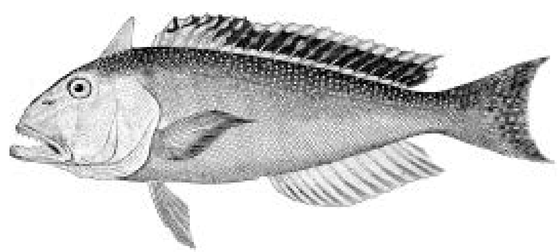
Golden Tilefish, *Lopholatilus chamaeleonticeps,* data update through 2017 in the Middle Atlantic-Southern New England Region



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Introduction

Golden tilefish, *Lopholatilus chamaeleonticeps*, inhabit the outer continental shelf from Nova Scotia to South America, and are relatively abundant in the Southern New England to Mid-Atlantic region at depths of 80 to 440 m. Tilefish have a narrow temperature preference of 9 to 14 C. Their temperature preference limits their range to a narrow band along the upper slope of the continental shelf where temperatures vary by only a few degrees over the year. They are generally found in and around submarine canyons where they occupy burrows in the sedimentary substrate. Tilefish are relatively slow growing and long-lived, with a maximum observed age of 46 years and a maximum length of 110 cm for females and 39 years and 112 cm for males (Turner 1986). At lengths exceeding 70 cm, the predorsal adipose flap, characteristic of this species, is larger in males and can be used to distinguish the sexes. Tilefish of both sexes are mature at ages between 5 and 7 years (Grimes et. al. 1988).

Golden Tilefish was first assessed at SARC 16 in 1992 (NEFSC 1993). The Stock Assessment Review Committee (SARC) accepted a non-equilibrium surplus production model (ASPIC). The ASPIC model estimated biomass-based fishing mortality (F) in 1992 to be 3-times higher than F_{MSY}, and the 1992 total stock biomass to be about 40% of B_{MSY}. The intrinsic rate of increase (r) was estimated at 0.22.

The Science and Statistical Committee reviewed an updated tilefish assessment in 1999. Total biomass in 1998 was estimated to be 2,936 mt, which was 35% of B_{MSY} = 8,448 mt. Fishing mortality was estimated to be 0.45 in 1998, which was about 2-times higher than F_{MSY} = 0.22. The intrinsic rate of increase (r) was estimated to be 0.45. These results were used in the development of the Tilefish Fishery Management Plan (Mid-Atlantic Fishery Management Council 2000). The Mid-Atlantic Fishery Management Council implemented the Tilefish Fishery Management Plan (FMP) in November of 2001. Rebuilding of the tilefish stock to B_{MSY} was based on a ten-year constant harvest quota of 905 mt.

SARC 41 reviewed a benchmark tilefish assessment in 2005. The surplus production model indicated that the tilefish stock biomass in 2005 has improved since the assessment in 1999. Total biomass in 2005 is estimated to be 72% of B_{MSY} and fishing mortality in 2004 is estimated to be 87% of F_{MSY}. Biological reference points did not change greatly from the 1999 assessment. B_{MSY} is estimated to be 9,384 mt and F_{MSY} is estimated to be 0.21. The SARC concluded that the projections are too uncertain to form the basis for evaluating likely biomass recovery schedules relative to B_{MSY}. The total allowable landings (TAL) and reference points were not changed based on the SARC 41 assessment.

Stock status from SARC 48 (2009) was also based on the ASPIC surplus production model which was the basis of the stock assessment for the last three assessments. The model is calibrated with CPUE series, as there are no fishery-independent sources of information on trends in population abundance. While the Working Group expressed concern about the lack of fit of the model to the VTR CPUE index at the end of the time series, they agreed to accept the estimates of current fishing mortality and biomass and associated reference points. The instability of model results in the scenario projections was also a source of concern. It was noted that the bootstrap uncertainty estimates do not capture the true uncertainty in the assessment. The ASPIC model indicates that the stock is rebuilt. However, the working group acknowledges that there is high uncertainty on whether the stock is truly rebuilt.

The golden tilefish stock was last assessed at SARC 58 in 2014 with a terminal year of 2012 (http://nefsc.noaa.gov/publications/crd/crd1403/partb.pdf, http://nefsc.noaa.gov/publications/crd/crd1404/partb.pdf). The Golden Tilefish stock was not overfished and overfishing was not occurring in 2012 relative to the SARC 58 accepted biological reference points. The stock was declared rebuilt in 2014 by NMFS based of SARC 58 results which indicated that SSB was at 101% of the accepted SSB_{MSY}. A new model, ASAP, was used in this assessment to incorporate newly available length and age data. The ASAP model integrates more realistic life history information on size and growth into a single model framework and better characterizes the population dynamics of the tilefish stock.

A golden tilefish model update was done in 2017 with updated commercial fishery landings, landings size distributions, and CPUE indices of abundance through 2016. The Golden tilefish stock was not overfished and overfishing was not occurring in 2016 relative to the newly updated biological reference points.

In this report, commercial landings, longline fishery CPUE, and landings size distributions were updated an additional year of data through 2017. Commercial landings maps from 1998 to 2017 are also summarized in Appendix 1. Updated data is summarized in Tables 1 to 3 and Figures 1, 2, 4-7, 10-11. Figures 3, 8, and 9 are taken from the last data update in 2016 and have not been updated. Evidence of the strong 2013 year class that was predicted in the 2017 model update is evident in the updated 2017 data with an increase in the CPUE and tracking of a mode in the commercial size distribution.

Commercial catch data

Total commercial landings (live weight) increased from less than 125 metric tons (mt) during 1967-1972 to more than 3,900 mt in 1979 and 1980. Annual landings have ranged between 666 and 1,838 mt from 1988 to 1998. Landings from 1999 to 2002 were below 900 mt (ranging from 506 to 874 mt). An annual quota of 905 mt was implemented in November of 2001. Landings in 2003 and 2004 were slightly above the quota at 1,130 mt and 1,215 mt respectively. Landing from 2005 to 2009 have been at or below the quota. Landings in 2010 at 922 mt were slightly above the quota (Table 1, Figure 1). Since 2010 landings have been below the quota. The preliminary landings retrieval for 2017 as of 2/09/18 was 695 mt which was and increase from 2016 but remains below the TAL of 856 mt.

The TAL was reduced for the first time in 2015 to 796 mt from a TAL of 905 mt which was in place from 2001-2014. The TAL in 2016 and 2017 set at 856 mt based on projections from the SARC 58 assessment. The TAL was further reduced to 738 mt for 2018 to 2020 based on the model update in 2017.

