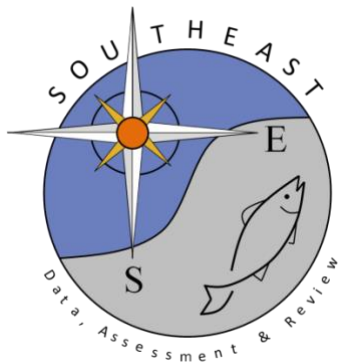


Size and age information for Red Snapper, *Lutjanus campechanus*,
collected in association with fishery-dependent projects along Florida's
Gulf of Mexico coast

Julie Vecchio, Jessica Carrol, Dominique Lazarre, Beverly Sauls

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Size and age information for Red Snapper, *Lutjanus campechanus*, collected in association with fishery-dependent projects along Florida's Gulf of Mexico coast

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Introduction:

The Fishery Dependent Monitoring subsection (FDM) of the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) monitors commercial and recreational fishing in marine environments along the Florida coast in association with several fishery-dependent research and monitoring projects. FDM administers two federal surveys, the Marine Recreational Information Program (MRIP) for the recreational sector and the Trip Interview Program (TIP) for the commercial sector. Additionally, FDM conducts several unique surveys of recreational anglers that allow for the collection of supplemental biological data. Each fishery dependent research or monitoring project that contributed to the age and length data provided to the Life History Group is described below. Because fish must be returned to anglers quickly during fishery-dependent surveys, priority was given to collecting the left otolith if both otoliths could not be removed.

Commercial Fishery Data

Trip Interview Program (TIP)

The commercial fishery is sampled via the NOAA Trip Interview Program (TIP) in which Florida participates. Biological samples collected from the commercial fishery included in this dataset encompass the years 2002-2019. The primary focus of the TIP program is collecting random size frequency data and biological samples from commercial marine species. Samplers take information from harvested fish being offloaded from commercial fishing vessels. Length measurements include fork length and natural total length (mm). Weight measurements are whole weight or gutted weight (kg), dependent upon on the status of the fish upon landing. Typically a single otolith is extracted below the operculum to retain filet integrity. Length and weight data are provided as part of a single federal dataset. Otoliths are aged with samples collected from recreational fisheries by FWRI Age and Growth Laboratory, and are provided with the current dataset.

Recreational Fishery Data

At-Sea Observer Sampling of For-Hire Fisheries

In 2005, at-sea observer survey coverage started on headboats operating from the Gulf coast of Florida from the panhandle through the Florida Keys. The at-sea headboat survey was funded by the Gulf Fisheries Information Network (GulfFIN) continuously through 2007 and was discontinued in 2009. In June of 2009, the state of Florida secured alternative funds to continue at-sea observer coverage in the northwest panhandle and central peninsula and expanded coverage to include charter boats in these regions. In 2010, sampling coverage in the Florida Keys was re-initiated for both headboat and charter vessels through the present, with exception of a sampling hiatus in 2014. In 2014, representative at-sea observer data was only collected from charter vessels in the Florida Keys. Data from headboats and charter vessels in northwest and southwest Florida were a small subset of the for-hire fleet, and may not be representative of the fleet as a whole in that year. For the survey, both headboats and charter boats were randomly selected weekly throughout the year. Biological data was collected from harvested Red Snapper dockside after observed trips, including midline length (mm), whole weight (kg), and whenever possible a left otolith was extracted from sampled fish. Measurements and otoliths collected from observer coverage represent supplemental sampling separate of the dockside sampling conducted for the Southeast Regional Headboat Survey (SRHS).

State Reef Fish Survey of recreational fishers

The State Reef Fish Survey has run continuously on the Florida Gulf coast since May 2015. This survey is a directed effort to collect data from offshore private recreational anglers who target reef fish species. Anglers wishing to harvest certain reef fish species, including Red Snapper, on the Gulf or Atlantic coasts of Florida are required to have a State Reef Fish Angler designation on their fishing license. The State Reef Fish Survey is composed of two survey components: a mail survey of State Reef Fish anglers, which collects data on angler effort, and a dockside intercept survey, which collects data on angler catches and fishing practices. Interview assignments are drawn from a subset of sampling sites known to have offshore fishing activity to intercept fishers that target reef fish. The dockside interview includes biological sampling of reef

fish species, including measurement of midline length (in mm) and whole weight (in kg). Otoliths are also taken during dockside sampling for retained fish.

Opportunistic Biological Sampling

Between 2000 and 2018 opportunistic biological sampling was conducted at angler intercept sites along the Gulf coast of Florida, supported by a limited amount of funding from GulfFIN. Sampling assignments were conducted opportunistically to maximize the number of biological samples collected, primarily from busy charter landing sites. While the sampling sites were not selected using a randomized methodology, the fish sampled were not sampled in a biased manner. Biological sampling of intercepted fish included collection of length measurements (midline length in mm), whole weight (in kg) and collection of aging structures (otoliths or spines).

Representative Biological Sampling Program

The Representative Biological (RepBio) sampling program conducts supplemental biological sampling along the Gulf coast of the Florida peninsula (Escambia to Collier County) and the Florida Keys (Monroe). The survey began a pilot phase in 2018 and was fully implemented by 2019 along the entire Gulf coast of Florida. A randomized draw process is used to ensure representative collection of biological samples, along with a species list that prioritizes collection of biological samples from data-poor, state-managed, and federally managed species when encountered. Interviews of recreational anglers are conducted at fishing access points identified via the MRIP Site Register and assigned via a weekly draw by sub-region. Biological sampling of harvested species includes collection of length measurements (midline length in mm), whole weight (in kg) and collection of aging structures (otoliths or spines).

Ageing Protocols:

Sagittal otoliths were removed from the head, cleaned, dried, and stored in vials. The left otolith was processed for age determination unless it was broken through the core, in which case the right otolith was processed. The core of the otolith was marked with pencil and the whole otolith was mounted on card stock using hot glue. Otoliths were processed on a Buehler Isomet low

speed saw that was equipped with four equally spaced diamond wafering blades. With this multi-blade technique, one transverse cut yields three $\sim 400\mu\text{m}$ thick sections that encompass both the core and the entire region surrounding the core (VanderKooy et al. 2020). After processing, sections were mounted on glass slides with Flo-texx, a chemical mounting medium.

Sectioned otoliths were examined on a stereo microscope using either reflected or transmitted light, which was at the reader's discretion. Each otolith was examined with at least two blind reads. These reads were conducted either by two readers working independently, or by a single reader examining the otolith two separate times. When age estimates did not agree between reads, a third read was conducted to resolve the discrepancy. Ageing was conducted on the dorsal lobe of the otolith along an axis near the sulcal groove from the core to the edge.

Annual ages were calculated using annulus count (number of opaque zones), degree of marginal completion, average date of otolith increment deposition, and date of capture. This traditional method is based on a calendar year instead of time since spawning (Jerald 1983; VanderKooy, et al. 2020). Previous studies have found that Red Snapper off the Southeastern US complete annulus formation by late spring to early summer (Wilson and Nieland 2001; White and Palmer 2004, Allman, et al. 2005). Using these criteria, age was advanced by one year if a large translucent zone was visible on the margin and the capture date was between January 1 and June 30. For all fish collected after June 30, age was assigned to be annulus count, since opaque zone formation is typically complete (Allman, et al. 2005). Calendar ages were converted to fractional, or monthly biological, ages by adding or subtracting the fraction of a year calculated between the assumed July 1 birth date and month of capture.

The total number of otoliths aged from FWRI sampling along the Gulf Coast of Florida was 61,211. Given the timespan of otolith collections and turnover in the FWRI ageing lab, 14 individual readers contributed to ageing these otoliths. Prior to ageing these samples, each ager read through an in-house reference set of Red Snapper otoliths representing a range of age classes, seasons, sexes and collection locations (Campana 2001) to calibrate ageing technique, particularly identification and interpretation of the first annulus and margin type. Quality control subsets were read each sampling year by all active readers to estimate precision. Readers were assigned different portions of the collections for individual reading. The average percent error on all first and second reads was 0.83%, which is considered highly precise (Campana 2001);

moreover, there was an 93% age agreement between all first and second reads, and a 99% agreement \pm 1 year. All age data provided for SEDAR74 included increment count, calendar age and fractional age; however, the summaries including ages in this report were based on adjusted calendar age.

