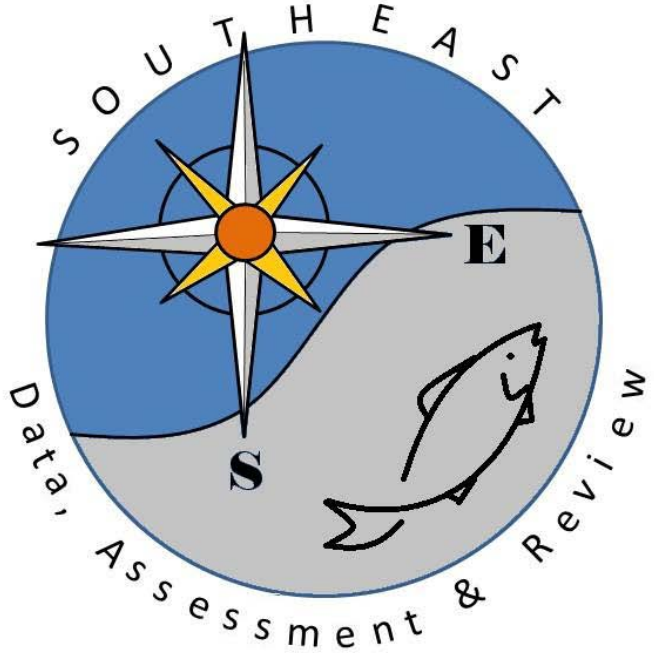
Red snapper (*Lutjanus campechanus*) otolith ageing summary for collection years 2009-2011

Robert Allman, Beverly Barnett, Hannah Trowbridge, Laura Goetz and Nancy Evou

SEDAR31-DW05

31 July 2012



Please cite as:

Allman, R., B. Barnett, H. Trowbridge, L. Goetz, and N. Evou. 2012. Red snapper (*Lutjanus campechanus*) otolith ageing summary for collection years 2009-2011. SEDAR31-DW05. SEDAR, North Charleston, SC. 26 pp.

Red snapper (*Lutjanus campechanus*) otolith ageing summary for collection years 2009-2011

Robert Allman, Beverly Barnett, Hannah Trowbridge, Laura Goetz and Nancy Evou

July 2012

National Marine Fisheries Service

Southeast Fisheries Science Center

Panama City Laboratory

3500 Delwood Beach Road

Panama City, FL 32408

Panama City Laboratory Contribution Series 12-03

INTRODUCTION

The economic importance of red snapper and controversies over its management has resulted in increased sampling and ageing of the catch since the early 1990s. Understanding the age structure of the red snapper fishery is crucial for accurate stock assessment and for determining year class strength. Numerous studies have used otoliths to age red snapper and provide basic information on growth and annulus formation (Futch and Bruger, 1976; Bortone and Hollingsworth, 1980; Nelson and Manooch, 1982; Wilson and Nieland, 2001; Manooch and Potts, 1997; Patterson et al., 2001). The longevity of red snapper has been validated to at least 38 years using bomb radio carbon ^{14}C (Baker and Wilson, 2001). Additionally, red snapper otolith reader interpretation and the repeatability of age estimates (i.e., precision) have been examined (Allman et al., 2005). The goal of this report is to update and summarize the size and age structure of red snapper since the last update in 2009, which covered red snapper ageing from 2003 through 2008 (Allman et al., 2009). The sampling years covered in this report are 2009 through 2011.

METHODS

Red snapper were sampled from Gulf of Mexico landings from Texas to the west coast of Florida from January 2009 through December 2011. Samples were collected from the recreational and commercial fisheries and from fishery independent surveys. Most fish were measured to total length (TL) or were converted to total length from fork length (FL) with the equation TL (mm) = 1.06 x FL (mm) + 1.89 (N = 7,568, $r^2 = 0.99$). Sagittal otoliths were removed, cleaned with distilled water, dried and weighed to the nearest 0.0001 g prior to sectioning. Fish were weighed to the nearest g, and sex was determined macroscopically if the fish was landed whole. All otoliths were processed and aged with the exception of those from the commercial hand-line fishery from the Florida Panhandle and Louisiana, which consisted of the largest numbers and were subsequently sub-sampled. Sub-sampling was conducted by randomly selecting at least 100 otoliths per 2-month wave, from each area for processing and ageing (a minimum of 600 otoliths per area, per year).

Otoliths were processed with a high-speed thin sectioning machine utilizing the methods of Cowan et al. (1995). Two transverse cuts were made through the otolith core to a thickness of 0.5 mm. Ages were assigned based on the count of annuli (opaque zones observed on the dorsal side of the sulcus acusticus in the transverse plane with reflected light at 40x, including any partially completed opaque zones on the otolith margin) and the degree of marginal edge completion. Red snapper off the

Southeastern U.S. complete annulus formation by late spring to early summer (Patterson et al., 2001; Wilson and Nieland, 2001; White and Palmer, 2004; Allman et al., 2005). Therefore, age was advanced by one year if a large translucent zone was visible on the margin and capture date was from 1 January to 30 June; after 30 June age was equal to opaque zone count. By this traditional method, an annual age cohort is based on a calendar year rather than time since spawning (Jearld, 1983; Vanderkooy and Guindon-Tisdel, 2003). Biological (fractional) ages were also estimated for use in fitting growth curves. Biological age accounts for the difference in time between peak spawning (defined as 1 July for red snapper) and capture date (difference in days divided by 365). This fraction is added to annual age if capture date is after 1 July and subtracted if capture date is before 1 July (Vanderkooy and Guindon-Tisdel, 2003; Wilson and Nieland, 2001).

Three experienced otolith readers were responsible for ageing otoliths from each collection year. Prior to ageing, an otolith reference collection (N= 200) was read annually to ensure repeatability (i.e., precision) of ageing. Average percent error (APE; Beamish and Fournier, 1981) was used to estimate precision between readers. An APE ≤ 5% is considered acceptable for moderately long-lived species with relatively difficult to read otoliths (Morison et al., 1998; Campana, 2001). Once an APE of ≤ 5% was achieved, the reader was considered to be proficient and could begin ageing. All three otolith readers had an APE below 3%.

Collection

A total of 17,305 red snapper otoliths collected from 2009 to 2011 were processed with 2% (347) rejected due to processing problems or otoliths which were too diffuse to read. The gear type recorded most often was hand-line followed by long-line, trap and trawl. A small number of spear, vertical long-line and gear unknown were also recorded (Table 1). The majority of red snapper were sampled through the Trip Interview Program and this was reflected in the large number of commercial samples collected annually. Commercial samples annually ranged from 46%-75% of otoliths aged (Fig. 1). Fishery-independent survey sampling has steadily increased in recent years accounting for 40% of samples in 2011, due largely to the expanded stock assessment survey program (EASA) (Fig. 2). The fraction of recreational samples received by the Panama City laboratory has increased since the last update from 4% in 2008 to 13% in 2011, mainly through the Beaufort headboat program. To date, the recreational fishery remains largely sampled by the Southeast Recreational Fisheries Information Network (RecFIN) through the Gulf States Marine Fisheries Commission (GSMFC). The geographic

distribution of aged fish was similar to the distribution of commercial landings with slightly more than half from the western gulf (LA and TX; 55%). Otoliths collected from Florida, Texas and Louisiana made up the majority of collections (41%, 30% and 24%, respectively), while Alabama and Mississippi together contributed about 4% (Table 2). (Fig. 3; Table 3). Recorded catch depths for red snapper ranged from 6.7 to 258 m (Table 4).

Size frequency

Size frequency distributions can provide some indication of the underlying age structure and differences were noted in the sizes of red snapper by fishing mode. The commercial long-line fishery was composed of the largest individuals, with a dominant size class in the 551-600 (mm) TL size range and mean size of 593 (mm) TL (Fig. 4). The commercial hand-line and recreational fishery had similar size distributions with modes in 401-450 (mm) TL and 451-500 (mm) TL size range and mean sizes of 502 and 554 (mm) TL, respectively. Fishery independent size distributions were similar to the fishery dependent counterparts. The long-line survey consisted of the largest individuals with a mode at the 701-750 (mm) TL size class (mean 690 (mm) TL) and the hand-line survey consisted of smaller fish with a mode from 401-450 (mm) TL (mean 494 (mm) TL). The smallest individuals were collected by fishery independent trawl and trap. Both gears collected a modal size of 201-250 mm TL and mean sizes of 292 and 424 mm TL, respectively.

