A review of Gulf of Mexico and Atlantic king mackerel (*Scomberomorus cavalla*) age data, 1986 – 2007, from the Panama City Laboratory, Southeast Fisheries Science Center, NOAA Fisheries Service

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Introduction

King mackerel, *Scomberomorus cavalla*, are highly sought after and economically valuable to both U. S. commercial and recreational fishermen from Texas to North Carolina (Manooch, 1979). The fishery is managed under the Coastal Migratory Pelagic Resources Fishery Management Plan which outlines two different stocks or migratory groups for management purposes: the Gulf of Mexico stock, extending from the Florida west coast to the Texas border with Mexico, and the Atlantic stock, ranging from the New England area to the Florida southeast coast. Tag return data collected during 1975 – 1978 showed considerable seasonal movement between the Atlantic Ocean and the Gulf of Mexico (Sutter et al., 1991). The boundary between the Gulf of Mexico and Atlantic stocks is defined as the Volusia – Flagler County line (northeast Florida) during November – March and the Monroe – Collier County line (southwest Florida) during April – October.

In December of 2003, the first SEDAR (Southeast Data, Assessment and Review –SEDAR 5) for king mackerel was held and reviewed age data from 1977 through 2002. The primary objective of this report is to give an overview of the temporal and spatial distributions, as well as distributions by fishery and gear, of king mackerel age samples from the years 1986 through 2007 aged by the Panama City Laboratory of the Southeast Fisheries Science Center, NOAA Fisheries Service. Information on quality control and sub-sampling procedures is also provided.

Methods

Otolith collection and data proofing

Otoliths were collected 1986 – 2007 by federal and state agencies and academic institutions from both commercial (CM) and recreational (REC) fisheries. Fishery dependent samples were obtained from several NMFS programs, including the Trip Interview Program (TIP), Panama City Lab (PCLAB), Beaufort Lab Head Boat Survey (HB), and Marine Fisheries Recreational Statistical Survey (MRFSS), as well as from the Florida Fish and Wildlife Research Institute (FWRI), Gulf States Marine Fisheries

Commission's Recreational Fisheries Independent Network (RECFIN), North Carolina Department of Natural Resources (NCDNR), South Carolina Department of Natural Resources (SCDNR), Louisiana Department of Wildlife and Fisheries (LADWF), and the Universities of West Florida (UWF) and South Alabama (USAL). Fishery independent samples were obtained from NMFS Pascagoula (MSLAB) and NMFS Woods Hole surveys and the University of West Florida.

Each of the data collection sources had separate but similar sampling procedures, data protocols, and reporting methods. Data quality control guidelines as described by the Panama City Lab's Procedure Manual for Age, Growth, and Reproduction (AGR) (NMFS, 2004) were used to interpret source-specific datasheets. First, beginning in 2000, each species specific collection was assigned an annual collection (or tracking) number and all collection-specific data (i.e. source, source number, state, sector, and gear) was entered into a Microsoft® Access database. Validation rules for data entry and user-specific security for data accessibility guidelines were followed to enhance data quality control. The source (or interview) number is a source-specific number that permits cross-referencing of data between the original and the Panama City Annual AGR databases. Next, all individual fish data were proofed against the original data sheets. Corrections were made to the Annual AGR Database as needed and any specific data issues were resolved by personal contact with port agents or samplers.

To insure uniform standards of quality control, all 1986 – 1997 data, collected prior to the establishment of written data quality guidelines in 1998, were proofed against original data sheets (archived at the Panama City lab). TIP specific data were proofed using original TIP data sheets or by accessing online TIP files.

Sampling trends

Annual numbers of otolith samples received and aged at the Panama City lab during 1986 through the first half of 2007 were summarized by sector (commercial - CM, recreational - REC, and tournament - TRN) and by commercial gear type (hand-line - HL, longline - LL, and gillnet - GN). Hand-lines included rod and reel gear or methods such as bandit rigs, trolling, site casting, etc. Gill nets were broadly defined as any type of entangling net, including cast nets. The recreational sector included samples from charter

boats (CP), head boats (HB), and private vessels (PR), but excluded tournament samples. Data that could not be verified was classified as pending data verification (PDV).

Sample numbers were also summarized by region (Gulf and Atlantic) where the fish were caught (not necessarily where they were landed nor their stock or migratory group as currently defined in the FMP). In addition, data were summarized by sub-region within those regions (Figure 1). Gulf sub-regions included Mexico, the states of Texas, Louisiana, Mississippi, and Alabama, and four areas on the west coast of Florida. The Florida sub-regions included northwest Florida (NWF) (all coastal counties north of Levy County to the Florida–Alabama state border), west Florida (WF) (Citrus County south to Sarasota County), southwest Florida (SWF) (Charlotte County south to Collier County), and south Florida (SF) (Monroe County only). Atlantic sub-regions included southeast Florida (SEF) (Dade through Broward County), east Florida (EF) (Palm Beach through Volusia County), and northeast Florida (NEF) (Flagler County to the Florida-Georgia border), the states of Georgia, South Carolina, North Carolina, and all remaining coastal states north of North Carolina.

Sub-sampling

Prior to 2005, all king mackerel otoliths received by the Panama City lab were aged. Beginning with the 2005-06 fishing season, because of significant increases in number of otoliths received as the GSMFC's RECFIN program was ramped up, and because of increasing demands on lab staff to conduct production ageing on several other species, only a subsample of king mackerel were aged. From each of the following three periods -- the 2005 portion of the 2005-06 fishing season, the first half of calendar year 2006, and the second half of 2006 -- a randomly selected subsample of approximately 800 fish was aged (Figures 2 and 3). A random number generator in Microsoft® Excel was used to select the subsamples. For king mackerel otoliths collected during the 2007 portion of the 2006-07 fishing season, a different sub-sampling procedure was used. After examining the size distributions and sample sizes within sub-regions and sexes, we determined that sub-sampling would only be appropriate for northwest Florida females and east Florida males and females. For all other groups sample sizes were already small (panels a,d, and e in Figure 4). For NWF and EF females we attempted to draw a

uniformly distributed subsample of 5 fish per 25 mm size interval between 625 and 875 mm FL (panels b and c in Figure 4). We did not subsample larger fish because of their much greater variance in age at size. With EF males we drew a uniformly distributed subsample of 6 fish per 25 mm interval between 625 and725 mm FL (panel f in Figure 4). We sampled more males per interval because they do not grow as large or as fast as females, so there is much more variance in age at size at smaller sizes than in females.

Age determination and estimates of precision

All ages were derived from sagittal otoliths (Beaumariage, 1973) by at least two readers. Otoliths from males < 80 cm and from females < 90 cm were read whole while larger specimens from both sexes were sectioned (DeVries and Grimes, 1997). Annuli of whole otoliths were identified as stated by Johnson et al. (1983) and annuli in sections as described by Waltz (1986). All king mackerel collected prior to the 2001-02 fishing season were aged by Reader 2. Thereafter, Reader 1 became the primary ager. About 20% (1,113 of 5,694) of all otoliths from the 2001–02 and 2002–03 fishing seasons were read by both Readers 1 and 2 , and three indices of precision were calculated from those data to check for consistency and drifts in precision between readers. The indices were average percent error (APE), coefficient of variation (CV), and precision (D). The goal was to achieve an APE of less than 5.0%. See Palmer et al. 2007 for further discussion on ageing precision. Reader 3 became primary reader for all sectioned samples beginning with the 2006 collections. Roughly 15% (100 of 683) of sectioned samples from 2006 and 2007 were read by both Readers 1 and 3, and those data were also analyzed to assure acceptable levels of precision. To check for drift in otolith interpretation over time between Readers 1 and 2, 10% of the 2006 whole otoliths (95 out of 979) were aged by both readers.