Delivered ages and lengths:

Fishery-Dependent Results: Age and length composition

All fishery-dependent age data have been provided to the life history workgroup; what follows is a summary of the calendar ages and lengths of aged Red Snapper. The following summaries were performed using all fish that were caught in either the central (Zone 7-12) or eastern (Zone 1-6) sub-area of the Gulf of Mexico and landed in Florida. Depending on data source, fish were geographically grouped based on capture zone or landing county. Fish for which capture zone was 7-12 (Central sub-area) were coded as northwest Florida (NWFL). Fish for which capture zone was 1-6 (Eastern sub-area) were coded as southwest FL (SWFL). Fish collected by recreational surveys (SRFS, At-Sea, Representative Biological Sampling, or Targeted Biological Sampling) were grouped by landing county if no capture zone was given. All fish landed in Escambia to Levy counties (Central sub-area) were coded as NWFL. All fish landed in Citrus to Monroe counties (Eastern sub-area) were included in SWFL if no fishing area code was given. Data are presented in three ways, as a single time unit, separated into two time periods (2000-2008 and 2009-2019), and presented by individual collection year. The data were split into an early and a late time period at 2008/2009 for two reasons. First, commercial length limit was reduced from 16" to 13" TL in 2008. Second, TAC was cut dramatically in 2007 and 2008 before being increased again in 2009.

Age data are summarized for a total of 61,211 individuals. A total of 27,502 samples were collected from the commercial sector (44.9% of samples). The majority of age samples were obtained from surveys of the recreational sector, including 3,338 samples from private recreational boat trips, 23,453 from charter trips, and 6,622 from headboats. In addition, 296 aged fish were from an unknown source (primarily fishing tournaments; Table 1). Over 95% of fish aged from the private boat fishery were collected between 2009 and 2019 with total otolith

collections being above 100 per year every year since 2014 (Tables 2 & 3). Over 58% of otoliths collected from charter vessels were collected from before 2009 with fish collected in NWFL representing the bulk of collections each year (Table 2 & 3). Commercial samplers collected over 1,000 otoliths each year from 2011 until 2019, primarily in NWFL (Table 3). Headboat samples were heavily concentrated in the later period as well, with large collections in 2014 and 2015 in NWFL (Table 2 & 3).

Approximately 26.3% (16,095 fish) were female, 25.7% (15,788 fish) were male, and 47.9% (29,328 fish) were unsexed. The ages of fish from each sector were consistent across the aggregated dataset, with mean age ($y \pm SD$) differing by no more than 0.8 years among all sectors (Table 1). Over the full time series, the mean ages varied little by fleet. The lowest mean age was 4.07 ± 1.83 y in the NWFL charter fishery. The highest mean age was 4.93 ± 2.18 y in the SWFL commercial fishery. The oldest fish aged was from the charter fishery that was aged to 40 years. The next oldest fish was a 38-year-old that was sampled from the commercial fishery. A total of 18 fish in the full dataset were over 20 years of age (Figure 1). The three sub-sectors of the recreational fishery showed similar distributions with ~30% of fish aged to 3 years and another ~25% age to 4 years. The commercial fishery had a broader age range with aged 2-6 heavily represented (Figure 2).

When data were divided into early (2001-2008) and later (2009-2019) time periods, age distributions were markedly different, especially in the recreational sector. Older fish were more common in each of the sectors with fish over 10 years of age being more frequent than in the later period. In the charter, headboat, and commercial fisheries, the most frequently sampled age increased by 1 year (from 3 to 4 years; Figure 3). Age distributions by region and year are presented in Figures 4-7. In years with larger sample sizes, age distributions become representative. In years with relatively low sample sizes, age distributions are skewed. The commercial fishery included the largest range of both ages and sizes of any sector, but the age-length relationships remained consistent across regions and sectors (Figure 8).

Table 1. Numbers of fish aged, mean (\pm SD) age, and length landed by fishing fleet (2000-2019). Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

Fishing Fleet	NWFL			SWFL		
	# Fish	Mean age (y)	Mean FL (mm)	# Fish	Mean age (y)	Mean FL (mm)
Charter	22,458	4.07 \pm 1.83	461 \pm 87	995	4.45 \pm 1.91	515 \pm 81
Commercial	19,191	4.37 \pm 1.86	468 \pm 102	8,003	4.93 \pm 2.17	521 \pm 105
Headboat	4,471	4.91 \pm 1.96	476 \pm 88	2,151	4.52 \pm 1.51	503 \pm 86
Private	2,961	4.67 \pm 2.21	495 \pm 92	377	3.67 \pm 1.26	473 \pm 82
Unknown	206	4.68 \pm 1.65	524 \pm 93	90	5.30 \pm 2.20	578 \pm 101

Table 2. Numbers of fish aged, mean (\pm SD) age, and length landed by fishing fleet divided into early (2000-2008) and late (2009-2019) time periods. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

	NWFL			SWFL		
	# Fish	Mean age (y)	Mean FL (mm)	# Fish	Mean age (y)	Mean FL (mm)
Charter						
2001-2008	13,653	3.30 \pm 1.22	428 \pm 66	43	3.63 \pm 0.72	465 \pm 42
2009-2019	8,805	5.27 \pm 2.00	510 \pm 93	952	4.48 \pm 1.96	518 \pm 82
Commercial						
2001-2008	544	3.43 \pm 1.09	402 \pm 73	131	4.07 \pm 1.88	493 \pm 76
2009-2019	18,647	4.40 \pm 1.87	470 \pm 102	7,872	4.95 \pm 2.17	521 \pm 105
Headboat						
2001-2008	202	3.47 \pm 0.85	417 \pm 42	184	3.74 \pm 1.13	473 \pm 62
2009-2019	4,269	4.97 \pm 1.98	479 \pm 88	1,967	4.59 \pm 1.52	505 \pm 87
Private						
2001-2008	127	3.46 \pm 0.92	438 \pm 60	16	3.00 \pm 0.37	446 \pm 64
2009-2019	2,834	4.72 \pm 2.24	497 \pm 92	361	3.70 \pm 1.28	475 \pm 83
Unknown						
2009-2019	206	4.68 \pm 1.65	524 \pm 93	90	5.30 \pm 2.20	578 \pm 101

Table 3. Numbers of fish aged mean & SD age and length landed by fishing fleet by year 2001-2019. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

	NWFL					SWFL				
	N	mean age	SD age	mean FL (mm)	SD FL	N	mean age	SD age	mean FL (mm)	SD FL
Charter										
2001	1	3.00	0.00	432	0					
2003	3855	3.24	1.19	432	67	11	3.09	0.30	469	20
2004	2897	3.55	1.43	439	73	3	4.33	0.58	507	31
2005	4239	3.18	1.07	422	63	5	2.80	0.84	424	50
2006	2423	3.27	1.25	419	58	5	4.00	0.00	451	12
2007	98	3.21	0.76	425	48	14	4.00	0.39	459	26
2008	140	3.52	0.63	451	59	5	3.80	1.10	499	86
2009	204	4.34	1.06	492	82	16	3.56	0.51	478	35
2010	1115	4.35	1.09	496	77	119	4.51	1.15	524	83
2011	645	5.12	1.10	501	84	73	4.88	1.22	528	88
2012	1168	5.55	1.27	537	95	14	5.57	1.79	557	123
2013	1606	5.65	1.77	527	98	20	5.80	1.01	552	69
2014	708	5.50	2.05	514	99	81	5.23	1.65	545	110
2015	1432	5.75	2.22	501	95	130	4.78	0.95	567	61
2016	691	5.55	2.60	508	100	24	2.92	1.21	439	87
2017	260	4.96	2.77	494	92	61	3.39	0.78	466	56
2018	591	4.68	2.44	491	87	207	4.04	0.61	486	60
2019	385	4.70	2.28	502	81	207	4.66	1.07	523	78
Commercial										
2002	2	6.00	1.41	647	44	0				
2003	237	3.60	1.08	410	80	1	4.00	0.00	488	0
2006	0					22	4.36	1.33	527	77
2007	180	2.69	0.96	365	57	30	3.20	1.00	429	59
2008	125	3.94	0.93	457	58	78	4.33	2.17	508	67
2009	120	3.11	1.11	405	75	71	3.30	1.15	437	68
2010	299	3.55	1.15	431	80	673	4.58	1.02	522	83
2011	1776	4.58	1.39	478	86	423	4.89	1.15	517	81
2012	1547	4.86	1.39	479	82	257	5.25	1.32	528	82
2013	1230	5.12	1.87	510	113	375	5.75	1.28	547	83
2014	1103	5.59	2.01	520	110	321	5.93	2.01	542	108
2015	1557	5.20	2.28	514	112	283	5.68	2.45	531	112
2016	1934	4.25	2.59	468	122	1287	4.92	2.44	526	120
2017	2281	3.66	1.78	447	96	1479	4.50	2.50	496	117
2018	3231	3.90	1.45	453	89	1199	4.70	2.20	517	101
2019	3569	4.28	1.54	453	96	1504	5.26	2.26	539	101

