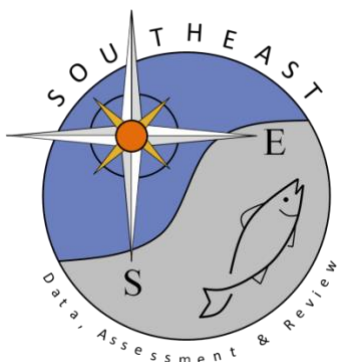# A review of Gulf of Mexico Spanish mackerel (*Scomberomorus maculatus*) age data, 1987 -2021, from various age-data sources

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SEDAR81-WP-03

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A review of Gulf of Mexico Spanish mackerel *(Scomberomorous maculatus)* age data, 1987 -2021, from various age-data sources

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SEDAR81 DW-03

Introduction

Spanish mackerel, *Scomberomorus maculatus*, range from the western area of the Atlantic Ocean from the Gulf of Maine to the Yucatan Peninsula (Collete et al. 1978). The coasts of Florida make up the bulk of the population which is targeted by both the recreational and commercial fishing sectors throughout this range (Trent and Anthony 1978). Coastal Migratory Pelagic species which includes Spanish mackerel, are managed jointly by the Gulf of Mexico and South Atlantic Fishery Management Councils from the Mexico – Texas border to New York. The objective of this report is to summarize the Gulf of Mexico aged samples collected from Mexico through Monroe, Florida and north of Highway 1 from the years 1987 – 2021 (to date) aged by the Panama City Laboratory of the Southeast Fisheries Science Center, NOAA Fisheries Service (PC Lab), Florida Fish and Wildlife Research Institute (FWRI) and The Gulf States Marine Fisheries Commission (GulfFin). Information on quality control procedures is also provided.

Methods

Otolith collection and data proofing

Otoliths were collected (1987 – 2021) by federal and state sampling programs from commercial (COM) and recreational (REC) fisheries and fishery-independent surveys. Fishery dependent samples were collected from several NMFS programs, including the Trip Interview Program (TIP), Southeast Regional Headboat Survey (SRHS), Marine Recreational Fisheries Statistical Survey (MRFSS), Marine Fisheries Initiative (MARFIN), NMFS Panama City Laboratory (PCLAB), Gulf States Marine Fisheries Commission (GulfFIN), and Marine Fisheries, Recreational Fisheries Information Network (RECFIN). Fishery independent sampling programs included NMFS Panama City Lab (PCLAB), NMFS Pascagoula Lab (MSLAB), and Florida Fish Wildlife Research Institute (FWRI), and Trip Interview Programs (TIP). Samples from Texas Parks and Wildlife Department (TPWD) and Mote Marine Laboratory (MOTE) could not be reconciled as either fishery dependent or independent samples.

Each of the age data sources had separate sampling protocols, methods, and reporting types unique to that source. The NMFS Panama City Lab (PCLAB) aged data protocols are

outlined in the PC Lab's Procedure Manual for Age, Growth, and Reproduction (AGR). Initially, beginning in 2000, species-specific collections were given an annual collection (or tracking) number and all collection-specific data (i.e. source, source number, sate, sector, and gear) were entered in a Microscoft© Access database, which has now been converted to an Oracle© database effective May 2017. Validation rules for data entry and user-specific security data for access guidelines were followed to enhance data quality control. The source (or interview) numbers are source-specific umbers that allows for the cross-referencing of data between the originator's database and the AGR databases. Individual fish data were proofed against original data sheets and corrections were made as needed along with contacting samplers or port agents as needed. In 2016 the PCLAB began using barcoding technology to streamline the tracking of individual samples, collections, archive storage, and age-data for direct input into both AGR and the BioSample Database (BSD).

Sampling trends

Annual numbers of Spanish mackerel (Gulf of Mexico) ages provided (1987 – 2021) were summarized by sector (commercial – COM, and recreational – REC) and, for commercial samples, by gear type (hand-line HL, gillnet – GN, trawl – TRW, cast net – CN, or unknown\incomplete data - UNK). Hand-lines included rod and reel gear and trolling methods. The recreational sector included samples from charter boats (CP), headboat (SRHS), private vessels (PR), shore (SH), or unknown\incomplete data (UNK). It could not be determined if tournament samples (TRN) were bi-catch samples from other species-specific tournaments such as king mackerel, or catch-all tournament types, or if Spanish mackerel were specifically targeted. Aged sample numbers were also summarized by Gulf of Mexico coastal states north of Highway 1 in Monroe County Florida to Texas.