Annual ages, based on calendar year, were calculated using the annulus count, edge-type and capture date. Annulus formation typically occurs in the spring (Beaumariage, 1973; Johnson et al., 1983), and advancement of ages is often necessary for fish captured that time of year in order to assign fish to the correct cohort (DeVries and Grimes, 1997). The protocol for advancing ages was: 1) fish sampled January - May with a marginal increment estimated to be >35% of the previous increment were

advanced one year; and 2) fish sampled June - July 15th with >2 annuli and a marginal increment >35% of the previous increment were advanced one year, while those with 2 or fewer annuli sampled during that time were advanced one year only if the marginal increment was >70% of the previous one. This distinction was made because younger fish grow more and faster than older fish, and it is not uncommon for them to already have relatively large marginal increments as early as June. Ages were not advanced for fish sampled July 16th - December (DeVries and Grimes, 1997).

Results and Discussion

Sampling trends

A total of 43,590 king mackerel collected from 1986 through mid-2007 (24,446 from the Atlantic and 19,144 from the Gulf of Mexico) have been aged by the Panama City Laboratory and made available for SEDAR 16. Of all the aged samples, 35% were from the commercial sector, 28% from the recreational sector (CP, HB, and PR combined and excluding tournaments), and 30% from tournaments (Table 1). In addition, 0.7% of the fish aged were from scientific surveys, 5.3% were from unknown sectors, and for 0.4%, sector data is pending verification. North Carolina (37%) and east Florida (48%) were the main sources of age samples from the Atlantic region (Table 2). From the Gulf of Mexico, northwest Florida (36%) accounted for the majority of samples, with another 50% coming from Texas (12.2%), Louisiana (14.1%), west Florida (11.3%), and south Florida (12.5%) (Table 3).

Of the Atlantic commercial samples, the vast majority (90%) came from east Florida (Table 4), while in the Gulf they were more evenly distributed geographically, with almost 80% from three sub-regions: Louisiana (33%), northwest Florida (20%), and south Florida (27%) (Table 5). By far the largest proportion of Atlantic recreational samples, excluding tournament fish, came from east Florida (57%) (Table 6). Northwest Florida accounted for the majority (59%) of Gulf recreational samples, again excluding tournament fish, with Texas the only other significant source (20%) (Table 7). North Carolina was, by far, the largest source of the tournament samples (n = 7,074); 54% of all, and 80% of Atlantic, samples came from that state (Figure 12, Table 8). Most (74%)

Gulf tournament samples were collected in west Florida (33%), northwest Florida (25%), and Louisiana (16%) (Table 9).

Of all commercial king mackerel age samples from the Atlantic and Gulf combined, 91% were collected from hand-line fisheries (Table 10). Within regions, 98% of Atlantic commercial samples were from hand line fisheries, compared to 81% for the Gulf (Tables 11 and 12). All other Gulf commercial samples (21%) were taken from gillnet fisheries.

Age determination and estimates of precision

Reader comparison results (Table 13) showed high precision between Readers 1 and 2 for the 2001-02 and the 2002-03 data years (fishing seasons). An APE of 2.05%, CV of 2.90%, and a resulting 1.45% index of precision (D) reflect low reader error. Analysis of the 2006 whole otolith age comparison yielded an APE of 2.77%, CV of 3.51%, and a corresponding D of 1.95%, indicating low reader error and little, if any, drift in otolith interpretation over time. Precision levels were also high between Readers 1 and 3 for section ages from the 2006-07 data years, with an APE of 1.67%, CV of 2.37%, and a resultant D of 1.18% (Table 13).

Age and length composition

King mackerel collected during 1986-2007 and aged by the NMFS Panama City Lab ranged from age 0 to 26 yr, with 68% of Atlantic and 72% of Gulf fish between the ages of 1 and 5 yr (Figure 5). Females ranged from ages 0 to 26 and males from 0 to 24 yr. Females from the Atlantic ranged from ages 0 to 26 with 68% between 1 and 5, and those from the Gulf were ages 0 to 24 with 73% ages 1 - 5 (Figures 6 and 7). Atlantic males were ages 0 to 24 with 69% between the ages of 1 and 5, and Gulf males were 0 to 23 with 71% ages 1 - 5 (Figures 6 and 7).

The size distributions of the commercial age samples from the Atlantic and Gulf were very similar, although the mode of the Atlantic samples appeared to be slightly (25-50 mm) larger than that for the Gulf (Figure 8). The size distribution of the recreational samples by region showed a very similar pattern, although there were greater proportions

of small fish <575 mm FL than seen in the commercial data, especially from the Gulf (Figure 9). Not surprisingly, tournament sampled fish averaged larger than those from the commercial and recreational sectors (Figure 10). The sizes of fish in Gulf tournament samples were noticeably more evenly distributed than those from the Atlantic.

The ranges in length at age for females were similar in both regions (Figure 11). Among males, however, Gulf fish ages 5 - 9 showed a larger range in length at age than Atlantic fish. Conversely, Atlantic males age 14 and older had larger ranges in size at age than Gulf fish, although this could just be an artifact of small sample sizes.

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Table 1. Annual numbers of king mackerel, 1986-2007, by source, aged by NMFS Panama City. Data from 2007 includes only those months included in the 2006-07 fishing season (Jan-Feb for Atlantic and Jan-Jun for Gulf). CM = commercial, TRN = tournament, CP = charter boat, PR = private, HB = head boat, SS = scientific survey, PDV = pending data verification, UNK = unknown.

Year	CM	TRN	CP	PR	HB	SS	PDV	Unknown	Total
1986	27	98	157	2	50			544	878
1987	10	403	208	3	144			640	1,408
1988	20	476	76		117	23		576	1,288
1989	8	848	302	291	189	30		222	1,890
1990	189	923	373	77	137		33	178	1,910
1991	673	848	756	53	262	2		2	2,596
1992	601	1,274	755	19	154	9		3	2,815
1993	1,053	709	352	19	136	24	12		2,305
1994	878	755	198	73	96		18		2,018
1995	845	609	200	9	21				1,684
1996	1,220	676	684	4	14			131	2,729
1997	894	582	220	6	1	1	35	3	1,742
1998	712	544	123	2	12		57	1	1,451
1999	664	509	192	72	3		32		1,472
2000	772	541	217	3	13	6			1,552
2001	1,729	546	301			5			2,581
2002	1,494	519	646	93	42	170			2,964
2003	1,245	1,234	1,388	201	24	2			4,094
2004	958	440	511	840	111	6			2,866
2005	631	310	283	23	85	2			1,334
2006	511	177	542	218	68	42			1,558
2007	198	57	177	3	20				455
Total	15,332	13,078	8,661	2,011	1,699	322	187	2,300	43,590
% of Total	35.17	30.00	19.87	4.61	3.90	0.74	0.43	5.28	100.00

Table 2. Annual numbers of king mackerel from the Atlantic, 1986-2007, by sub-region, aged by NMFS Panama City. Data from 2007 includes Jan -- Feb only. NEF = northeast Florida, EF = east Florida, SEF = southeast Florida.

