Description of red snapper, *Lutjanus campechanus*, age data collected from the northern Gulf of Mexico from 1980-2023

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Description of red snapper, *Lutjanus campechanus*, age and growth data collected from the northern Gulf of Mexico from 1980-2023

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INTRODUCTION

Northern Gulf of Mexico red snapper, *Lutjanus campechanus*, are a relatively long-lived species with highly variable size-at-age (Nelson and Manooch 1982; Patterson et al. 2001; Fischer et al. 2004), ontological habitat shifts, and early maturation but delayed peak reproductive output (Porch et al. 2015; Kulaw et al., 2017). Inhabiting a variety of low and high-relief habitats throughout the shallow continental shelf and shelf-edge (Rooker et al., 2004; Karnauskas et al., 2017; Streich et al. 2017; Garner et al. 2019; Murawski et al. 2019), multiple fisheries contribute to red snapper mortality across its lifespan (Porch, 2005; SEDAR74, 2024). Discarded as bycatch in the shrimp trawl fishery as juveniles (Gazey et al. 2008), red snapper become fully recruited to some of the directed fisheries by age-2 (Neiland et al., 2007). Recreational fishers heavily target red snapper during the open season and produce large numbers of regulatory discards during the closed season throughout most of the year (SEDAR 74, 2024). Commercial fishers with IFQs target red snapper throughout the year primarily with hook and line. Bottom longline gear also used in the commercial fishery as well as the fishery independent SEAMAP bottom longline survey is the only gear that fully selects for the older larger individuals residing away from reef structure. The complexity of this fishery necessitates intense sample collection and processing efforts throughout the GOM annually to produce robust estimates of fishing mortality, selectivity, and age-structure from stock assessment models (SEDAR74, 2024). The recent decision to switch from an assessment model with a two-region substock structure to a three-region model has further increased the importance of both representative sample collection and age-data quality (SEDAR74, 2024).

Quality age data (i.e., high precision without bias) are crucial for informing a variety of parameter estimates in stock assessments, such as growth, egg production-at-age, age-specific natural mortality, and cohort tracking. Several studies were conducted using sagittal 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; Fischer et al. 2004). Recently, the maximum age of Gulf of Mexico red snapper has been validated to at least 45 years using otolith core $\Delta^{14}C$ analysis (Barnett et al. 2018; Andrews et al. 2019). 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 characterize the age data for Gulf of Mexico (GOM) red snapper collected in 1980 and from 1986-2019 as they pertain to length distributions, growth, natural mortality, and ageing error.

METHODS

Sample collection and processing

Red snapper otoliths were sampled from recreational landings from the Gulf of Mexico (GOM) between Texas and the Florida Keys beginning in 1980. Samples collected during 1986 to 1990 were taken almost exclusively from recreational headboats, predominantly in the west GOM (Table 1). Otoliths were collected from the commercial handline and longline fleets beginning in 1991 (Table 1; Figures 1 and 2), with efforts intensifying in 1998. Otoliths were first collected during fishery-independent (FI) surveys in 1994 (NMFS Pascagoula - MSLab) with sample numbers increasing after 2004 (Table 2). Relatively few samples were collected from any fleet in the east GOM prior to 2000. Sample collection from the commercial fleets intensified in the early 2000s while samples remained sparse from recreational fleets until ~2009-2010. Only in 2017 have more than 40 age samples been collected from the private recreational (REC PR) fleet in the east GOM. Similarly, few age samples were collected from the COM LL fleet in the central GOM in most years.

Federal or state funded programs that collected red snapper otoliths included the Gulf States Marine Fisheries Commission Fisheries Information Network (GulfFIN), Alabama Marine Resources

Division (AMRD), Florida Wildlife Research Institute (FWRI), Southeast Region Headboat Survey (SRHS) formerly the Beaufort Headboat Survey (HB), Marine Recreational Fisheries Statistical Survey (MRFSS), Trip Interview Program (TIP), Pelagic Observer Program (POP), Galveston Observer Program (GOP), Recreational Fisheries Information Network (RECFIN), Shark Bottom Longline Observer Program (SBLOP), and United States Geological Survey (USGS) (Table 2). Additional programs that collected red snapper age samples during a one-time study include the Alliance project, Congressionally Supported Supplemental Survey (CSSS; formerly known as the Expanded Annual Stock Assessment, EASA, project), and CO-OP/CO-OP Ward projects. The Alliance project was conducted in 2010 during which red snapper samples were collected from commercial fishers using handline gear. The CSSS project was conducted in 2011, during which samples were collected throughout the nGOM onboard vessels using either bottom longline or bandit gear with the goal of better characterizing growth rates. The CO-OP Ward project was conducted by William Ward and Glen Brooks during 2009, during which the first regulatory discard of each reef fish species (i.e., red snapper) was retained from either longline or handline/bandit gears during normal fishing operations with a goal of n = 300 individuals from each species per gear at the end of the study. The entire catch was retained twice from one handline vessel and one longline vessel in each of the three study areas.

Other samples were provided from university projects conducted by researchers at Louisiana State University (LSU), Texas A&M – Corpus Christi (TAMUCC), University of Southern Mississippi/Gulf Coast Research Laboratory USM/GCRL, University of Florida, Auburn University (AU), or University of South Alabama/Dauphin Island Sea Laboratory (USA/DISL). Hillary Glenn, Danielle Kulaw, and Jim Cowan (LSU) collected reproductive samples (including length, weight, and age) from fish sampled in 2009 during a study of effects of toppled oil rigs (Cowan et al. 2012; Kulaw et al. 2017) or natural vs artificial reefs (Glenn et al. 2017). Nancy Brown-Peterson et al. (USM/GCRL) submitted data from two studies. One was a National Fish and Wildlife Foundation study conducted from 2016 – 2020 during which length, weight, age, and reproductive samples were collected with vertical longlines at fish havens or decommissioned oil platforms with sampling methodologies adopted from the Southeast Area Monitoring Program (NFWF 2023; Brown-Peterson et al. 2022). The other study was conducted in 2009 during which (undersized) fish discarded from headboats were collected to study release mortality. Researchers at TAMUCC collected samples from reef sites from 2012-2015 following SEAMAP vertical line (bandit gear) protocols (GSMFC 2016). Szedlmayer et al. (AU) provided samples collected in 1999 from shell/block reefs sampled with fish traps or hook and line. The USA/DISL provided samples collected via annual standardized reef-fish surveys using vertical line or bottom longline gear. Researchers at UF provided length, weight, age, and reproductive samples from a study conducted from 2013-2016 in which samples were predominantly collected from fishery independent (FI) surveys but also came from recreational fishing tournaments (n = 2) or charterboats (n = 3), all of which used hook and line gear. The Louisiana Department of Wildlife and Fisheries (LDWF) submitted length, weight, and age data from samples collected at a recreational tournament in 2012 (Lang and Falterman 2017). A portion of these samples also were submitted by researchers at UF after being examined for reproductive information. LDWF also submitted age data collected during standard SEAMAP surveys conducted from 2011-2016.

Throughout the time series, red snapper were measured to the nearest mm standard, fork, natural total, or maximum (stretched) total length and weighed to the nearest g or kg. Final lengths were reported in mm and taken directly from observed fork lengths (mm) if available. If not available, fork length (mm) was predicted from the following hierarchy in available length measurements: 1) standard, 2) maximum (pinched or stretched) total, or 3) natural total length. Final weights were reported in g and taken from observed whole weight if available. If not available, final whole weight was predicted from observed gutted weight if the condition type was head-on. If gutted weight was any other condition type or unknown, final whole weight was predicted from final length (mm FL) if available. Final age was taken directly from calendar age, and biological (i.e., fractional) age was estimated from final age and capture date given a birthdate of July 1.

