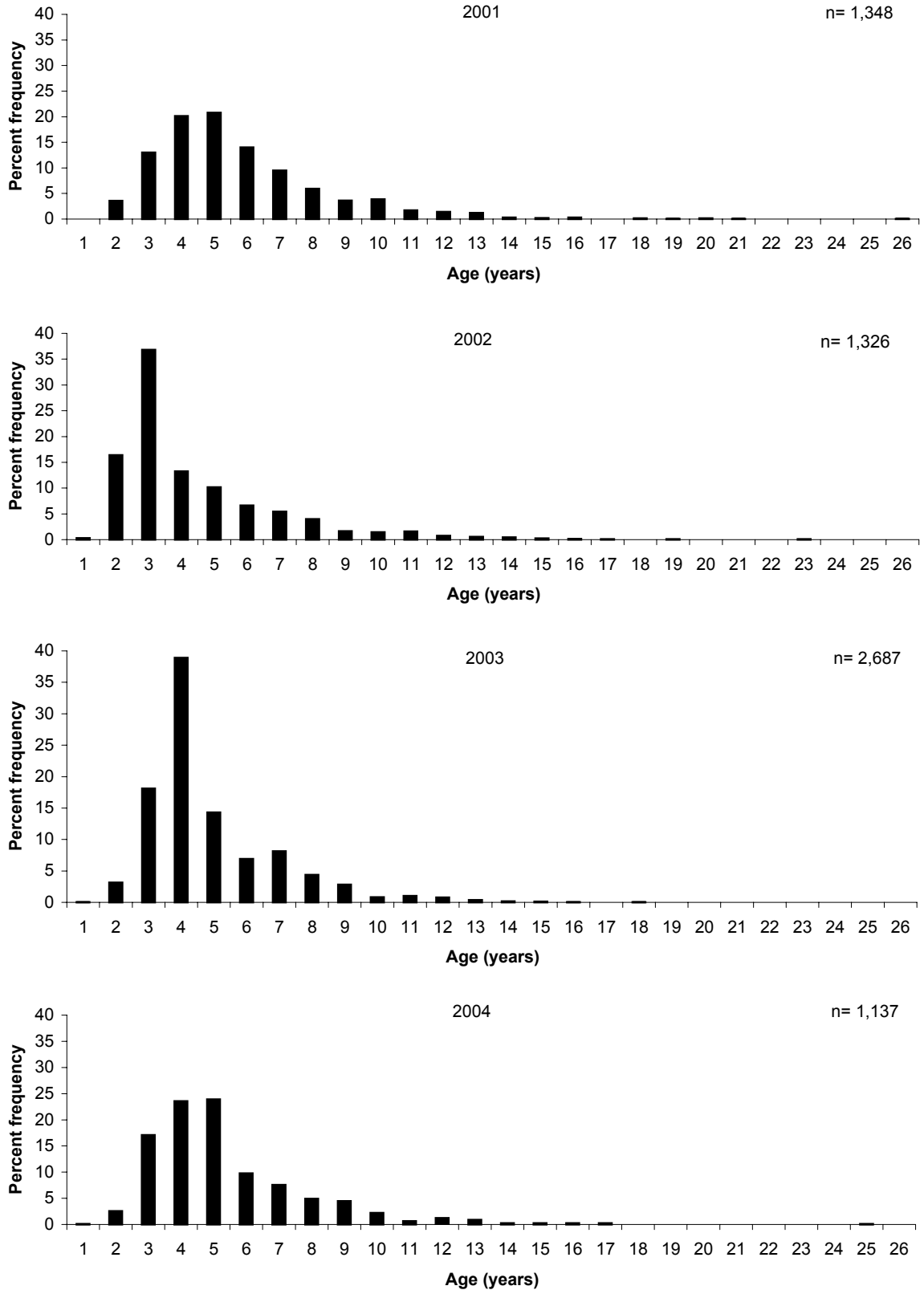


Figure 11. Vermilion snapper age frequency distribution for the recreational fishery by year.