Age Structure

A comparison of age distributions by fishing mode indicated differences by fishing mode and by sampling year. Red snapper collected from 2009 through 2011 ranged from young-of -the-year (<1 year) to 55 years. The commercial long-line selected the oldest individuals with fish first fully recruited to the fishery by age 4, with a mean age of 5.6 years and 6.8% of individuals 10 years or older (Fig. 5). The recreational fishery selected younger fish with fish first entering the fishery at 4 years with 76% of individuals ages 2 to 5 (mean= 4.8 years) and only 0.4% of fish 10 years or older. The commercial hand-line fishery selected a similar age range as the recreational fishery with a mode of 4 years, mean age of 4.3 years and 0.4% of fish 10 years or greater. The fishery independent long-line survey had a modal age of 6 years, a mean age of 8.9 years with 25% of ages 10 years or greater, while the fishery independent hand-line gear had a mode of 5 years, mean age of 4.6 years and 0.7% of fish 10 years or older. Fishery independent trawl and trap collected the youngest individuals with modes at 1 and 3 year and average ages of 1.9 and 3.7 years, respectively. Size-at-age data indicated that rare and relatively old fish (ages >

20 years) were caught by all sectors and gears with the exception of fishery independent trap, but were most commonly associated with the commercial fishery (Fig. 6).

Year class

Age frequency distributions by sampling year revealed changes in the age at recruitment, as well as the potential influence of strong year classes. The annual recruitment pattern of red snapper from the recreational fishery indicated recruitment occurred by age 4 in 2009 and age 5 in 2010 and 2011(Fig. 7). Recruitment to the commercial hand-line fishery was similar, age 4 in 2009 and 2010 and age 5 in 2011 (Fig. 8). The age of recruitment to the commercial long-line fishery varied between age 4 in 2009 to age 5 in 2010 and 2011 (Fig. 9). Sample size for fishery-independent hand-line and long-line surveys were too small for annual comparisons.

There was some indication of strong year-classes in the directed fisheries. The commercial hand-line fishery showed potential evidence of a strong 2006 year-class with a relatively large percentage of 3 year olds in 2009 (32%) followed by 4 year olds in 2010 (33%) and 5 year olds in 2011 (31%). To a lesser degree this was also evident in the recreational and commercial long-line fisheries. Both the recreational and commercial long-line fisheries showed some evidence of a strong 2005 year class. Generally, the influence of these strong year classes can be followed for 2 to 3 consecutive years.

Geographic distribution

On average red snapper caught in the western Gulf of Mexico (Louisiana and Texas) tended to be larger and older than those from the east (Florida, Alabama, and Mississippi). However, fish caught in the recreational, commercial hand-line fisheries and by fishery independent hand-line were similar in size and age (Figs. 10 & 11). The biggest differences were noted in the commercial long-line fishery and fishery-independent long-line survey. Recruitment to the commercial long-line fishery was by age 4 in the east and age 9 in the west with a mean age of 4.9 years for the east and 9.1 years for the west. This pattern was consistent with the fishery independent long-line survey with recruitment in the eastern gulf at age 6 with a mean age of 6.3 years, while in the western gulf recruitment was at age 7 and a mean age of 9.7 years.

ACKNOWLEDGEMENTS

We wish to thank the port agents and scientists throughout the gulf region who sampled red snapper.

REFERENCES

Allman, R.J., B.K. Barnett, N. Evou, R.A. Farsky, J. Keesee and P. Colson. 2009. Red snapper (*Lutjanus campechanus*) otolith ageing summary 2003 to 2008. Panama City Laboratory contribution Series 09-15.

Allman, R.J., G.R. Fitzhugh, K.J. Starzinger and R.A. Farsky. 2005. Precision of age estimation in red snapper (*Lutjanus campechanus*). Fisheries Research 73:123-133.

Baker, M.S., Jr., and C.A. Wilson. 2001. Use of bomb radiocarbon to validate otolith section ages of red snapper, *Lutjanus campechanus*, from the northern Gulf of Mexico. Limnology and Oceanography 46: 1819-1824.

Beamish, R.J. and D.A. Fournier. 1981. A method for comparing the precision of a set of age determinations. Canadian Journal of Fisheries and Aquatic Science 38:982-983.

Bortone, S.A. and C.L. Hollingsworth. 1980. Ageing red snapper, *Lutjanus campechanus*, with otoliths, scales and vertebrae. Northeast Gulf Science 4(1):60-63.

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

Cowan, J.H. Jr., R.L. Shipp, H.K. Bailey IV, and D.W. Haywick 1995. Procedure for rapid processing of large otoliths. Transactions of the American Fisheries Society 124:280-282.

Futch, R.B. and G.E. Bruger. 1976. Age, growth and reproduction of red snapper in Florida waters. Pages 165-183 *in*: H.R. Bullis Jr. and A.C. Jones (eds.) Proceedings: Colloquium on snapper-grouper fishery resources of the western central Atlantic ocean. Florida Sea Grant College Program Report No. 17, Gainesville, Florida.

Jearld., A. Jr. 1983. Age determination. Pages 301-324 *in*: L.A. Nielsen and D.L. Johnson, (eds.) *Fisheries Techniques*. Southern Printing Company, Inc., Blacksburg, Virginia.

Kutkuhn, J.H. 1962. Gulf of Mexico commercial shrimp populations-trends and characteristics, 1956-59. U.S. Fish Wildl. Serv., Fish. Bull. 62:343-402.

Manooch, C.S. III and J.C. Potts. 1997. Age and growth of red snapper, *Lutjanus campechanus*, Lutjanidae, collected along the southeastern United States from North Carolina through the east coast of Florida. Journal of the Elisha Mitchell Society 113(3):111-112.

Morison, A.K., P.C. Coutin and S.G. Robertson. 1998. Age determination of black bream, *Acanthopagrus butcheri* (Sparidae), from the Gippsland Lakes of south-eastern Australia indicates slow growth and episodic recruitment. Marine and Freshwater Research 49:491-498.

Nelson, R.S. and C.S. Manooch III. 1982. Growth and mortality of red snappers in the west-central Atlantic Ocean and northern Gulf of Mexico. Transactions of the American Fisheries Society 111:465-475.

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. U.S. Fishery Bulletin 99:617-627.

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

White, D.B. and S.M. Palmer. 2004. Age, growth, and reproduction of the red snapper, *Lutjanus campechanus*, from the Atlantic waters of the Southeastern U.S. Bulletin of Marine Science 75(3):335-360.

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

Table 1. Number of otoliths processed and assigned an age (in parentheses) during years 2009 through 2011. Sub-sampling was only conducted for the commercial hand-line sectors for Florida (Panhandle area only) and Louisiana. Further, all sub-sampling was based upon yearly, bi-monthly waves (i.e., wave 1 = January/February; wave 2 = March/April; wave 3 = May/June; wave 4 = July/August; wave 5 = September/October; and wave 6 = November/December).

	2009	**2010**	**2011**	**TOTAL**
COMMERCIAL				
Hand-line	3,316 (3,204)	2,995 (2,948)	2,724 (2,708)	**9,035 (8,860)**
Long-line	983 (937)	430 (417)	346 (343)	**1,759 (1,697)**
Spear		1 (1)		**1 (1)**
Unknown		4 (4)		**4 (4)**
Vertical Long-line	1 (1)	123 (123)		**124 (124)**
Sub-Total	**4,300 (4,142)**	**3,553 (3,493)**	**3,070 (3,051)**	**10,923 (10,686)**
RECREATIONAL				
Charter boat	3 (3)	57 (56)	81 (81)	**141 (140)**
Headboat	659 (629)	529 (522)	784 (761)	**1,972 (1,912)**
Sub-Total	**662 (632)**	**586 (578)**	**865 (842)**	**2,113 (2,052)**
TOURNAMENT				
Hand-line			23 (23)	**23 (23)**
Spear			16 (16)	**16 (16)**
Sub-Total			**39 (39)**	**39 (39)**
FISHERY INDEPENDENT				
Hand-line	273 (271)	21 (21)	1,758 (1,747)	**2,052 (2,039)**
Long-line	78 (76)	53 (51)	762 (746)	**893 (873)**
Trap	457 (450)	93 (91)	142 (141)	**692 (682)**
Trawl	157 (153)	301 (299)		**458 (452)**
Vertical Long-line		102 (102)	33 (33)	**135 (135)**
Sub-Total	**965 (950)**	**570 (564)**	**2,695 (2,667)**	**4,230 (4,181)**
TOTAL	**5,927 (5,724)**	**4,709 (4,635)**	**6,669 (6,599)**	**17,305 (16,958)**

Table 2. Number of otoliths processed and assigned an age (in parentheses) by state during years 2009 through 2011. Sub-sampling was only conducted for the commercial hand-line sectors for states Florida (Panhandle area only) and Louisiana. Further, all sub-sampling was based upon yearly, bi-monthly waves (i.e., wave 1 = January/February; wave 2 = March/April; wave 3 = May/June; wave 4 = July/August; wave 5 = September/October; and wave 6 = November/December).