Generally among all processing labs, otoliths were processed with either a Hillquist high-speed thin sectioning machine utilizing the methods of Cowan et al. (1995) or on an Isomet low-speed saw. Two transverse cuts were made through the otolith's core at a thickness of ~0.5 mm. Calendar ages were estimated from annuli counts and the degree of marginal edge completion viewed under transmitted and/or reflected light. Red snapper in the northern Gulf of Mexico 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 (≥66% of preceding translucent zone width) was visible on the margin and capture date was January 1st through June 30th. After June 30th, calendar age was equal to the annuli count. By this traditional method, an annual age cohort is based on a calendar year rather than time since spawning (Jearld, 1983; Vanderkooy et al., 2020). 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 365.25). This fraction is added to annual age if capture date is after July 1st and subtracted if capture date is before July 1st (Vanderkooy et al., 2020).

PC Lab subsampling protocols

The NMFS PC Lab has utilized subsampling protocols to accomplish sample processing deadlines due to the high volume of red snapper age samples received during most years. Subsampling protocols were applied only to samples collected from the commercial handline (COM HL) fleet after 2002 due to their disproportionate volume (Figure 3). Subsampling protocols were applied to select from among samples from all fishery-dependent fleets in prior years in which subsampling occurred (i.e., 1993, 1994, 1998-2002). The number of red snapper age samples received increased dramatically after 1997 in response to declarations of emergency sampling after burgeoning concerns about stock status (Figure 4). Samples received remained steady until another dramatic increase was observed in 2012 and declined steadily after 2013 to a recent minimum in 2020, during which sample collection was stopped due to the pandemic. The number of samples received has increased steadily since 2020. The number of otolith samples from the COM HL fleet processed for age estimation has remained steady around ~2000 per year for the COM HL fleet since 1998 (Figure 4).

1980-2002

Otoliths collected in 1993, 1994, and from 1998 to 2002, were randomly subsampled for age estimation due to time and labor limitations of processing staff. Port sampler interview numbers were randomly selected and all otoliths collected during each selected interview were processed with a target of 4,000 total otoliths per year. Interviews were randomly selected from among all fishing sectors (i.e., commercial handline or longline or recreational private, charterboat, or headboat) available that were represented in the landings. Approximately 50% of interviews/samples were selected from either the eastern or western GOM. Fewer samples received in 1980, 1991, 1992 and 1995-1997 allowed for processing of all otoliths without subsampling. Fishery-independent samples were not subsampled during this period. Otoliths taken from size-selected samples (e.g., large fish requested for sampling by fishers or for fecundity information) during an interview were included for processing if that interview was randomly selected. However, characterization of the fishery by length and age was restricted to only the otoliths randomly sampled during the interview process. Size-selected samples were included only for estimating growth and reproductive parameters.

2003-2012

Rather than subsampling from among all fleets, the SEFSC Sustainable Fisheries Division recommended refining the subsampling strategy in 2003 to randomly sample otoliths from only the COM HL fleet due to the disproportionately large number of samples received compared to all other fleets (Fitzhugh et al., 2004). The new subsampling strategy randomly selected samples from the COM HL fleet during each 2-month wave (n = 6) of the year with the following spatial strata: Texas, Louisiana and eastern GOM (Mississippi to Florida). The target number of otoliths per wave was 100 with a total of 600 otoliths per strata annually. In 2012, sub-sampling targets increased to 300 otoliths per wave per strata in response to supplemental congressional funding, which increased sampling of red snapper and other reef fish in that year. All commercial longline, recreational and fishery independent otolith samples received from 2003 to 2012 were processed for age estimation.

2013-2023

The sub-sampling strategy for COM HL samples was updated in 2013 to reflect regional stock demographic stratification defined by habitat, hydrodynamic circulation, and historical fishing patterns that had become more apparent through time (e.g., SEDAR 31 data review). Subregional groupings (n = 6) were assigned to each otolith sample based on its NMFS statistical grid information collected during port sampler interviews. Statistical grids 1-4 (SW Florida) were denoted by the broad carbonate shelf with little freshwater input and historical fishing surveys for red snapper that located productive areas south of Tampa to Tortugas Banks extending back to the 1880s (reference Map V in Moe 1963, “A survey of offshore fishing in Florida”). Grids 5-7 (W Florida) were grouped because Cape San Blas is both a faunal and hydrodynamic circulation break. The Area SE of the Cape has been historically dominated by grouper fishing (extensive shallows denoted for gag and red grouper) with less recognition for the prevalence of red snapper and only limited commercial snapper harvests along the outer shelf (Moe 1963). Grids 8-12 (central GOM), especially off the Alabama-Florida panhandle, were recognized as the historical origin of the US fishery. Fishing in this area is highly associated with intensive artificial reef placement throughout the continental shelf and among natural reef sites as well as the outer shelf-edge habitat (Desoto Canyon and associated pinnacle trends). Grids 13-17 (West of the Mississippi River), represent another faunal and circulation break but also have high sedimentation rates, a lack of inner-shelf natural reef habitat, outer shelf diapirs, and intensive oil and gas development. Red snapper from this region were not harvested until well after (post WWII) the fishery began in the eastern GOM. Grids 18-19 (N Texas) include industrial development and relatively intensive recreational fishing (via Galveston and Port of Houston) as well as inner banks of the Texas continental shelf. Finally, grids 20-21 (S Texas), south of around Matagorda Bay, are characterized by relict carbonate shelf and drowned coral reefs. This region may have experienced the lowest historical fishing pressure for red snapper within the US GOM. By 2013, the database was updated to allow for selection of individual fish records for sample selection instead of sampling by the entire collection/interview as was done in both pre-2003 methodological stanzas. Instead, otoliths were randomly selected in proportion to the landings within each grid group (n = 6) with a target of 500 otoliths per grid group and a total target of 3,000 age samples from the COM HL fleet per year. In 2018, due to oversampling of the headboat fishery in Texas, 1,000 otoliths were subsampled for age estimation via simple random selection. All other otolith samples received from commercial long-line, recreational, or FI collections from 2013 to 2023 were processed and aged.

RESULTS

<u>Sample collection</u>

A total of 276,797 red snapper age samples had a valid final age estimate and 276,233 (99.8%) were assigned to a stock ID region (West, Central, or East). Fleet and region-specific age sample tallies are shown in Table 1. The remaining 0.2% of age samples had no latitude or longitude, NMFS grid, headboat area, state landed, or county landed information by which to assign to a region. Samples were collected from 92,841 unique sampling interviews of fishery dependent (FD) trips or collection sites during FI surveys. Prior to 2002, nearly all age samples were received and processed at the Panama City NMFS laboratory (PC Lab) with most samples collected from the headboat program. Starting in 2002, GulfFIN processed similar numbers of age samples as the PC Lab with the RECFIN, Fisheries Information Network Biostatistics (FIN_BIOSTAT), and TIP programs collecting the majority of samples from 2002 to 2023 (Table 2). The TIP program provided nearly half (43.5%) of all age samples collected. Samples were collected from only recreational sources from 1980 to 1990, while sample numbers were roughly similar between all commercial or recreational sources since 1991 (Table 1). Fishery-independent samples were first collected in 1992 and have contributed relatively large sample numbers compared to FD sources since 2009 (13.0% of total). Numerous FI studies have intermittently provided age samples throughout the time series, with USA/DISL, FWRI Fisheries-Independent Monitoring (FWRI_FIM), and Mississippi Laboratory (MS Lab) FI sampling programs consistently providing samples annually since the early 2000s.

Few COM HL age samples were collected from any grid prior to 1998; samples from the west region increased and remained consistent throughout the rest of the time series while samples from the east were scarce through 2009 and rarely collected from grids 1 or 2 (Figure 1). Unlike the number of age samples collected from the COM HL fleet, which gradually increased over time throughout the GOM, age samples collected from the COM LL fleet were relatively sparse throughout the time series, but tended to be taken from the same few grids. Many age samples were collected from COM LL vessels fishing in grids 13-15 and grids 4-6 in various years, especially after 2008 in the east region. Samples were collected from all five Gulf states during most years starting in 1991 with consistent sample numbers collected from all five states from 1998 to 2023 (Table 3). The greatest number of samples were collected in Florida (FL) (46.3%) and the fewest in Mississippi (MS) (4.0%) in most years; MS and Alabama (AL) have collected similar numbers of samples since 2007. The overwhelming majority (81.0%) of age samples were collected via hook and line in all years, with relatively large sample collections from bottom (9.9%) and vertical longline (4.3%) gears beginning in the early 2000s (Table 4). Few samples (~1% or less) were collected with spear, trap, or trawl gear.

