Catch-per-unit-effort of golden tilefish from MARMAP bottom longlining

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1. Abstract

Golden tilefish catch-per-unit effort was calculated from MARMAP bottom longlining data in 1983–1986, 1996–2007, and 2009–2010. Sampling occurred primarily off of South Carolina, but in some years ranged as far south as central Florida. Catch-per-unit-effort (CPUE; number of golden tilefish caught per hour soak time) was not standardized using a delta-GLM model due to few longline sets and concomitant low catches of golden tilefish in some years. For years in which longline sampling took place, golden tilefish CPUE was variable, ranging from 0.00 in 2004 and 2005 to 3.57 in 2009. Golden tilefish CPUE was also calculated for only those years in which at least 20 longline sets were made, as well as for 5-year bins; these alternative CPUE calculations dampened some of the variability in CPUE.

2. Introduction

For over thirty years, fishery-independent sampling for reef fishes in the southeast USA has been conducted by the Marine Resources Monitoring, Assessment, and Prediction (MARMAP) program of the South Carolina Department of Natural Resources. The overall mission of MARMAP has been to determine the distribution, relative abundance, and critical habitat of economically and ecologically important reef fishes between Cape Hatteras, NC, and St. Lucie Inlet, FL.

MARMAP has historically used a variety of gears to sample reef fishes, but the focus of this paper is on 'horizontal' bottom longlining conducted intermittently since 1982. The horizontal longline consisted of 1676 m of 3.2 mm galvanized cable deployed from a longline reel. A total of 1219 m of the cable is used as groundline and the remaining 457 m is buoyed to the surface. One hundred gangions, each consisting of an AK snap, approximately 0.5 m of 90 kg monofilament, and a #6 or #7 tuna circle hook, were baited with a whole squid and clipped to the ground cable at intervals of 12 m. The gear is set while running with the current at a speed of 4.5 kts. An 11 kg weight is attached to the terminal end and 100 gangions are then attached to the groundline, followed by another weight at the terminal end of the groundline. The remaining cable is pulled off the reel and buoyed with a Hi-Flyer and a polyball trailer buoy. The gear is soaked for approximately 90 minutes and retrieved by fairleading the cable from a side davit of

the vessel back on to the longline reel. Longlining has been conducted in water depths from 160 to 280 m from South Carolina to central Florida between the months of May and September.

3. Data and treatment

3.1 Available data

For each longline set, the MARMAP database included a unique collection number, soak time (in minutes), date, longitude, latitude, bottom depth, bottom temperature, number of golden tilefish caught, and collective weight of golden tilefish caught. All analyses use number, not weight, of golden tilefish caught by the longline survey. Catch-per-unit-effort (CPUE) for each trap set was standardized to the number of golden tilefish caught per hour of soak time. All longline sets made in 1982 ($N = 32$) lacked soak time information, so these data were excluded from further analyses. Bottom temperature was only available for 37% of all longline sets, so this variable was excluded from further analyses.

3.3 Data treatment

Data were treated in three different ways for calculation of nominal CPUE and proportion of longline sets with positive golden tilefish catch. The first approach considered all longline sets ($N = 416$) in the calculation of annual CPUE. However, nominal CPUE and proportion of positive sets was highly variable due to the inclusion of some years with low overall catch and effort. In an attempt to deal with low sample sizes, the second approach only considered years for which at least 20 longline sets were made in a year. The third approach considered catch and effort information within 5 year bins: 1983 –1985, 1986–1990, 1991–1995, 1996–2000, 2001–2005, and 2006–2010.

3.2 Standardization

No standardization of golden tilefish CPUE was pursued due to low overall sample size of longline sets per year (mean = 23 sets/year; range = 5–57) and concomitantly low catches of golden tilefish (mean = 62/year; range = 0–208).

4. Results

There was some annual variability in mean depth, latitude, and date sampled (Table 1), suggesting somewhat inconsistent sampling among years. Most sampling occurred off South Carolina and Georgia, but some sampling did occur as far south as central Florida in 1999 (Figure 1). Nominal mean CPUE of golden tilefish varied from 0.0 in 2004 and 2005 to 3.57 in 2009 (Table 2; Figure 2). The proportion of longline sets with positive golden tilefish CPUE varied from 0.0 in 2004 and 2005 to 0.67 in 1984 (Figure 2). The proportion of sets with positive golden tilefish catch and nominal CPUE was somewhat less variable when only considering years with at least 20 longline sets (Figure 3) or when combining data into 5 year bins (Figure 4).

The ages of golden tilefish collected in the MARMAP horizontal longlining survey varied from 2 to 40, with a mean of 8.2 (Figure 5). Note that ages presented here are actually increment counts (and not true ages) because edge types could not be distinguished accurately.

Table 1. Information associated with longline sets in the MARMAP horizontal longline survey. Data from 1982 were excluded because soak time was not available, and no horizontal longline sampling occurred in 1987–1995 or 2008.

Year	Number of longline sets	Mean depth (m)	Depth range (m)	Mean latitude (° N)	Latitude range (° N)	Mean date	Date range
1983	33	196.1	187-216	32.59	32.48-32.73	9/14	9/6-9/21
1984	57	209.8	165-214	32.29	31.84-32.56	6/28	5/22-9/22
1985	44	215.4	168-265	32.11	31.85-32.51	9/3	8/22-9/8
1986	21	214.2	185-254	32.19	31.87-32.50	6/10	6/10-6/12
1987	0	-	-	-	-	-	-
1988	0	-	-	-	-	-	-
1989	0	-	-	-	-	-	-
1990	0	-	-	-	-	-	-
1991	0	-	-	-	-	-	-
1992	0	-	-	-	-	-	-
1993	0	-	-	-	-	-	-
1994	0	-	-	-	-	-	-
1995	0	-	-	-	-	-	-
1996	15	198.3	163-240	32.11	31.51-32.56	7/14	5/1-9/19
1997	21	204.2	164-235	32.18	31.84-32.53	8/16	8/12-8/20
1998	8	197.5	173-234	32.12	31.91-32.50	5/28	5/19-6/25
1999	30	213.1	181-280	31.67	27.94-32.53	8/25	7/14-9/9
2000	11	202.2	166-228	31.50	30.05-32.02	8/13	7/26-9/20
2001	14	207.8	181-231	31.88	31.21-32.05	8/21	6/24-8/30
2002	20	226.0	184-254	31.89	31.52-32.21	9/5	7/17-9/19
2003	14	218.6	169-251	31.92	31.66-32.22	9/23	9/22-9/25
2004	5	193.6	183-209	32.02	31.96-32.08	9/30	9/30-9/30
2005	16	211.6	175-250	31.94	31.70-32.20	9/20	9/20-9/22
2006	7	200.7	176-218	32.04	31.84-32.15	9/26	9/26-9/27
2007	24	212.6	180-240	32.04	31.24-32.48	8/18	6/26-9/25
2008	0	-	-	-	-	-	-
2009	36	215.8	179-244	31.88	31.42-32.55	8/30	8/15-9/24
2010	40	228.3	183-261	32.01	31.42-32.55	8/19	8/10-9/15

Table 2. Golden tilefish catch information from the MARMAP horizontal longline database. All CPUE calculations are number of golden tilefish caught per hour soak time, and mean individual weight was calculated as total weight of golden tilefish caught each year divided by the number of golden tilefish caught.