During the late 1970s and early 1980s Barnegat, NJ was the principal tilefish port; more recently Montauk, NY has accounted for most of the landings. Most of the commercial landings are taken by the directed longline fishery. Discards in the trawl and longline fishery appear to be a minor component of the catch. Recreational catches have also appeared to be low and were not included as a component of the removals in the assessment model.

Commercial CPUE data

A fishery independent index of abundance does not exist for tilefish. Analyses of catch (landings) and effort data were confined to the longline fishery since directed tilefish effort occurs in this fishery (e.g. the remainder of tilefish landings are taken as bycatch in the trawl fishery). Most longline trips that catch tilefish fall into two categories: (a) trips in which tilefish comprise greater than 90% of the trip catch by weight and (b) trips in which tilefish accounted for less than 10% of the catch. Effort was considered directed for tilefish when at least 75% of the catch from a trip consisted of tilefish.

Three different series of longline effort data were analyzed. The first series was developed by Turner (1986) who used a general linear modeling approach to standardize tilefish effort during 1973-1982 measured in kg per tub (0.9 km of groundline with a hook every 3.7 m) of longline obtained from logbooks of tilefish fishermen. Two additional CPUE series were calculated from the NEFSC weighout (1979-1993) and the VTR (1995-2015) systems. Effort from the weighout data was derived by port agents' interviews with vessel captains whereas effort from the VTR systems comes directly from mandatory logbook data. In the SARC 58 assessment (2014) and in the 2009, 2005 and 1998 tilefish assessments, Days Absent was used as the best available effort metric. In the 1998 assessment an effort metric based on Days Fished (average hours fished per set / 24 * x number of sets in trip) was not used because effort data were missing in many of the logbooks and the effort data were collected on a trip basis as opposed to a haul by haul basis. In the SARC 58 assessment effort was calculated as:

Effort = days absent (time & date landed - time & date sailed) – 1 day per trip.

For some trips, the reported days absent were calculated to be a single day. This was considered unlikely, as a directed tilefish trip requires time for a vessel to steam to near the edge of the continental shelf, time for fishing, and return trip time. Thus, to produce a realistic effort metric based on days absent, a one day steam time for each trip (or the number of trips) was subtracted from days absents and therefore only trips with days absent greater than one day were used.

The number of vessels targeting tilefish has declined since the 1980s (Table 2, Figure 2); during 1994-2003 and 2005-2015, five vessels accounted for more than 70 percent of the total tilefish landings. The number of vessels targeting tilefish has remained fairly constant since the assessment in 2005. The length of a targeted tilefish trip had been generally increasing until the mid 1990s. At the time of the 2005 assessment trip lengths have shorten to about 5 days. Trip length has increased slightly until 2008 and has subsequently declined until 2011. Trip lengths have been increasing slightly since 2011 to about 8.5 days in 2017 (Figure 2). In the weighout data the small number of interviews is a source of concern; very little interview data exists at the beginning of the time series (Table 2, Figure 3). The 5 dominant tilefish vessels make up almost all of the VTR reported landings.

The number of targeted tilefish trips declined in the early 1980s while trip length increased at the time the FMP was being developed in 2000 (Figures 2 and 4). During the 2005 assessment the number of trips became relatively stable as trip length decreased. The interaction between the number of vessels, the length of a trip and the number of trips can be seen in the total days absent trend in Figure 4. Total days absent remained relatively stable in the early 1980s, but then declined at the end of the weighout series (1979-1994). In the beginning of the VTR series (1994-2004) days absent increased through 1998 but declined to 2005. Days absent increased from 2005 to 2008 but subsequential declined until 2010. Again days absent increased from 2010 to 2014 and has subsequently declined. When interpreting total days absent trends, it is important to note with improvements in data collection more recently that the subset of CPUE landings makes up a greater proportion of the total dealer landings (Figure 4).

CPUE trends are very similar for most vessels that targeted tilefish. A sensitivity test of the general linear model (GLM) using different vessel combinations was done in SARC 41. The SARC 41 GLM was found not to be sensitive to different vessels entering the CPUE series. Very little CPUE data exist for New York vessels in the 1979-1994 weighout series despite the shift in landing from New Jersey to New York before the start of the VTR series in 1994. Splitting the weighout and VTR CPUE series can be justified by the differences in the way effort was measured and difference in the tilefish fleet between the series. In breaking up the series we omitted 1994 because there were very little CPUE data. The sparse 1994 data that existed came mostly from the weighout system in the first quarter of the year. Very similar trends exist in the four years of overlap between Turner (1986) CPUE and the weighout series (Figure 5). At SARC 58 additional logbook data for three New York vessels was collected from New York fishermen from 1991-1994 and added to the VTR series. This was done to provide more information (years of overlap) in the modeling between the Weighout and the VTR series.

Since 1979, the tilefish industry has changed from using cotton twine to steel cable for the backbone and from J hooks to circle hooks. The gear change to steel cable and snaps started on New York vessels in 1983. In light of possible changes in catchability associated with these changes in fishing gear, the working group considered that it would be best to use the three available indices separately rather than combined into one or two series. The earliest series (Turner 1986) covered 1973-1982 when gear construction and configuration was thought to be relatively consistent. The Weighout series (1979-1993) overlapped the earlier series for four years and showed similar patterns and is based primarily on catch rates from New Jersey vessels. The VTR (1991-2017) series is based primarily on information from New York vessels using steel cable and snaps.

The NEFSC Weighout and VTR CPUE series were standardized using a GLM incorporating year and individual vessel effects. The CPUE was standardized to an individual longline vessel and the year 1984; the same year used in the last assessment. For the VTR series the year 2000 was used as the standard. Model coefficients were back-transformed to a linear scale after correcting for transformation bias. The updated GLM model that accounted for individual vessel effects appears to show more of an overall increasing trend in CPUE in comparison to the nominal series (Figure 6).

More recently changes in the CPUE can be generally explained with evidence of strong incoming year classes that track through the landings size composition over time (See below). Since the SARC 58 assessment there appear to be increases in CPUE due to one or two new strong year classes. In general, strong year classes appear to persist longer in the fishery after the FMP and after the constant quota management came into effect which is evident in both the CPUE and size composition data. The CPUE has increased in 2017 which is consistent with the growth of a strong 2013 year class.

Commercial market category and size composition data

Seven market categories exist in the database. From smallest to largest they are: extra small, small, kitten, medium, large/medium, large and extra-large as well as an unclassified category. Differences in the naming convention among ports tend to cause some confusion. For example, small and kitten categories reflect similar size fish. Smalls is the naming convention used in New Jersey whereas the kitten market category is used primarily in New York ports. A new code was recently developed for the large-medium category in 2013 and 2014. In 2014 it appears that fish which would have been called unclassified in the past are now being correctly coded as large-mediums.