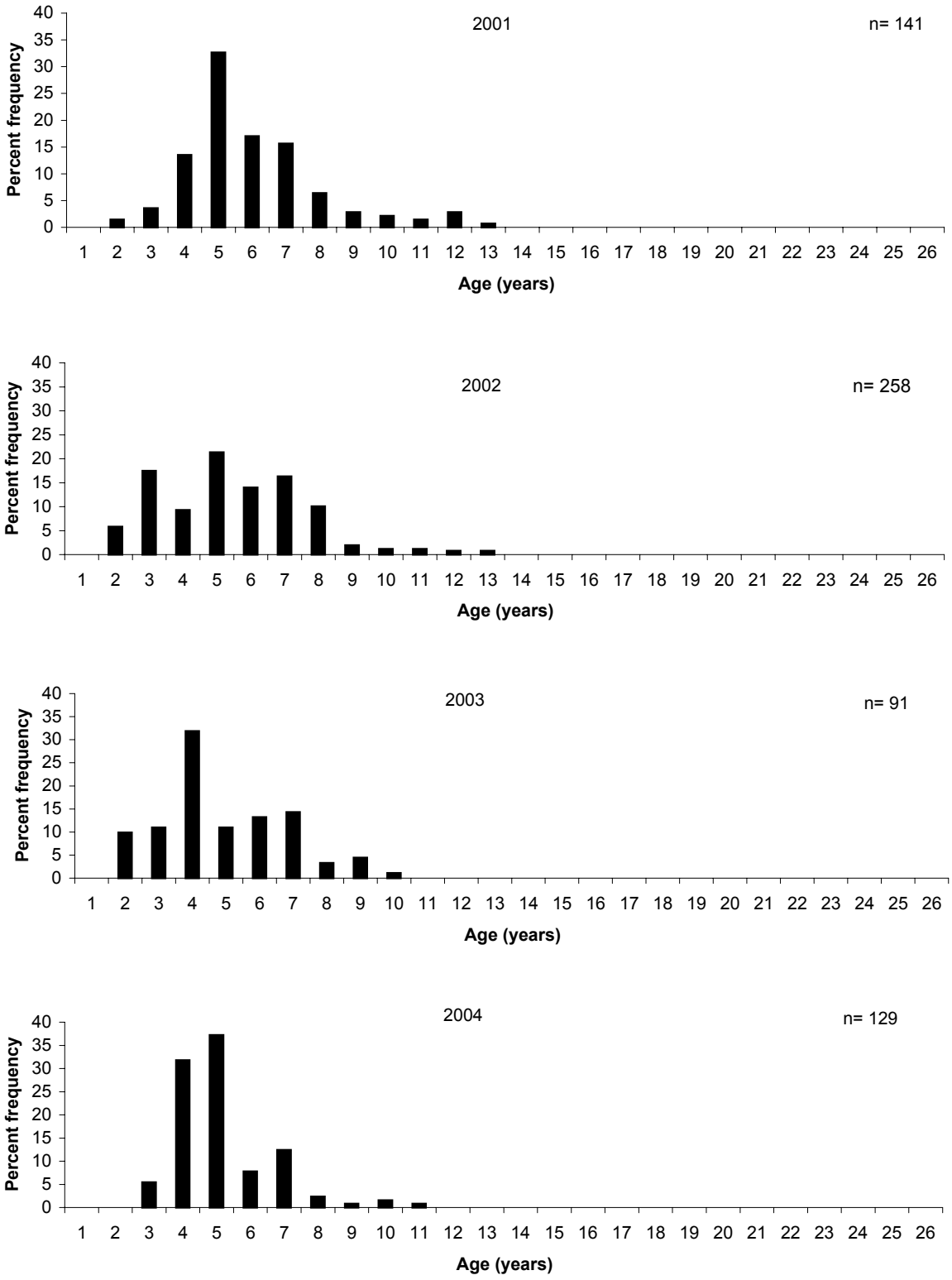


Figure 12. Vermilion snapper age frequency distribution for fishery-independent survey by year.