Table 3 (cont.). Numbers of fish aged mean & SD age and length landed by fishing fleet by year 2001-2019. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

	NWFL					SWFL				
	N	mean age	SD age	mean FL (mm)	SD FL	N	mean age	SD age	mean FL (mm)	SD FL
Headboat										
2003	9	3.44	0.53	451	44	2	3.50	0.71	441	37
2004	28	4.11	1.26	412	31	1	3.00	0.00	421	0
2005	0					52	3.50	0.80	444	52
2006	20	3.50	0.83	410	30	78	4.36	1.12	498	59
2007	0					7	3.29	0.49	436	30
2008	145	3.34	0.72	417	45	44	3.05	1.06	471	64
2009	165	3.52	0.86	421	50	284	3.93	0.94	496	76
2010	108	4.03	1.06	486	80	240	4.53	1.10	516	83
2011	84	4.99	0.88	497	79	260	4.28	0.87	485	67
2012	78	4.68	1.30	495	93	126	5.30	1.57	527	82
2013	188	5.55	1.83	458	66	150	4.91	1.39	523	91
2014	2073	5.24	1.98	485	93	100	5.38	1.88	507	95
2015	1289	5.02	2.09	484	88	203	5.73	2.09	560	107
2016	39	4.23	1.78	470	84	39	4.82	2.21	508	109
2017	92	3.82	2.29	436	73	158	3.20	0.79	434	60
2018	123	3.50	0.81	437	43	236	4.47	1.57	487	78
2019	30	3.70	1.34	440	73	171	5.03	1.14	534	77

Table 3 (cont.). Numbers of fish aged mean & SD age and length landed by fishing fleet by year 2001-2019. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

	NWFL					SWFL				
	N	mean age	SD age	mean FL (mm)	SD FL	N	mean age	SD age	mean FL (mm)	SD FL
Private										
2003	11	3.09	0.70	436	47	3	3.33	0.58	497	18
2004	52	3.79	0.61	456	47	0				
2005	21	3.10	0.83	433	56	0				
2006	43	3.33	1.17	417	76	2	3.00	0.00	395	12
2007						1	3.00	0.00	415	0
2008						10	2.90	0.32	444	71
2009	3	4.67	2.08	456	34	2	4.50	0.71	467	10
2010	14	4.00	0.78	503	90	13	5.15	0.80	589	57
2011	54	5.33	1.21	546	89	13	5.15	0.69	580	54
2012	52	5.35	1.60	546	85	0				
2013	46	6.04	1.73	578	93	7	4.29	0.76	490	68
2014	258	5.62	2.09	517	94	10	4.20	1.32	483	99
2015	404	4.92	2.28	481	87	0				
2016	725	5.00	2.50	502	102	10	2.00	0.00	383	24
2017	447	4.30	2.49	489	93	252	3.47	1.29	462	79
2018	468	4.25	1.91	481	79	40	4.13	0.52	499	59
2019	363	4.15	1.60	497	82	14	4.21	0.97	484	79
Unknown										
2009	0					6	3.67	0.52	513	42
2010	0					33	5.00	1.12	581	95
2011	0					17	5.41	0.87	587	80
2012	206	4.68	1.65	524	93	16	5.81	1.33	606	113
2017	0					18	5.83	4.36	559	127

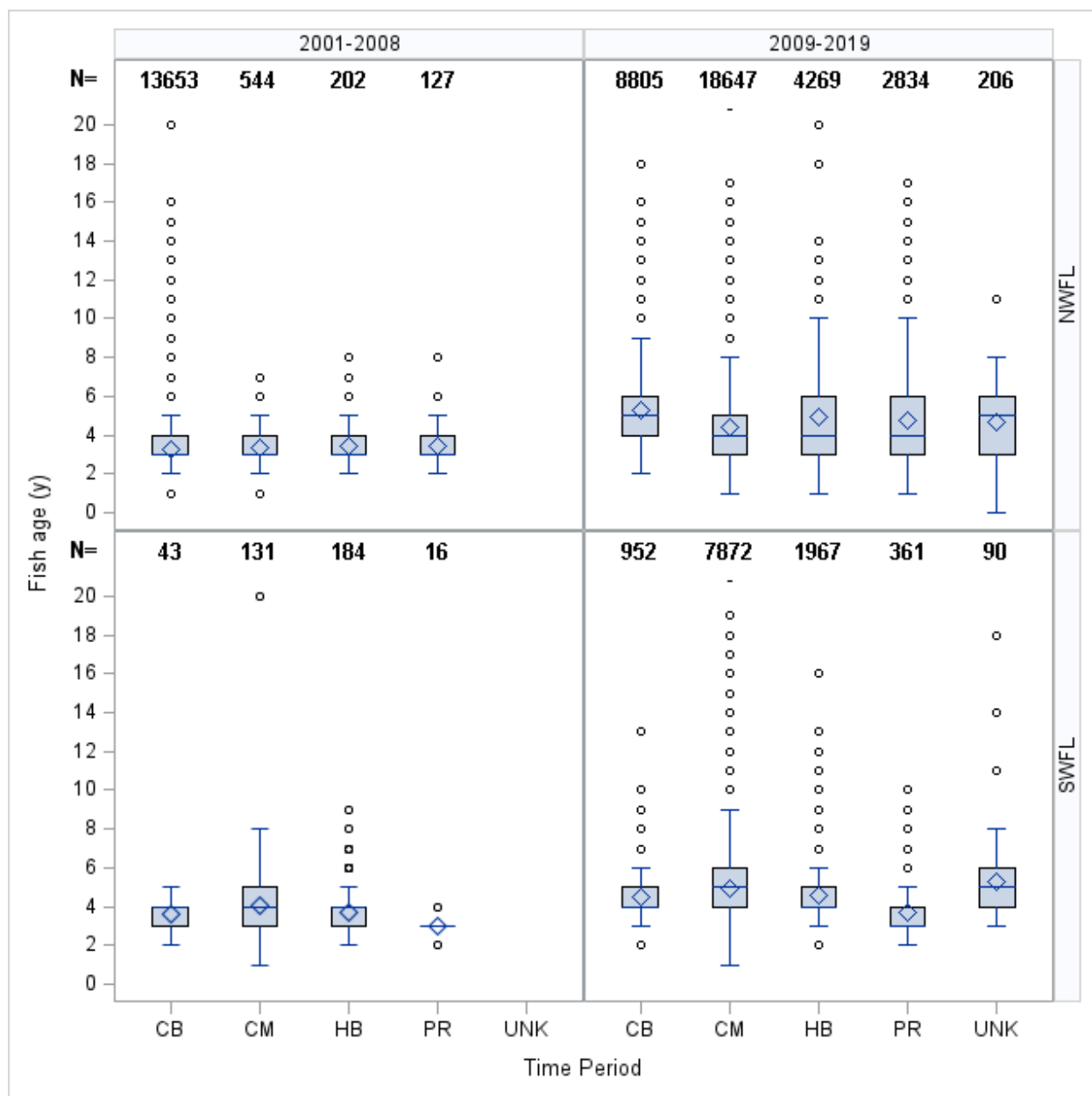


Figure 1. Age distribution by fishing fleet, area, and time period. N = total numbers of samples included in each box. Y-axis is truncated at 20 years. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