Year	Number of longline sets	Total golden tilefish caught	Proportion positive longline sets	Mean (SD) CPUE (catch · hr^{-1})	Minimum CPUE (catch · hr^{-1})	Maximum CPUE (catch · hr^{-1})	Mean individual weight (kg)
1983	33	76	0.48	1.12 (1.72)	0.00	6.11	4.8
1984	57	161	0.67	1.31 (2.02)	0.00	9.32	6.3
1985	44	54	0.45	0.64 (1.33)	0.00	6.40	1.5
1986	21	23	0.38	0.59 (1.00)	0.00	3.90	1.0
1987	0	-	-	-	-	-	-
1988	0	-	-	-	-	-	-
1989	0	-	-	-	-	-	-
1990	0	-	-	-	-	-	-
1991	0	-	-	-	-	-	-
1992	0	-	-	-	-	-	-
1993	0	-	-	-	-	-	-
1994	0	-	-	-	-	-	-
1995	0	-	-	-	-	-	-
1996	15	30	0.13	1.20 (3.09)	0.00	11.61	1.9
1997	21	120	0.52	3.33 (4.55)	0.00	15.35	7.8
1998	8	25	0.50	2.03 (2.92)	0.00	7.02	3.9
1999	30	156	0.63	2.90 (4.11)	0.00	15.15	6.8
2000	11	19	0.36	0.87 (1.56)	0.00	4.53	1.6
2001	14	48	0.57	2.06 (2.72)	0.00	9.03	5.8
2002	20	25	0.45	0.68 (1.06)	0.00	3.26	3.2
2003	14	5	0.21	0.20 (0.55)	0.00	1.82	0.7
2004	5	0	0.00	0.00 (0.00)	0.00	0.00	-
2005	16	0	0.00	0.00 (0.00)	0.00	0.00	-
2006	7	5	0.29	0.39 (0.95)	0.00	2.55	0.5
2007	24	34	0.21	0.85 (1.73)	0.00	5.33	3.8
2008	0	-	-	-	-	-	-
2009	36	208	0.58	3.57 (5.43)	0.00	19.79	22.0
2010	40	128	0.60	2.01 (2.57)	0.00	9.36	13.5

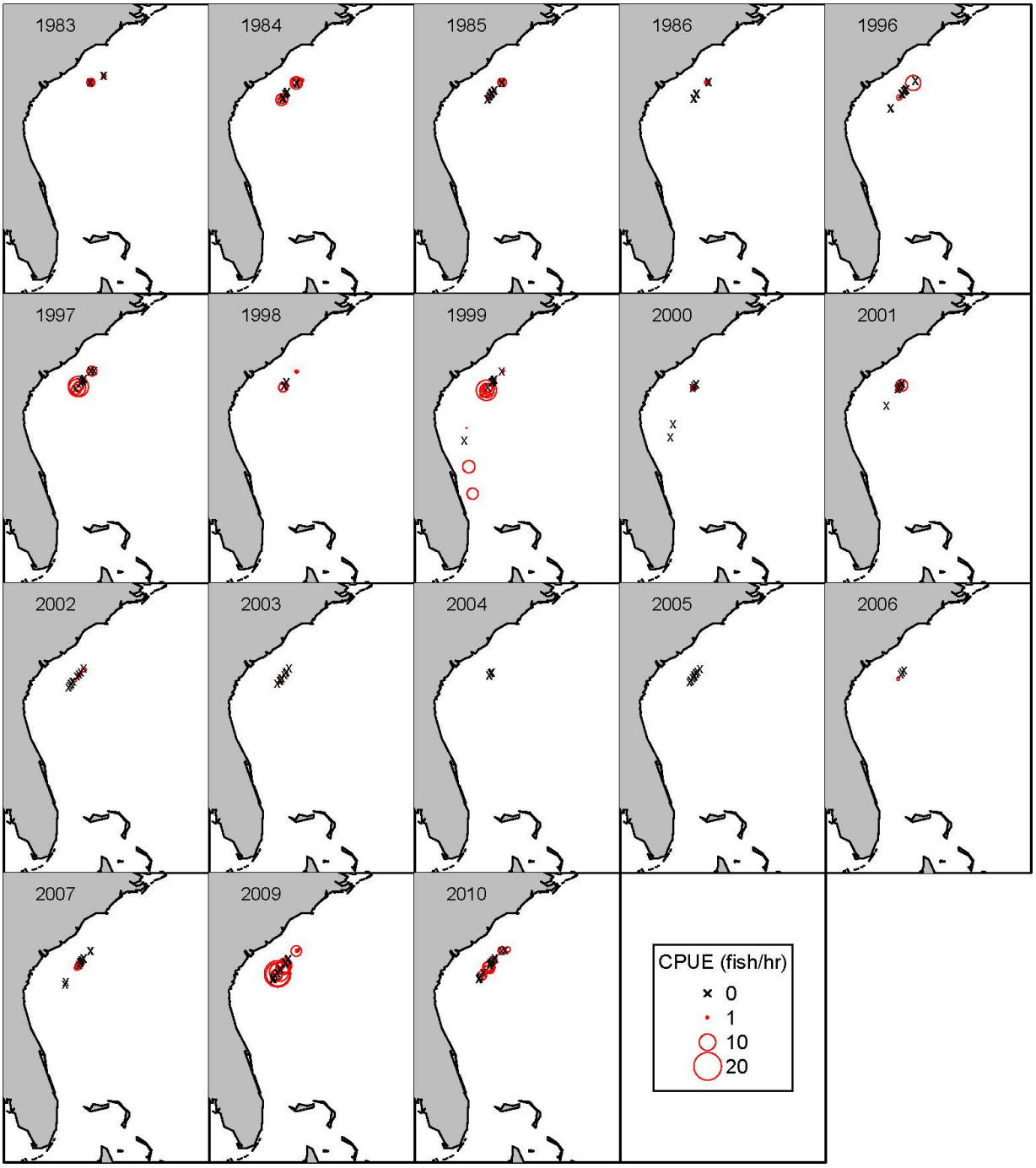

Figure 1. Map of MARMAP horizontal longline stations sampled in 1983–1986, 1996–2007, and 2009–2010. Years with no sampling are excluded from the figure. Stations with zero catch of golden tilefish are shown by the black 'x' and stations with positive CPUE of golden tilefish are shown by the red circle (and the size of the circle is proportional to CPUE).