Age determination and estimates of precision

All ages were derived from sagittal otoliths. Otoliths from males < 450 mm FL and females < 550 mm FL were read whole; larger fish were ages using sectioned otoliths. Annuli of whole and sectioned otoliths were identified using the methods of Fable et al. (1987). All Spanish mackerel aged by the Panama City lab after SEDAR 28 were aged by C. Palmer. Three

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indices of precision – average percent error (APE), coefficient of variation (CV), and precision (D) – were calculated from whole ages of 100 and 100 section ages by C. Palmer to check for consistency and precision. The goal was to achieve an APE of < 5.0%. See Palmer et al. (2007) for further discussion on ageing precision.

Calendar ages based on calendar year, were calculated using annulus count, edge-type, and capture date. Typically, annuli are deposited in the spring (Fable et al. 1987), and advancing ages if often necessary for fish captured in the early part of the year to enter fish in the correct cohort (DeVries and Grimes 1997). Protocols for advancing ages were the same as those used for similarly related king mackerel: 1) fish samples January – May with marginal increments estimated to be > 35% of the previous increment were advanced one year; and 2) otoliths sampled June – July 15th with > 2 annuli and marginal increments > 35% of the previous increment were advanced one year. Otoliths with 2 or fewer annuli during the same time were advanced one year if the marginal increment was > 70% of the previous increment. This different standard for younger fish was necessary because their overall annual growth is much greater and their growth rate is faster than older fish, and it is a normal occurrence for them to already have relatively large marginal increments as early as June. Ages were not advanced for fish sampled July 16th through the end of the calendar year (DeVries and Grimes 1997).

For fish estimated as calendar age = 0 with no annulus present and date of capture was between Jan 1 and April 30th (peak spawning month = May for Gulf of Mexico stock, Finucane and Collins, 1986), fractional ages were negative. Similarly, in SEDAR 78 (Palmer et al., 2021) there were a considerable amount of age = 0 fish sampled before June (i.e., peak spawning month used for the U.S. South Atlantic stock). To resolve this issue for the U.S. South Atlantic stock, a plot of fork lengths by day of capture for U.S. South Atlantic Spanish mackerel with a calendar age = 0 (i.e., no annulus present) revealed a natural progression of size at age, and those fish caught prior to June 1 were of such a size that their calendar age was advanced from age = 0 to age = 1. An additional plot of length by day of capture for U.S. South Atlantic Spanish mackerel with a calendar age = 1 showed that the size of fish with calendar age = 0 and a date of capture prior to June 1 fell into a similar size range as the age-1 fish. To resolve the issue of negative fractional ages for the Gulf of Mexico stock, the same methodology used in SEDAR 78

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for the U.S. South Atlantic Spanish mackerel was also applied to Gulf of Mexico Spanish mackerel. A plot of fork lengths by day of capture for Gulf of Mexico Spanish mackerel with a calendar age = 0 (i.e., no annulus present) revealed a natural progression of size at age, and those fish caught prior to May 1 were of such a size that their calendar age was advanced from age = 0 to age = 1. An additional plot of length by day of capture for Gulf of Mexico Spanish mackerel with a calendar age = 1 showed that the size of fish with calendar age = 0 and a date of capture prior to May 1 fell into a similar size as the age-1 fish.

Results and Discussion

<u>Sampling trends</u>

A total of 19,510 (1987 – 2021, Gulf of Mexico) Spanish mackerel ages from the Panama City Laboratory of the Southeast Fisheries Science Center, NOAA Fisheries Service (PCLAB), Florida Fish and Wildlife Research Institute (FWRI), and Gulf States Marine Fisheries Commission (GulfFIN) were compiled for the age data set provided for SEDAR 81 (Table 1). Of those ages, 52% were from the recreational sector (CP, SRHS, PR and SH combined), 27% from the commercial sector, and 15% from scientific surveys (Table 2). Tournament samples made up < 3% of aged samples and it is unknown whether these were specifically targeted Spanish mackerel tournaments or bi-catch from other species targeted fish. The Trip Interview Program (TIP) was the largest source of samples (35%) followed by the Panama City Laboratory (PCLAB) 32%, and Recreational Fisheries Information Network (RECFIN) 7% (Table 3). The state of Florida (73%) supplied the majority of samples followed by Louisiana (12%), and Mississippi (6%) (Table 4). The majority of recreational samples came from the state of Florida (86%) followed by Mississippi (7%), and Texas (3%) (Table 5). Florida also contributed the most commercial samples (44%), with Louisiana (34%) next, and Mexico (11%) (Table 5). Hand-lines

(45%) and gill-net gears (44%) brought in the bulk of commercial samples (Table 6) and charter boats (80%) were targeted most often for recreational samples (Table 6).