The proportion of landings in the kittens and small market categories increased in 1996 and 1997. Evidence of several strong recruitment events can be seen tracking through the market category proportions (Table 3, Figures 7). The proportion of the large market category has been relatively low in the 1990s until around 2004. The proportion of larges has increased since 2005. The strong year class tracking through the small kitten and mediums in the late 1990s did not materialize into the large market category.

Evidence of two strong recruitment events can be seen tracking through these market categories. At the time of the 2005 tilefish assessment the proportion of large market category had declined since the early 1980s. However more recently a greater proportion of the landings are coming from the large market category as the last strong year class (1999) has grown (Table 3, Figure 7). Commercial length sampling was inadequate over most of the early time series. However, some commercial length sampling occurred in the mid to late 1990s. More recently there has been a substantial increase in the commercial length sampling from 2003 to 2015.

Commercial length frequencies were expanded for years where sufficient length data exist (1995-1999 and 2002-2015). The large length frequency samples from 1996 to 1998 were used to calculate the 1995 to 1999 expanded numbers at length while the large length samples from 2001 and 2003 were used to calculate the 2002 expanded numbers at length. No lengths for extra small (xs) exist in 2013. In 2013 kittens' lengths were used to characterize the extra small category.

Evidence of strong 1992/1993 and 1998/1999 year classes can be seen in the expanded numbers at length in the years when length data existed (1995-1999, 2002-2008, and 2008-2014) (Figures 8 to 11). The matching of modes in the length frequency with ages was done using Turner's (1986) and Vidal's (2009) growth studies and the 2007-2013 catch at age information. In 2004 and 2005 the 1998/1999 year class can be seen growing into the medium market category and in 2006 and 2007 the year class has entered the large market category (Figure 9). From 2002 to 2007 it appears that most of the landings were comprised of this year class.

A similar pattern occurred with the 2005 year class from 2009-2013. An increase in the landings and CPUE can be seen when the 1992/1993, 1998/1999 and 2005 year classes recruit to the longline fishery. As the year classes gets older the catch rates decline. At this point the catch also gets more widely distributed over multiple year classes. This can be seen in 2007-2008 and 2012-2015 (Figure 9). CPUE appears to decline as the strong year classes get older than about 6 years. From 2013 to 2015 catch appears to be comprised of multiple year classes with a wide distribution of fish sizes being caught as the catch rates have declined in the VTR series (Figure 10).

Concern was expressed at SARC 48 (2009) with little evidence of an incoming year class, catch rates declining and the mismatch between the biomass trends predicted by the surplus production model in comparison to the observed CPUE at the end of the time series. However, since the 2009 assessment there is evidence of a strong year class (2005) tracking through the landings size distributions. In 2012 that year class has entered the large market category and as expected, there is a decline in the CPUE since 2011. However, there is also some evidence of a broader size distribution of the fish being caught from 2011 to 2015 which suggests the fishery is less reliant on a single year class and that larger fish remain in the population.

The updated data in 2017 appears to comport with the 2017 model update with a 2016 terminal year. The model update predicted a strong 2013 year class which began to enter the fishery in 2016. This 2018 data update did show increases in CPUE as the strong year class became more selected by the fishery in 2017. There is also evidence for the 2013 year class with the tracking of the length model in the landings at length. The 2017 model update indicates that this year class was about 50% selected in 2017 and is predicted to be 100% selected in 2018. Therefore, catch rates in 2018 are predicted to continue to increase. However, considerable uncertainty remains with the estimated size of the 2013 year class since the model was not updated in 2018 to reestimate the size of the year class.

Conclusions

Landings have remained between 814 and 845 mt from 2012 to 2014. Landing has declined in 2016 to 494 mt which appears to be the result of a combination of lower catch rates and some inactive vessels. However landing have increase in 2017 to 695 mt. Updated CPUE in 2017 has also increase relative to 2016 which appears to be consistent with a strong 2013 year class that was estimated in the 2017 model update. The commercial size distribution provided further evidence for the strong 2013 year class with the tracking of the length mode into the kitten and small market categories.

Table 1. Landings of tilefish in live metric tons from 1915-2017. Landings in 1915-1972 are from Freeman and Turner (1977), 1973-1989 are from the general canvas data, 1990-1993 are from the weighout system, 1994-2003 are from the dealer reported data, and 2004-2017 is from Dealer electronic reporting. - indicates missing data. * Preliminary data retrieved on 1/17/18.

year	mt	year	mt	year	mt
1915	148	1960	1,064	2005	676
1916	4,501	1961	388	2006	907
1917	1,338	1962	291	2007	749
1918	157	1963	121	2008	737
1919	92	1964	596	2009	864
1920	5	1965	614	2010	922
1921	523	1966	438	2011	864
1922	525	1967	50	2012	834
1923	623	1968	32	2013	846
1924	682	1969	33	2014	814
1925	461	1970	61	2015	593
1926	904	1971	66	2016	494
1927	1,264	1972	122	2017	*695
1928	1,076	1973	394		
1929	2,096	1974	586		
1930	1,858	1975	710		
1931	1,206	1976	1,010		
1932	961	1977	2,082		
1933	688	1978	3,257		
1934	-	1979	3,968		
1935	1,204	1980	3,889		
1936	-	1981	3,499		
1937	1,101	1982	1,990		
1938	533	1983	1,876		
1939	402	1984	2,009		
1940	269	1985	1,961		
1941	-	1986	1,950		
1942	62	1987	3,210		
1943	8	1988	1,361		
1944	22	1989	454		
1945	40	1990	874		
1946	129	1991	1,189		
1947	191	1992	1,653		
1948	465	1993	1,838		
1949	582	1994	786		
1950	1,089	1995	666		
1951	1,031	1996	1,121		
1952	964	1997	1,810		
1953	1,439	1998	1,342		
1954	1,582	1999	525		
1955	1,629	2000	506		
1956	707	2001	874		
1957	252	2002	851		
1958	672	2003	1,130		
1959	380	2004	1,215		

Table 2. Total commercial and vessel trip report (VTR) landings in live mt and the commercial catch-per-unit effort (CPUE) data used for tilefish. Dealer landings before 1990 are from the general canvas data. CPUE data from 1979 to the first half of 1994 are from the NEFSC weighout database, while data in the second half of 1994 to 2017 are from the vtr system (below the dotted line). Effort data are limited to longline trips which targeted tilefish (= or >75% of the landings were tilefish) and where data existed for the days absent. Nominal CPUE series are calculated using landed weight per days absent minus one day steam time per trip. Da represents days absent.