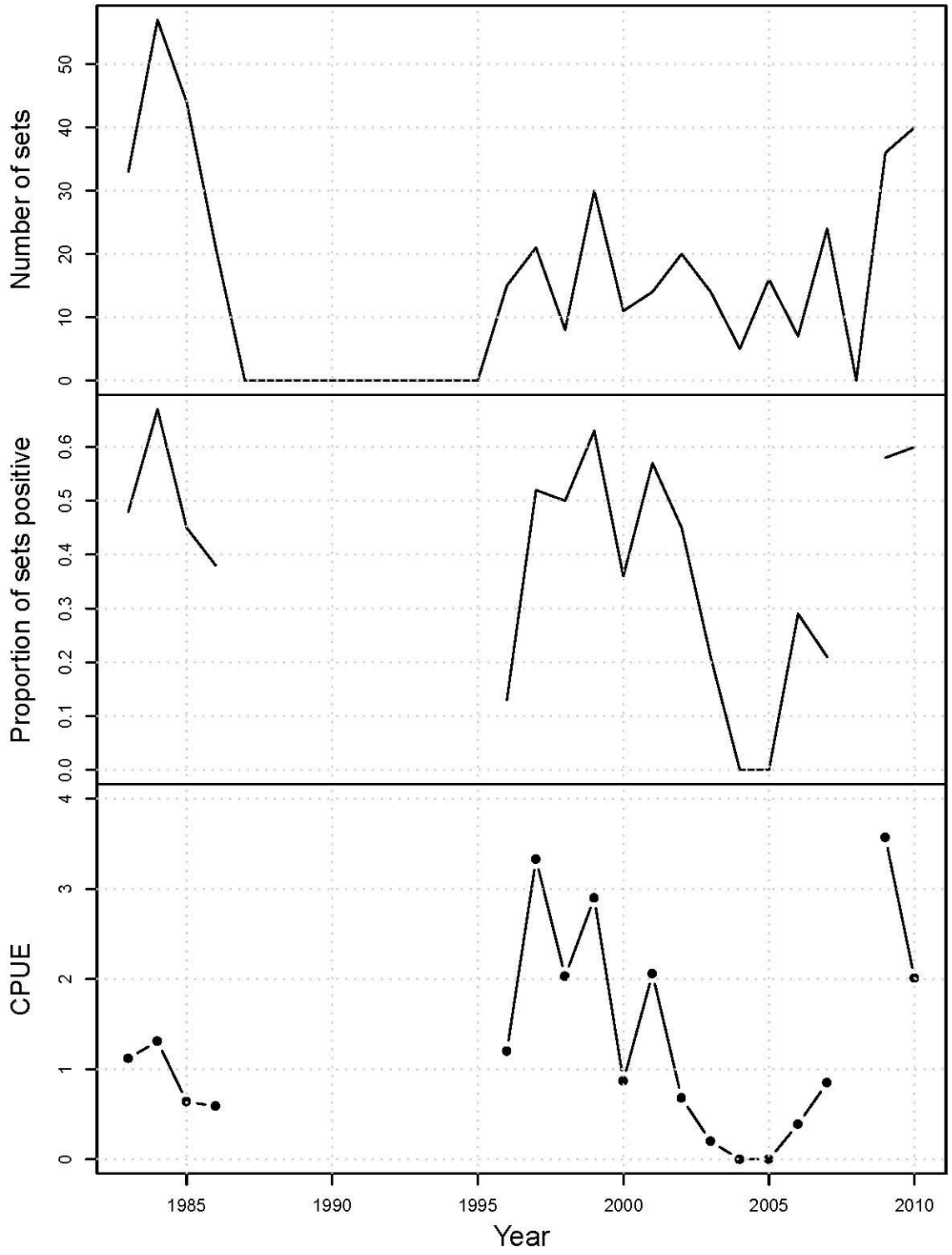

Figure 2. The total number of longline sets deployed, the proportion of longline sets with positive golden tilefish catch, and the nominal CPUE of golden tilefish caught in MARMAP bottom longlining.