	ALABAMA	**FLORIDA**	**LOUISIANA**	**MISSISSPPI**	**TEXAS**	**TOTAL**
COMMERCIAL						
Hand-line	124 (119)	3,601 (3,515)	2,215 (2,174)	220 (218)	2,875 (2,834)	**9,035 (8,860)**
Long-line		1,461 (1,408)	32 (32)		266 (257)	**1,759 (1,697)**
Spear		1 (1)				**1 (1)**
Unknown		4 (4)				**4 (4)**
Vertical Long-line		124 (124)				**124 (124)**
Sub-Total	**124 (119)**	**5,191 (5,052)**	**2,247 (2,206)**	**220 (218)**	**3,141 (3,091)**	**10,923 (10,686)**
RECREATIONAL						
Charter Boat		132 (131)			9 (9)	**141 (140)**
Headboat	188 (165)	270 (264)	481 (468)		1,033 (1,015)	**1,972 (1,912)**
Sub-Total	**188 (165)**	**402 (395)**	**481 (468)**		**1,042 (1,024)**	**2,113 (2,052)**
Hand-line		23 (23)				**23 (23)**
Spear		16 (16)				**16 (16)**
Sub-Total		**39 (39)**				**39 (39)**
FISHERY INDEPENDENT						
Hand-line	66 (66)	713 (708)	831 (825)		442 (440)	**2,052 (2,039)**
Long-line	73 (72)	124 (124)	369 (357)		327 (320)	**893 (873)**
Trap		519 (509)	102 (102)		71 (71)	**692 (682)**
Trawl	18 (17)	68 (67)	156 (154)		216 (214)	**458 (452)**
Vertical Long-line	6 (6)	83 (83)	20 (20)		26 (26)	**135 (135)**
Sub-Total	**163 (161)**	**1,507 (1,491)**	**1,478 (1,458)**		**1,082 (1,071)**	**4,230 (4,181)**
TOTAL	**475 (445)**	**7,139 (6,977)**	**4,206 (4,132)**	**220 (218)**	**5,265 (5,186)**	**17,305 (16,958)**

Table 3. Number of samples aged and mean age (years) for commercial hand-line and long-line samples, fishery independent hand-line and long-line samples with recorded statistical subareas in the Gulf of Mexico for years 2009 through 2011.

	Commercial Hand-line		Commercial Long-line		Fishery Independent Hand-line		Fishery Independent Long-line			
Statistical Subarea	**N**	**Mean Age (years)**	**N**	**Mean Age (years)**	**N**	**Mean Age (years)**	**N**	**Mean Age (years)**	**Total N**	**Mean Age (years)**
1	1	5.0							1	5.0
2	15	5.9	184	4.2					199	4.4
3	11	5.9	17	4.7	6	4.5	11	5.4	45	5.1
4	300	4.7	161	5.0	2	4.5	8	5.8	471	4.8
5	503	4.9	526	4.8	27	4.8	18	5.9	1,074	4.9
6	703	4.2	397	4.8	155	4.0	21	5.2	1,276	4.4
7	184	3.5	1	4.0	17	4.7	5	4.4	207	3.6
8	478	4.1			337	4.5	28	5.5	843	4.3
9	257	3.6			130	4.0	13	5.7	400	3.8
10	673	3.5			36	5.2	54	6.6	763	3.8
11	524	3.9	12	8.9	71	4.8	52	7.6	659	4.4
12	102	3.7							102	3.7
13	299	4.4	17	7.9	146	4.8	46	5.9	508	4.8
14	230	4.1	19	9.5	31	5.0	57	6.5	337	4.9
15	511	4.7	45	5.6	124	5.3	62	8.3	742	5.2
16	316	4.9	1	6.0	222	5.2	39	11.2	578	5.5
17	876	4.2			282	4.4	115	12.8	1,273	5.0
18	490	5.2	57	5.9	230	5.1	66	11.7	843	5.7
19	182	4.4			89	3.7	23	14.8	294	5.0
20	369	4.4	83	11.2	96	4.0	110	10.1	658	6.1
21	1,643	4.4	147	9.1	25	4.9	118	8.6	1,933	5.0
Total	8,667	4.3	1,667	5.6	2,026	4.6	846	9.0	13,206	4.8

Table 4. Number of samples aged and mean age (years) for commercial hand-line and long-line samples and fishery independent hand-line and long-line samples which had recorded depths in the Gulf of Mexico by depth (meters) range in 20 meter increments for years 2009 through 2011.

	Commercial Hand-line				Commercial Long-line				Fishery Independent Hand-line				Fishery Independent Long-line					
Depth Range (meters)	**EAST**		**WEST**		**EAST**		**WEST**		**EAST**		**WEST**		**EAST**		**WEST**			
	N	Mean Age (years)	N	Mean Age (years)	N	Mean Age (years)	N	Mean Age (years)	N	Mean Age (years)	N	Mean Age (years)	N	Mean Age (years)	N	Mean Age (years)	Total N	Mean Age (years)
1 – 20	6	3.5	30	4.9	2	4.0			6	4.2	5	5.6	2	4.5	1	4.0	52	4.6
21 – 40	995	4.2	653	4.3	213	4.3			310	3.8	210	3.7	58	5.7	72	9.9	2,511	4.3
41 – 60	1,288	4.2	1,164	4.7	406	4.8	14	5.8	125	4.5	487	4.7	73	6.2	219	9.4	3,776	4.8
61 – 80	537	4.2	121	4.8	304	5.2			192	5.4	325	5.2	44	6.9	239	10.0	1,762	5.6
81 – 100	88	3.8	129	4.8					34	5.5	225	5.1	13	8.1	92	10.4	581	5.8
101 – 120	5	5.8	47	3.9	56	6.1			13	3.4	6	7.7	2	5.5	38	7.6	167	5.6
121 – 140					21	7.4							4	7.3	11	9.5	36	8.0
141 – 160	3	3.3					20	6.4	19	3.2							42	4.7
161 – 180																		
181 – 200			10	4.3	10	6.8	2	9.5									22	5.9
201 – 220							10	6.0									10	6.0
221 – 240															5	10.2	5	10.2
241 – 260			14	3.2	1	4.0											15	3.3
Total	**2,922**	**4.2**	**2,168**	**4.6**	**1,013**	**5.0**	**46**	**6.3**	**699**	**4.4**	**1,258**	**4.8**	**196**	**6.3**	**677**	**9.7**	**8,979**	**4.9**

Figure 1. Number of red snapper aged by year and fishing mode.

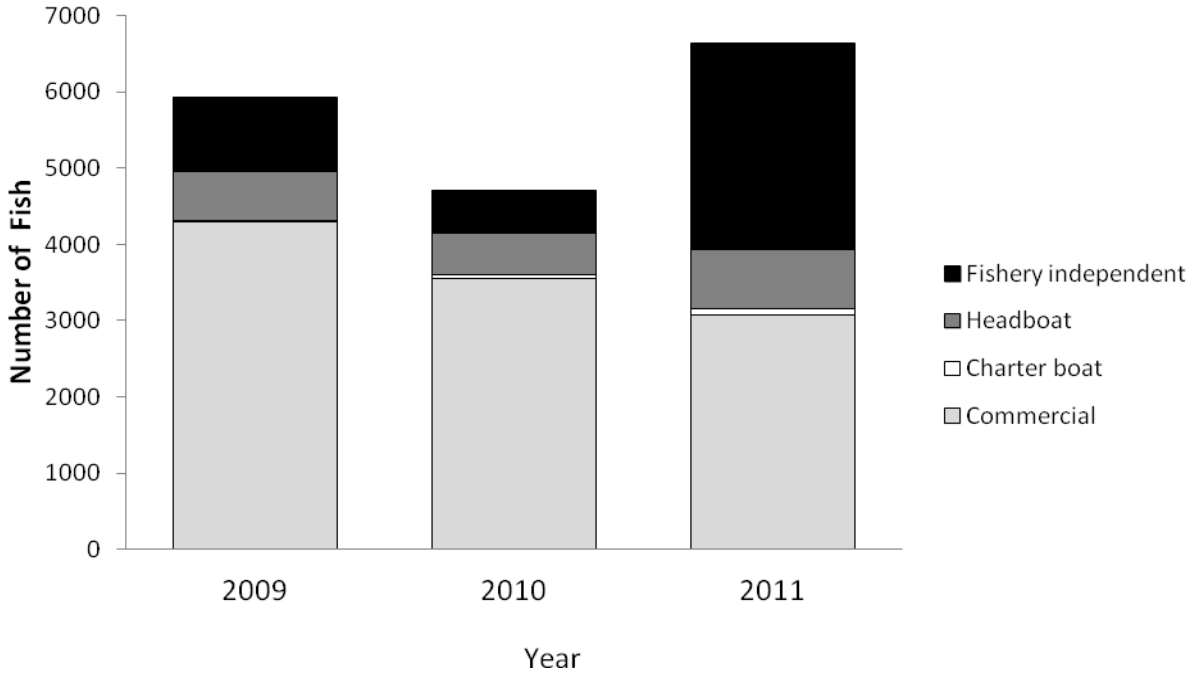


Figure 2. Number of red snapper aged from fishery independent surveys for 2009 to 2011 (EASA= expanded stock assessment survey, FWRI= Florida Fish and Wildlife Research Institute survey, MSLAB= Mississippi laboratory survey and PCLAB= Panama City laboratory survey).