	Atlantic mackerel states								
Year	MA	VA	NC	SC	GA	NEF	EF	SEF	Total
1986			155	94	107	26	101	21	504
1987			235	124	14	32	142		547
1988			105	167	60		120	53	505
1989		17	568	108	139		16	3	851
1990	2		767	93	98		35		995
1991			633	109	15		184		941
1992	5		831	140	81		293		1,350
1993			603	80			263		946
1994			527				372		899
1995			307				528		835
1996			376	29	49	121	982		1,557
1997			361		24		785	9	1,179
1998			452			64	544		1,060
1999			491				525	11	1,027
2000			526	7		63	651		1,247
2001			507	76		73	1,256	32	1,944
2002			463	29		72	1,083	18	1,665
2003			430			419	1,602	3	2,454
2004			377			703	1,204	45	2,329
2005			89			97	402	57	645
2006			146			88	518	48	800
2007							160	6	166
Total	7	17	8,949	1,056	587	1,758	11,766	306	24,446
% of total	0.03	0.07	36.61	4.32	2.40	7.19	48.13	1.25	100.00

Table 3. Annual numbers of king mackerel from the Gulf, 1986-2007, by sub-region, aged by NMFS Panama City. Data from 2007 includes Jan -- Jun only. NWF = northwest Florida, WF = west Florida, SWF = southwest Florida, SF = south Florida.

	Gulf mackerel states									
Year	MEX	TX	LA	MS	AL	NWF	WF	SWF	SF	Total
1986		113	50	59	72	59	4		17	374
1987		334	75	67	232	148	2		3	861
1988	102	320	68	84	83	118			8	783
1989	177	349	58	13	7	377			58	1,039
1990	244	236	41	100	18	207			69	915
1991	166	378	303	59	4	556	90		99	1,655
1992	114	337	294	47	9	439	119		106	1,465
1993	99	139	567		8	243	222	29	52	1,359
1994	100	80	319			325	253	16	26	1,119
1995			187			400	179	39	44	849
1996						910	116	69	77	1,172
1997						482	72		9	563
1998				20		112	134	23	102	391
1999				66	5	180	43	51	100	445
2000				18		180		53	54	305
2001			216	9	22	198	13	44	135	637
2002		6	41	1	124	460	97	102	468	1,299
2003		9	32			738	397	1	463	1,640
2004		26	40		8	200	133		130	537
2005		10	201			130	160	23	165	689
2006		3	206		81	286	87		95	758
2007		1				132	35		121	289
Total	1,002	2,341	2,698	543	673	6,880	2,156	450	2,401	19,144
% of total	5.23	12.23	14.09	2.84	3.52	35.94	11.26	2.35	12.54	100.00

Table 4. Annual numbers of king mackerel from Atlantic commercial samples, 1986-2007, by sub-region, aged by NMFS Panama City. Data from 2007 includes Jan -- Feb only. NEF = northeast Florida, EF = east Florida, SEF = southeast Florida.

	Atlantic mackerel states								
Year	MA	VA	NC	SC	GA	NEF	EF	SEF	Total
1986									
1987									
1988									
1989									
1990			50				31		81
1991			69	1			164		234
1992			65				230		295
1993			173	1			238		412
1994			166				331		497
1995			53				486		539
1996			38	29		24	974		1,065
1997					24		785	9	818
1998						22	533		555
1999			9				525	11	545
2000				7		27	651		685
2001				39			1,181	19	1,239
2002			29	29			818	15	891
2003							674	2	676
2004			4				642	15	661
2005							241	12	253
2006							214	7	221
2007							139		139
Total			656	106	24	73	8,857	90	9,806
% of total	0.00	0.00	6.69	1.08	0.24	0.74	90.32	0.92	100.00

Table 5. Annual numbers of king mackerel from Gulf commercial samples, 1986-2007, by sub-region, aged by NMFS Panama City. Data from 2007 = Jan -- Jun only. NWF = northwest Florida, WF = west Florida, SWF = southwest Florida, SF = south Florida.

	Gulf mackerel states									
Year	AL	LA	MEX	MS	NWF	SF	SWF	TX	WF	Total
1986				2				25		27
1987		10								10
1988		19				1				20
1989					8					8
1990			83	8		17				108
1991		247	166		1	25				439
1992		128	114			64				306
1993	8	430	47		89	38	29			641
1994		186	63		95	19	16		2	381
1995		106			159	34	7			306
1996					59	27	69			155
1997					56	1			19	76
1998						61	23		73	157
1999						28	51		40	119
2000					20	14	53			87
2001	22	163			172	88	44		1	490
2002		40			46	375	102		40	603
2003		32			207	326			4	569
2004	8	39			149	95			6	297
2005		197			25	132	23		1	378
2006		206			7	77				290
2007					2	57				59
Total	38	1,803	473	10	1,095	1,479	417	25	186	5,526
% of total	0.69	32.63	8.56	0.18	19.82	26.76	7.55	0.45	3.37	100.00

Table 6. Annual numbers of king mackerel from Atlantic recreational samples (excluding tournaments), 1986-2007, aged by the NMFS Panama City, by sub-region. NEF = northeast Florida, EF = east Florida, SEF = southeast Florida. 2007 includes Jan -- Feb only.

	Atlantic mackerel states								
Year	MA	VA	NC	SC	GA	NEF	EF	SEF	Total
1986			41	5		23	28	7	104
1987				10		32	142		184
1988				14			90	28	132
1989		17	126	29	69		3	3	247
1990			49	33					82
1991			19	62			19		100
1992			70	81			59		210
1993				79			11		90
1994			26				23		49
1995			15				42		57
1996							2		2
1997			6						6
1998			2						2
1999			12						12
2000			26			36			62
2001			62	2		16	75	13	168
2002							265	3	268
2003						6	858	1	865
2004			9			703	562	30	1,304
2005						1	161	45	207
2006			24			88	271	41	424
2007							21	6	27
Total		17	487	315	69	905	2,632	177	4,602
% of total	0.00	0.37	10.58	6.84	1.50	19.67	57.19	3.85	100.00

Table 7. Annual numbers of king mackerel from Gulf recreational samples (excluding tournaments), 1986-2007, by sub-region, aged by NMFS Panama City. NWF = northwest Florida, WF = west Florida, SWF = southwest Florida, SF = south Florida. 2007 includes Jan -- Jun only.

	Gulf mackerel states									
Year	MEX	TX	LA	MS	AL	NWF	WF	SWF	SF	Total
1986		23	1	22		56			3	105
1987		52				116			3	171
1988		55				6				61
1989		248		13		236			38	535
1990		217		66		170			52	505
1991		370	1	37		489			74	971
1992		328				347	1		42	718
1993	52	139	72			138	2		14	417
1994	37	80				194			7	318
1995						163			10	173
1996						650			50	700
1997						215	1		5	221
1998						95			40	135
1999				55	5	171	3		21	255
2000						154			17	171
2001			53			21	12		47	133
2002		6		1		356	57		93	513
2003		9				486	125	1	127	748
2004		26				50	74		8	158
2005		10	4			97	57		16	184
2006		3			44	263	87		7	404
2007		1				130	35		7	173
Total	89	1,567	131	194	49	4,603	454	1	681	7,769
% of total	1.15	20.17	1.69	2.50	0.63	59.25	5.84	0.01	8.77	100.00

Table 8. Annual numbers of king mackerel from Atlantic tournaments, 1986 – 2007, by sub-region, aged by NMFS Panama City. NEF = northeast Florida, EF = east Florida.