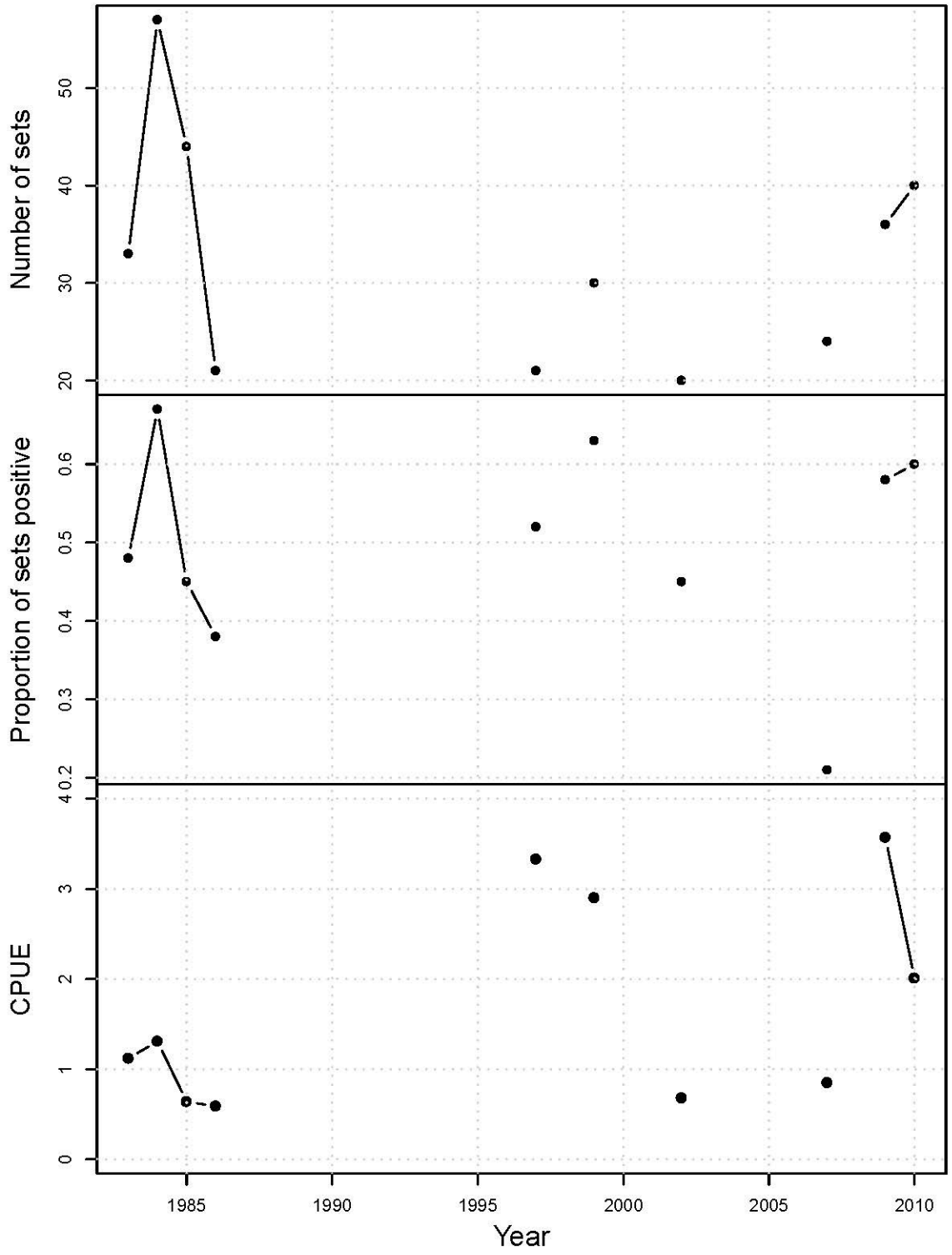

Figure 3. The total number of longline sets deployed, the proportion of longline sets with positive golden tilefish catch, and the nominal CPUE of golden tilefish caught in MARMAP bottom longlining sets only for those years in which at least 20 longlines were deployed.

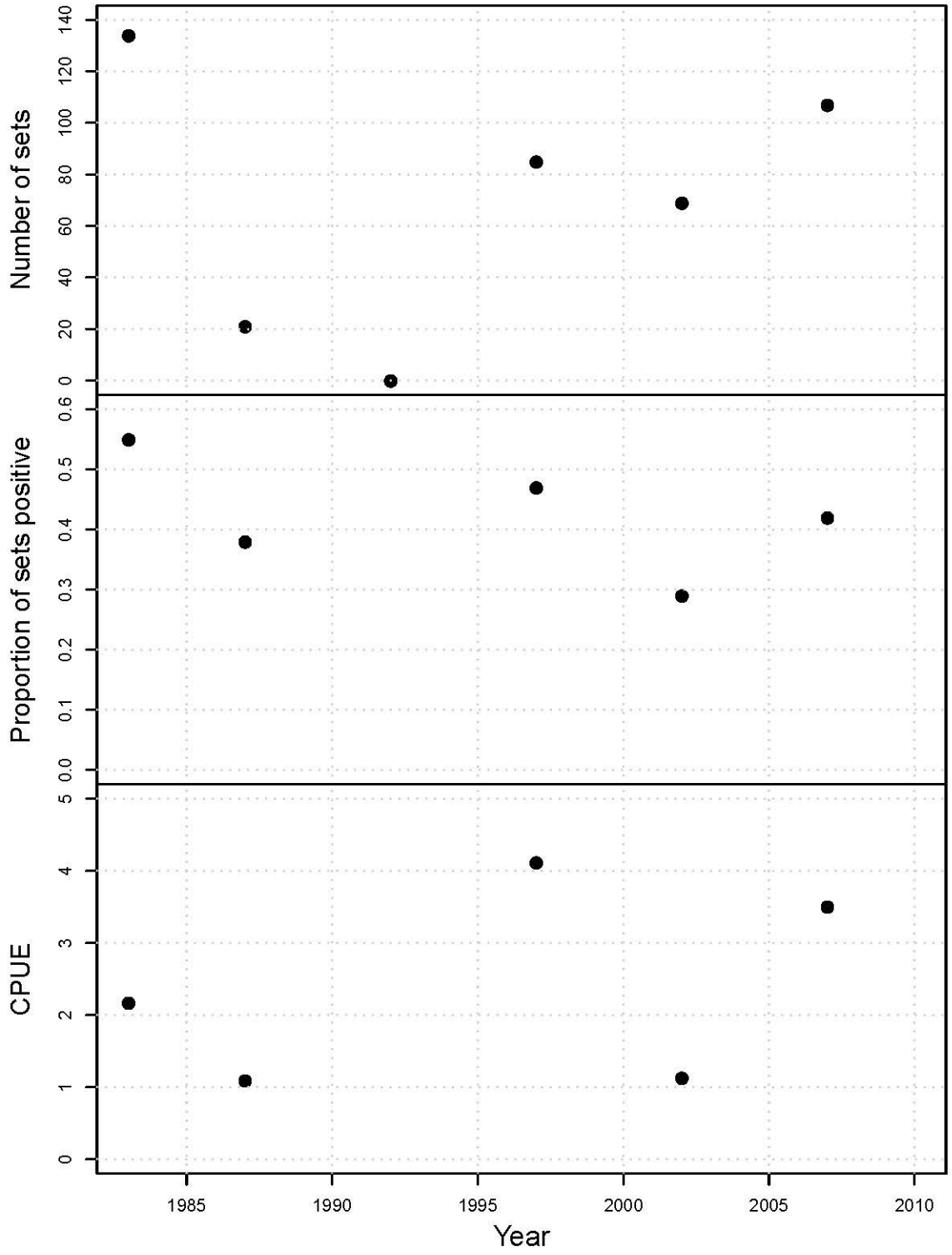

Figure 4. The total number of longline sets deployed, the proportion of longline sets with positive golden tilefish catch, and the nominal CPUE of golden tilefish caught in MARMAP bottom longlining within 5 year bins: 1983 –1985, 1986–1990, 1991–1995, 1996–2000, 2001–2005, and 2006–2010 (points shown in the middle of each year bin). Note that no longline sets were made in the 1991–1995 bin.