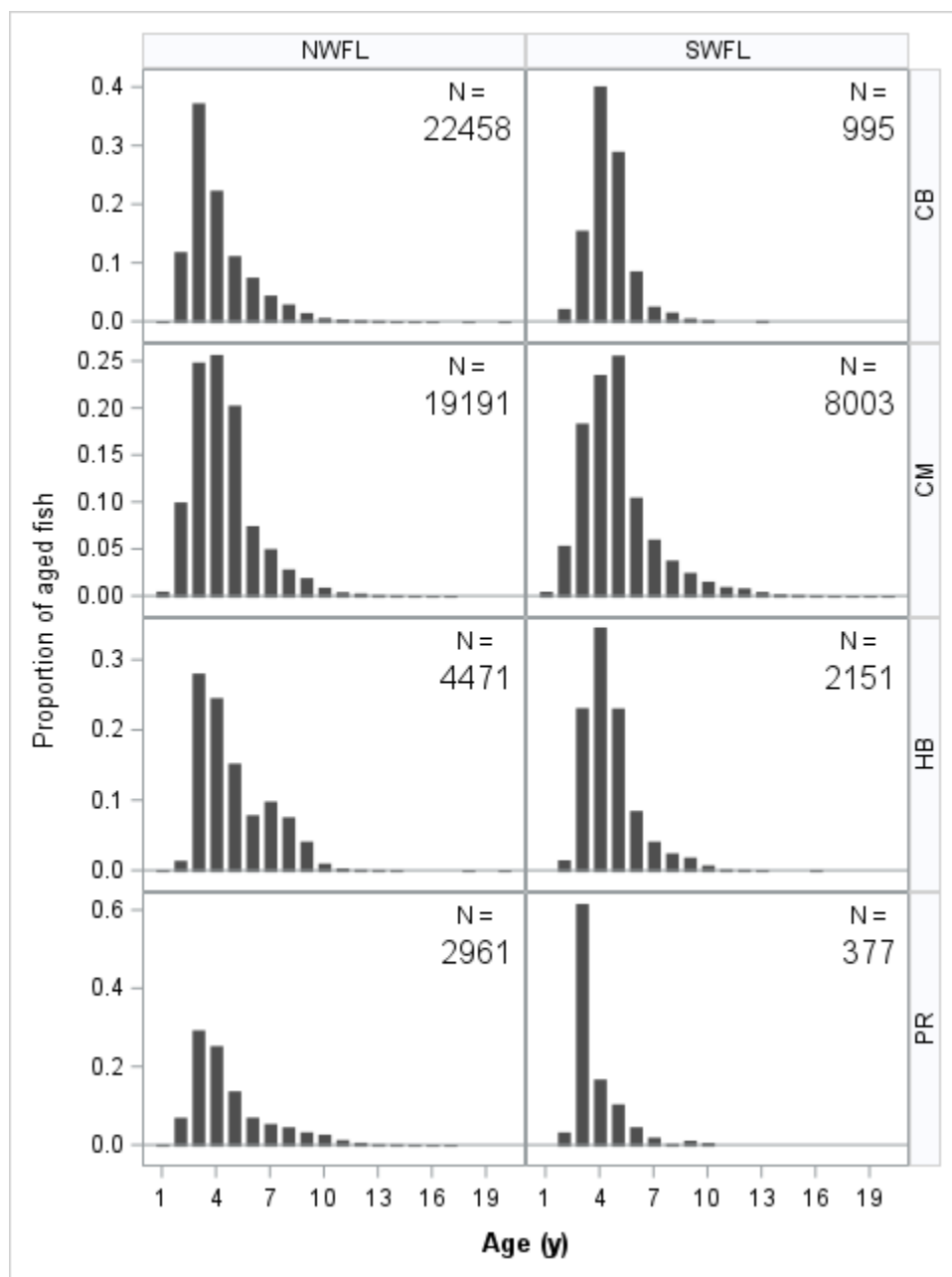


Figure 2. Age distribution of fish across entire time series in each fishery. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

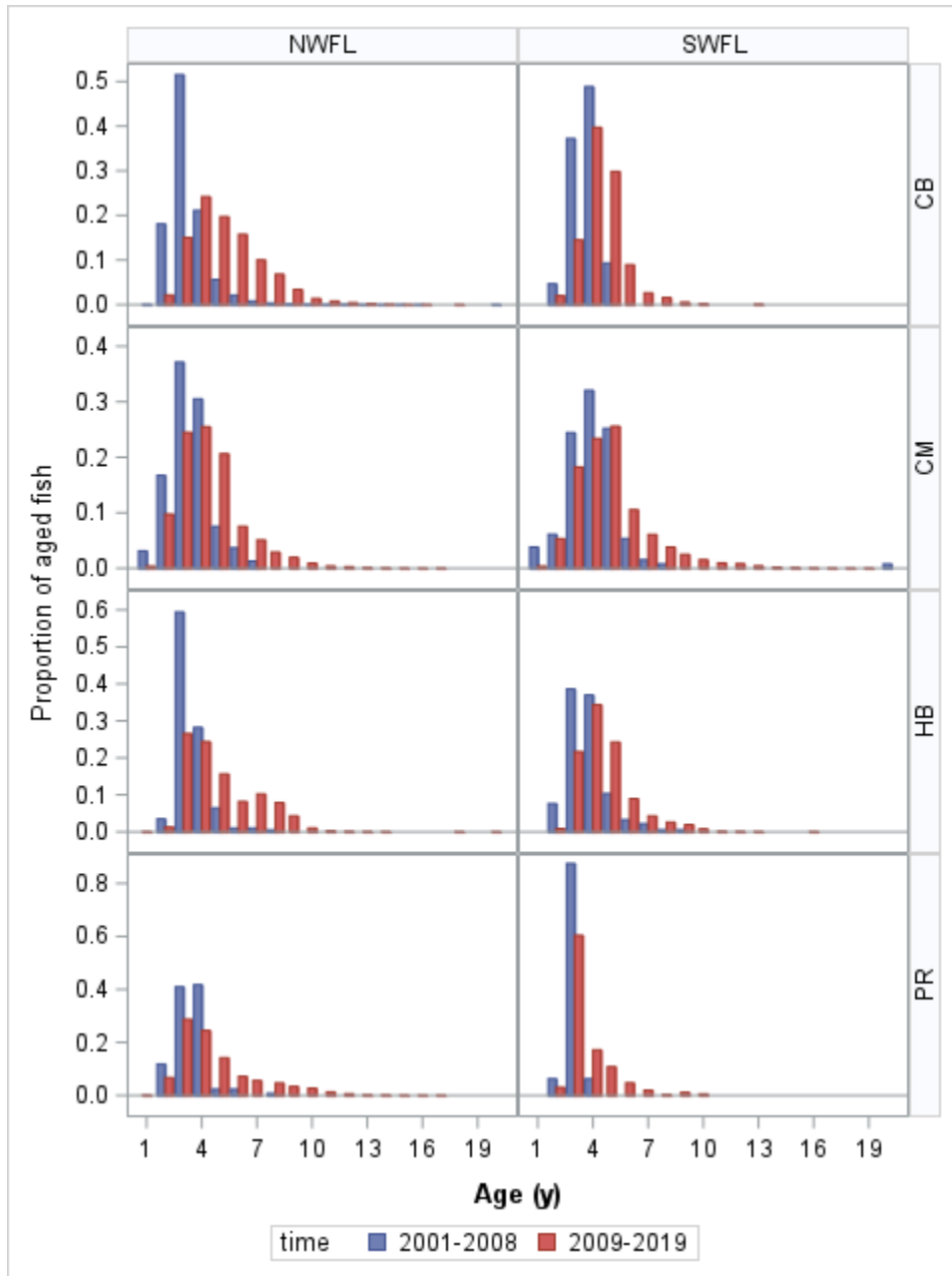


Figure 3. Age distribution by fishing sector separated into early (2001-2008) and later (2009-2019) time periods. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