	Tournament aged king mackerel					
Year	NC	SC	GA	NEF	EF	Total
1986	23	23	9			55
1987	43	106	4			153
1988	38	86	60			184
1989	442	79	70			591
1990	634	60	98		4	796
1991	545	46	15		1	607
1992	696	59	81			836
1993	394				14	408
1994	317				18	335
1995	239					239
1996	338		33	97	6	474
1997	319					319
1998	393			42	11	446
1999	438					438
2000	500					500
2001	445	35		57		537
2002	265			72		337
2003	430			413	70	913
2004	364					364
2005	89			96		185
2006	122					122
2007						0
Grand Total	7074	494	370	777	124	8,839
% of total	80.03%	5.59%	4.19%	8.79%	1.40%	100.00%

Table 9. Annual numbers of king mackerel from Gulf tournaments, 1986 – 2007, by sub-region, aged by NMFS Panama City. NWF= northwest Florida, WF = west Florida, SWF = southwest Florida, SF = south Florida. 2007 includes Jan -- Jun only.

	Tournament aged king mackerel								
Year	TX	LA	MS	AL	NWF	WF	SWF	SF	Total
1986	2		11	27	3				43
1987	138	65		15	32				250
1988	131	42		59	60				292
1989	99	58		7	93				257
1990	18	33	26	18	32				127
1991	8	55	21	4	63	90			241
1992	8	166	47	9	90	118			438
1993		65			16	220			301
1994		133			36	251			420
1995		81			78	179	32		370
1996					201	1			202
1997					211	52			263
1998			20		17	61			98
1999			11		9			51	71
2000			18					23	41
2001			9						9
2002				124	58				182
2003					43	268		10	321
2004						53		23	76
2005					6	102		17	125
2006				29	15			11	55
2007								57	57
Total	404	698	163	292	1,063	1,395	32	192	4,239
% of total	9.53	16.47	3.85	6.89	25.08	32.91	0.75	4.53	100.00

Table 10. Annual numbers of commercial king mackerel (Atlantic and Gulf combined) samples by gear type aged by NMFS Panama City. 120 = purse seine, 943 = diving outfit (from TIP manual), GN = gill net, HL = hand-lines, LL = long lines.

Year	120	943	GN	HL	LL	Unknown	Total
1986	2			25			27
1987				10			10
1988			1	19			20
1989				4		4	8
1990				17		172	189
1991			71	602			673
1992			21	580			601
1993			47	1,006			1,053
1994		2	62	814			878
1995		8	11	816		10	845
1996			75	1,145			1,220
1997				894			894
1998			9	703			712
1999			39	625			664
2000				772			772
2001			20	1,709			1,729
2002			338	1,156			1,494
2003			280	965			1,245
2004			62	896			958
2005			45	586			631
2006			24	487			511
2007			42	156			198
Total	2	10	1,147	13,987	0	186	15,332
% of Total	0.01	0.07	7.48	91.23	0.00	1.21	100.00

Table 11. Annual numbers of Atlantic commercial king mackerel samples, 1991-2007, from gill nets (GN) and hand-lines (HL) aged by NMFS Panama City. NEF = northeast Florida, EF = east Florida, SEF = southeast Florida.

	GN					HL							Atlantic
Year	NC	SC	NEF	EF	Total	NC	SC	GA	NEF	EF	SEF	Total	Total
1991						69	1			164		234	234
1992				1	1	65				229		294	295
1993						173	1			238		412	412
1994						166				329		495	495
1995						53				468		521	521
1996		29	24	6	59	38				968		1,006	1,065
1997								24		785	9	818	818
1998									22	533		555	555
1999	9				9					525	11	536	545
2000							7		27	651		685	685
2001							39			1,181	19	1,239	1,239
2002	29			44	73		29			774	15	818	891
2003										674	2	676	676
2004						4				642	15	661	661
2005										241	12	253	253
2006										214	7	221	221
2007										139		139	139
Total	38	29	24	51	142	568	77	24	49	8,755	90	9,563	9,705
% of Total	0.39	0.30	0.25	0.53	1.46	5.85	0.79	0.25	0.50	90.21	0.93	98.54	100.00

Table 12. Annual numbers of Gulf commercial king mackerel samples, 1986-2007, from gill nets (GN) and hand-lines (HL) aged by NMFS Panama City. NWF= northwest Florida, WF = west Florida, SWF = southwest Florida, SF = south Florida. 2007 includes Jan -- Jun only.

	GN					HL									
Year	MEX	NWF	SWF	SF	Total	MEX	TX	LA	AL	NWF	SWF	WF	SF	Total	Gulf Total
1986							25							25	25
1987								10						10	10
1988				1	1			19						19	20
1989										4				4	4
1990													17	17	17
1991	71				71	95		247		1			25	368	439
1992	20				20	94		128					64	286	306
1993	47				47			430	8	89	29		38	594	641
1994	57	5			62	6		186		90	16	2	19	319	381
1995				11	11			106		159	7		23	295	306
1996			16		16					59	53		27	139	155
1997										56		19	1	76	76
1998				9	9						23	73	52	148	157
1999			12	18	30						39	40	10	89	119
2000										20	53		14	87	87
2001			20		20			163	22	172	24	1	88	470	490
2002				265	265			40		46	102	40	110	338	603
2003				280	280			32		207		4	46	289	569
2004				62	62			39	8	149		6	33	235	297
2005				45	45			197		25	23	1	87	333	378
2006				24	24			206		7			53	266	290
2007				42	42					2			15	17	59
Total	195	5	48	757	1,005	195	25	1,803	38	1,086	369	186	722	4,424	5,429
% total	3.59	0.09	0.88	13.94	18.51	3.59	0.46	33.21	0.70	20.00	6.80	3.43	13.30	81.49	100.00

Table 13. Indices of precision from reader comparisons. APE = average percent error, CV = coefficient of variation, and D = index of precision.

Reader pair	Data years	Ageing method	APE	CV	D
1 and 2	01-02, 02-03	Whole and sectioned	2.05%	2.90%	1.45%
1 and 2	06	Whole	2.77%	3.51%	1.95%
1 and 3	06-07	Sectioned	1.67%	2.37%	1.18%

Figure 1. Mackerel sampling sub-regions (states and sub-areas of Florida): NWF – northwest Florida, WF – west Florida, SWF – southwest Florida, SF – south Florida, SEF – southeast Florida, EF – east Florida, NEF – northeast Florida.