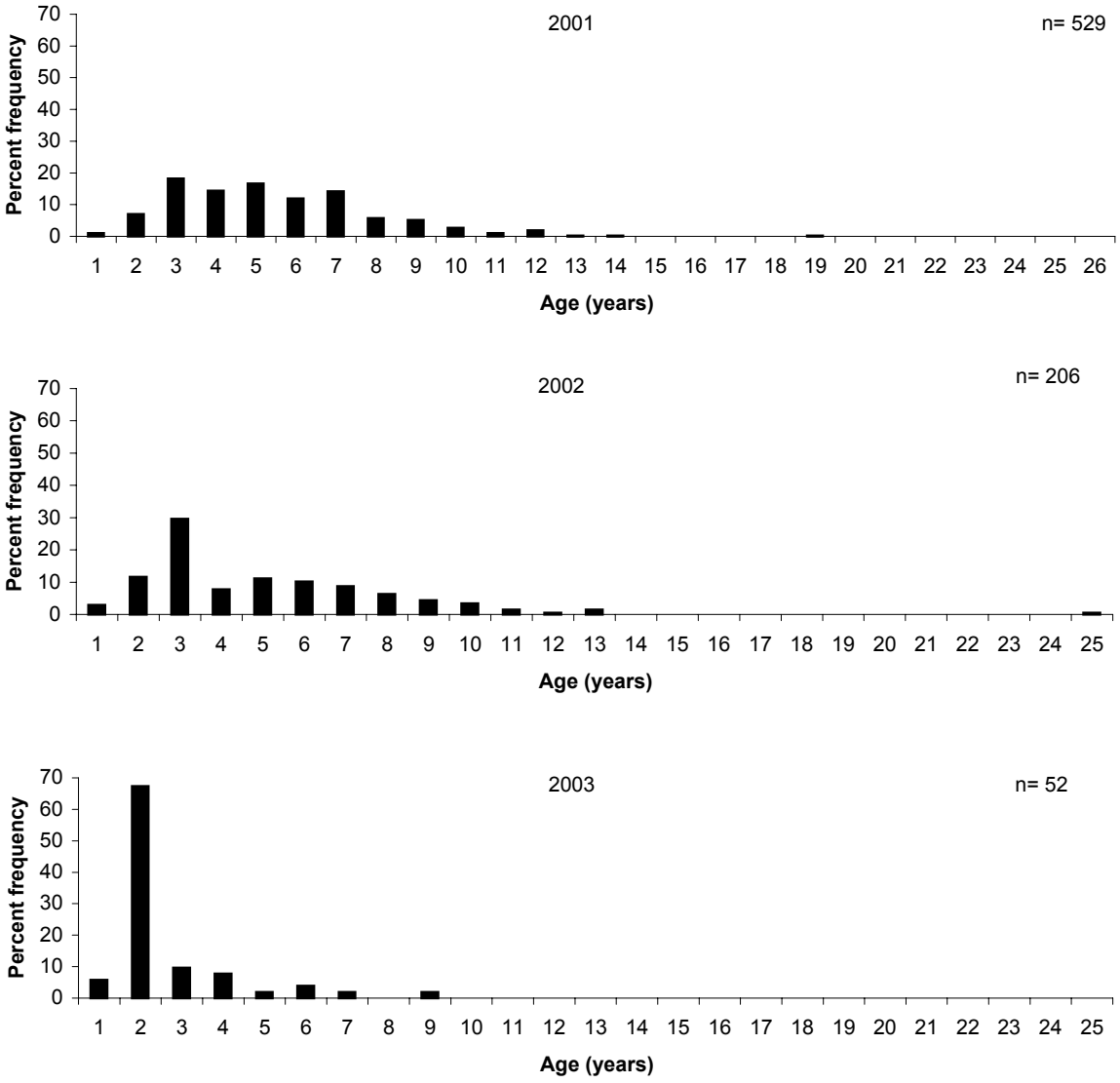


Figure 13. Vermilion snapper total length by age and fishing mode.