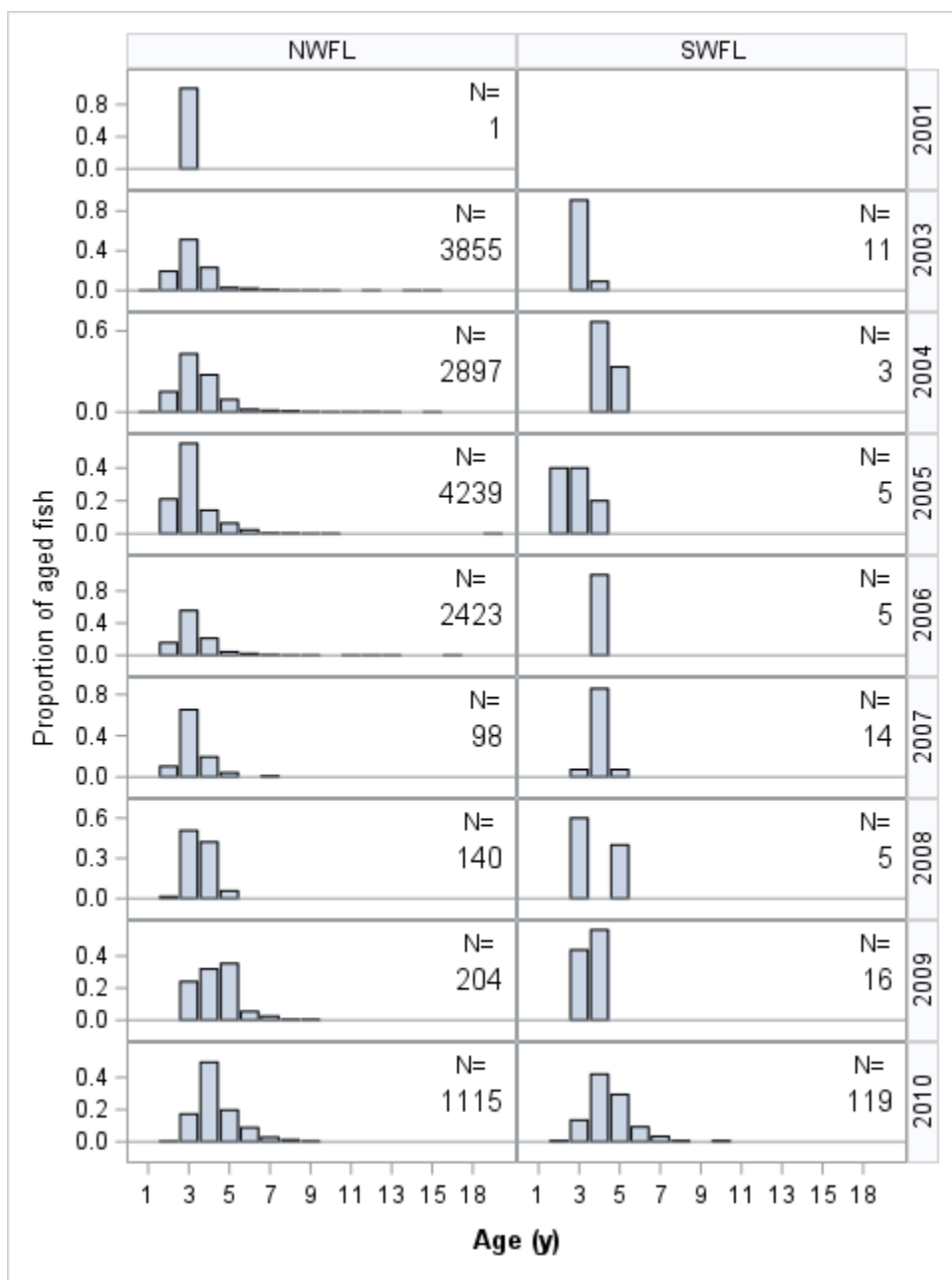


Figure 4. Proportion of total fish aged by year and region from the **CHARTER** fishery. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

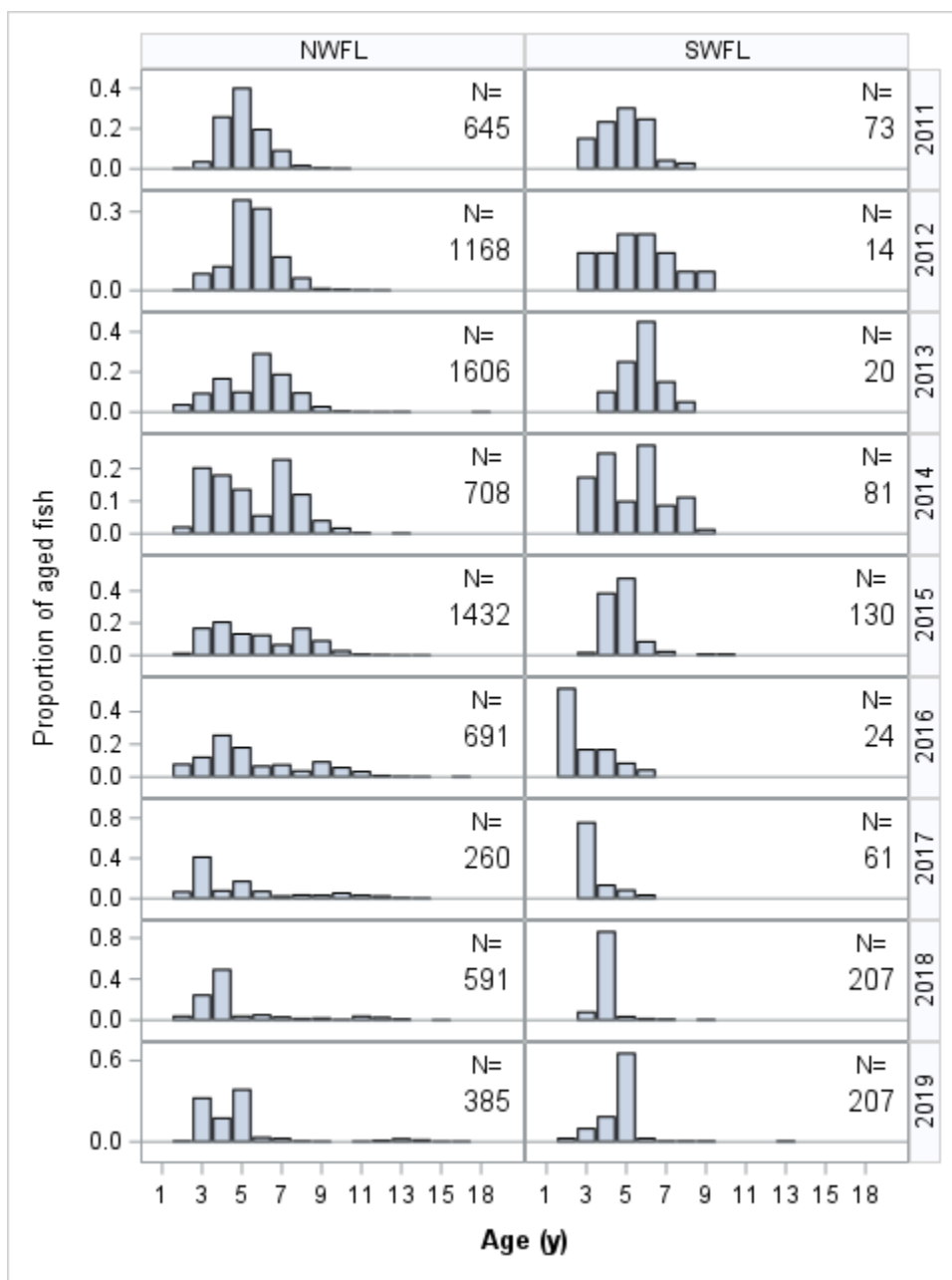


Figure 4 (cont) Proportion of total fish aged by year and region from the **CHARTER** fishery. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