The median age of sampled red snapper was 2-3 yrs throughout the 90s for all three regions, increased to 3-4 yrs during the 2000s, and then to ~5 yrs until around 2016 (Figure 5). Starting in 2016, median ages and the distribution of ages within a region began to diverge. Fished collected in the west region had higher median age and a wider age distribution than aged fish collected from the other two regions. Since 2020, aged fish from the east region had a higher median age and age distribution than aged fish from the central region, which appear to decrease in median age during the last four years of the time series from a median age of ~5 yrs to ~2 yrs (Figure 5). Mean ages of fish collected from the private sector (charterboats – 4.28 ± 2.11 yrs, headboats – 4.68 ± 2.16 yrs, and private recreational vessels – 4.53 ± 2.22 yrs) were younger than fish collected from commercial (4.91 ± 2.71 yrs) or FI (5.14 ± 3.90 yrs) sources, while samples from tournament fish were the oldest (6.05 ± 3.92 yr). Age samples collected with bottom longline gear (7.82 ± 4.67 yrs; 610.16 ± 112.60 mm FL) were considerably older and larger than fish collected with any other gear, while samples collected with trawls (1.39 ± 1.84 yrs; 211.26 ± 119.52 mm FL) were considerably younger and smaller. Fish sampled south of LA had the highest mean age (5.30 ± 3.37 yrs) and length (506.48 ± 150.52 mm FL), while fish sampled south of MS had the lowest mean age (3.49 ± 2.52 yrs) and were the smallest (408.88 ± 150.52 mm FL).

Median lengths of aged fish were more variable over time among regions than median ages. Median lengths and length distributions were highly inconsistent but increased throughout the late 80s and early 90s until they began to stabilize through the 2000s (Figure 6), likely due to increases in sample numbers. However, trends in length distributions vary among regions. Aged fish from the west GOM were roughly stable around a median length of 400 mm (FL) throughout the 2000s, then increase to nearly 500 mm FL with a wider length distribution for the remainder of the time series. Aged fish from the central region were similar in length to fish from the west throughout the 2000s but began to decline in median length and age distribution starting in ~2014 to lengths much lower than fish from the other two regions as time progressed. Aged fish from the east GOM were much larger than aged fish from the other two regions throughout the 2000s, but have been relatively stable throughout the entire time series around 500 mm FL. Aged fish from the other two regions simply increased to similar sizes as were observed in the east until median lengths of aged fish from the central region began to decrease in recent years. Boxplots of aged fish indicate strong differences in age and length among gear types with fish collected with bottom longline gear being older and larger than all other known gear types (Figures 7 and 8); fish collected with trawl gear were much younger and smaller than fish collected with other gear types. Median age among the other gear types was 3-4 yrs while median lengths among the other gear types ranged from ~400 to 500 mm FL.

Reader precision

Average percent error (Beamish and Fournier, 1981; Campana 2001) was calculated for age estimates of the red snapper reference set provided by PC Lab, FWRI, and AMRD. Of the 200 otolith sections included in the reference set, n = 198 had age estimates provided by all three laboratories with an overall APE = 3.45, ACV = 4.48, and agreement ranging from 76.8 to 84.5% with the reference set ages. Reference set reads provided by the PC Lab had the highest individual APE (2.6) and ACV (3.7), while estimates from the FWRI lab had the lowest APE (1.5) and ACV (2.1) estimates. Age estimates within ±1 yr of the reference set consensus ages accounted for 97.5, 97.5, and 98.5% of age estimates provided by the PC lab, AMRD lab, and FWRI labs, respectively. Within each production ageing lab, additional QAQC measures may be required, but the reference set provides the only means of comparing APE across labs for the same reference slides given that multiple production ageing labs provide significant numbers of red snapper age samples for SEDAR stock assessments.

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Table 1. Number of red snapper (final) age samples collected from the Gulf of Mexico from 1980 to 2023 by fleet (commercial handline, COM HL; bottom longline, COM LL; private recreational, REC PR; recreational charterboat, REC CB; or recreational headboat, REC HB) and region (West, W; Central, C; or East, E). No age samples were processed from 1981-1985.

	COM HL			COM LL			REC PR			REC CB			REC HB		
Year	**W**	**C**	**E**	**W**	**C**	**E**	**W**	**C**	**E**	**W**	**C**	**E**	**W**	**C**	**E**
1980	0	0	0	0	0	0	0	0	0	0	325	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	526	17	3
1987	0	0	0	0	0	0	0	0	0	0	0	0	148	3	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	354	7	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	83	14	1
1990	0	0	0	0	0	0	0	0	0	0	0	0	36	3	0
1991	25	179	0	0	0	12	0	0	0	526	237	2	102	20	0
1992	214	119	18	0	0	15	0	2	0	485	353	0	26	73	5
1993	344	139	12	29	0	31	24	0	0	189	371	62	913	254	0
1994	507	122	28	0	0	8	0	0	0	0	426	0	388	21	0
1995	97	85	7	0	0	19	0	0	0	0	362	0	10	11	0
1996	0	9	0	0	0	6	0	0	0	0	101	0	0	95	0
1997	0	1	31	0	0	10	0	0	0	0	56	0	0	94	1
1998	1200	186	11	348	0	25	220	240	0	135	946	1	981	647	1
1999	1792	908	70	76	0	102	75	581	0	97	659	0	267	352	14
2000	695	1382	29	345	0	84	3	0	0	3	504	2	252	139	2
2001	1027	1242	66	179	14	77	0	2	0	0	376	12	74	218	1
2002	2422	1155	14	341	10	168	322	309	0	245	2543	14	207	219	0
2003	1395	1474	9	259	27	170	600	353	3	229	6025	35	140	71	2
2004	1892	970	113	640	18	235	627	197	0	400	3815	3	168	63	7
2005	2318	1101	68	252	34	311	815	194	0	422	5089	5	208	48	52
2006	2599	1146	153	556	0	202	1081	251	2	237	3384	5	205	109	78
2007	1447	1077	54	352	93	124	531	64	1	475	402	14	69	185	7
2008	1578	933	23	344	183	315	340	30	10	467	366	7	133	146	44
2009	2127	929	596	271	20	679	323	73	2	427	519	19	429	367	282
2010	2055	1149	451	84	1	882	435	58	13	49	1270	103	394	236	240
2011	1665	2471	906	14	22	551	130	80	13	413	1138	73	660	185	260
2012	2914	3226	951	149	51	228	380	157	0	401	1668	14	364	236	127
2013	1500	1798	767	116	14	705	313	113	7	615	1989	21	1476	668	150
2014	1112	1500	987	77	14	1120	515	314	12	241	838	81	1232	2926	70
2015	1640	2208	644	97	23	846	381	675	0	455	1813	130	1002	2341	203
2016	1681	2545	909	108	31	828	567	860	10	341	1318	24	727	317	39
2017	1235	2961	1282	120	36	528	433	583	267	529	904	66	1082	382	158
2018	1488	3931	925	307	116	537	509	814	40	601	1232	207	1079	709	236
2019	1109	4310	1018	681	53	804	540	713	14	382	1462	207	1060	772	207
2020	908	3208	1117	126	51	291	538	315	12	309	698	62	8	26	0
2021	810	2912	720	175	86	417	585	327	18	418	1011	264	84	217	39
2022	1052	2653	1729	420	146	1659	547	211	30	170	894	172	236	443	115
2023	1028	887	501	406	173	822	817	285	35	348	868	133	258	457	157

Table 2. Number of red snapper (final) age samples collected from the Gulf of Mexico from 1980 to 2023 by sampling program. No age samples were processed from 1981-1985.