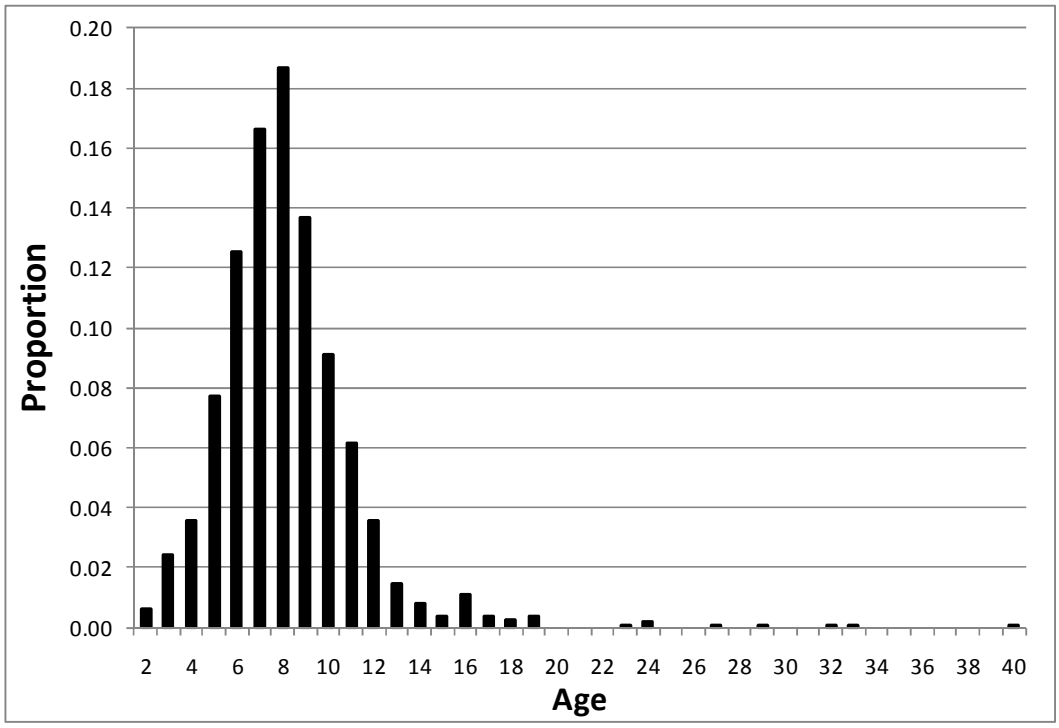

Figure 5. Ages of golden tilefish collected by MARMAP bottom longlining in 1983–1986, 1996–2007, and 2009–2010. Note that ages provided here are actually increment counts (and thus not true ages) because edge type could not be distinguished accurately.

Addendum: 4 May 2011

Catch-per-unit-effort of golden tilefish from MARMAP bottom longlining

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1. Abstract

Golden tilefish catch-per-unit effort was calculated from MARMAP bottom longlining data in four year bins: 1983–1986, 1996–1999, 2000–2003, 2004–2007, and 2009–2010. Sampling occurred primarily off of South Carolina, but in some years ranged as far south as central Florida; anomalous Florida samples were excluded from analysis. Catch-per-unit-effort (CPUE; number of golden tilefish caught per hour soak time) was not standardized using a delta-GLM model due to few longline sets and concomitant low catches of golden tilefish in some years. For the groups of years in which longline sampling took place, golden tilefish CPUE was variable, ranging from 0.45 in 2004-2007 to 2.82 in 2009-2010.

2. Introduction

For over thirty years, fishery-independent sampling for reef fishes in the southeast USA has been conducted by the Marine Resources Monitoring, Assessment, and Prediction (MARMAP) program of the South Carolina Department of Natural Resources. The overall mission of MARMAP has been to determine the distribution, relative abundance, and critical habitat of economically and ecologically important reef fishes between Cape Hatteras, NC, and St. Lucie Inlet, FL.

MARMAP has historically used a variety of gears to sample reef fishes, but the focus of this paper is on 'horizontal' bottom longlining conducted intermittently since 1982. The horizontal longline consisted of 1676 m of 3.2 mm galvanized cable deployed from a longline reel. A total of 1219 m of the cable is used as groundline and the remaining 457 m is buoyed to the surface. One hundred gangions, each consisting of an AK snap, approximately 0.5 m of 90 kg monofilament, and a #6 or #7 tuna circle hook, were baited with a whole squid and clipped to the ground cable at intervals of 12 m. The gear is set while running with the current at a speed of 4.5 kts. An 11 kg weight is attached to the terminal end and 100 gangions are then attached to the groundline, followed by another weight at the terminal end of the groundline. The remaining cable is pulled off the reel and buoyed with a Hi-Flyer and a polyball trailer buoy. The gear is

soaked for approximately 90 minutes and retrieved by fairleading the cable from a side davit of the vessel back on to the longline reel. Longlining has been conducted in water depths from 160 to 280 m from South Carolina to central Florida between the months of May and September.

3. Data and treatment

3.1 Available data

For each longline set, the MARMAP database included a unique collection number, soak time (in minutes), date, longitude, latitude, bottom depth, bottom temperature, number of golden tilefish caught, and collective weight of golden tilefish caught. All analyses use number, not weight, of golden tilefish caught by the longline survey. Catch-per-unit-effort (CPUE) for each trap set was standardized to the number of golden tilefish caught per hour of soak time. All longline sets made in 1982 ($N = 32$) lacked soak time information, so these data were excluded from further analyses. No sampling occurred in 1987–1995 and 2008. Bottom temperature was only available for 37% of all longline sets, so this variable was excluded from further analyses.

3.3 Data treatment

Sampling occurred south into Florida in only one year (1999), so those anomalous samples (< 31° N) were removed from further analyses. Due to low sample sizes in many years (Table 1), catch and effort information was combined into four-year bins, as recommended by the data workshop members: 1983 – 1986; 1996–1999; 2000–2003; 2004–2007; 2009–2010. Each longline set within each four-year bin was considered to be the experimental unit.