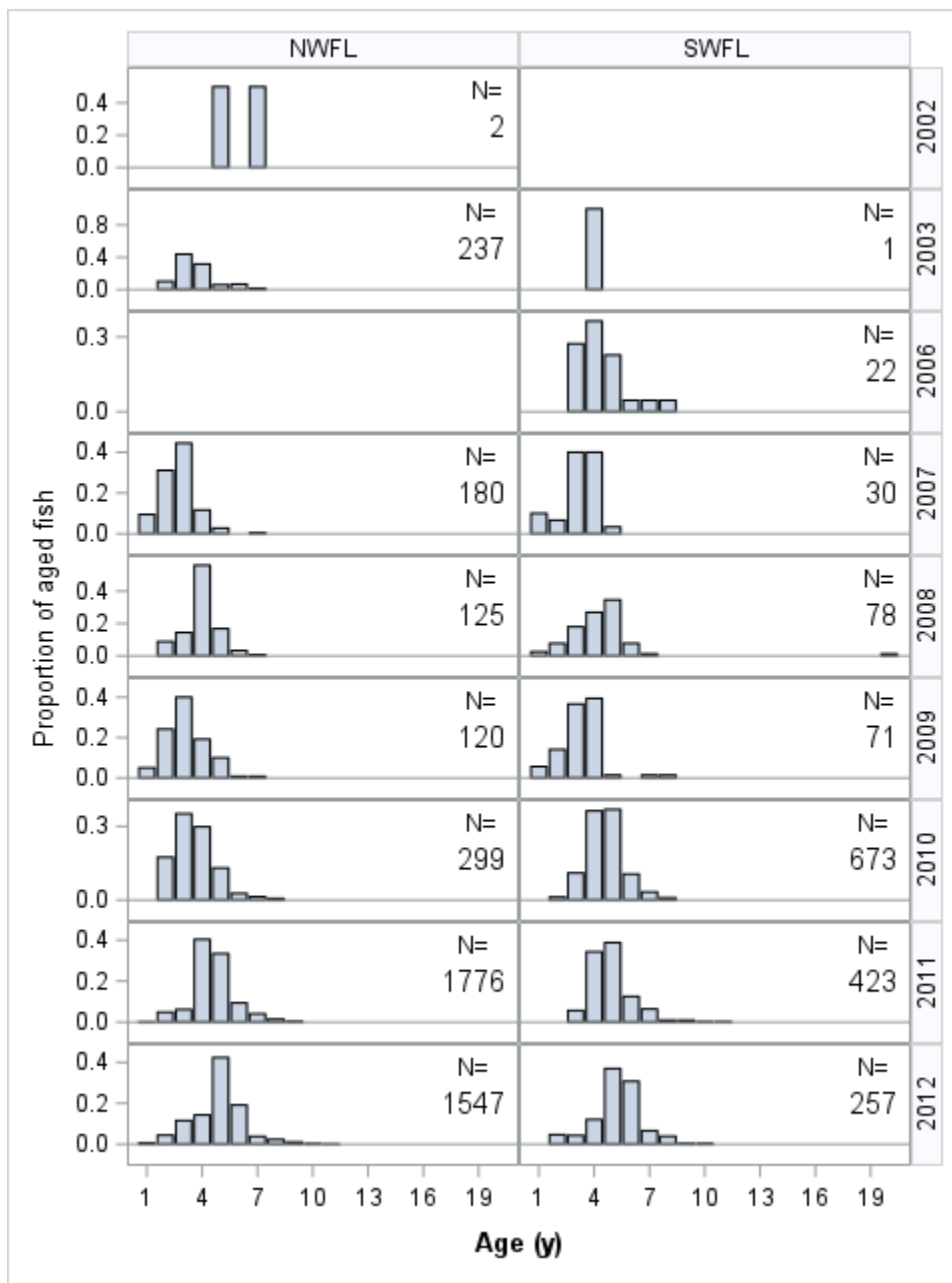


Figure 5. Proportion of total fish aged by year and region from the **COMMERCIAL** fishery. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

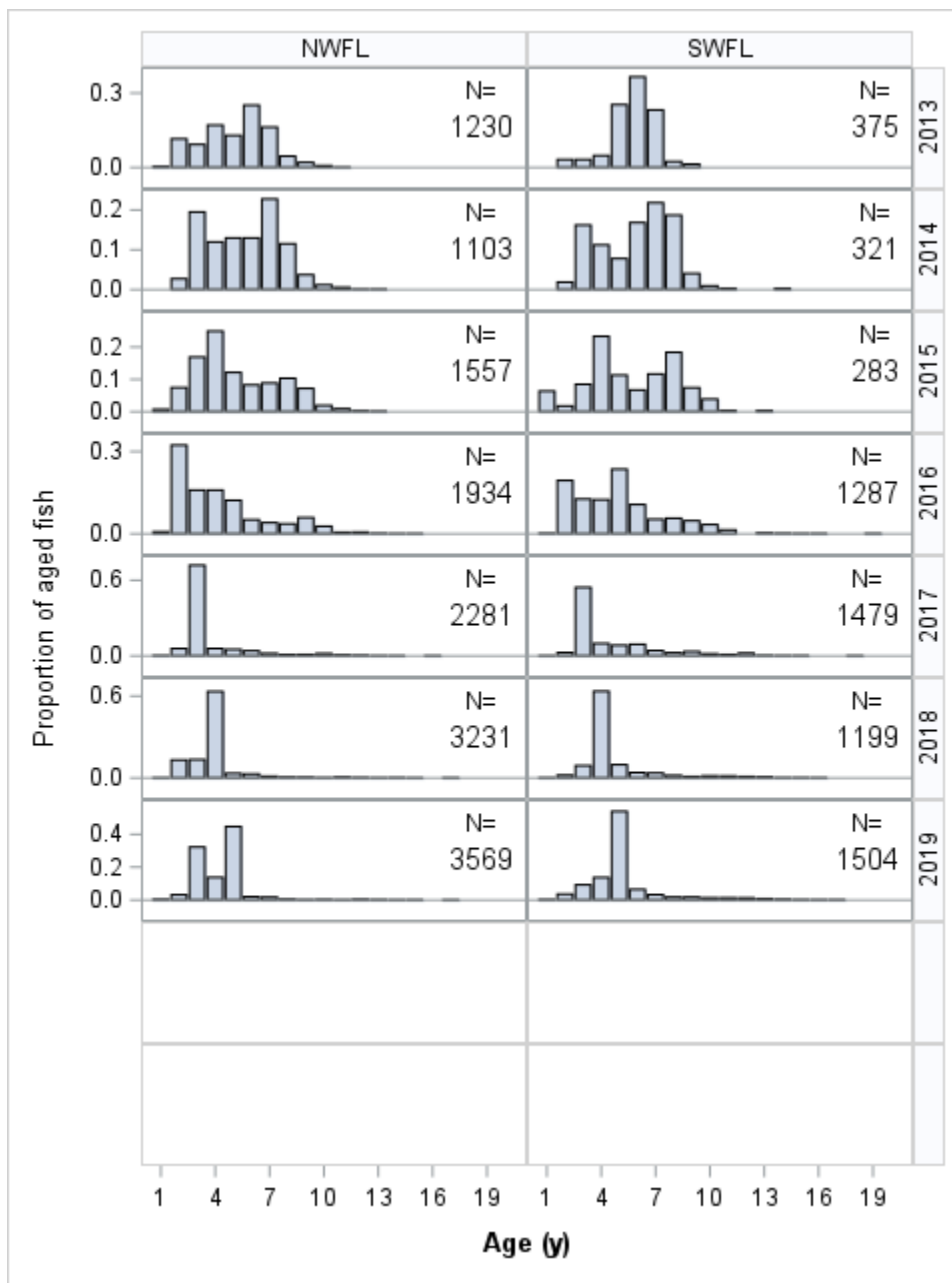


Figure 5 (CONT). Proportion of total fish aged by year and region from the **COMMERCIAL** fishery. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

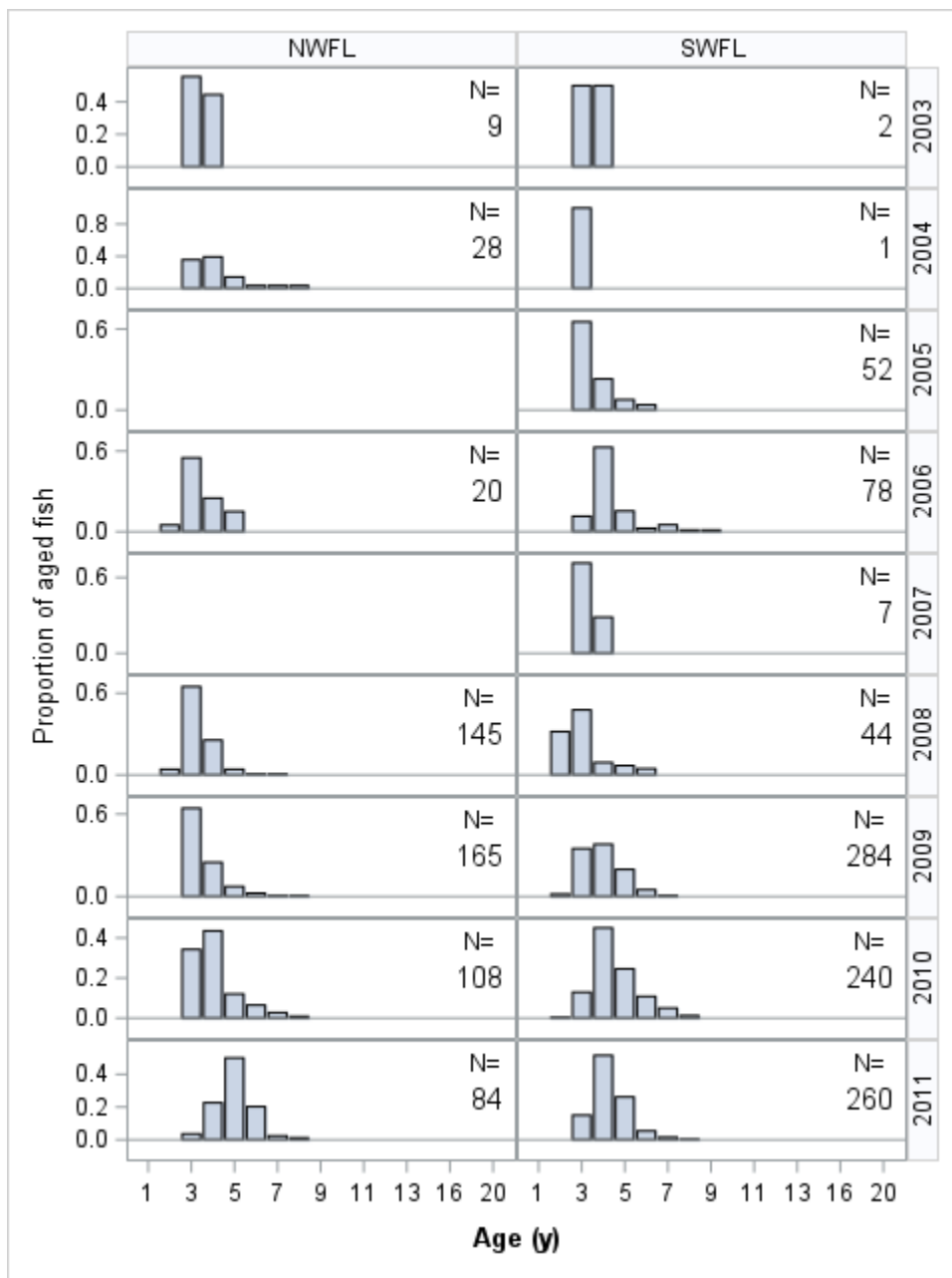


Figure 6. Proportion of total fish aged by year and region from the **HEADBOAT** fishery. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