	Weighout		Commerical CPUE data subset								
year	& Dealer landings	vtr landings	interview landings	No. interviews	% interview trips	No. vessels	subset landings	days absent	No. trips	da per trip	nominal cpue
1979	3,968		0.0	0	0.0%	20	1,807	1,187	330	3.6	1.93
1980	3,889		0.8	1	0.3%	18	2,153	1,390	396	3.5	1.99
1981	3,499		35.0	4	1.2%	21	1,971	1,262	333	3.8	1.95
1982	1,990		90.7	13	5.7%	18	1,267	1,282	229	5.6	1.10
1983	1,876		85.8	16	8.9%	21	1,013	1,451	179	8.1	0.73
1984	2,009		140.1	25	18.2%	20	878	1,252	138	9.1	0.72
1985	1,961		297.1	64	30.6%	25	933	1,671	209	8.0	0.59
1986	1,950		120.7	31	16.5%	23	767	1,186	188	6.3	0.71
1987	3,210		198.5	38	18.5%	30	1,014	1,343	206	6.5	0.82
1988	1,361		148.2	30	19.4%	23	422	846	154	5.5	0.56
1989	454		92.8	11	15.7%	11	165	399	70	5.7	0.46
1990	874		32.4	8	11.9%	11	241	556	68	8.2	0.45
1991	1,189		0.8	3	2.8%	7	444	961	107	9.0	0.48
1992	1,653		58.0	9	8.6%	13	587	969	105	9.2	0.62
1993	1,838		71.9	11	10.5%	10	571	959	105	9.1	0.61
1994	-		0	0	0.0%	7	127	385	42	9.2	0.34
1994	786	30				4	53	150	18	8.3	0.37
1995	666	547				5	466	954	99	9.6	0.50
1996	1,121	865				8	822	1,318	134	9.8	0.64
1997	1,810	1,439				6	1,427	1,332	133	10.0	1.09
1998	1,342	1,068				9	1,034	1,517	158	9.6	0.70
1999	525	527				10	516	1,185	133	8.9	0.45
2000	506	446				11	421	932	110	8.5	0.47
2001	874	705				8	691	1,046	116	9.0	0.68
2002	851	724				8	712	951	114	8.3	0.78
2003	1,130	790				7	788	691	101	6.8	1.22
2004	1,215	1,153				12	1,136	811	134	6.1	1.54
2005	676	808				11	802	470	93	5.1	1.95
2006	907	870				12	852	682	105	6.5	1.35
2007	749	710				12	691	727	101	7.2	1.01
2008	737	675				14	672	1,119	124	9.0	0.62
2009	864	812				12	800	1,106	130	8.5	0.75
2010	922	871				11	853	694	108	6.4	1.33
2011	864	822				9	781	517	89	5.8	1.68
2012	834	799				12	795	651	100	6.5	1.32
2013	846	844				11	796	831	112	7.4	1.02
2014	814	790				13	716	961	120	8.0	0.78
2015	593	593				12	515	920	111	8.3	0.58
2016	494	491				11	381	806	98	8.2	0.49
2017	695	635				9	527	725	85	8.5	0.76

Table 3. Landing (metric tons) by market category. A large-medium (lg/med) code was developed in 2013 and 2014. Smalls and Kittens were combined since these categories possess similar size fish. Xs is extra small and xl is extra large.

year	xs	small & kittens	medium	lg/med	large	xl	unclassified	total
1990	0	38	103	-	46	0	687	874
1991	0	59	154	-	85	0	891	1189
1992	0	330	88	-	86	0	1,149	1653
1993	0	368	206	-	66	4	1,193	1838
1994	0	19	89	-	54	7	617	786
1995	0	99	88	-	91	2	386	666
1996	0	592	149	-	156	2	221	1121
1997	0	1,130	260	-	111	2	307	1810
1998	0	475	700	-	103	6	58	1342
1999	0	181	201	-	106	8	29	525
2000	0	210	153	-	115	8	20	506
2001	0	564	161	-	124	6	19	874
2002	0	369	311	-	128	3	40	851
2003	0	776	171	-	144	5	35	1130
2004	20	397	523	-	129	9	137	1215
2005	0	18	335	-	149	1	173	676
2006	1	16	233	-	369	1	287	907
2007	3	96	142	-	397	4	106	749
2008	17	149	195	-	299	17	60	737
2009	35	334	179	-	226	28	61	864
2010	16	269	373	-	166	17	81	922
2011	6	142	339	-	216	10	152	864
2012	8	95	308	-	285	17	121	834
2013	19	138	281	14	290	21	82	846
2014	13	227	195	88	238	47	5	814
2015	12	92	160	84	186	57	2	593
2016	42	93	75	65	172	44	3	494
2017	35	299	132	43	152	26	9	695