Age determination and rates of precision

Reader comparison (C. Palmer vs. C. Palmer) for whole and sectioned otoliths resulted in and APE of 2.82%, CV of 3.77%, and a corresponding of D of 5.34%, indicating low reader error combined with high precision.

Age and length composition

Spanish mackerel collected during 1987 – 2021 ranged in age from 0 to 11 year with the majority of samples aged between 0 and 4 years and mean sizes at age were larger for females compared to males (Table 7, Figure 1). Comparing sectors, tournament caught fish mean size at ages were larger than recreational and commercially caught fish (Table 8, Figure 2) for ages 1 – 7 years suggesting that these may have been tournaments specifically targeting Spanish mackerel and were not bi-catch. However, smaller sample sizes at age compared to both recreational and commercial numbers may not give a clear enough picture to formalize a definitive answer.

Fish aged as age = 0 (n=12) that were caught prior to the peak spawning month of May (beginning day = 121) exhibited the same size range as age = 1 fish (Figures 3 and 4). To resolve the issue of negative fractional ages with the given peak spawning month of May, these fish (n=12) were advanced to age = 1 given the assumption that they would be one-year old fish that calendar year. A similar method was used in SEDAR 78 (Palmer et al. 2021).

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Table 1. Annual numbers (1987 - 2021) of aged Spanish mackerel by data provider. S28PCLAB - SEDAR 28 Age data PCLAB, PCLABAGR Panama City - AGR Database, GulfFIN - Gulf States Marine Fisheries Commission, PCLABBSD - Panama City Lab BSD Database, FWRIFIM - Florida Fish and Wildlife Research Institute Fisheries Independent Monitoring. UNK - Aged samples from the 1980's provided by the Panama City Lab.

Year	S28PCLAB	PCLABAGR	GulfFIN	PCLABBSD	FWRIFIM	Total
1987	379					379
1988	301					301
1989	596					596
1990	1,146					1,146
1991	914					914
1992	1,021					1,021
1993	452					452
1994	660					660
1995	437					437
1996	534					534
1997	121					121
1998	154					154
1999	565					565
2000	183					183
2001	208				3	211
2002	526				28	554
2003	701				15	716
2004	490				6	496
2005	372				2	374
2006	276				7	283
2007	389		5		27	421
2008	722				18	740
2009	258				82	340
2010	342				37	379
2011		474	92	230	51	847
2012		793	86	46	41	966
2013		541	18	38	77	674
2014		378	43	145	40	606
2015		190	245	395	12	842
2016		86	155	263	7	511
2017		157	73	171	2	403
2018		262	151	98	3	514
2019		214	407	121		742
2020		101	217	59	5	382
2021		179	402	260	1	842
UNK	204					204
Total	**11,951**	**3,375**	**1,894**	**1,826**	**464**	**19,510**
% of Total	**61.3%**	**17.3%**	**9.7%**	**9.4%**	**2.4%**	**100.0%**

Table 2. Annual numbers (1987 - 2021) of aged Spanish mackerel by sector. REC - recreational, COM - commercial, SS - scientific survey, TRN - tournament, UNK - incomplete data.

Year	REC	COM	SS	TRN	UNK	Total
1987	202		59		118	379
1988	136	35	75	20	35	301
1989	218	117	27	10	224	596
1990	442	494	24	81	105	1,146
1991	195	376	282	60	1	914
1992	241	652	20	48	60	1,021
1993	79	257	41	75		452
1994	101	475	26	58		660
1995	108	245	15	69		437
1996	248	251	15	20		534
1997	110	5	4	2		121
1998	129	10	6	9		154
1999	489	2	56	14	4	565
2000	153	21	8	1		183
2001	105	49	43	14		211
2002	428	13	109	4		554
2003	586	36	89	5		716
2004	337	17	140		2	496
2005	58	141	175			374
2006	133	11	139			283
2007	212	19	190			421
2008	402	22	316			740
2009	112	35	193			340
2010	230	38	111			379
2011	513	232	95	7		847
2012	600	75	290	1		966
2013	392	38	244			674
2014	364	159	83			606
2015	395	395	52			842
2016	241	263	7			511
2017	230	171	2			403
2018	413	98	3			514
2019	621	121				742
2020	318	59	5			382
2021	581	260	1			842
UNK					204	204
Total	**10,122**	**5,192**	**2,945**	**498**	**753**	**19,510**
% of Total	**51.9%**	**26.6%**	**15.1%**	**2.6%**	**3.9%**	**100.0%**