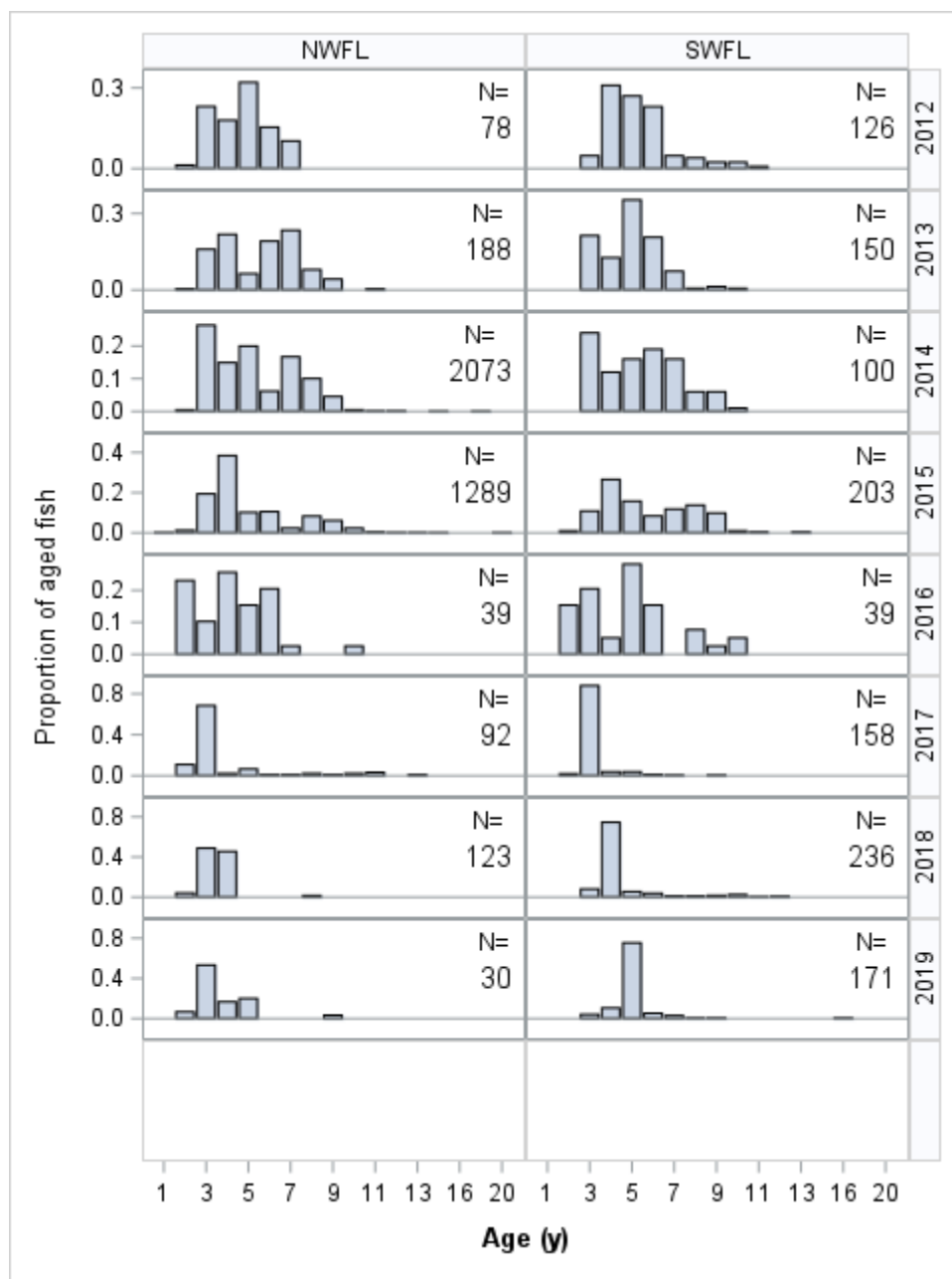


Figure 6 (CONT). Proportion of total fish aged by year and region from the **HEADBOAT** fishery. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

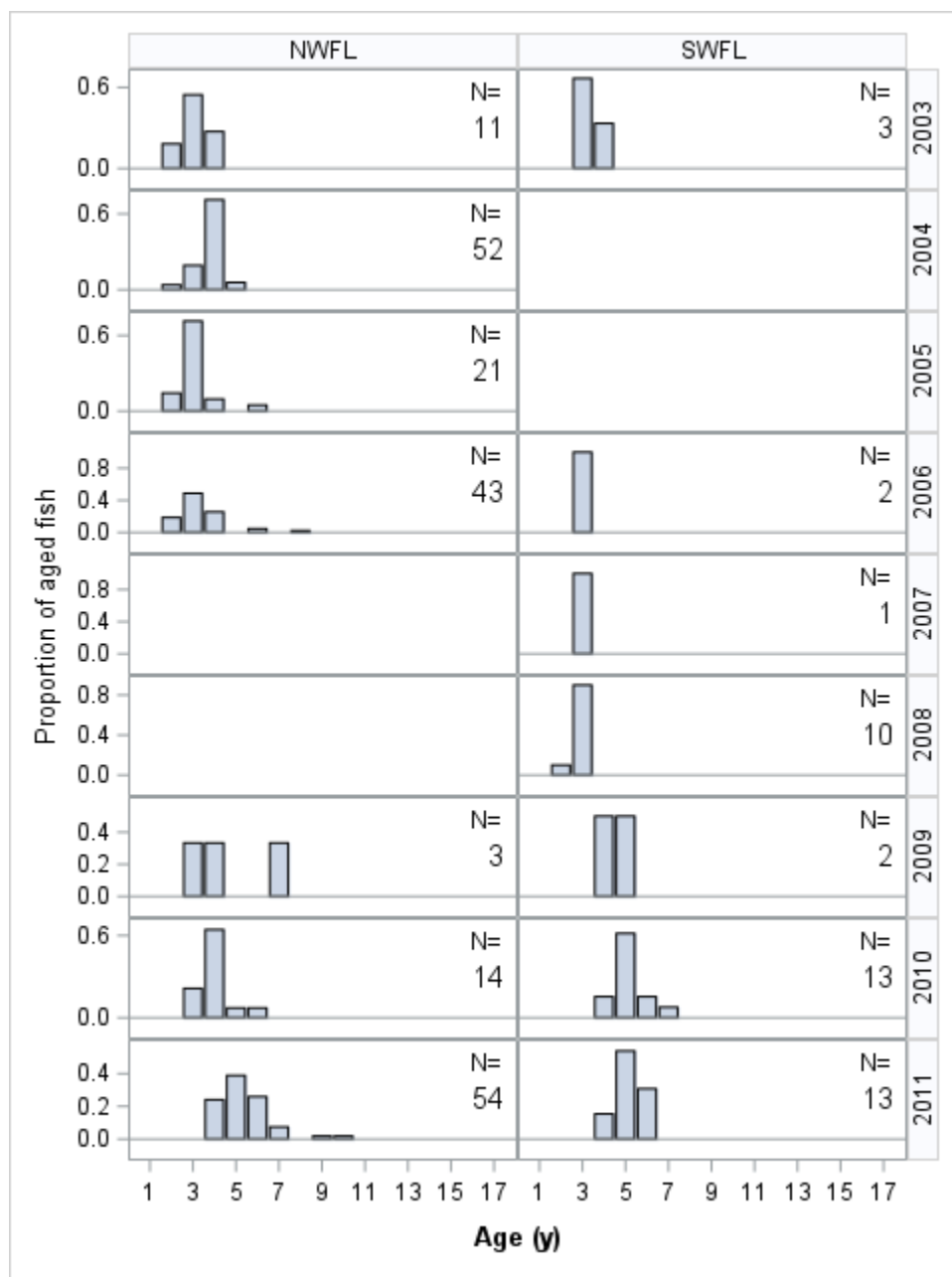


Figure 7. Proportion of total fish aged by year and region from the **PRIVATE** fishery. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