3.2 Standardization

No standardization of golden tilefish CPUE was pursued due to low overall sample size of longline sets per year and concomitantly low catches of golden tilefish (Table 1, 2)

4. Results

There was some variability in mean depth, latitude, and date sampled (Table 2), suggesting somewhat inconsistent sampling among groups of years. Most sampling occurred off South Carolina and Georgia (Figure 1). There were between 52 and 155 longline sets included in each grouping of years (Figure 2); the proportion of sets with positive golden tilefish catch in each grouping of years ranged from 0.12 in 2004-2007 to 0.59 in 2009-2010 (Figure 3). Nominal mean CPUE of golden tilefish varied from 0.45 in 2004-2007 to 2.82 in 2009-2010 (Figure 4).

The ages of golden tilefish collected in the MARMAP horizontal longlining survey varied from 2 to 40, with a mean of 8.2 (Figure 5). Note that ages presented here are actually increment counts (and not true ages) because edge types could not be distinguished accurately.

Table 1. Information associated with yearly longline sets in the MARMAP horizontal longline survey. Data from 1982 were excluded because soak time was not available, and no horizontal longline sampling occurred in 1987–1995 or 2008.

Year	Number of longline sets	Mean depth (m)	Depth range (m)	Mean latitude (° N)	Latitude range (° N)	Mean date	Date range
1983	33	196.1	187-216	32.59	32.48-32.73	9/14	9/6-9/21
1984	57	209.8	165-214	32.29	31.84-32.56	6/28	5/22-9/22
1985	44	215.4	168-265	32.11	31.85-32.51	9/3	8/22-9/8
1986	21	214.2	185-254	32.19	31.87-32.50	6/10	6/10-6/12
1987	0	-	-	-	-	-	-
1988	0	-	-	-	-	-	-
1989	0	-	-	-	-	-	-
1990	0	-	-	-	-	-	-
1991	0	-	-	-	-	-	-
1992	0	-	-	-	-	-	-
1993	0	-	-	-	-	-	-
1994	0	-	-	-	-	-	-
1995	0	-	-	-	-	-	-
1996	15	198.3	163-240	32.11	31.51-32.56	7/14	5/1-9/19
1997	21	204.2	164-235	32.18	31.84-32.53	8/16	8/12-8/20
1998	8	197.5	173-234	32.12	31.91-32.50	5/28	5/19-6/25
1999	26	217.3	181-280	32.03	31.61-32.53	8/31	8/23-9/9
2000	11	202.2	166-228	31.50	30.05-32.02	8/13	7/26-9/20
2001	14	207.8	181-231	31.88	31.21-32.05	8/21	6/24-8/30
2002	20	226.0	184-254	31.89	31.52-32.21	9/5	7/17-9/19
2003	14	218.6	169-251	31.92	31.66-32.22	9/23	9/22-9/25
2004	5	193.6	183-209	32.02	31.96-32.08	9/30	9/30-9/30
2005	16	211.6	175-250	31.94	31.70-32.20	9/20	9/20-9/22
2006	7	200.7	176-218	32.04	31.84-32.15	9/26	9/26-9/27
2007	24	212.6	180-240	32.04	31.24-32.48	8/18	6/26-9/25
2008	0	-	-	-	-	-	-
2009	36	215.8	179-244	31.88	31.42-32.55	8/30	8/15-9/24
2010	40	228.3	183-261	32.01	31.42-32.55	8/19	8/10-9/15

Table 2. Information associated with longline sets in the MARMAP horizontal longline survey, summarized by the groups of years used in the analysis.

Year group	N	Mean depth (m)	Depth range (m)	Mean latitude (° N)	Latitude range (° N)	Mean date	Date range
1983-1986	155	209.1	165-265	32.29	31.84-32.73	8/1	5/22-9/22
1996-1999	70	207.0	163-280	32.10	31.51-32.56	8/6	5/1-9/19
2000-2003	56	215.8	166-254	31.90	31.21-32.22	9/4	6/24-9/25
2004-2007	52	208.8	175-240	32.00	31.24-32.48	9/7	6/26-9/30
2009-2010	76	222.4	179-261	31.95	31.42-32.55	8/25	8/10-9/24

Table 3. Golden tilefish catch information from the MARMAP horizontal longline database, summarized by the groups of years used in the analysis. All CPUE calculations are number of golden tilefish caught per hour soak time.

Year	# sets	# tilefish caught	Proportion positive longline sets	Mean (SD) CPUE (catch · hr^{-1})	Minimum CPUE (catch · hr^{-1})	Maximum CPUE (catch · hr^{-1})
1983-1986	155	314	0.53	1.03 (1.68)	0.00	9.32
1996-1999	70	301	0.47	2.46 (3.91)	0.00	15.35
2000-2003	56	97	0.43	1.00 (1.75)	0.00	9.03
2004-2007	52	39	0.12	0.45 (1.27)	0.00	5.33
2009-2010	76	336	0.59	2.82 (4.24)	0.00	19.78