Table 3. Annual numbers (1987 - 2021) of aged Spanish mackerel by source. TIP - Trip Interview program, PCLAB - NMFS Panama City Lab, RECFIN - Recreational Fisheries Information Network, GulfFIN - Gulf States Marine Fisheries Commission, MRFSS - Marine Recreational Fisheries Statistical Survey, FWRISS - Florida Fish and Wildlife Scientific Survey, FWRIOBS - Florida Fish and Wildlife Observer, MSLAB - NMFS Pascagoula Lab, SRHS - Southeast Regional Headboat Survey, MARFIN - Marine Fisheries Initiative, MOTE - Mote Marine Laboratory, TPWD - Texas Parks and Wildlife, UNK - incomplete data.

Year	TIP	PCLAB	RECFIN	GulfFIN	MRFSS	FWRISS	FWRIOBS	MSLAB	SRHS	MARFIN	MOTE	TPWD	UNK	Total
1987		83											296	379
1988	32	80									24	8	157	301
1989		95											501	596
1990	37	252											857	1,146
1991	907	1											6	914
1992	961												60	1,021
1993	452													452
1994	660													660
1995	437													437
1996	534													534
1997	121													121
1998	154													154
1999	206				359									565
2000	60	123												183
2001	49	127			32	3								211
2002	13	295	125		93	28								554
2003	9	526			166	15								716
2004	20	228	163		79	6								496
2005	141	204	27			2								374
2006	11	254	11			7								283
2007	4	352	21	5	12	27								421
2008	22	523	97		80	18								740
2009	35	193	11		11	82		7		1				340
2010	39	133	128		42	37								379
2011	230	326	95	92	52	52								847

Table 3 . Continued

Year	TIP	PCLAB	RECFIN	GulfFIN	MRFSS	FWRISS	FWRIOBS	MSLAB	SRHS	MARFIN	MOTE	TPWD	UNK	Total
2012	46	668	68	86	7	80		6	5					966
2013	38	364	134	18		77		40	3					674
2014	145	243	111	43		40			24					606
2015	395	190	230	1		12	14							842
2016	263	85	111	5		7	39		1					511
2017	171	157	5	3		2	53			12				403
2018	98	262	53			3	87			11				514
2019	121	214		311			86			10				742
2020	59	101		194		5	18		5					382
2021	260	179		380		1	15		7					842
UNK													204	204
Total	6,730	6,258	1,390	1,138	933	504	312	53	46	33	24	8	2,081	19,510
% of Total	34.5%	32.1%	7.1%	5.8%	4.8%	2.6%	1.6%	0.3%	0.2%	0.2%	0.1%	0.0%	10.7%	100.0%

Table 4. Annual numbers (1987 - 2021) of aged Spanish mackerel by state. FL - Florida (Gulf of Mexico), LA - Louisiana, MS - Mississippi, AL - Alabama, MX- Mexico, TX - Texas, UNK - incomplete data.

Year	FL	LA	MS	AL	MX	TX	Total
1987	83	53	71	102		70	379
1988	112	21	110	17	24	17	301
1989	161	8	181		117	129	596
1990	476	95	391		128	56	1,146
1991	507	207			100	100	914
1992	666	124		14	183	34	1,021
1993	203	145		1	99	4	452
1994	549	62			49		660
1995	374	63					437
1996	534						534
1997	121						121
1998	148		6				154
1999	213		343	9			565
2000	175			8			183
2001	195	2	14				211
2002	554						554
2003	716						716
2004	496						496
2005	346	28					374
2006	272	11					283
2007	412	4		5			421
2008	730	10					740
2009	298	37	2			3	340
2010	342	37					379
2011	566	189		92			847
2012	841	35		86		4	966
2013	595	27		18		34	674
2014	456	88	19	43			606
2015	503	339					842
2016	251	260					511
2017	232	171					403
2018	416	98					514
2019	616	73	6	47			742
2020	330	1		51			382
2021	578	48	2	214			842
UNK	204						204
Total	14,271	2,236	1,145	707	700	451	19,510
% of Total	73.1%	11.5%	5.9%	3.6%	3.6%	2.3%	100.0%

Table 5. Annual numbers (1987 - 2021) of aged Spanish mackerel from recreational and commercial fisheries by state. FL - Florida (Gulf of Mexico), MS - Mississippi, TX - Texas, AL - Alabama, LA - Louisiana, MX - Mexico.