Year	ALLIANCE	CO-OP	CO-OP_WARD	DISL SEAMAP V2	DISL BLL	DISL VLL	EASA	FWRI_FIM	FIN_BIOSTAT	FIN_OBS	FWRI
1980											
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993											
1994											
1995											
1996											
1997											
1998											
1999											
2000											
2001											
2002		5							4658		
2003		18							5365		
2004									4464		
2005									4517	32	
2006								1	4932	71	
2007								20	1623	1	
2008								47	1695		
2009			863					109	1561		359
2010	98			573				1198	1086		5
2011							2403	97	1381		
2012		346			167	701		142	1680		
2013					70	528		596	1460		
2014					280	746		337	992		
2015					141	1100		335	1642		
2016					194	521		461	2167		
2017		1871			90	602		594	1680		
2018					99	427		576	2269		
2019					93	437		22	2023		
2020					77	236		9	1322		
2021					74	282		36	1365		
2022					50	218		228	1073		
2023								188	1446		

Table 2. Continued…

Year	FWRI_OBS	GOP	GRFS	HB	LDWF	MERR	MRFSS	MSLAB	GCRL_USM	PCLAB	RECFIN	REPBIO	SBLOP	SEAMAP
1980										327				
1986				553										
1987				151										
1988				361										
1989				98										
1990				39										
1991										12				
1992										6				
1993				1052										
1994				503				2						
1995				11				15		2				
1996				92				1						
1997				91				37						
1998				1599			1443			24				
1999				623			1108	7		3				
2000				391			5	87		133				
2001				284			112	88		24				
2002				326			274	166		75	429			
2003				103			44	77		2	3846			
2004				127			75	71		17	2906			
2005				125			44	693		95	4239			
2006				151			152	163		122	2347			
2007				260	75		13	373		269	100		8	
2008				133				381		191	348		34	
2009	431			645		3		305		286	298			
2010	648			530			1	463		162	971		15	
2011	257			771		4		96		241	879			199
2012	253	59		521	19		14	1032		211	1385		45	727
2013	524	59		1832		1		851		388	1483			1194
2014	580	38		3683				367		192	1011			525
2015	516	76	77	3246				277		386	1664			
2016	280	146	303	970				335	421	360	934		21	292
2017	448	32	674	28				432	404	400	138		34	
2018	552	14	503	71				502	557	438	539			
2019	424	30	339	76				358	431	479		545	57	
2020	75	5	102					5	225	245		178		
2021	405	55		3				632		463		471		
2022	366	39		23				203		347		337		
2023	433			87				1217		392		169		

Table 2. Continued…

Year	SRFS	SRH	TAMUCC	TIP	UF	UNK	USF	USGS	UTMSI
1980									
1986									
1987									
1988									
1989									
1990									
1991				1113					
1992				1358					
1993				1455					
1994				1403					
1995				748					
1996				142					
1997				110					
1998				2010					
1999				3262					
2000				3022				7	
2001				2874					
2002				3900					
2003				3221					
2004				2373					
2005				2394					
2006				2583					
2007				2989					6
2008				2849					
2009				3473					
2010				4352					
2011				5297			325		
2012			45	6750		485	311		
2013			584	4592	2		107		
2014			514	4694	17		79		
2015			220	4998	17				
2016				5389	4				
2017		1299		6055					
2018		1516		6873					
2019		1765		7679					
2020	140	8		5711					
2021	181	243		5118					
2022	139	603		7557					
2023	265	566		3840					

Table 3. Number of red snapper (final) age samples collected from the Gulf of Mexico from 1980 to 2023 by state landed (Alabama, AL; Florida, FL; Louisiana, LA; Mississippi, MS; or Texas, TX). No age samples were processed from 1981-1985.

Year	AL	FL	LA	MS	NL	TX	UNK
1980		327					
1986	1	3				352	197
1987			4			144	3
1988		1				354	6
1989		1				83	14
1990			13			23	3
1991	4	376	26	87		628	4
1992	9	607	214	1		533	
1993	8	846	788			865	
1994	5	851	898			154	
1995	261	214	205	96			
1996		234				1	
1997		202	9			27	
1998	645	1361	1744	238		1088	
1999	908	1215	1566	425		1002	
2000	271	1384	1630	302		188	
2001	253	1416	1261	292		212	
2002	2158	2050	2833	622		2170	
2003	2539	5357	1876	406		2498	
2004	1261	3892	1672	277		2937	
2005	1445	5389	2692	123		2490	
2006	1456	3655	2033	364	1	3013	
2007	602	1640	1861	245	20	1369	
2008	448	1837	1597	111	47	1638	
2009	683	3531	1877	111	109	2057	
2010	819	4469	1380	59	1198	2177	
2011	636	6169	2740	105	97	2203	
2012	771	6620	4264	204	142	2017	8
2013	358	5840	3119	205	596	3557	
2014	1093	6921	2083	120	337	2471	4
2015	752	7637	2144	538	335	2048	
2016	457	6186	2237	831	461	1911	
2017	468	6603	2113	472	594	3839	
2018	373	7604	2781	1091	576	1985	
2019	613	8243	2322	1033	22	1995	
2020	405	5362	1179	298	9	772	
2021	230	5713	1798	714	36	481	
2022	385	7342	1569	326	228	1065	
2023	281	3723	1835	1139	188	1172	265

Table 4. Number of red snapper (final) age samples collected from the Gulf of Mexico from 1980 to 2023 by gear group (handline, HL; essential fishing permit, EFP; bottom longline, LL; not coded, NC; seine net, SN; spear, SP; trap, TR; trawl, TW; unknown, UN; vertical longline, VL; or other). No age samples were processed from 1981-1985.

Year	HL	HL_EFP	LL	NC	Other	SN	SP	TR	TW	UN	VL
1980	325										
1986	553										
1987	151										
1988	361										
1989	98										
1990	39										
1991	1107		12								
1992	1304		15				14	7			
1993	2442		60					5			
1994	1892		8				6	2			
1995	733		19				9	1	14		
1996	228		7								
1997	192		10					36			
1998	4644		373								
1999	4819		184								
2000	3126		515					7			
2001	3024		358								
2002	7471		685	571	983		123				
2003	10329		533	418	1349		7		40		
2004	8227		964	471	349		28				
2005	10997		600	434			18	90			
2006	9226		792	207			24	273			
2007	4756		622	133	41		8	176			1
2008	4152		852	101	32		14	198	329		
2009	6533		1046	134			8	458	153		1
2010	7599		1025	173			25	99	304		873
2011	9834		1662	20			17	174	8		235
2012	11440		1289	51			1	195	708	19	1190
2013	10505		1331				8	118	580		1729
2014	10648		1709		31		57	214	145		1250
2015	11822		1352		10	2	57	253	56		1143
2016	9776		1392	50	1		80	152	30		1316
2017	12242	5	1075		17		100	210	32		1100
2018	12445		1277		3		30	52	37		1085
2019	11950		1832		7		26	53			868
2020	7168		550		96		54				461
2021	7395		923	37	138		19	37	497		282
2022	8384		2478				9		69		218
2023	5892		1666		3	1	31		980		