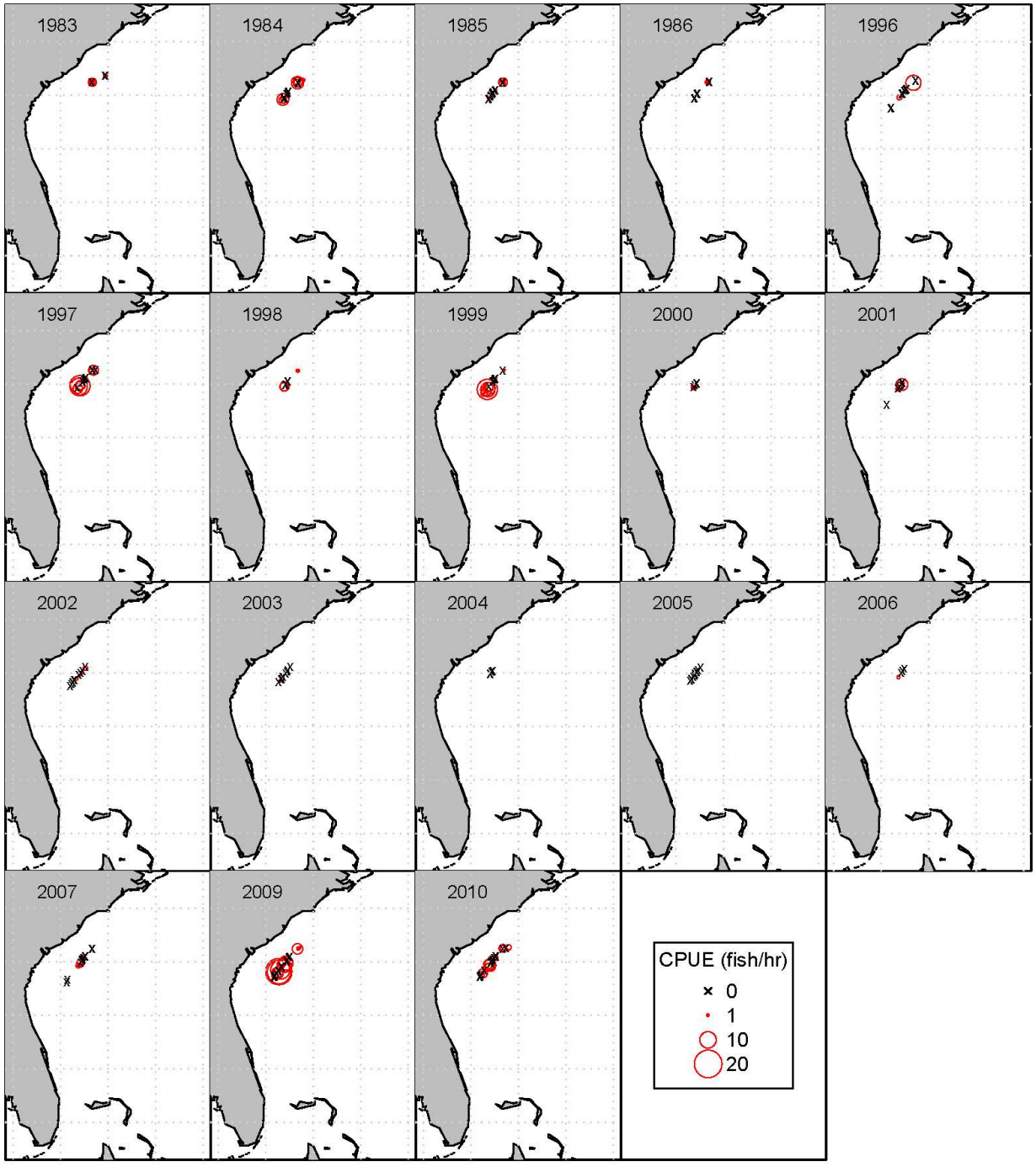

Figure 1. Map of MARMAP horizontal longline stations sampled in 1983–1986, 1996–2007, and 2009–2010. Years with no sampling are excluded from the figure. Stations with zero catch of golden tilefish are shown by the black 'x' and stations with positive CPUE of golden tilefish are shown by the red circle (and the size of the circle is proportional to CPUE).

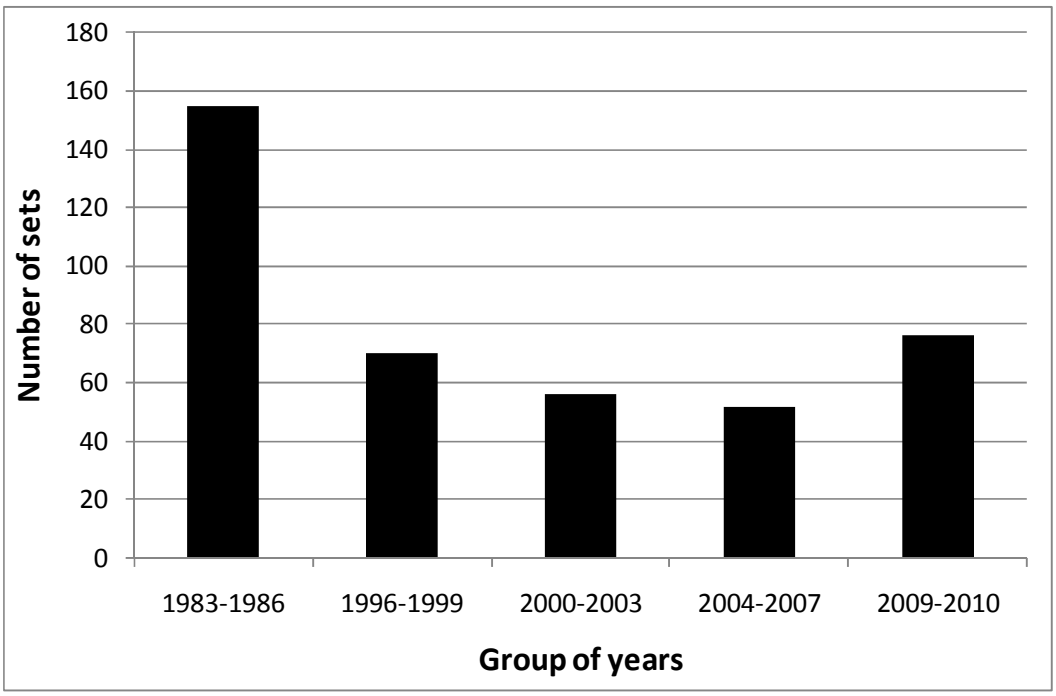

Figure 2. The total number of longline sets deployed by MARMAP within each of the groups of years used in the analysis.