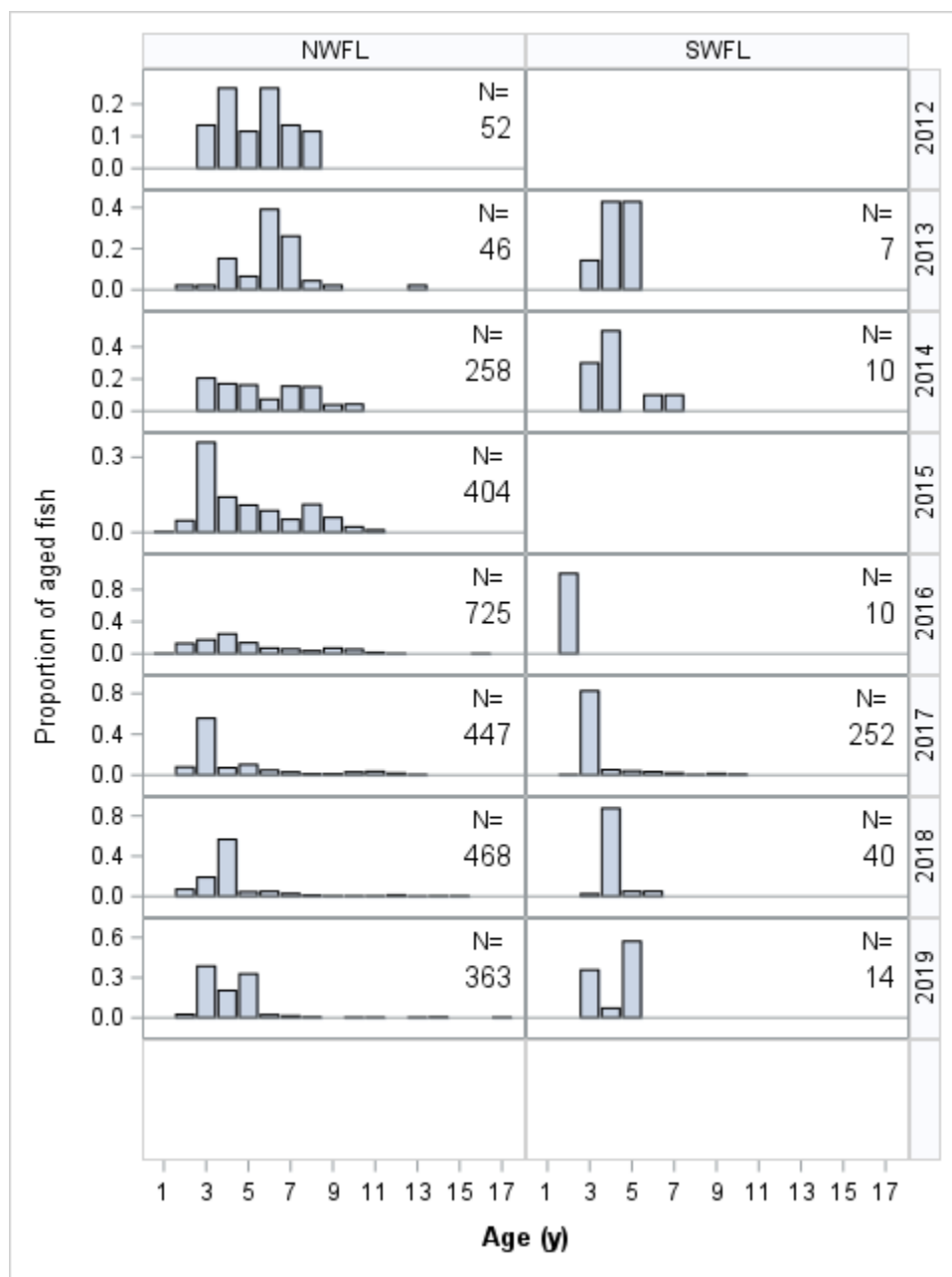


Figure7 (CONT). Proportion of total fish aged by year and region from the **PRIVATE** fishery. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

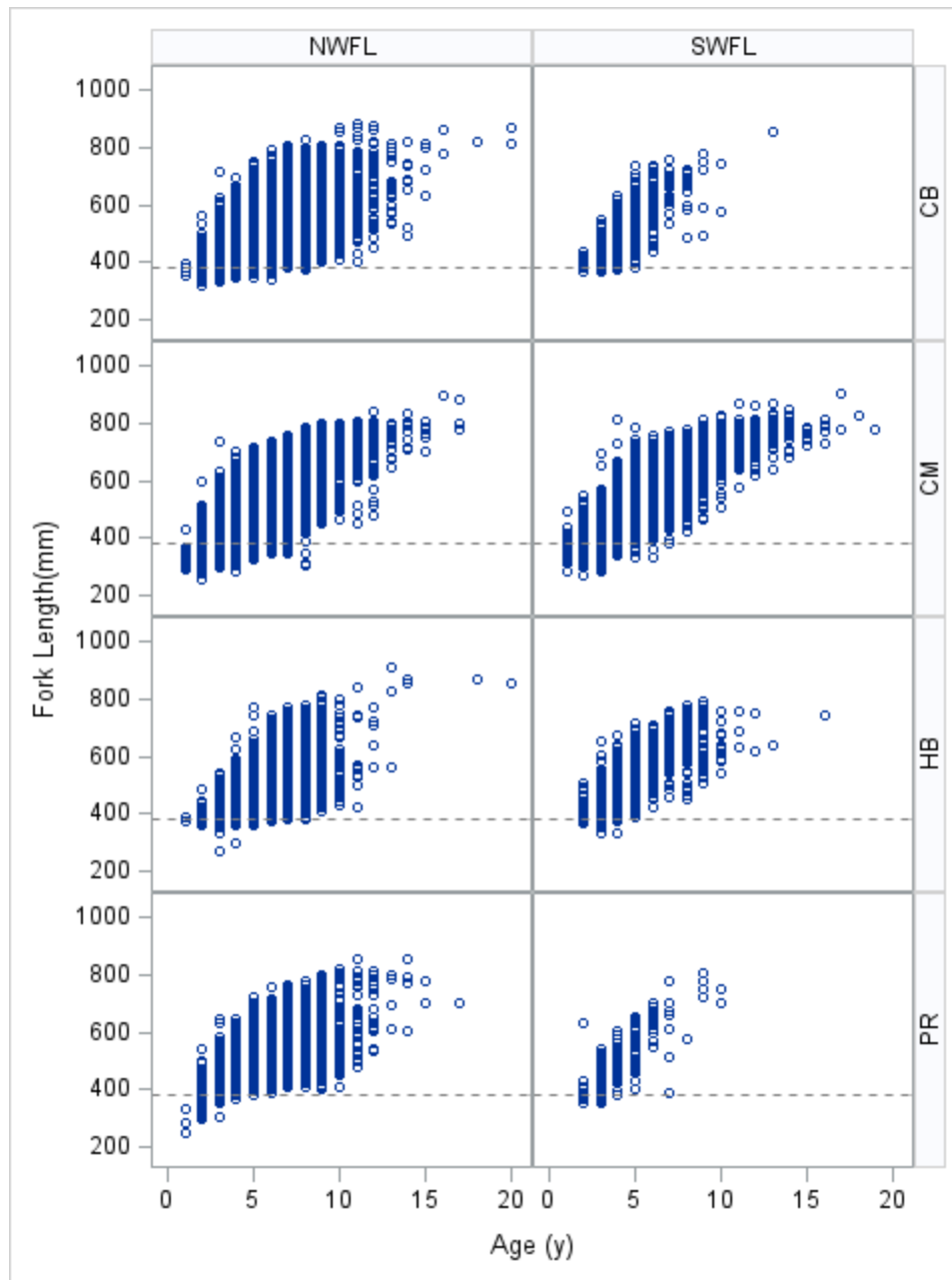


Figure 8. Fork length as a function of age in each fishery sector. The dashed line represents 16" TL, the minimum size for all recreational fisheries since 2000. The commercial sector decreased the minimum legal size to 13" TL in 2008. Regions are NWFL (central Gulf of Mexico) and SWFL (eastern Gulf of Mexico) as defined by the analysis team.

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