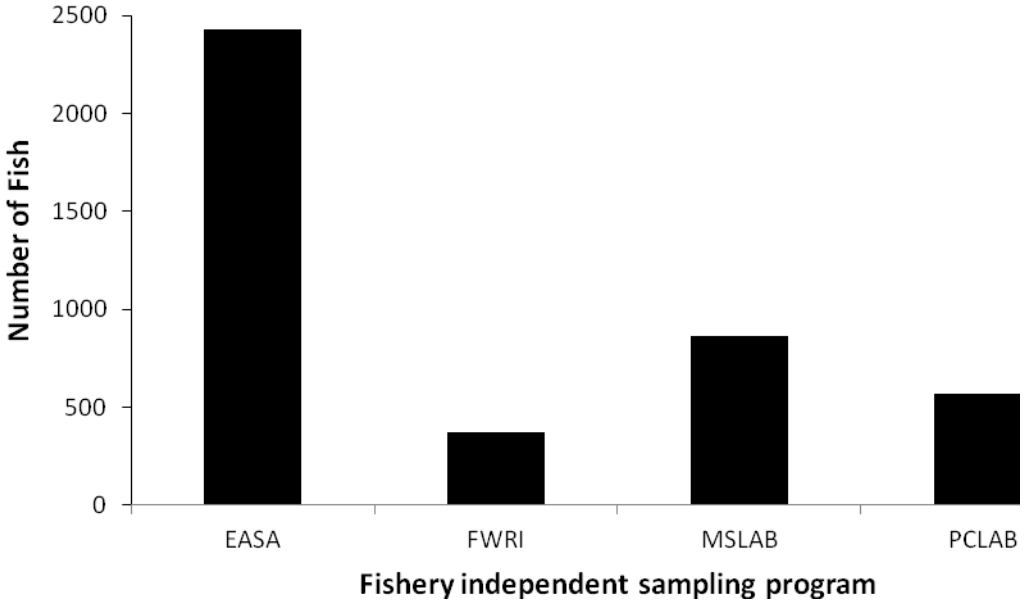


Figure 3. Map of Northern Gulf of Mexico indicating statistical subareas 1 – 21 (after Kutkuhn, 1962).

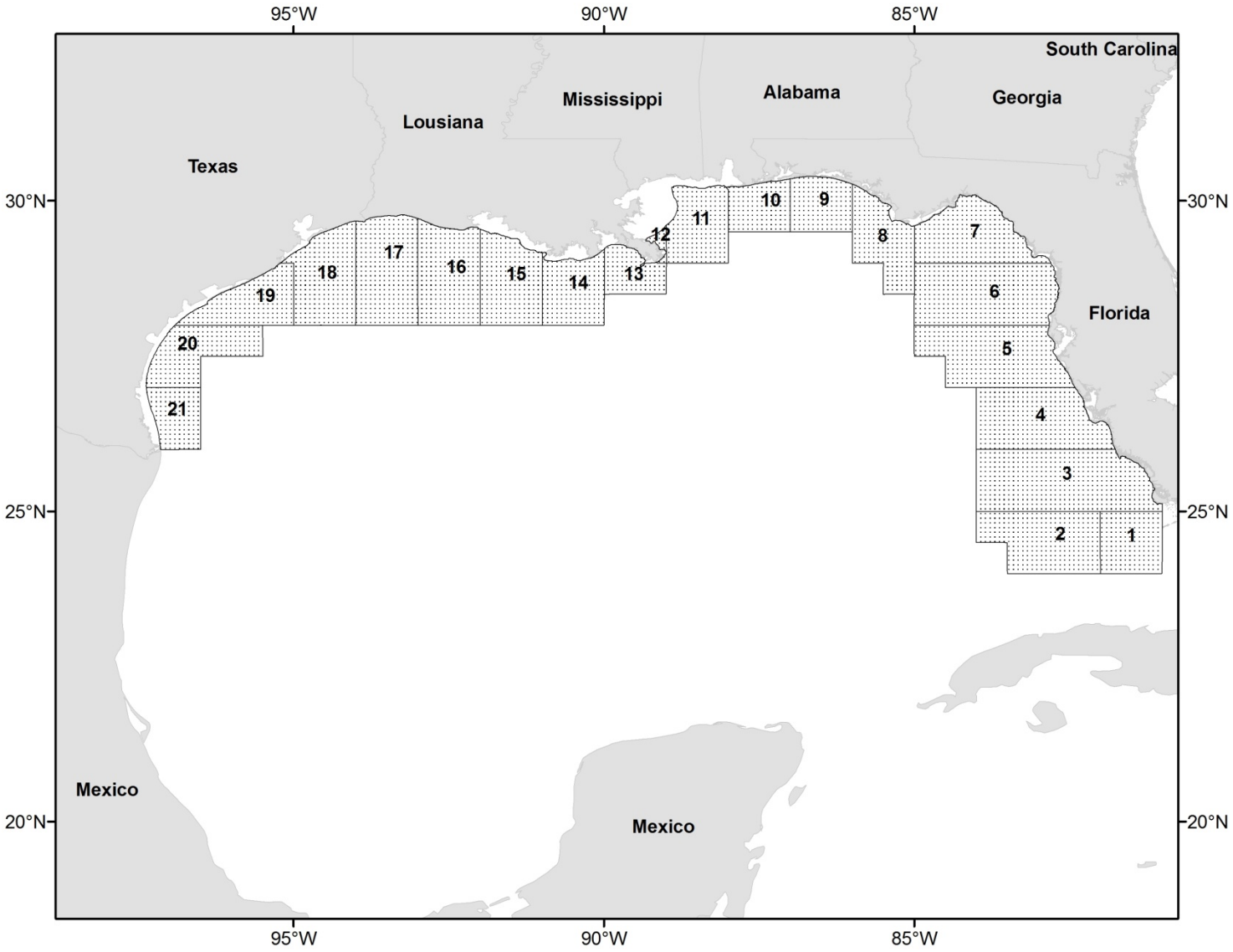
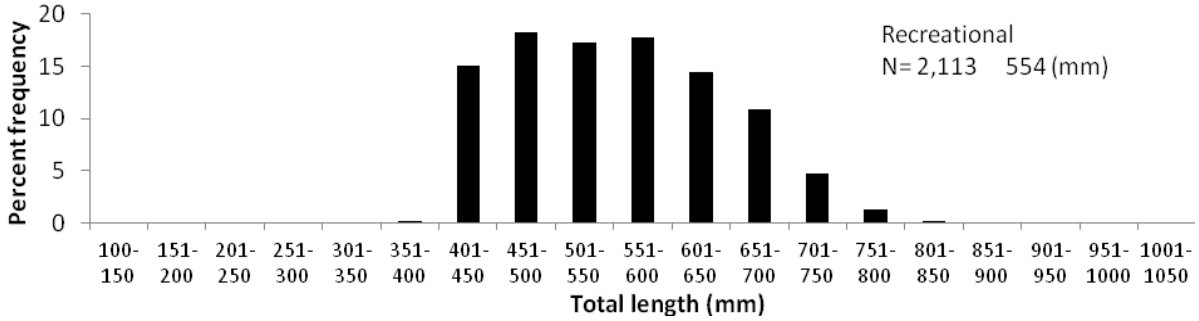
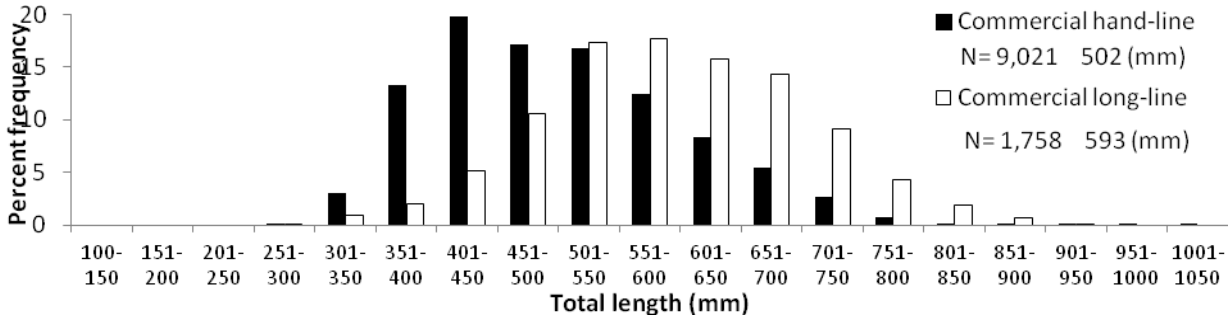
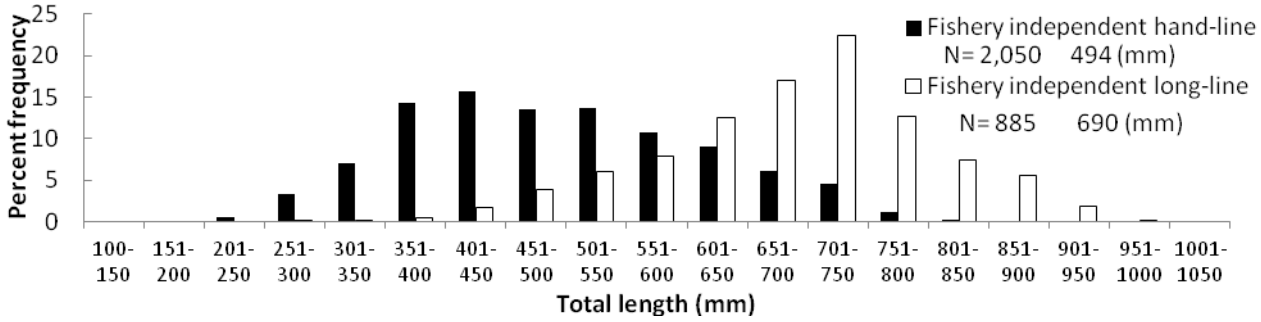


Figure 4. Red snapper length frequency distributions for aged fish by sector with mean total length (TL, mm) for years 2009 through 2011.