	Recreational						Commercial							Grand Total
Year	FL	MS	TX	AL	LA	Total	FL	LA	MX	AL	MS	TX	Total	
1987	24	65	37	76		202								202
1988	1	107	7		21	136	32				3		35	171
1989	59	47	110		2	218	4				113		117	335
1990	218	126	54		44	442	233		113		148		494	936
1991	96		97		2	195	129	146	100			1	376	571
1992	200		34		7	241	385	84	183				652	893
1993	75		4			79	83	75	99				257	336
1994	101					101	414	12	49				475	576
1995	108					108	239	6					245	353
1996	248					248	251						251	499
1997	110					110	5						5	115
1998	129					129	10						10	139
1999	155	325		9		489	2						2	491
2000	153					153	13			8			21	174
2001	105					105	47	2					49	154
2002	428					428	13						13	441
2003	586					586	36						36	622
2004	337					337	17						17	354
2005	58					58	113	28					141	199
2006	133					133		11					11	144
2007	207			5		212	15	4					19	231
2008	402					402	12	10					22	424
2009	112					112		35					35	147
2010	230					230	1	37					38	268
2011	425			88		513	39	189		4			232	745
2012	524			76		600	30	35		10			75	675
2013	373			18	1	392	18	20					38	430
2014	316	19		29		364	57	88		14			159	523
2015	395					395	56	339					395	790
2016	241					241	3	260					263	504
2017	230					230		171					171	401
2018	413					413		98					98	511
2019	615	6				621	1	73		47			121	742
2020	318					318	7	1		51			59	377
2021	577				4	581		44		214	2		260	841
Total	8,702	695	343	301	81	10,122	2,265	1,768	544	348	266	1	5,192	15,314
% of Total	86.0%	6.9%	3.4%	3.0%	0.8%	100.0%	43.6%	34.1%	10.5%	6.7%	5.1%	0.0%	100.0%	

Table 6. Annual numbers (1987 - 2021) of aged Spanish mackerel by sector. Recreational: CP - charter boat, PR - private, SH - shore, HB - headboat. Commercial: HL - hand lines, GN - gill net, TRW -trawl, CN - cast net. UNK - incomplete data, both sectors.

	Recreational						Commercial						
Year	CP	PR	SH	HB	UNK	Total	HL	GN	TRW	CN	UNK	Total	Grand Total
1987				1	201	202							202
1988				1	135	136	3	32				35	171
1989	116			68	34	218	117					117	335
1990	384	2		10	46	442	160	245	89			494	936
1991	102	12		81		195	177	198	1			376	571
1992	181	16		44		241	117	508	27			652	893
1993	44	31		4		79	63	178	16			257	336
1994	98	3				101	23	452				475	576
1995	46	62				108	18	213	14			245	353
1996	245	3				248	8	243				251	499
1997	109	1				110	5					5	115
1998	108	21				129	10					10	139
1999	352	135		2		489	2					2	491
2000	153					153		21				21	174
2001	105					105	12	37				49	154
2002	341	86		1		428	13					13	441
2003	458	128				586	36					36	622
2004	270	67				337	5	12				17	354
2005	52	6				58	28			113		141	199
2006	132	1				133	11					11	144
2007	187	24		1		212	19					19	231
2008	329	70		3		402	22					22	424
2009	101	8		3		112	35					35	147
2010	209	21				230	38					38	268
2011	452	24	35	2		513	195	37				232	745
2012	552	6	37	5		600	62	10		3		75	675
2013	368	17	4	3		392	20	15			3	38	430
2014	307	33		24		364	99	45			15	159	523
2015	299	43	46	7		395	357	38				395	790
2016	183	41	14	3		241	261				2	263	504
2017	220	5	2	3		230	171					171	401
2018	367	11	23	12		413	98					98	511
2019	555	54		12		621	74				47	121	742
2020	206	48	63	1		318	4			10	45	59	377
2021	385	64	129	3		581	86				174	260	841
Total	8,016	1,043	353	294	416	10,122	2,349	2,284	147	126	286	5,192	15,314
% of Total	79.2%	10.3%	3.5%	2.9%	4.1%	100.0%	45.2%	44.0%	2.8%	2.4%	5.5%	100.0%	

Table 7. Mean observed fork length (mm) at age and standard error for female and male Spanish mackerel (1987 - 2021) ages.