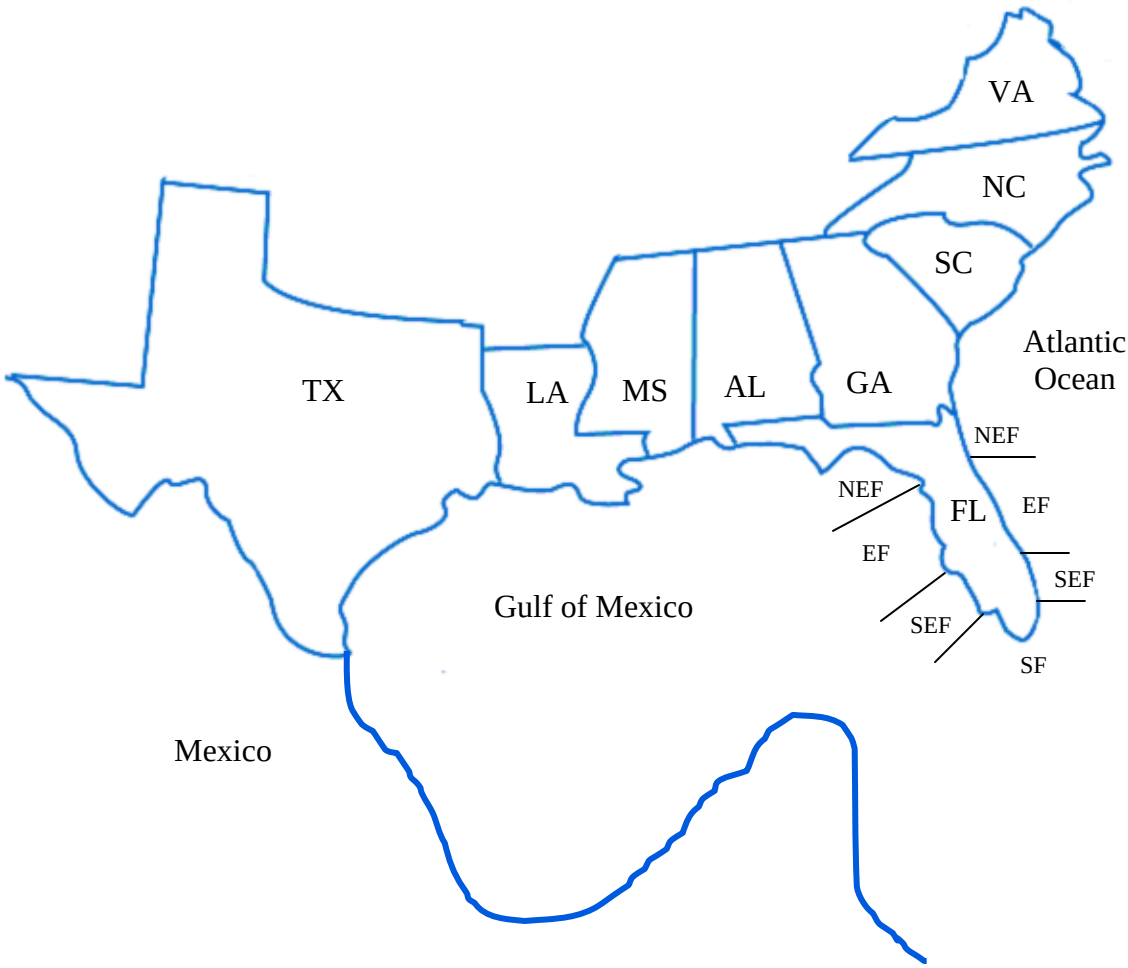

Figure 2. Size distributions of the total available and sub-sampled 2005-06 king mackerel age samples from the (a) Atlantic and (b) Gulf of Mexico. Fork length (FL) rounded to nearest 25mm.

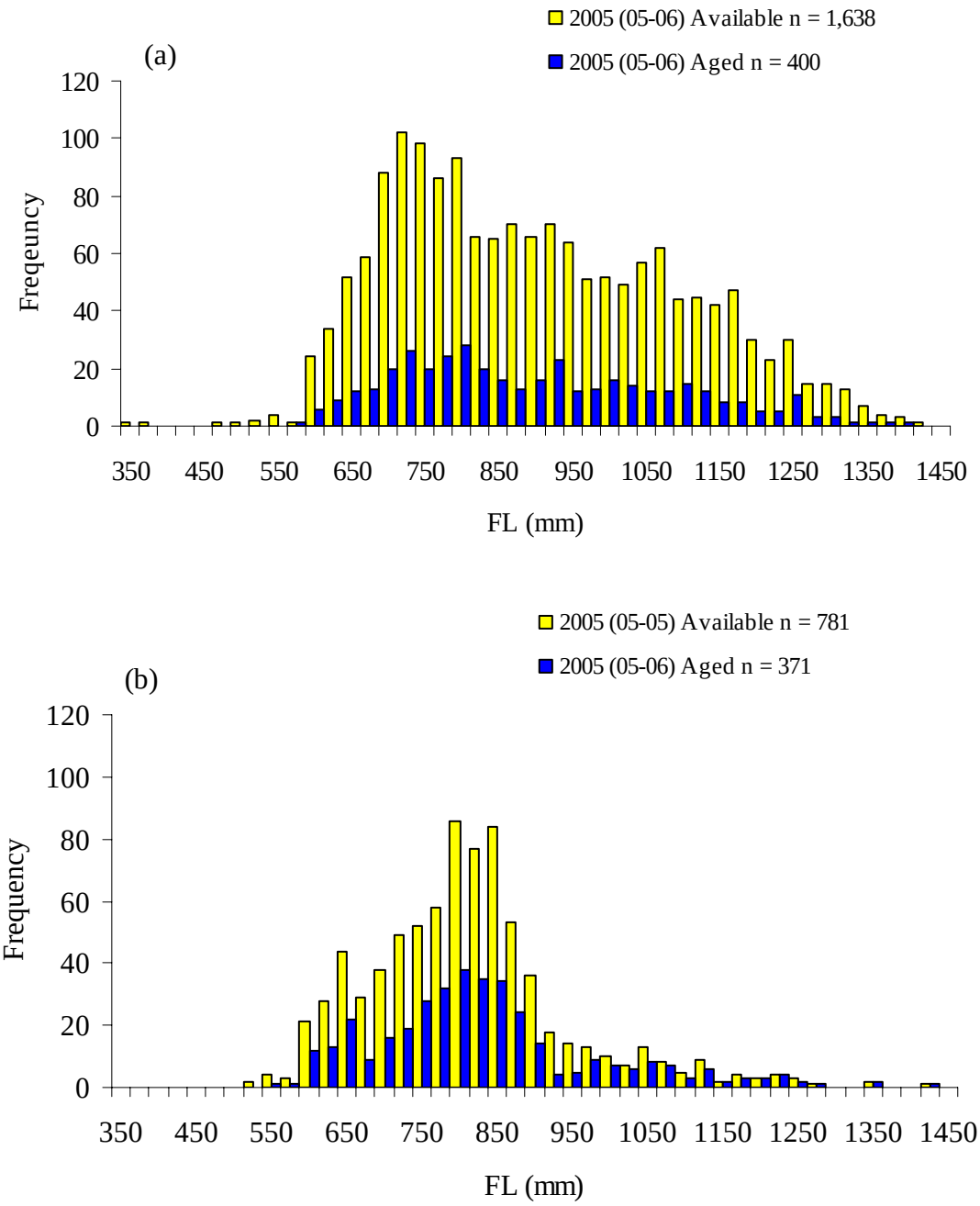

Figure 3. Size distributions of the total available and sub-sampled king mackerel age samples from the Atlantic and Gulf of Mexico for the first half (panels a and b) and second half (panels c and d) of 2006.