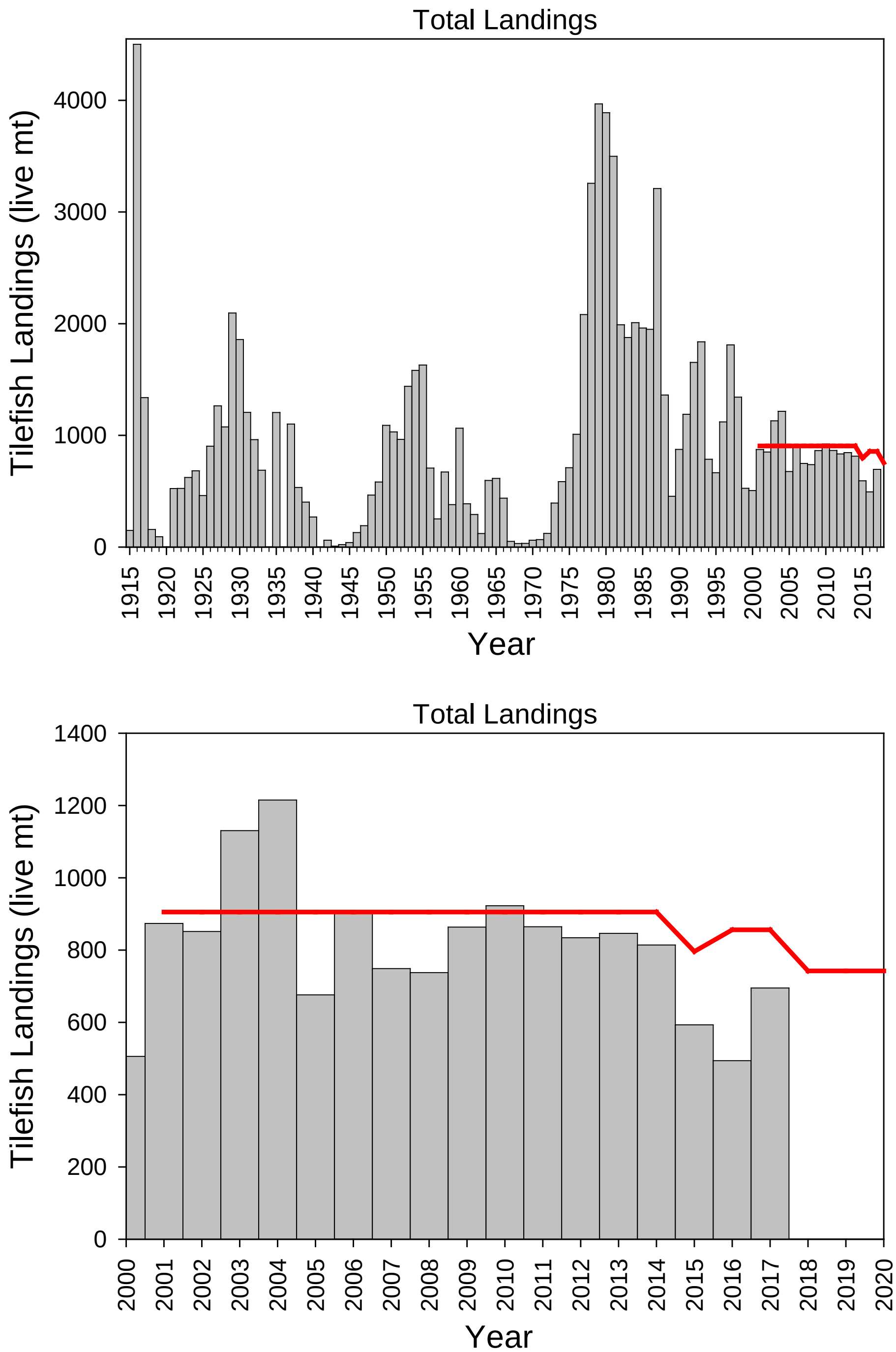


Figure 1. Landings of tilefish in metric tons from 1915-2015 (top) and from 2000-2015 (bottom). Landings in 1915-1972 are from Freeman and Turner (1977), 1973-1989 are from the general canvas data, 1990-1993 are from the weighout system, 1994-2003 are from the dealer reported data, and 2004-2015 is from dealer electronic reporting. Preliminary landings retrieved on 1/17/18. Red line is the TAL from 2001-2020.

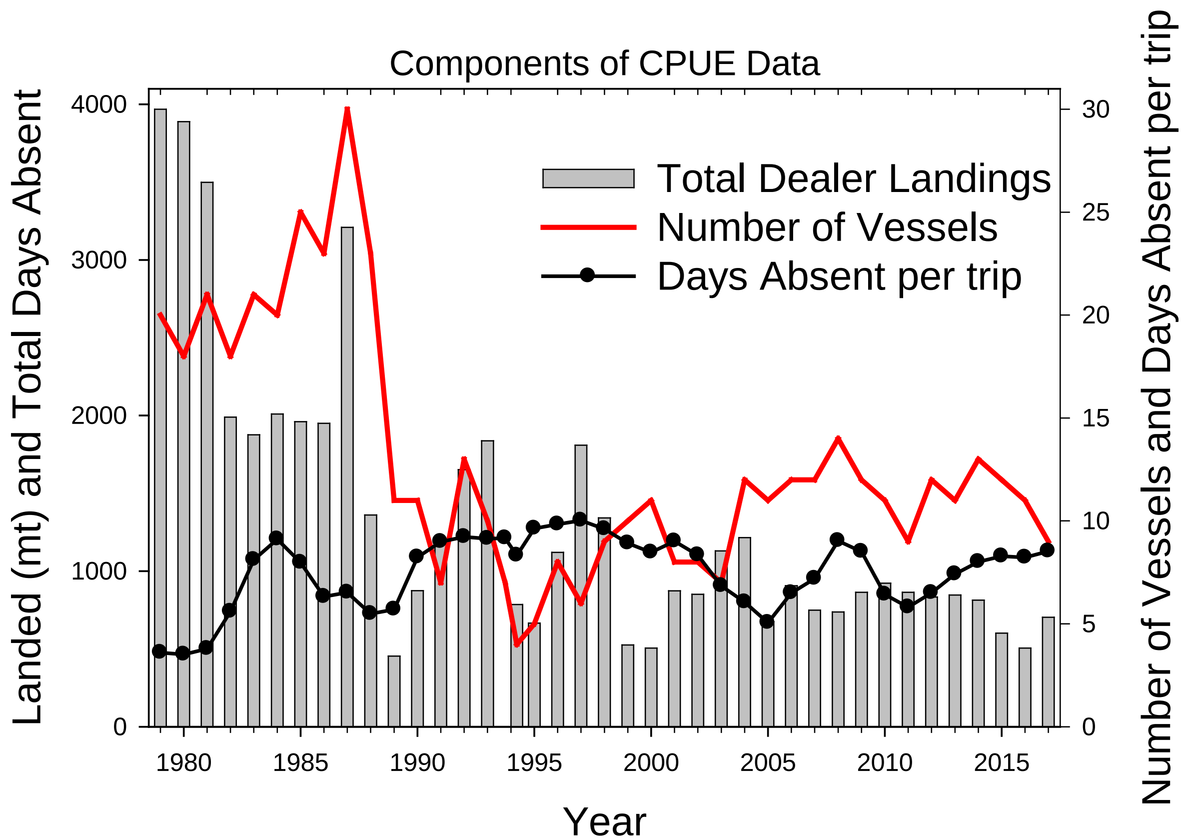


Figure 2. Number of vessels and length of trip (days absent per trip) for trips targeting tilefish (= or >75% tilefish) from 1979-2017. Total Dealer landings are also shown.