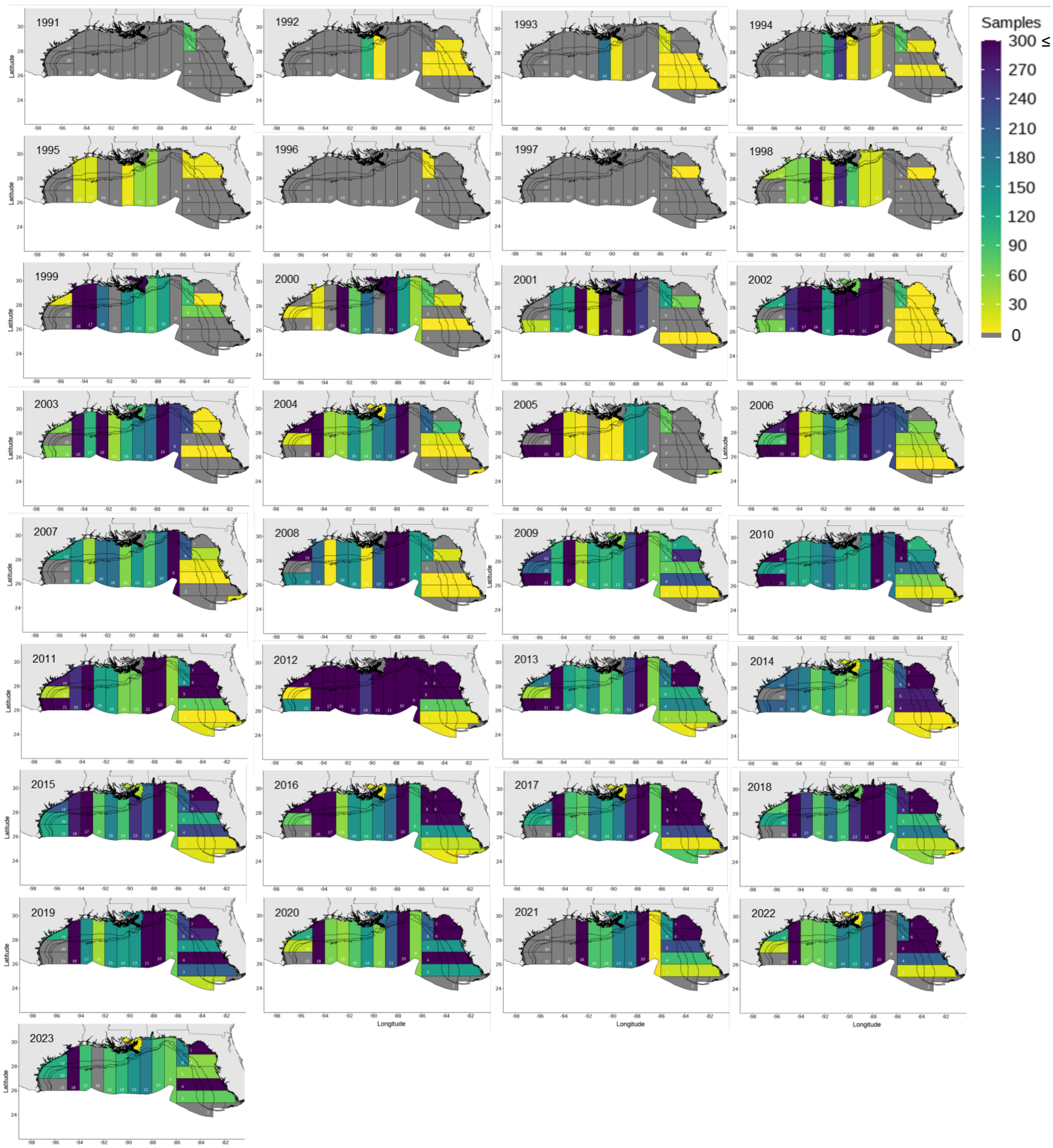

Figure 1. Number of commercial handline age samples per year by NMFS statistical grid. Gray indicates grids with no samples in a given year, with a maximum number of observed samples capped at 300.

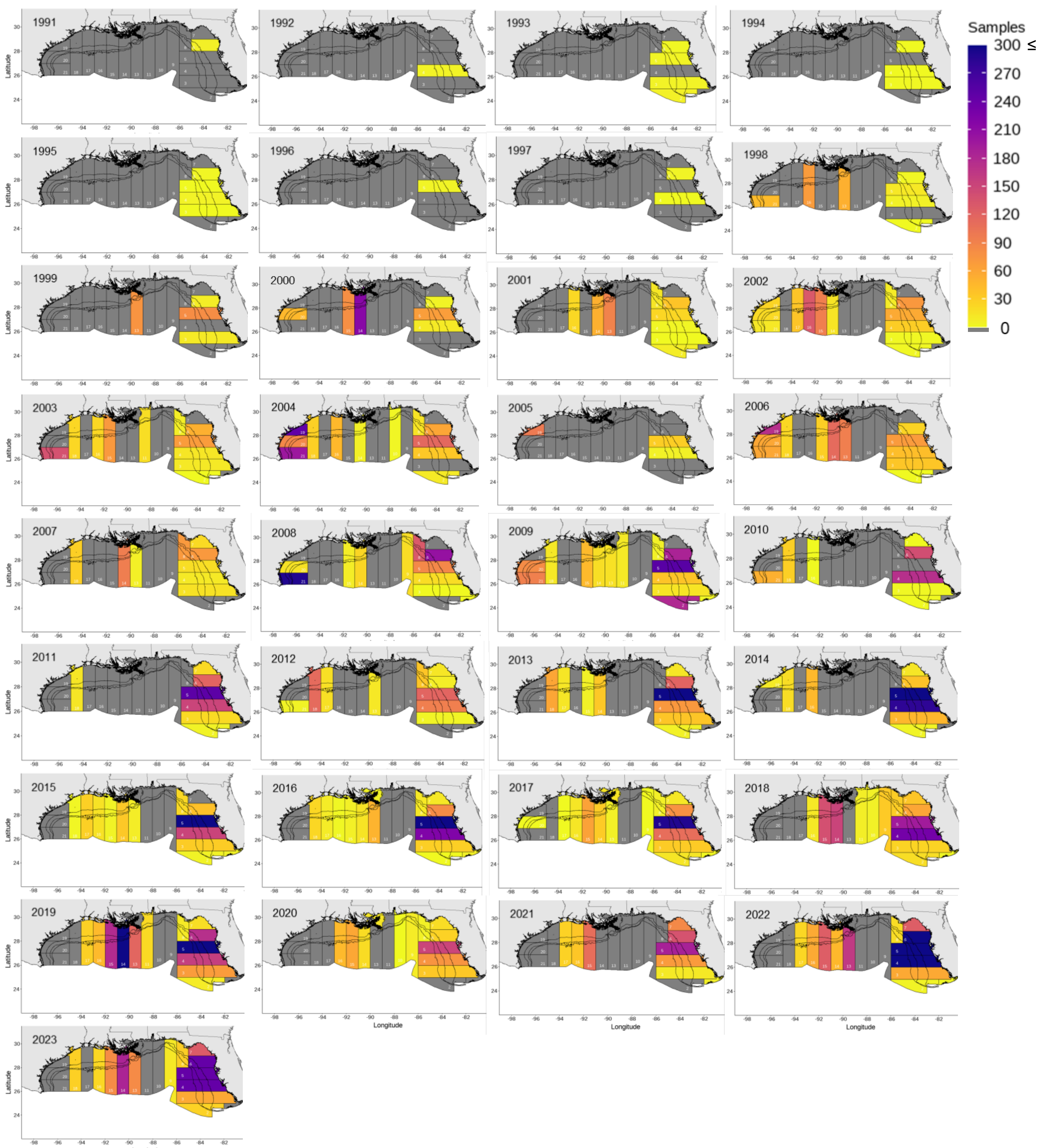

Figure 2. Number of commercial longline age samples per year by NMFS statistical grid. Gray indicates grids with no samples in a given year, with a maximum number of observed samples capped at 300.