	Females			Males		
Age	N	Mean	Std Error	N	Mean	Std Error
0	428	324.342	40.5593	167	311.247	30.6818
1	2,994	373.964	54.1299	1,736	341.394	37.5377
2	3,296	446.545	60.9809	1,717	387.827	44.3565
3	2,958	491.078	64.9409	1,224	423.601	54.7027
4	1,839	531.85	60.3838	674	466.991	57.4907
5	826	556.533	62.483	382	490.783	54.658
6	294	571.895	59.4403	175	512.006	54.8316
7	116	584.328	57.6105	69	529.014	45.7768
8	23	583.652	61.7094	26	542.423	59.0838
9	7	614.857	41.4826	10	565.7	22.9495
10	2	619.5	84.1457	2	550	14.1421
11	1	592				
Total	12,784			6,182		

Table 8. Mean observed fork length (mm) at age and standard error Spanish mackerel (1987 - 2021) ages from commercial, recreational, and tournament sectors.

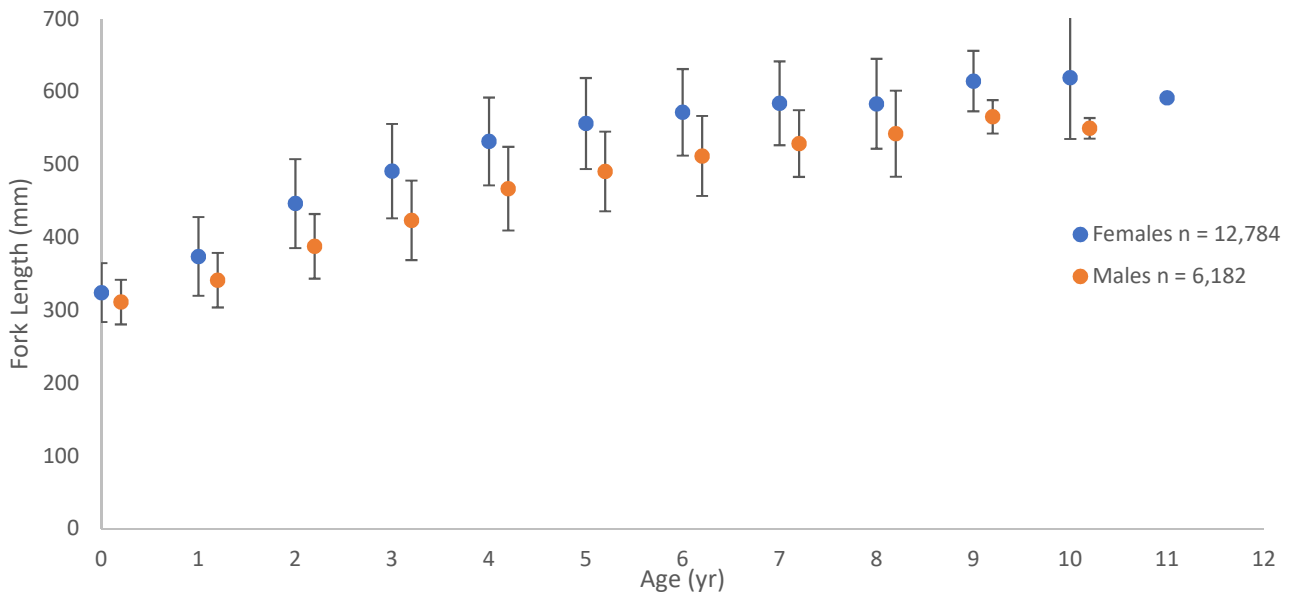|	Recreational			Commercial			Tournament		
Age	N	Mean	Std Error	N	Mean	Std Error	N	Mean	Std Error
0	448	323.635	35.8413	65	306.923	30.925	3	258.667	34.9619
1	3,039	363.655	47.6891	522	359.473	51.1678	68	408.309	61.2963
2	2,890	413.366	59.0929	1,016	453.286	64.8957	103	501.893	56.1585
3	1,957	449.109	68.3708	1,392	500.139	61.616	112	540.58	52.5704
4	943	500.318	71.0655	1,036	528.598	57.4488	113	559.814	55.9305
5	433	521.402	73.8505	515	543.406	58.3568	63	585.484	62.7674
6	170	545.747	68.348	207	551.647	56.4519	19	590.842	56.306
7	50	562.2	54.3515	86	563.465	57.5008	14	576.929	65.9399
8	16	544.938	69.0048	23	560	57.7314	2	535	63.6396
9	4	602.5	61.1583	10	579	28.5073			
11	3	553.333	11.547	1	592				
Total	9,953			4,873			497		