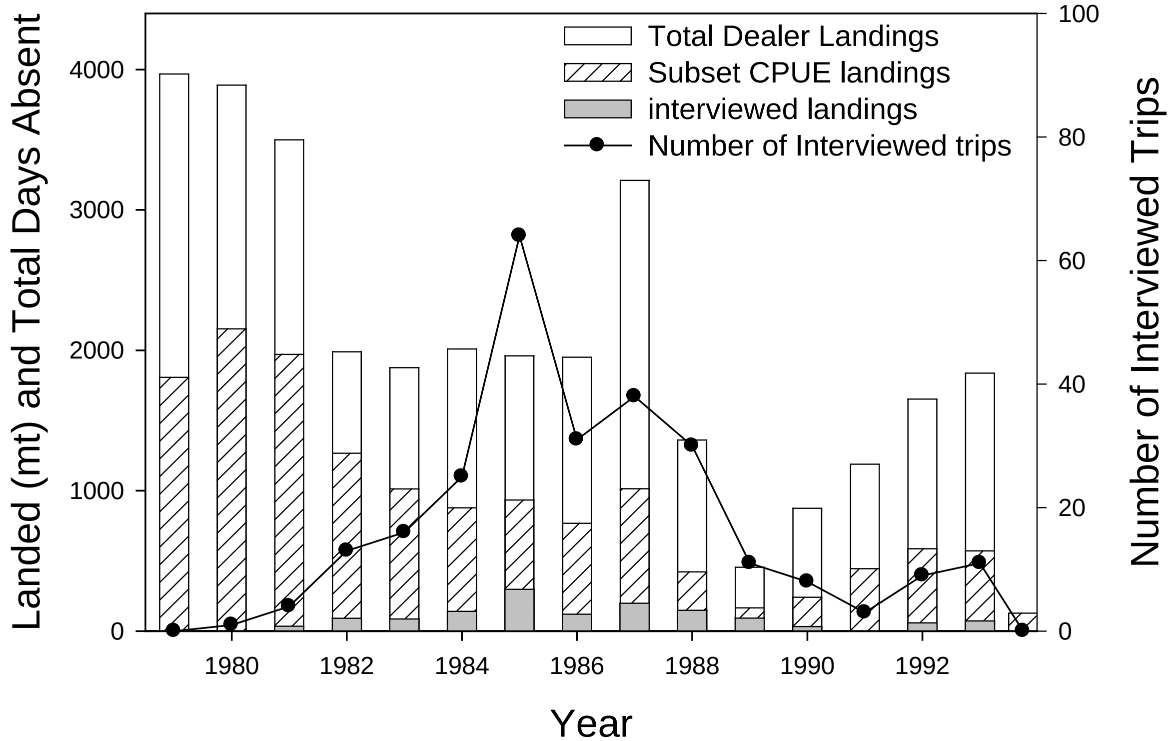


Figure 3. Number of interviewed trips and interviewed landings for trips targeting tilefish (= or >75% tilefish) for the Weighout data from 1979-1994. Total Weighout landings and the subset landings used in CPUE estimate are also shown.

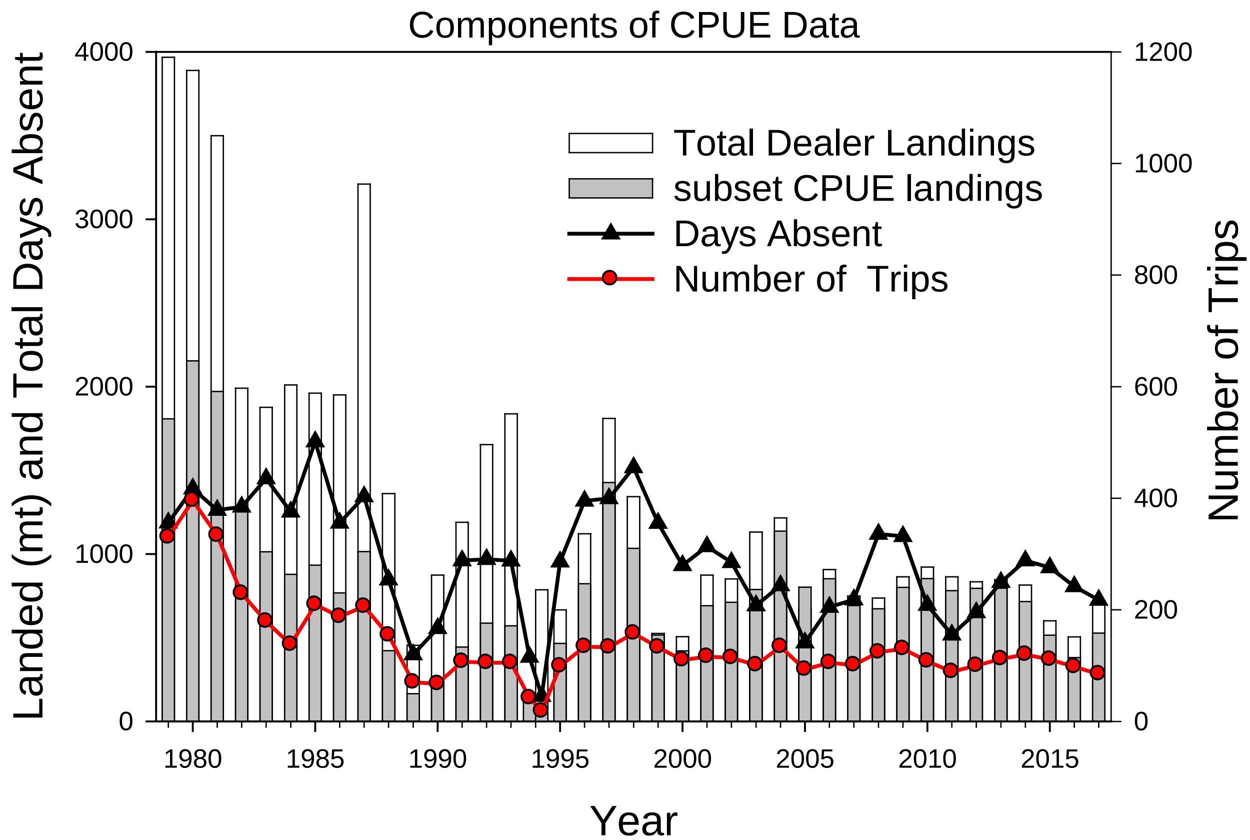


Figure 4. Total number of trips and days absent for trips targeting tilefish (= or >75% tilefish) from 1979-2017. Total Dealer and CPUE subset landings are also shown