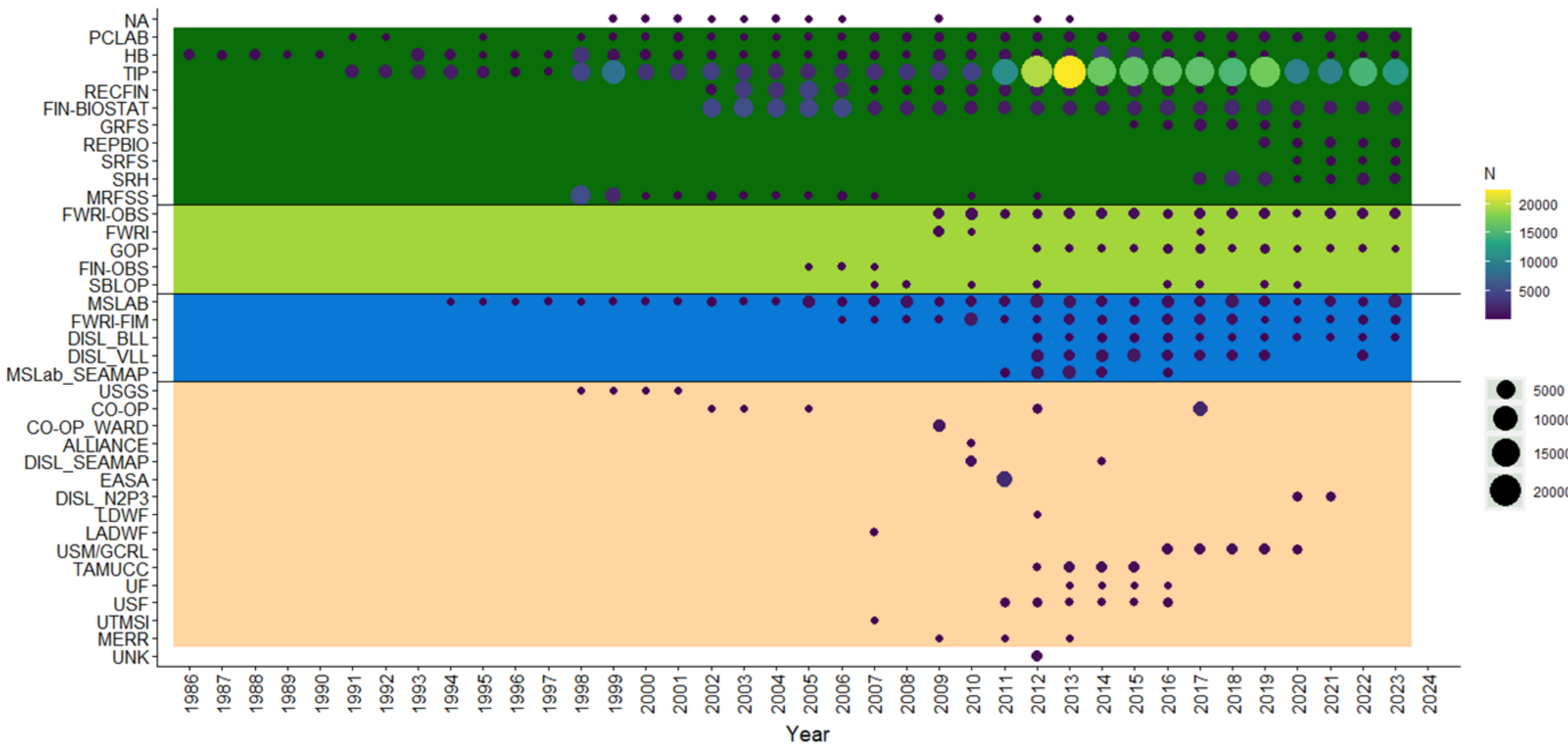

Figure 3. Bubble plots (coded redundantly by color and bubble size) of the number of age samples by collection program of origin by year.

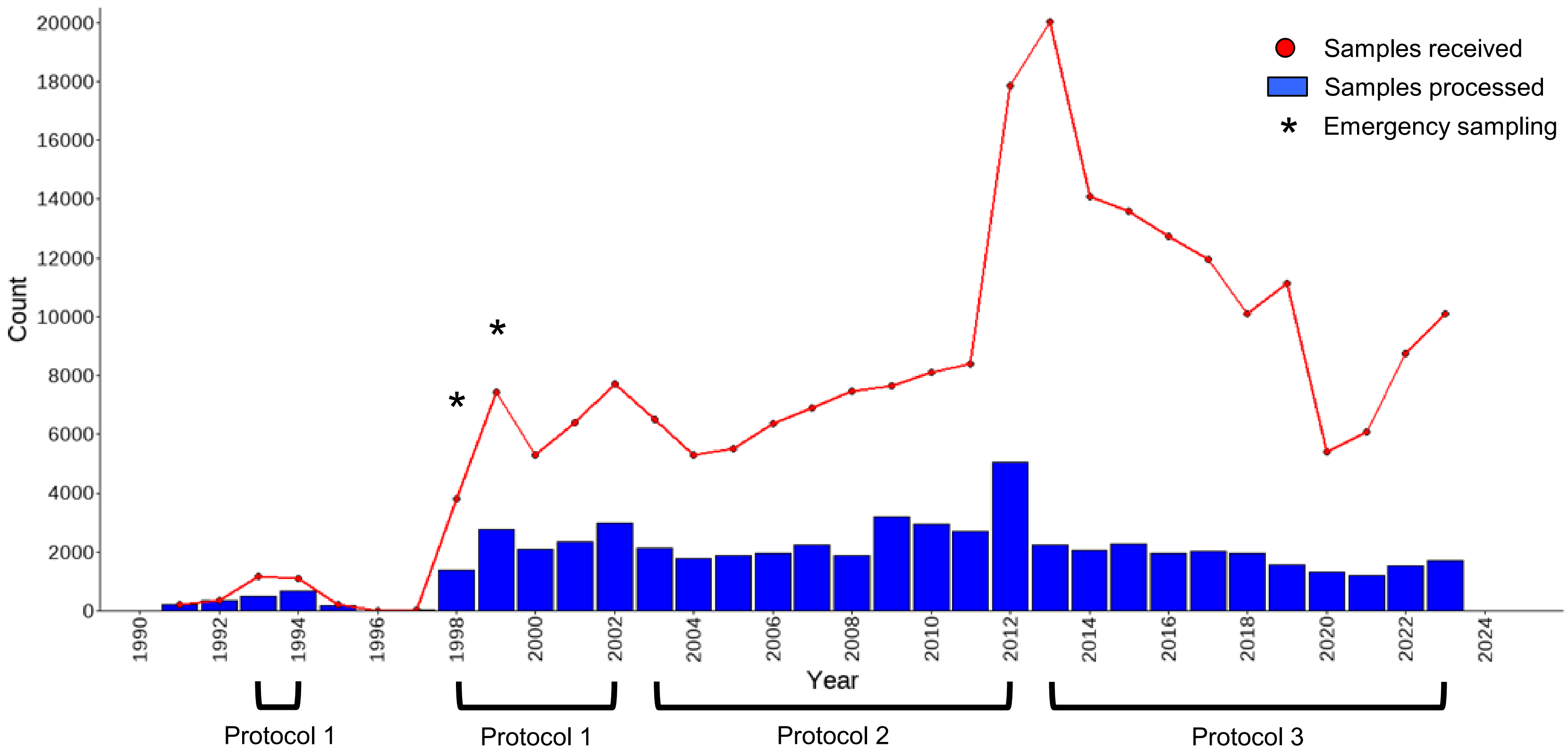

Figure 4. Number of otoliths received (red line) from port samplers of the commercial handline fleet vs number of otoliths processed and aged (blue bars) at the NMFS Panama City lab. Periods of derby fishing, IFQs and emergency sampling years are shown to indicate potential sources of variability in the number of otoliths received in a given year. Each of the three subsampling protocols (as well as the unknown protocol implemented in 1993 and 1994) and the years affected by each are indicated along the x-axis.