Figure 1. Mean size at age of female and male (1987 - 2021) Spanish mackerel. Error bars are +/- 1 standard deviation.
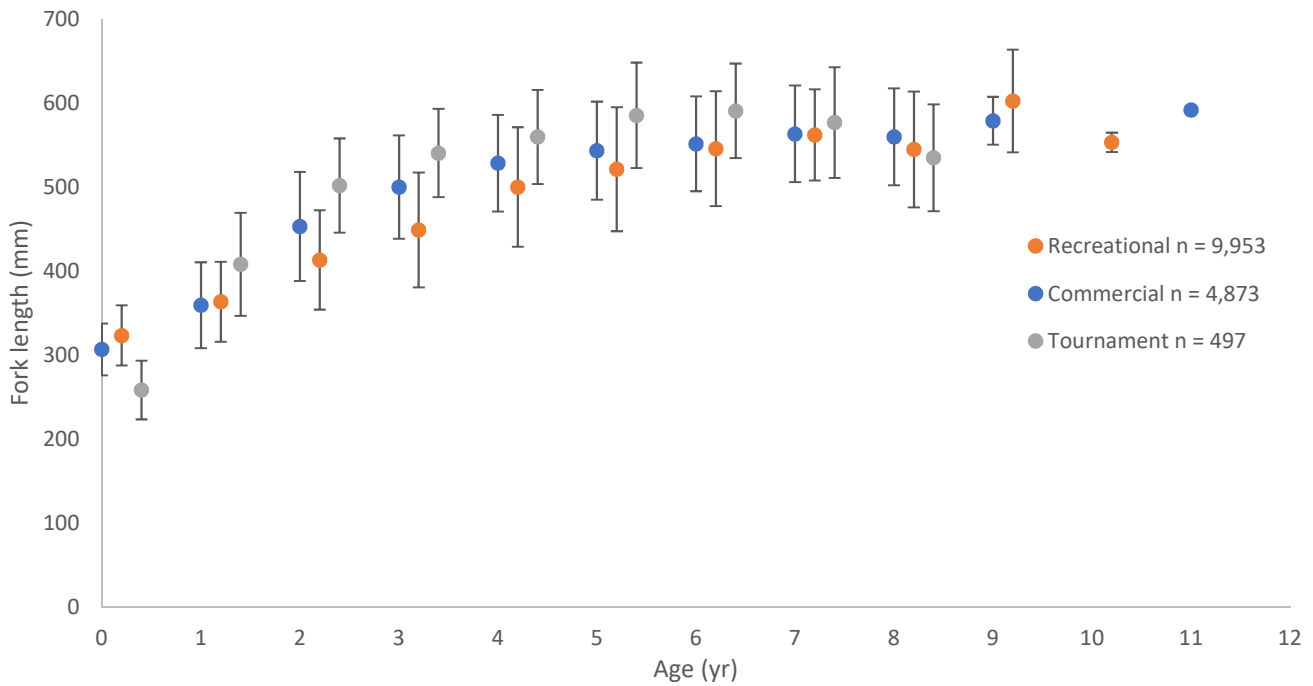