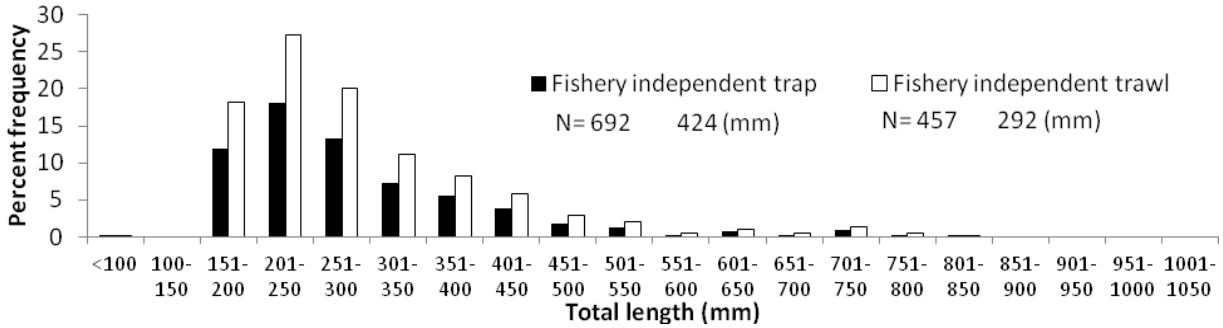


Figure 5. Red snapper age frequency distributions by sector with mean age (yr) for 2009 through 2011 combined.

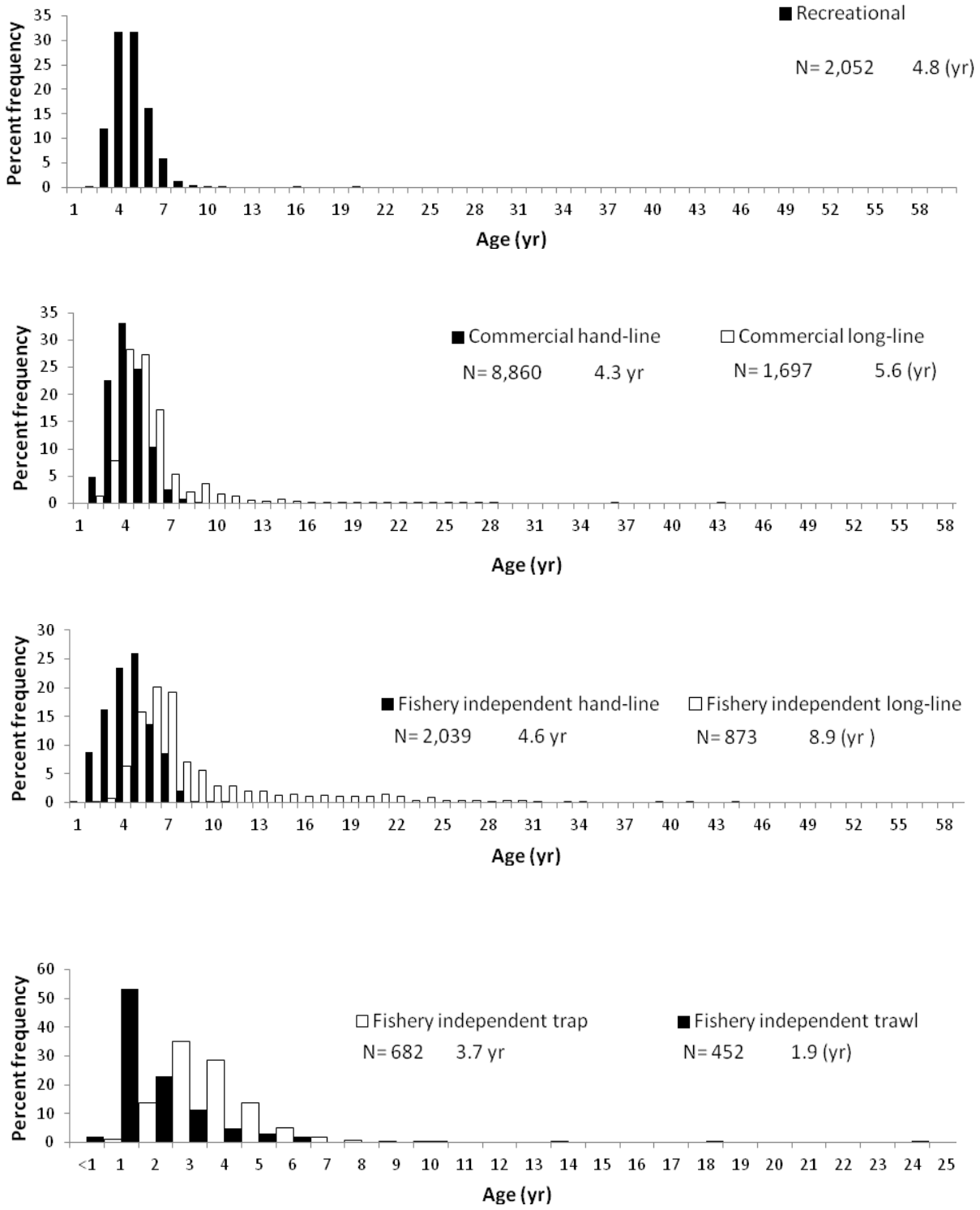


Figure 6. Red snapper total length (TL, mm) on age (yr) for the years 2009 through 2011 combined