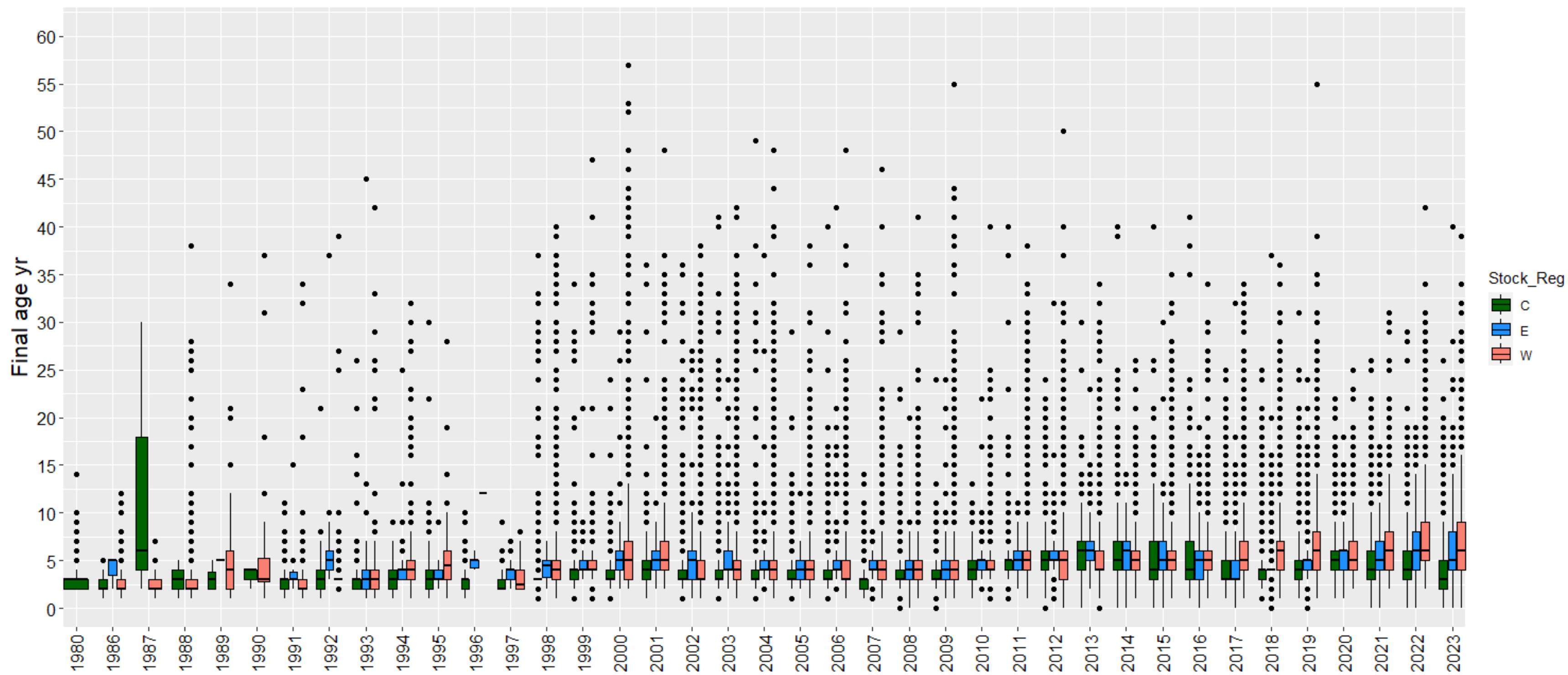

Figure 5. Boxplot of final age (yr) by year (1980 to 2023) for red snapper age samples collected from the central (C), east (E), or west (W) region of the Gulf of Mexico. Boxes indicate the 25th and 75th percentiles, vertical lines indicate median values, horizontal lines indicate the min and max values of the IQR*1.5, and points indicate values outside that range.

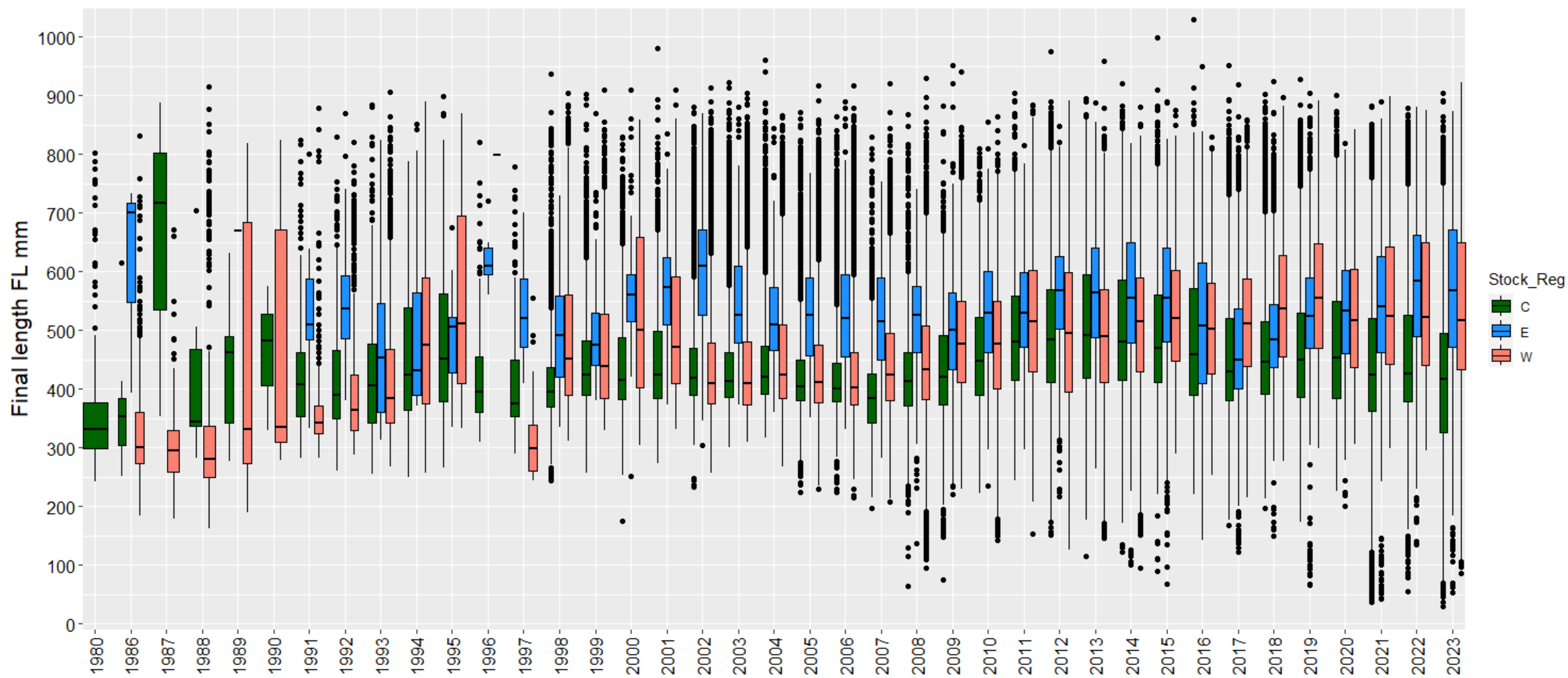

Figure 6. Boxplot of final length (FL mm) by year (1980 to 2023) for red snapper age samples collected from the central (C), east (E), or west (W) Gulf of Mexico. Boxes indicate the 25th and 75th percentiles, vertical lines indicate median values, horizontal lines indicate the min and max values of the IQR*1.5, and points indicate values outside that range.