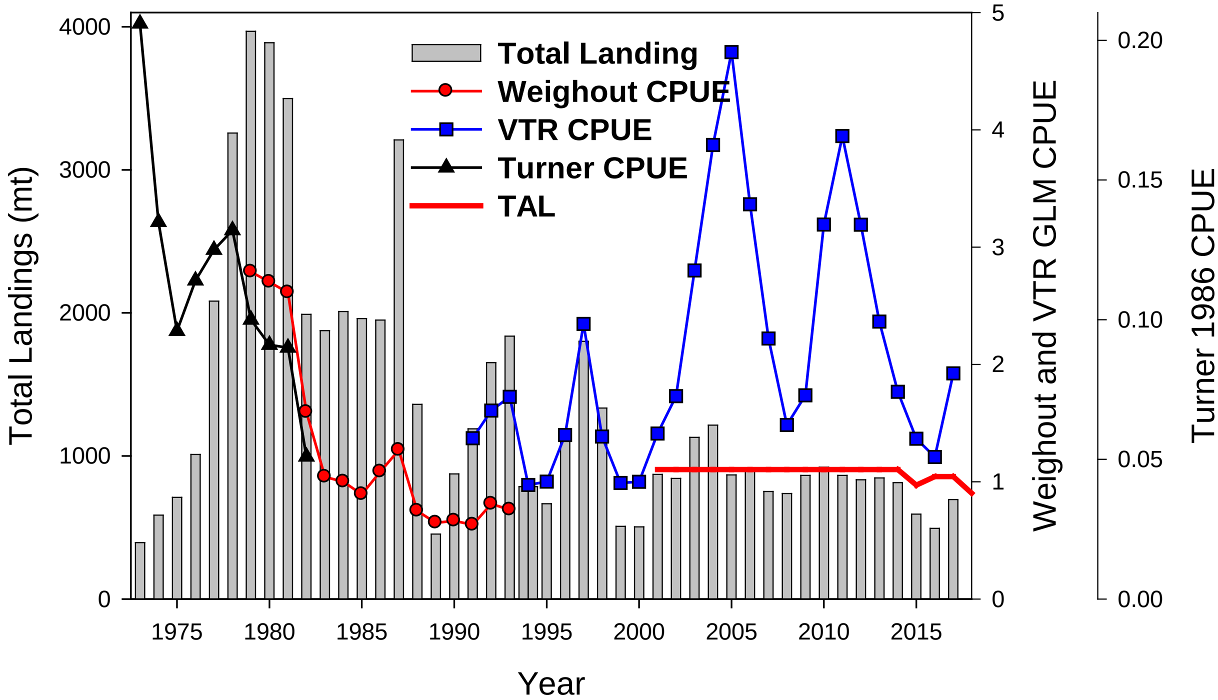


Figure 5. GLM CPUE for the Weighout and VTR data split into two series with additional New York logbook CPUE data from three vessels (1991-1994) added to the VTR series. Four years of overlap between Turner's and the Weighout CPUE series can also be seen. ASAP relative changes in qs amount CPUE series were not incorporated into the plot. Assumed total landings are also shown. Landing in 2005 was taken from the IVR system. Red line is the TAL.

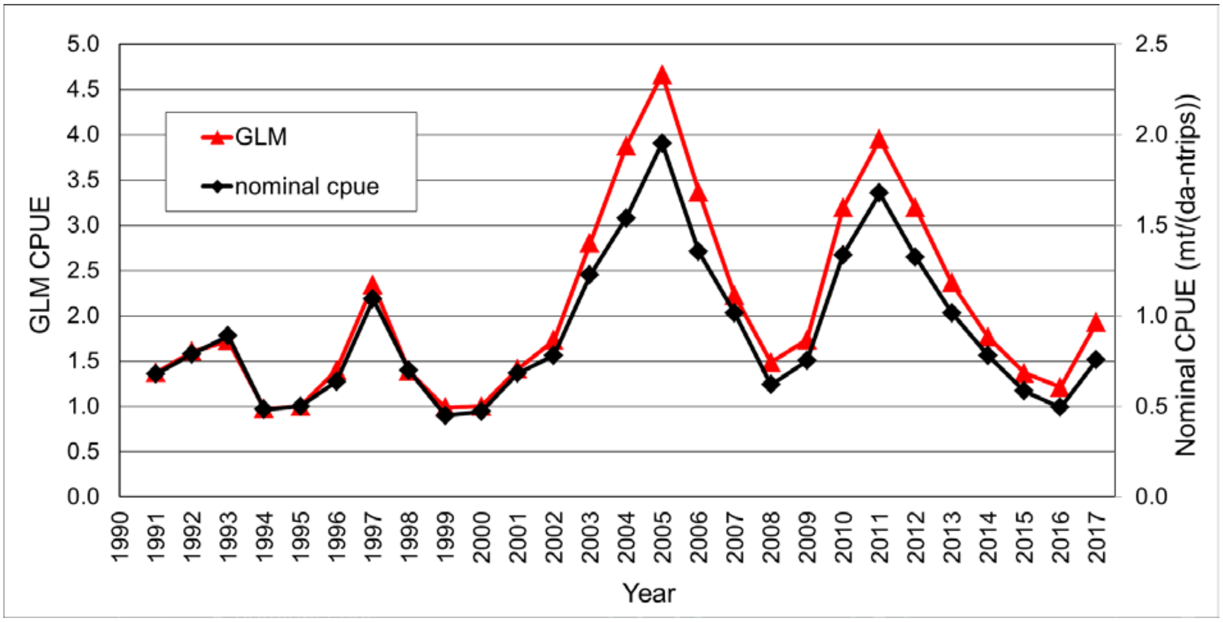


Figure 6. Comparison of the nominal and GLM VTR CPUE indices for golden tilefish with additional New York logbook CPUE data from three vessels (1991-1994) added to the VTR series.