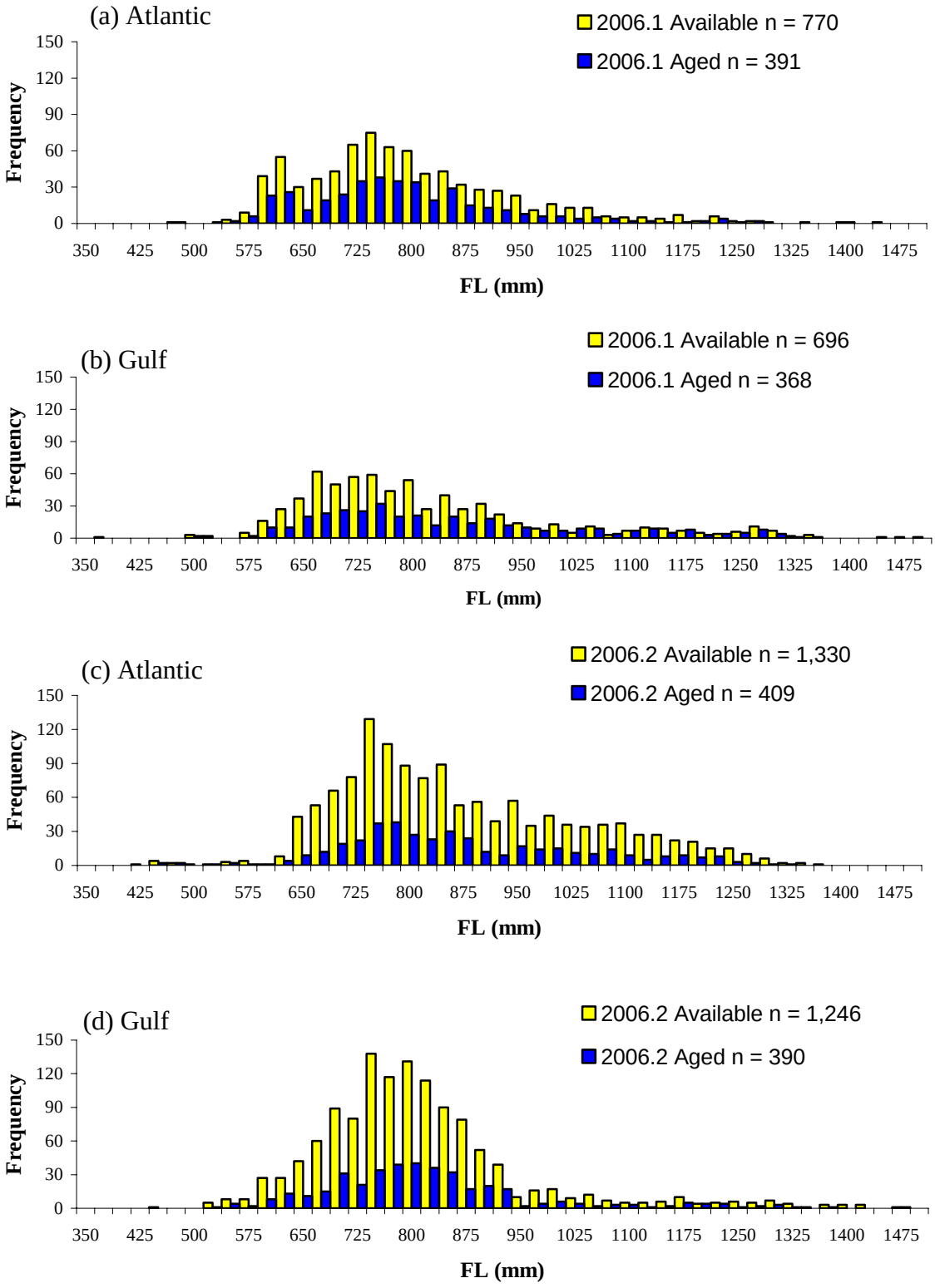

Figure 4. Size distributions of the total available (blue) and sub-sampled (yellow) king mackerel age samples for 2007 portion of the 2006-07 fishing seasons from (a) South Florida females, (b) Panama City females, (c) East Florida females, (d) South Florida males, (e) Panama City males, and (f) East Florida males.