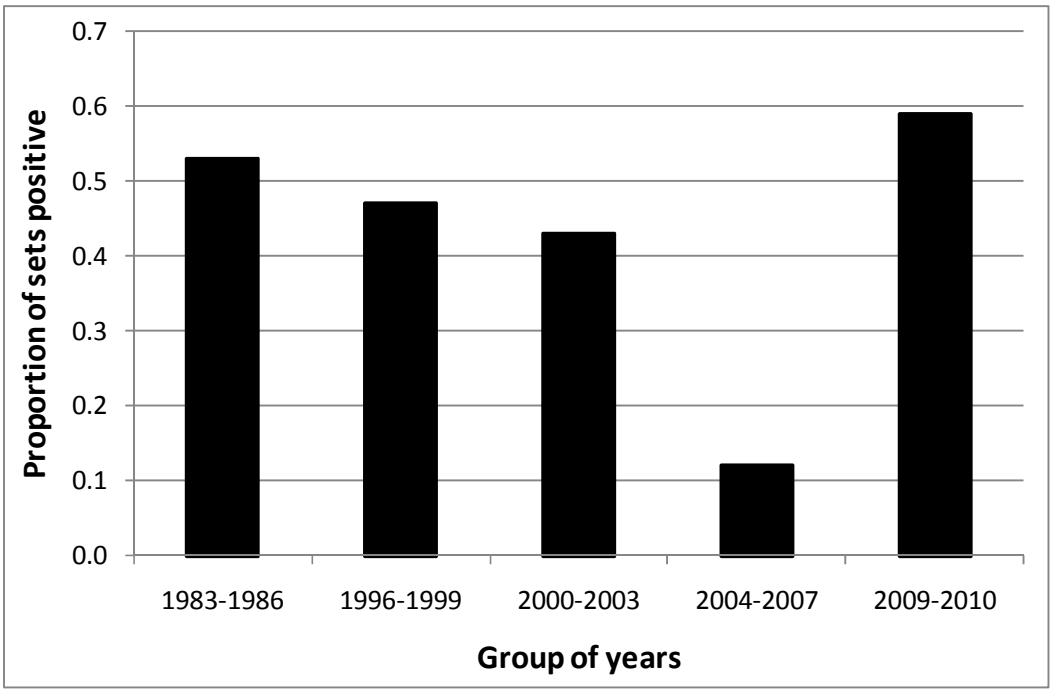

Figure 3. The proportion of MARMAP longline sets with positive golden tilefish catch within each of the groups of years used in the analysis.

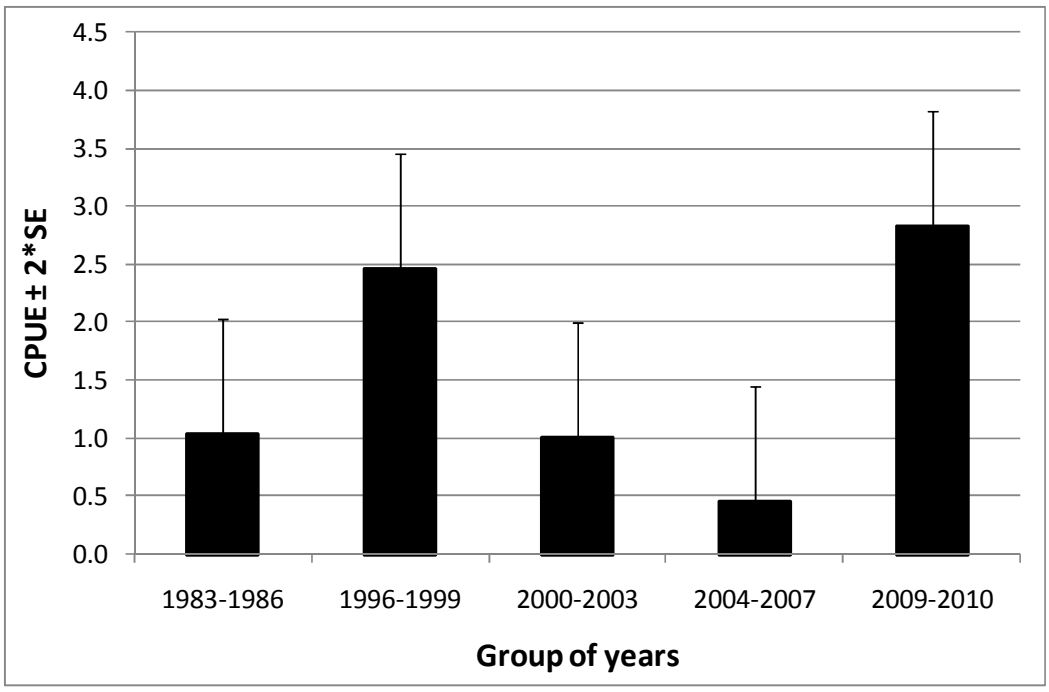

Figure 4. The nominal CPUE of golden tilefish caught in MARMAP bottom longlining within the groups of years used in the analysis.

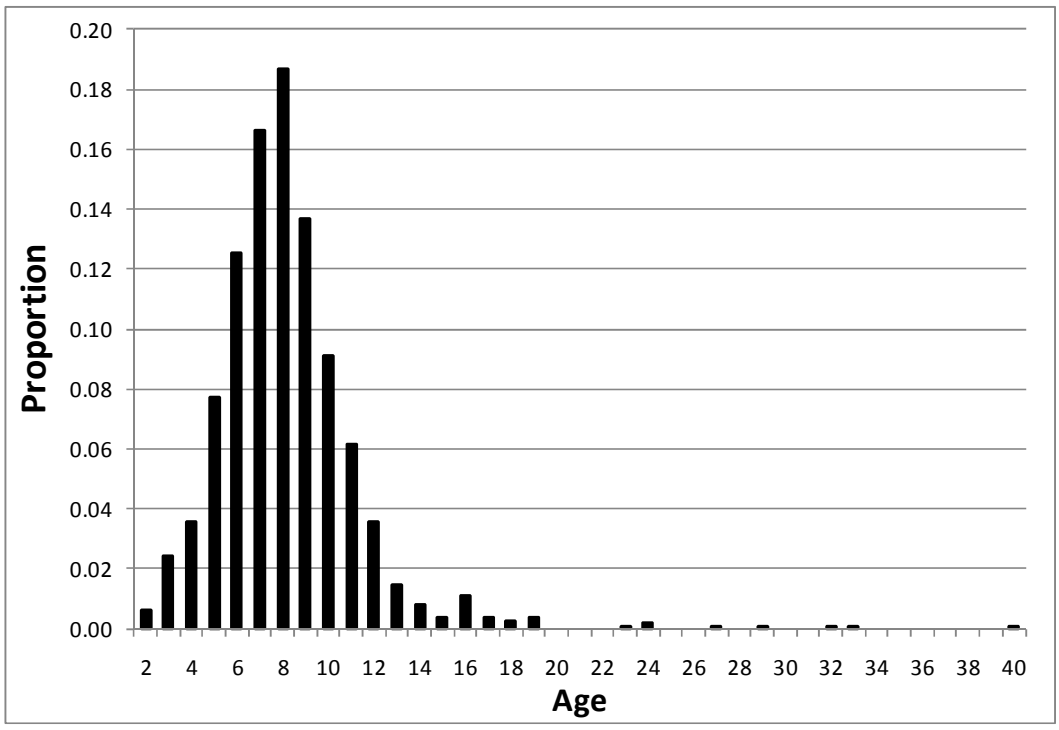

Figure 5. Ages of golden tilefish collected by MARMAP bottom longlining in 1983–1986, 1996–2007, and 2009–2010. Note that ages provided here are actually increment counts (and thus not true ages) because edge type could not be distinguished accurately.