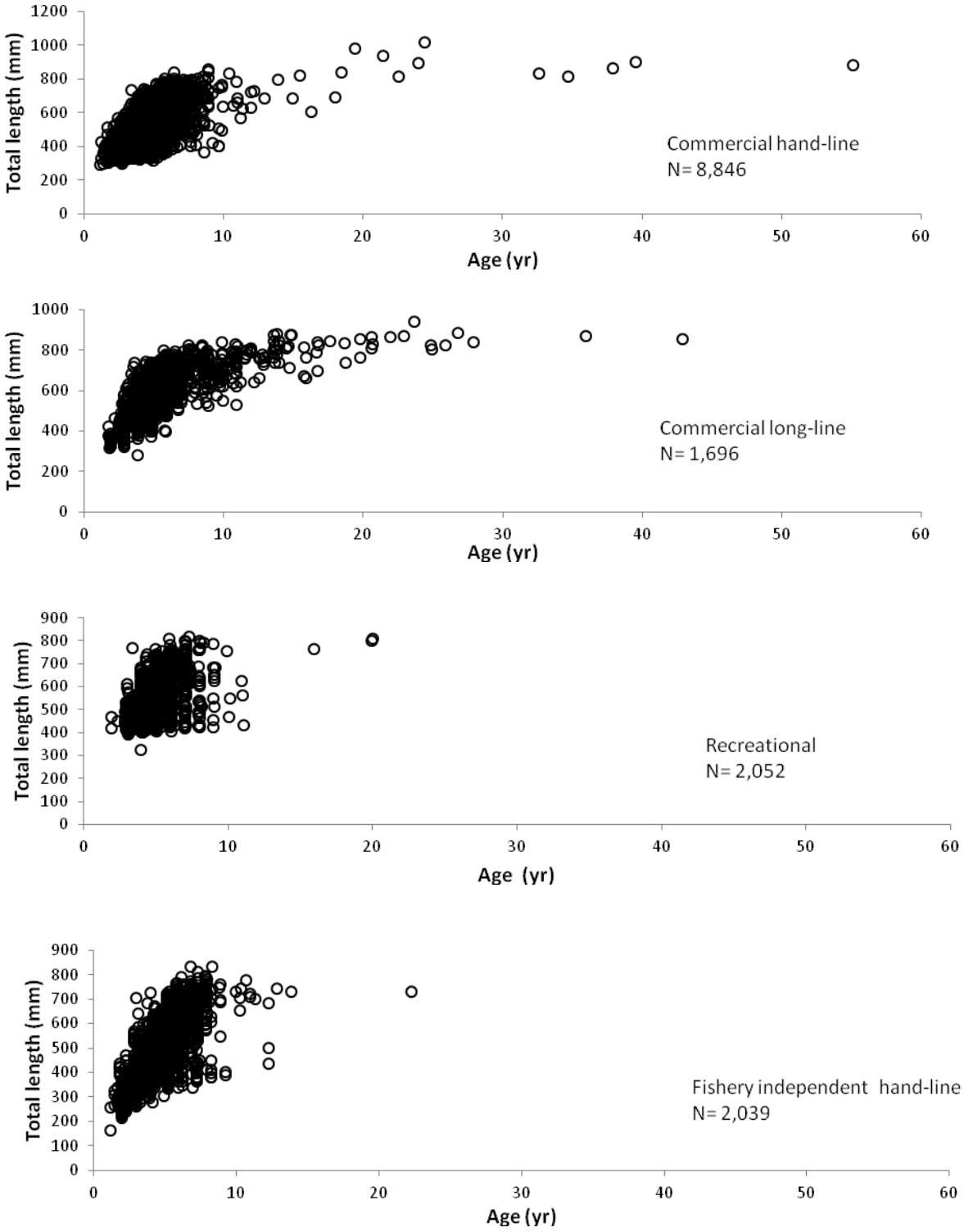


Figure 6. Continued

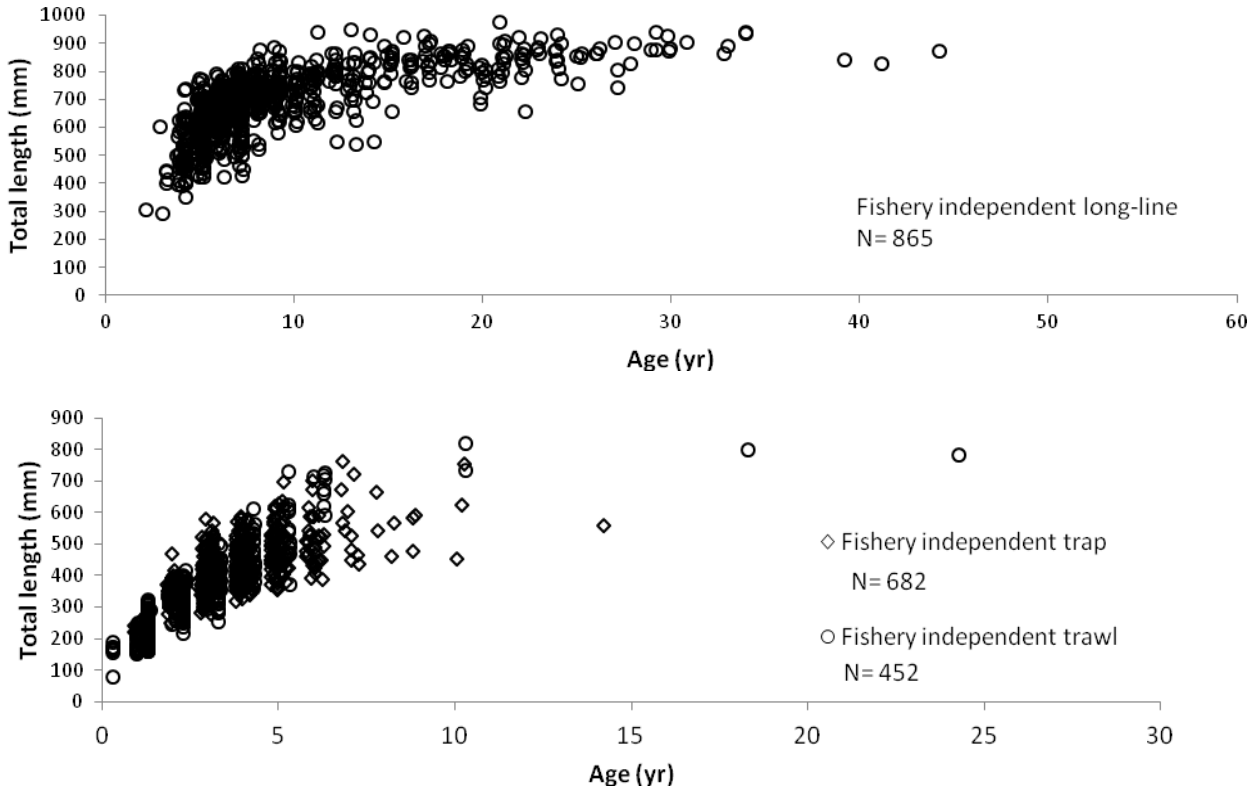


Figure 7. Red snapper recreational age frequency distributions by collection year

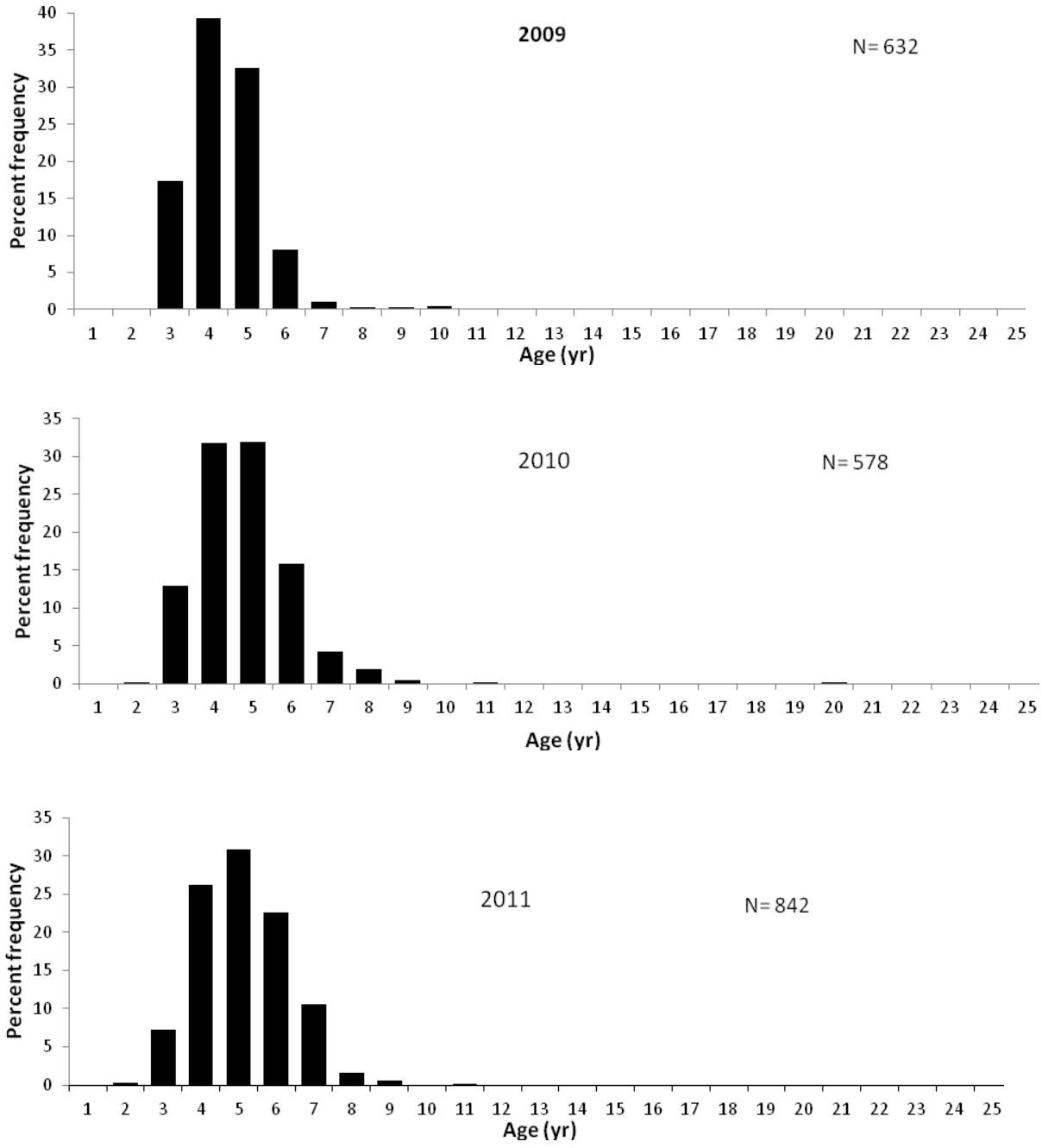


Figure 8. Red snapper commercial hand-line age frequency distributions by collection year