Figure 2. Mean size at age (1987 - 2021) Spanish mackerel from recreational, commercial, and tournament sectors. Error bars are +/- 1 standard deviation.
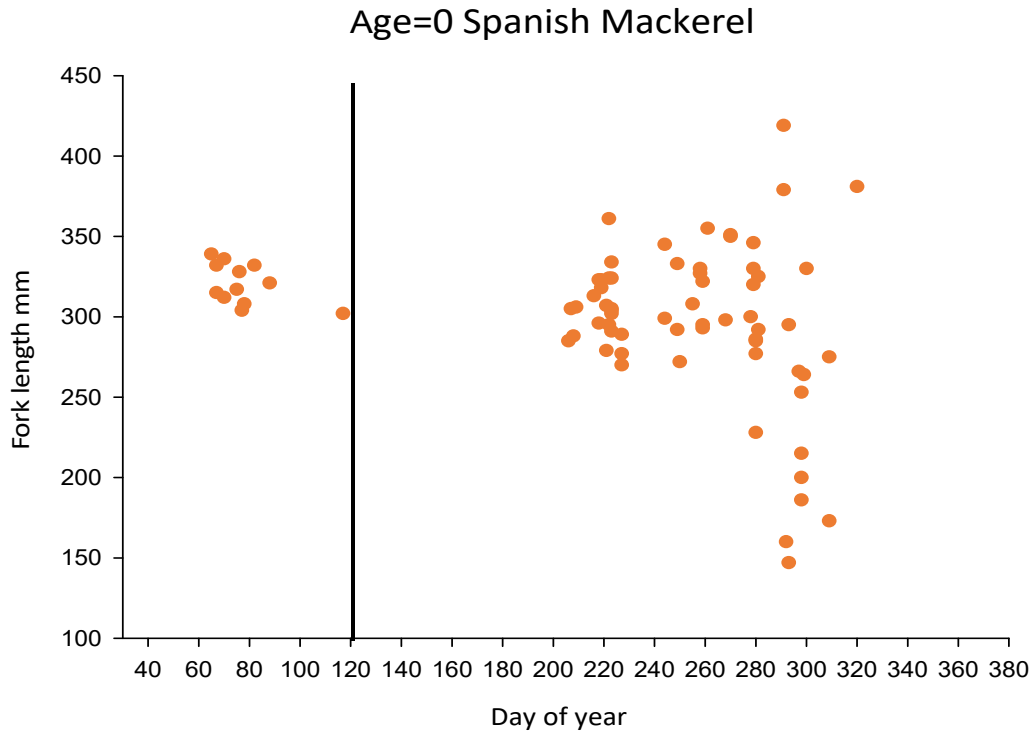
Age=0 Spanish Mackerel

Figure 3. Gulf of Mexico age=0 Spanish Mackerel. Vertical line represents day of year = 121 of the peak spawning month of May for the Gulf of Mexico stock.

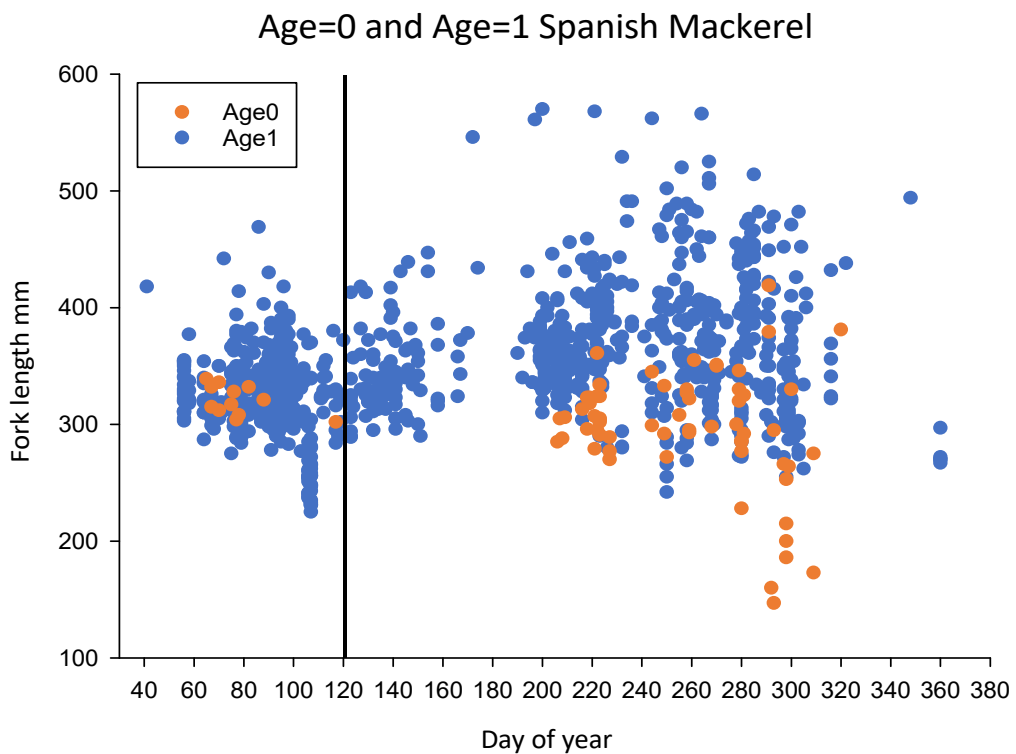**Age=0 and Age=1 Spanish Mackerel**

Figure 4. Gulf of Mexico age=0 and age=1 Spanish Mackerel. Vertical line represents day of year = 121 of the peak spawning month of May for the Gulf of Mexico stock.