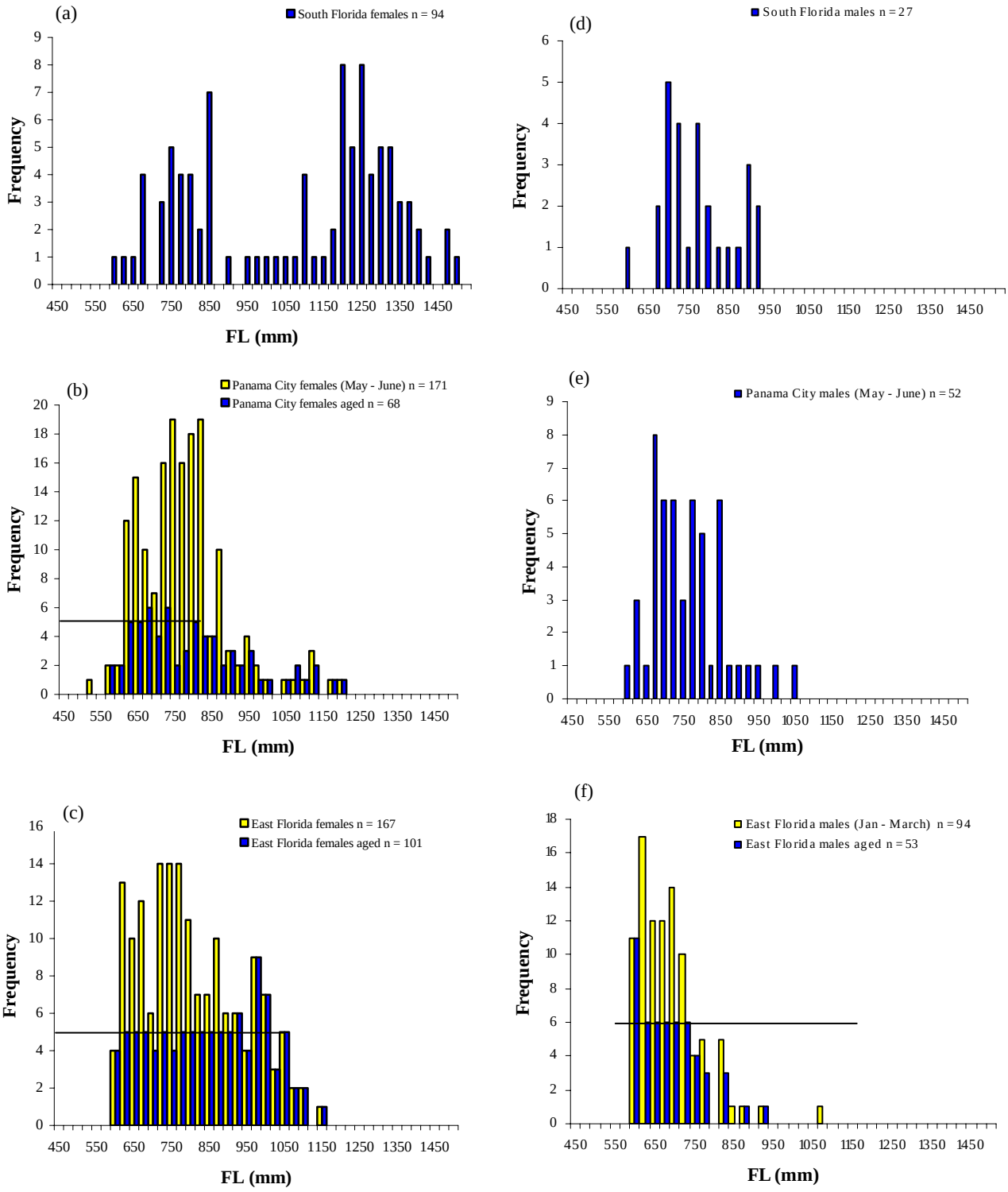

Figure 5. Age distribution of king mackerel from the Atlantic and Gulf (1986 – 2007) aged by NMFS Panama City.

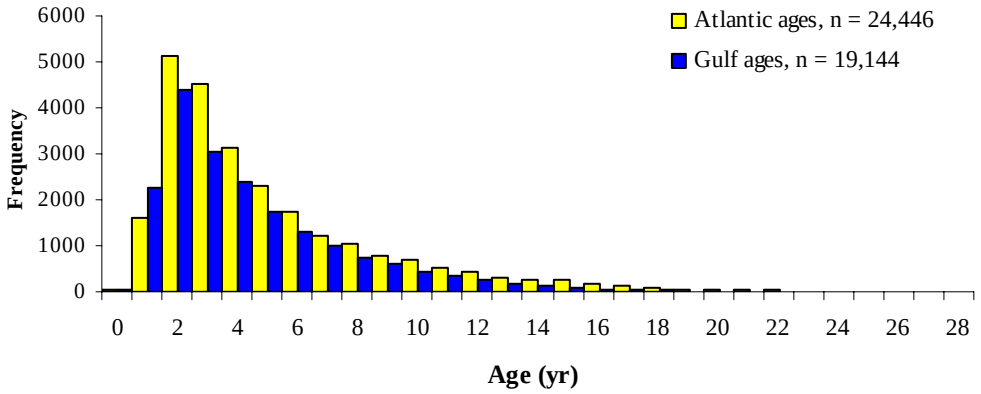

Figure 6. Age distribution of female king mackerel from the Atlantic and Gulf (1986 – 2007) aged by NMFS Panama City.

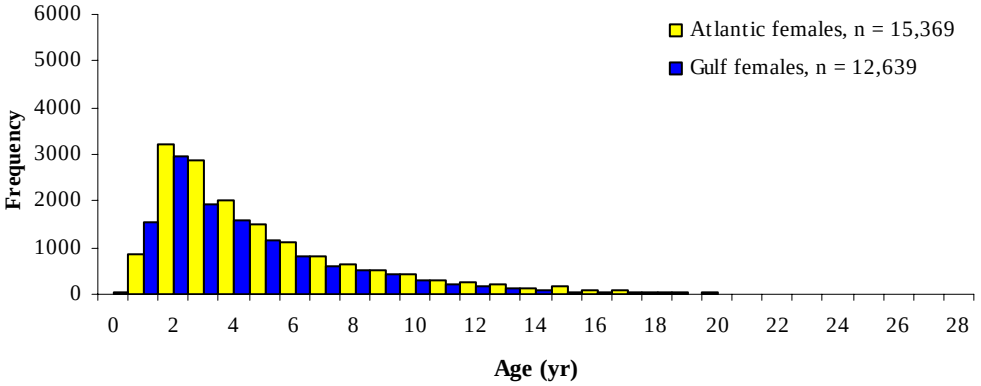

Figure 7. Age distribution of male king mackerel from the Atlantic and Gulf (1986 – 2007) aged by NMFS Panama City.

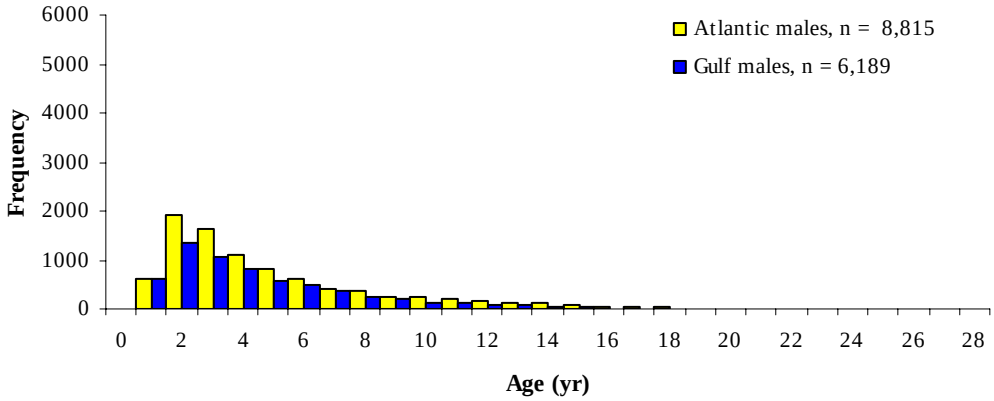

Figure 8. Size distribution of king mackerel from the Atlantic and Gulf commercial sectors, 1986-2007, aged by NMFS Panama City.

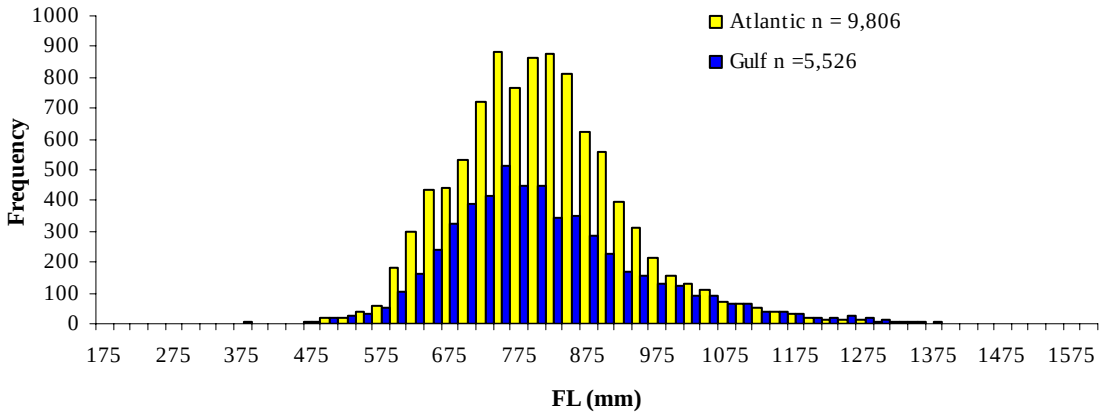

Figure 9. Size distribution of king mackerel from the Atlantic and Gulf recreational sectors, 1986-2007, aged by NMFS Panama City.