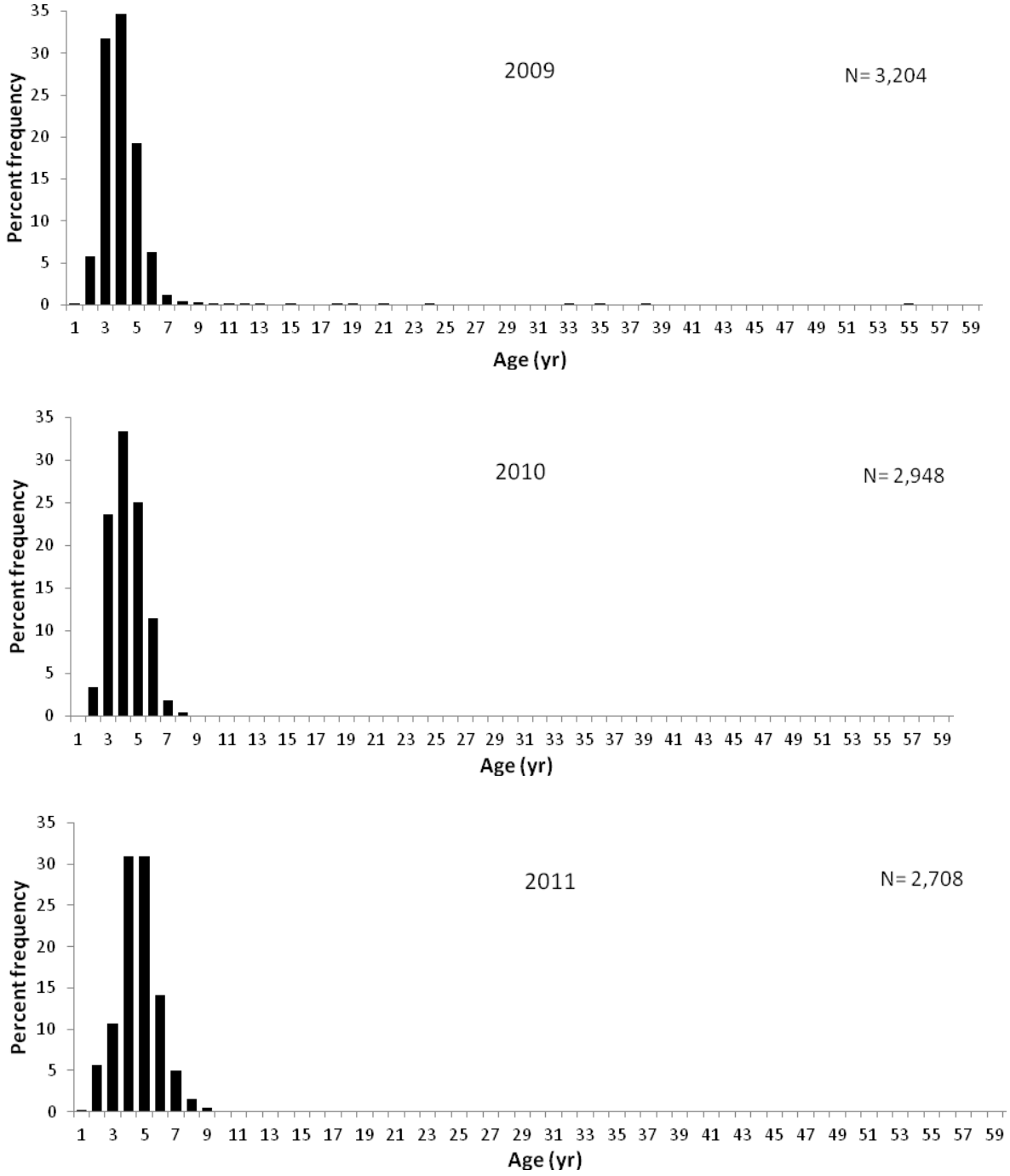


Figure 9. Red snapper commercial long-line age frequency distributions by collection year

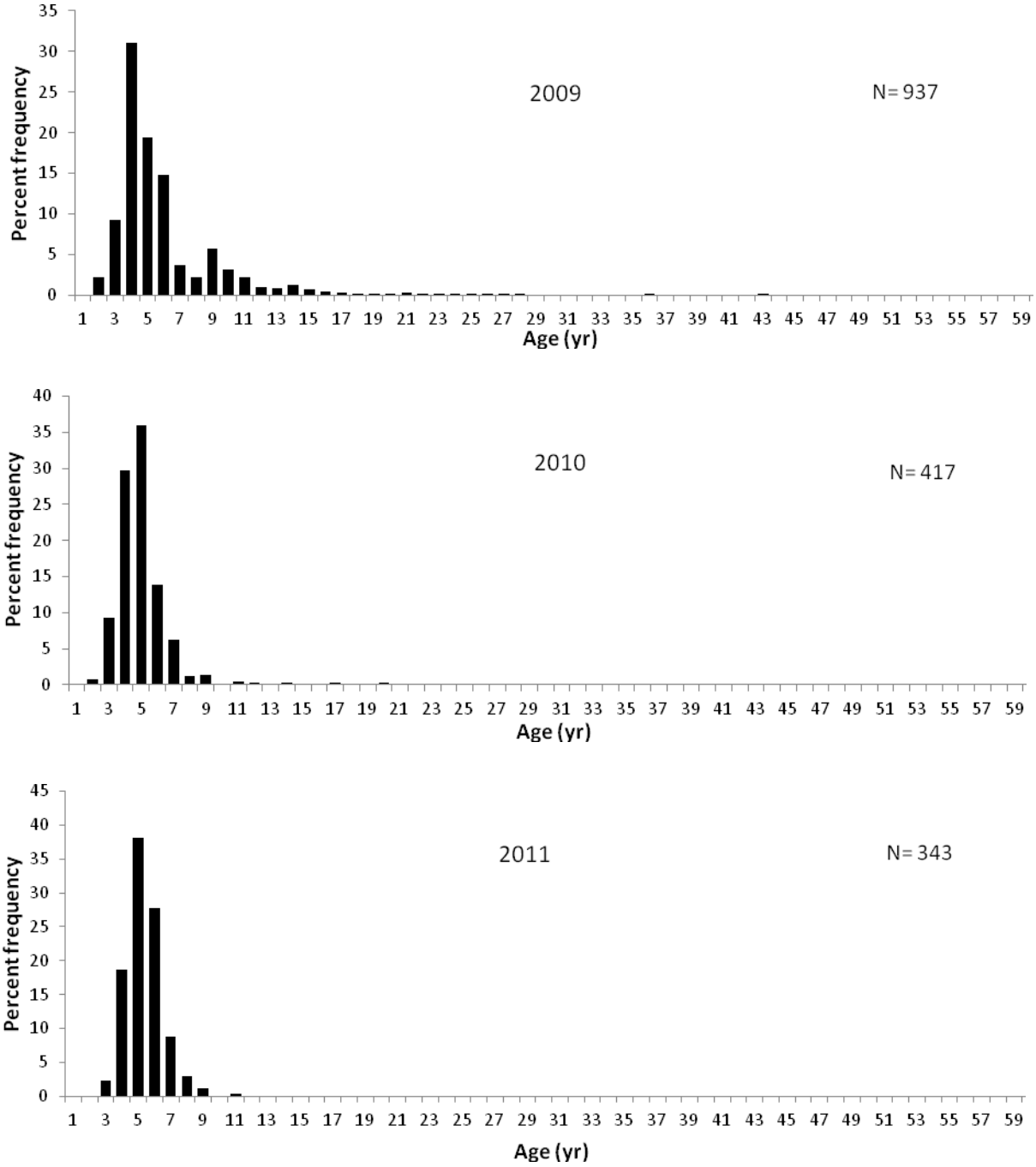


Figure 10. Red snapper length frequency distributions by sector with mean total length (TL, mm) for years 2009 through 2011