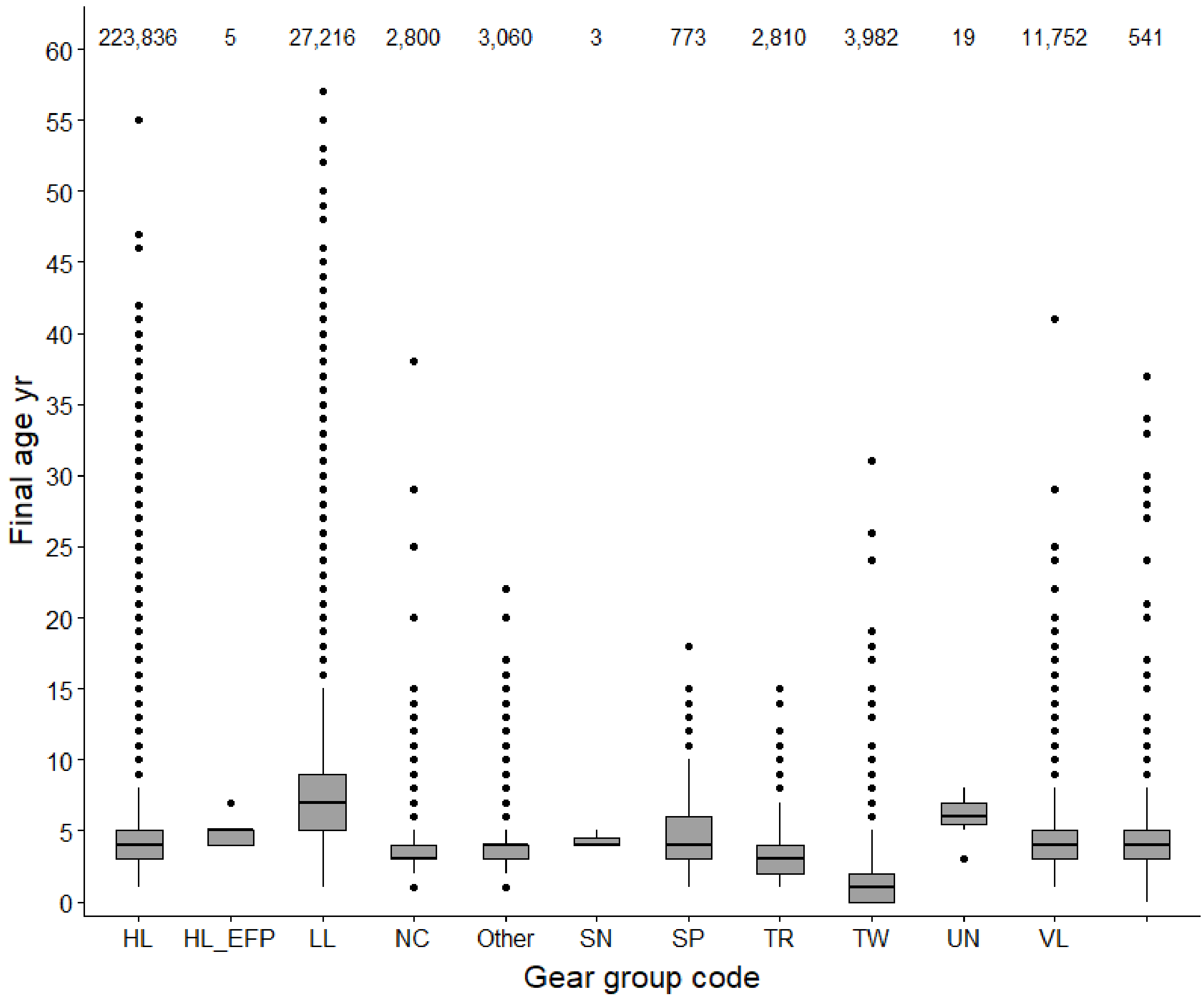

Figure 7. Boxplot of final age (yr) by gear group code (handline, HL; handline with exempted fishing permit, HL_EFP; bottom longline, LL; not coded, NC; seine net, SN; spear, SP; trap, TR; trawl, TW; unknown, UN or blank; or vertical longline, VL) for red snapper age samples collected from the Gulf of Mexico from 1980 to 2023. Sample numbers are shown along the top of the figure. Boxes indicate the 25^{th} and 75^{th} percentiles, vertical lines indicate median values, horizontal lines indicate the min and max values of the IQR*1.5, and points indicate values outside that range.

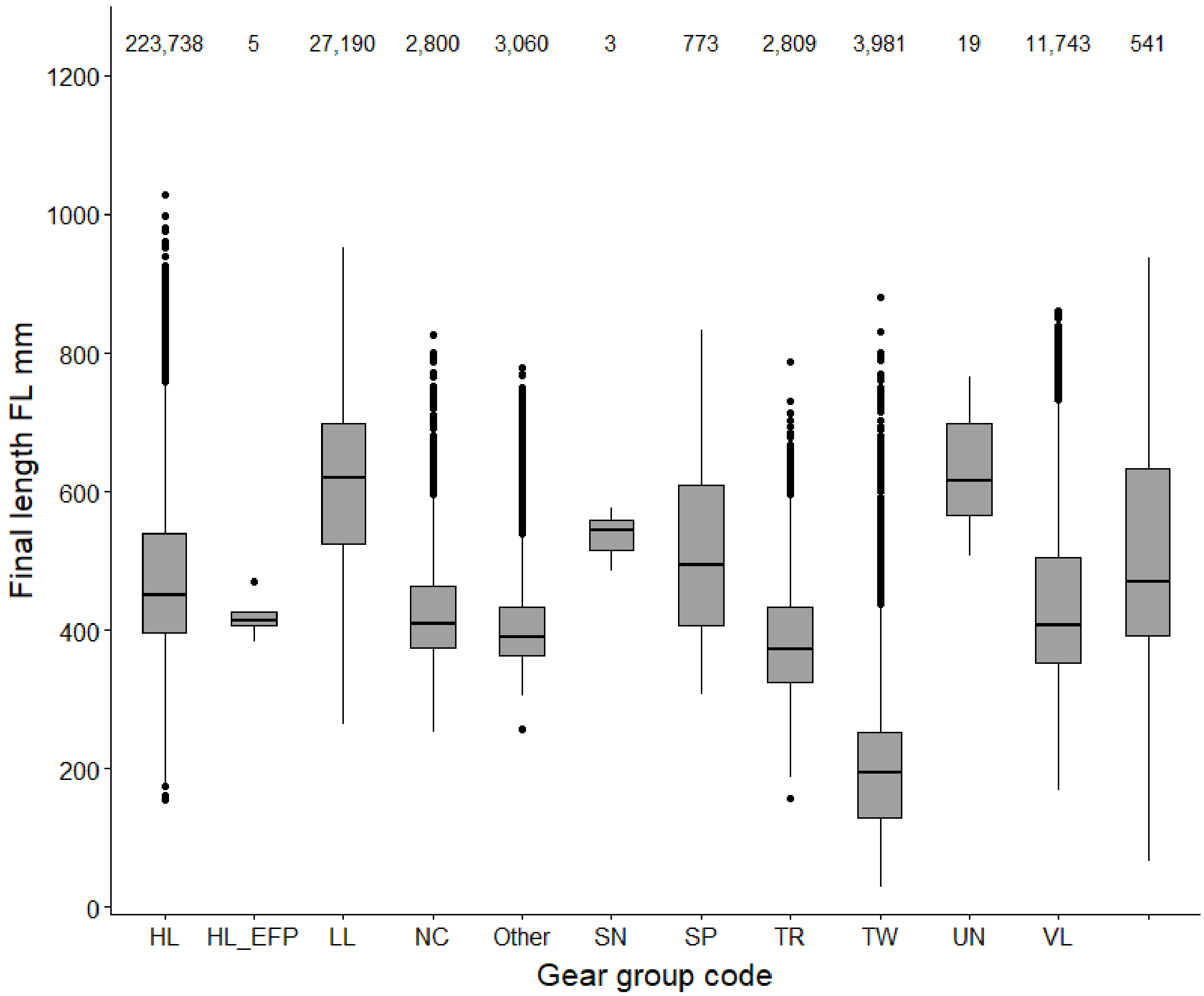

Figure 8. Boxplot of final length (FL mm) by gear group code (handline, HL; handline with exempted fishing permit, HL_EFP; bottom longline, LL; not coded, NC; seine net, SN; spear, SP; trap, TR; trawl, TW; unknown, UN or blank; or vertical longline, VL) for red snapper age samples collected from the Gulf of Mexico from 1980 to 2023. Sample numbers are shown along the top of the figure. Boxes indicate the 25th and 75th percentiles, vertical lines indicate median values, horizontal lines indicate the min and max values of the IQR*1.5, and points indicate values outside that range.