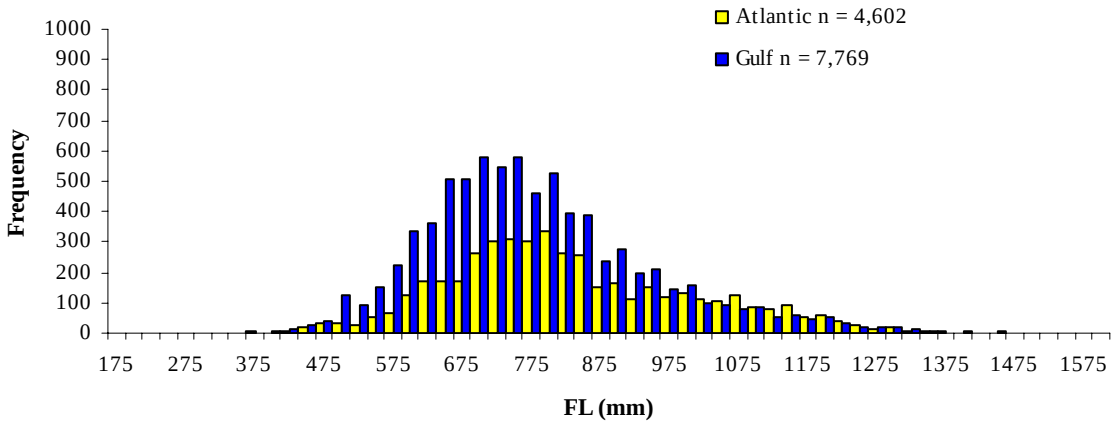

Figure 10. Size distribution of king mackerel from Atlantic and Gulf tournaments, 1986-2007, aged by NMFS Panama City.

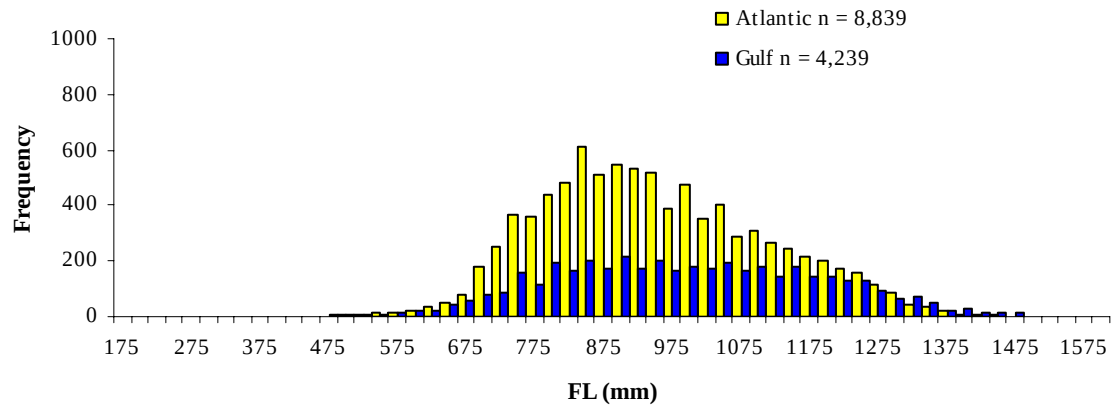

Figure 11. Sizes at age of female (a) and male (b) king mackerel from the Atlantic and Gulf (1986-2007) aged by NMFS Panama City.

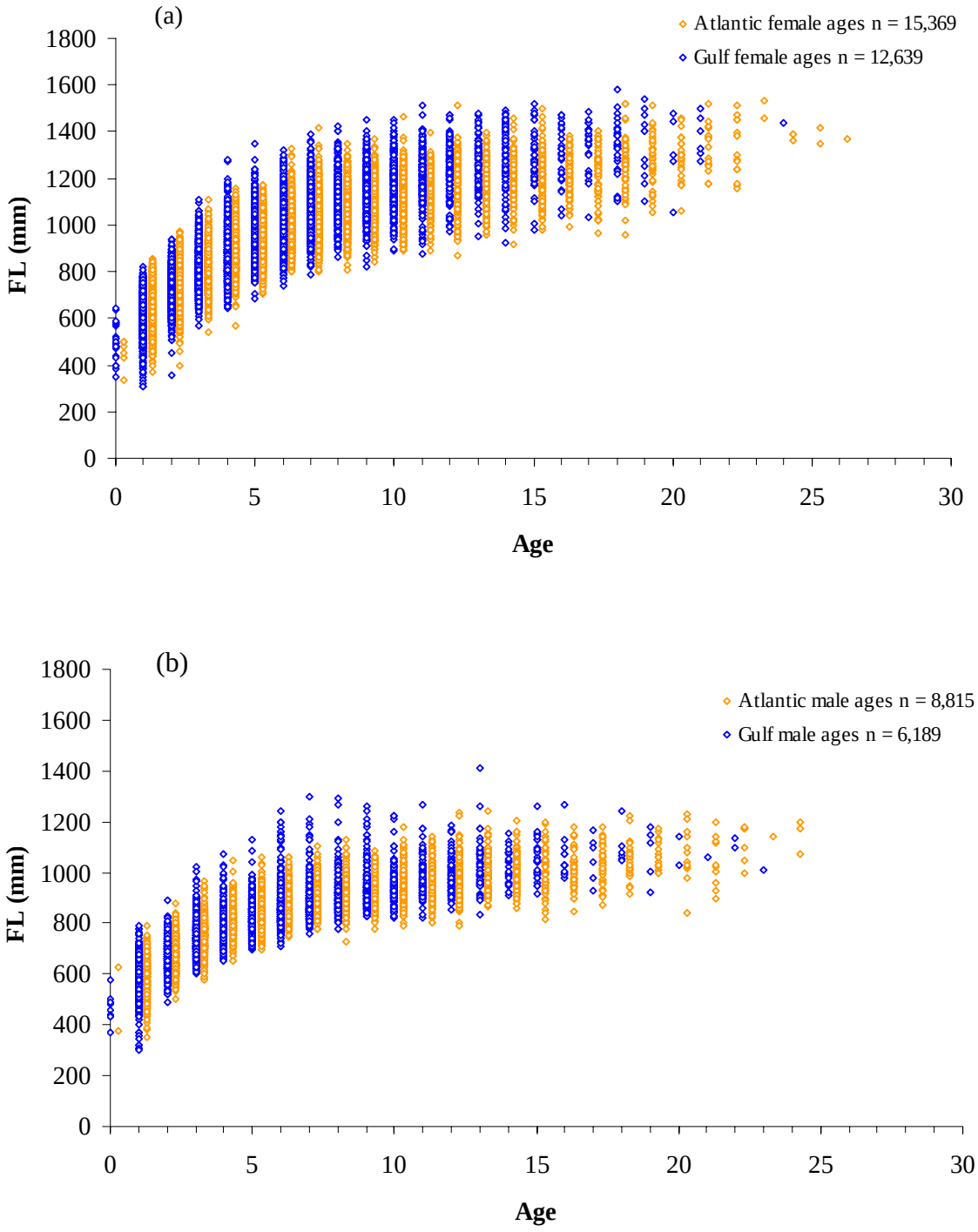

Figure 12. Geographic distribution of king mackerel sampled from tournaments and age by NMFS Panama City. WF = west Florida, NWF = northwest Florida, SF = south Florida, EF = east Florida, and SWF = southwest Florida.