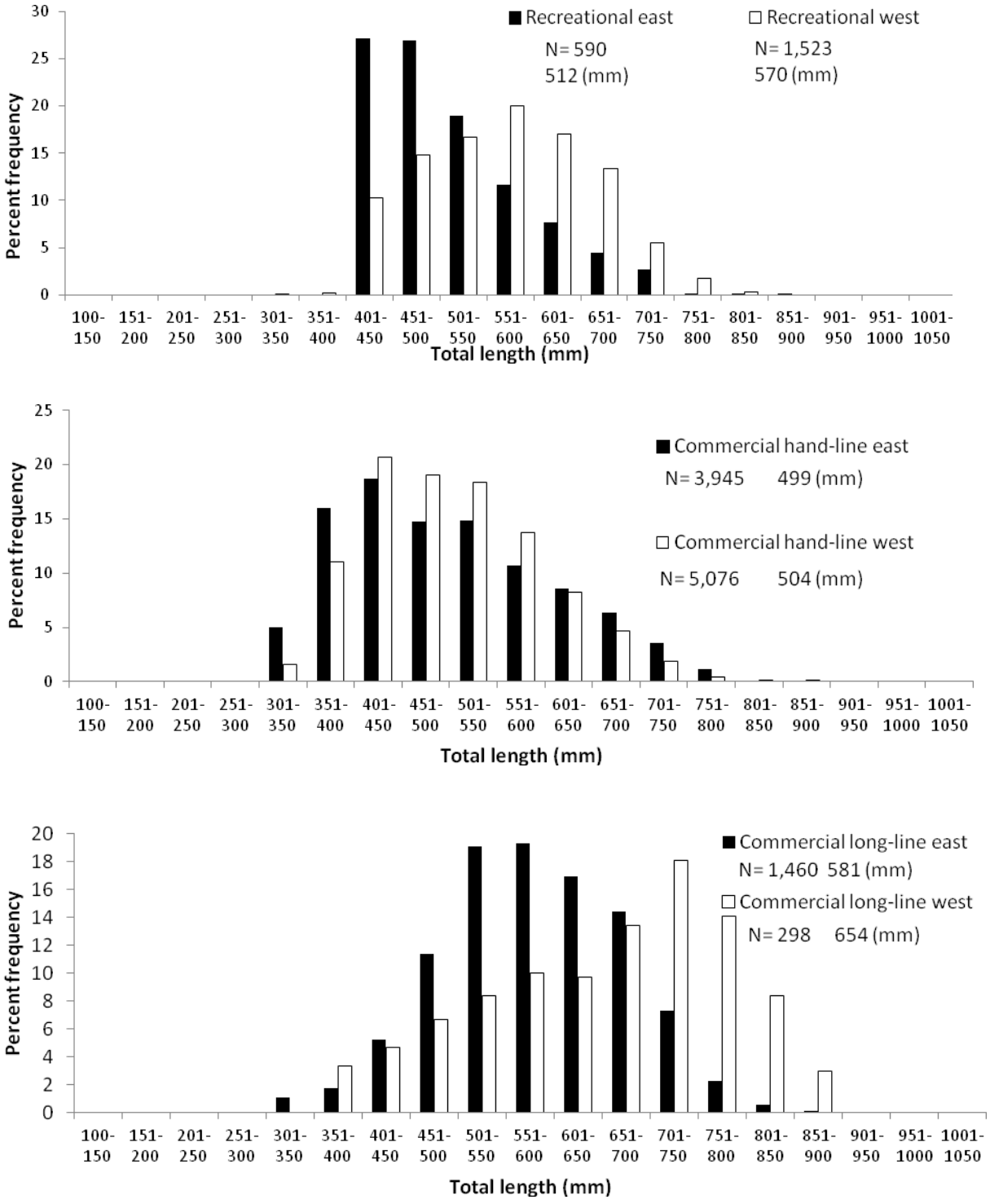
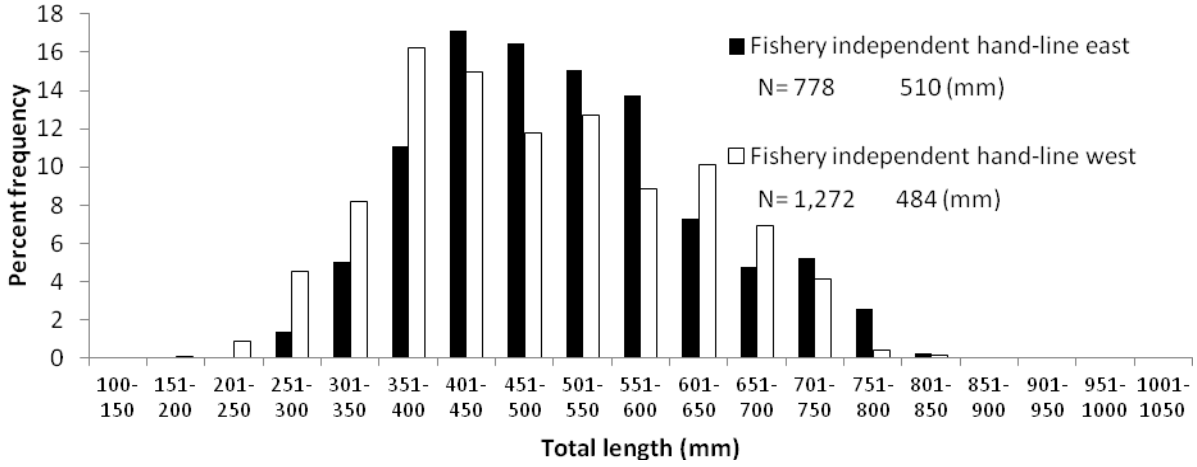


Figure 10. Continued



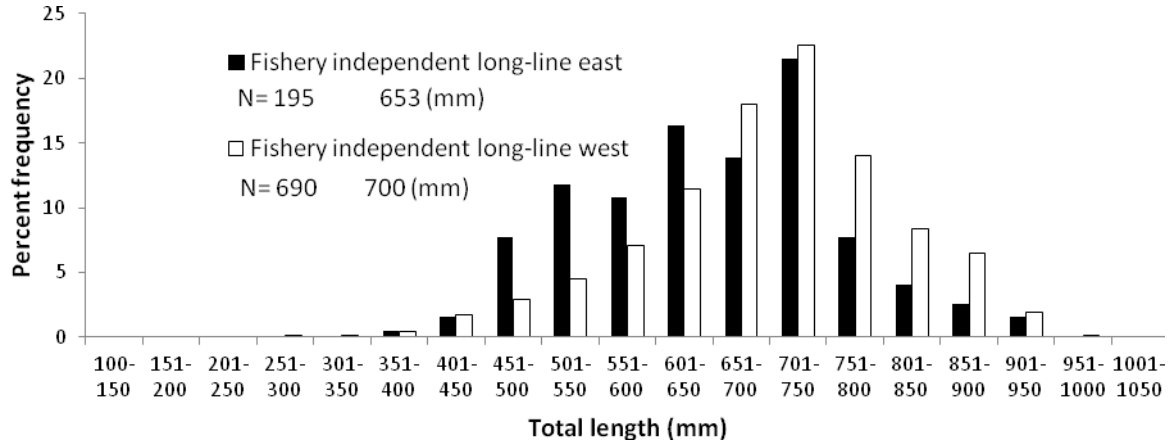


Figure 11. Red snapper age frequency distributions by sector with mean age (yr) for years 2009 through 2011 combined

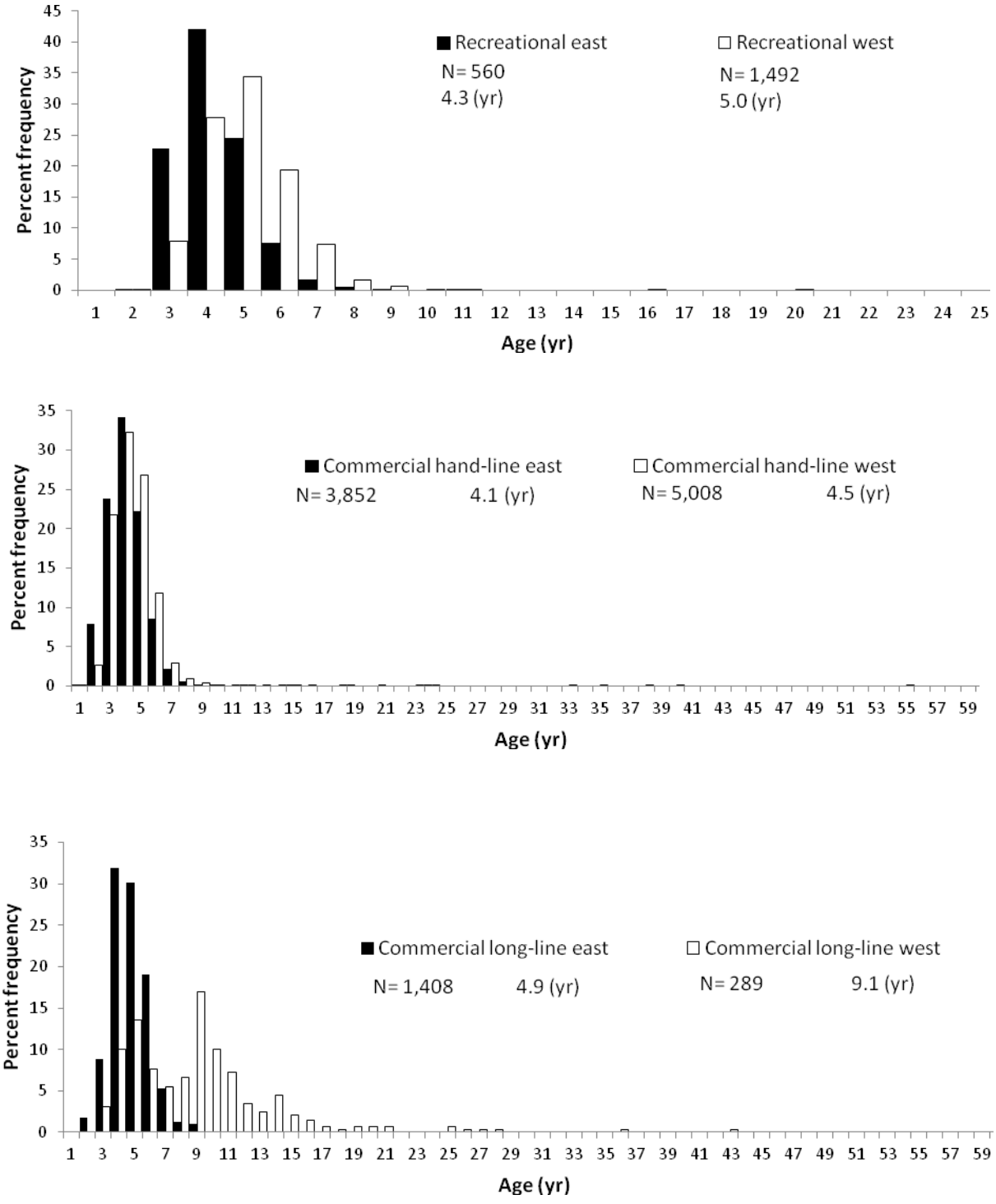


Figure 11. Continued