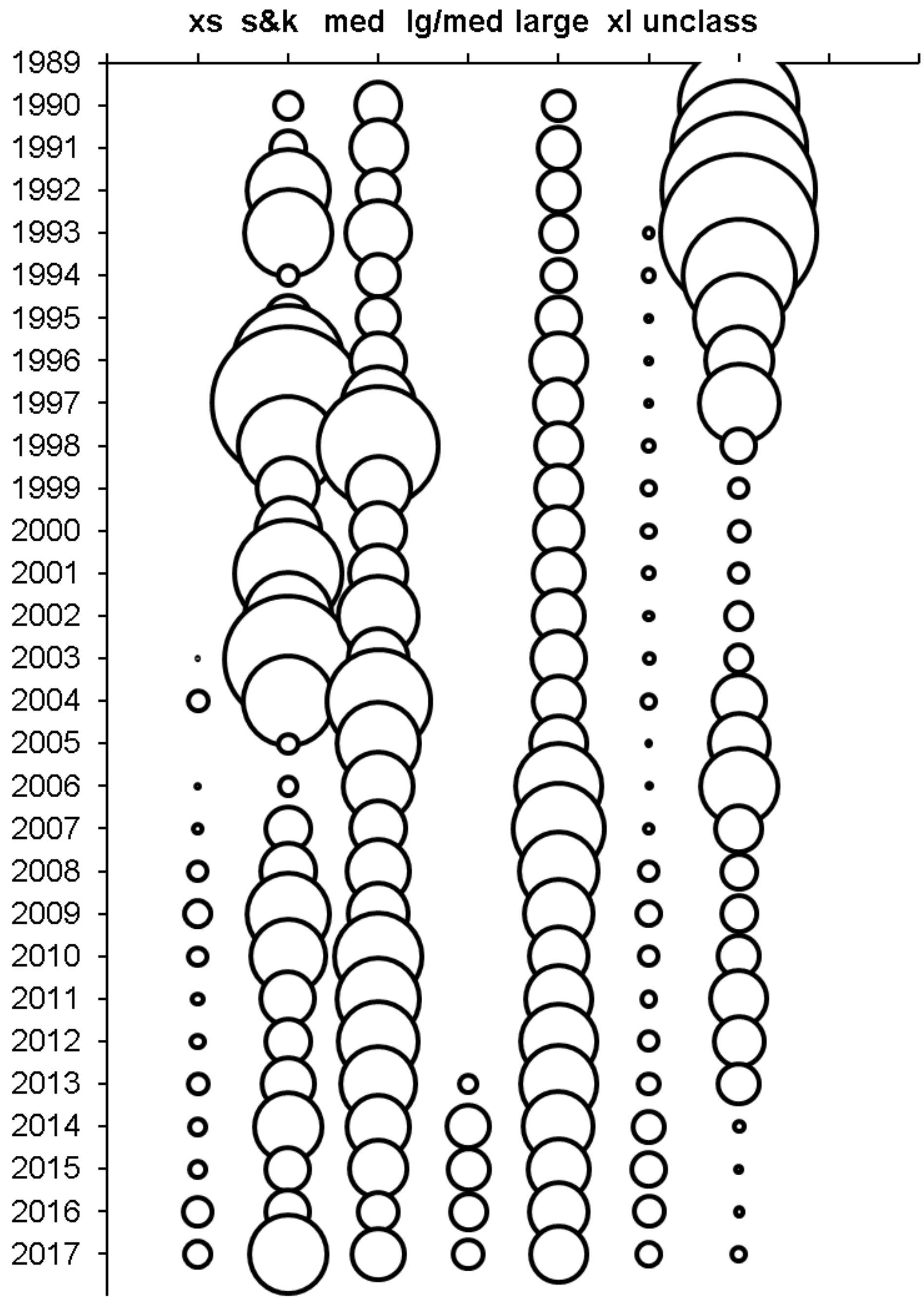


Figure 7. Bubble plot of Golden tilefish landings by market category. Large-medium market category code was added in 2013 and 2015. Smalls and Kittens (s&k) were combined since these categories possess similar size fish.

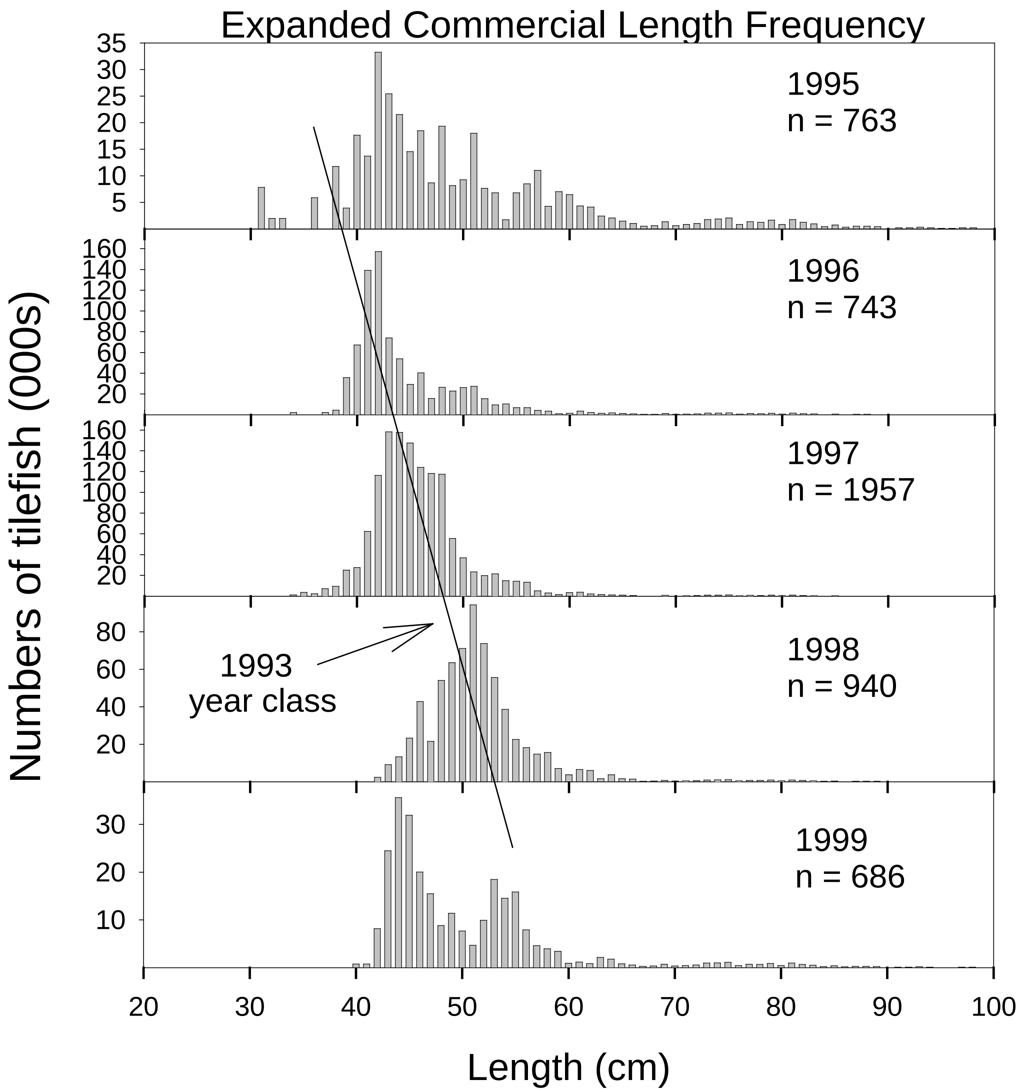


Figure 8. Expanded length frequency distributions by year. Large market category lengths used from 1995 to 1999 were taken from years 1996, 1998, and 1998. Smalls and kittens were combined and large and extra large were also combined.

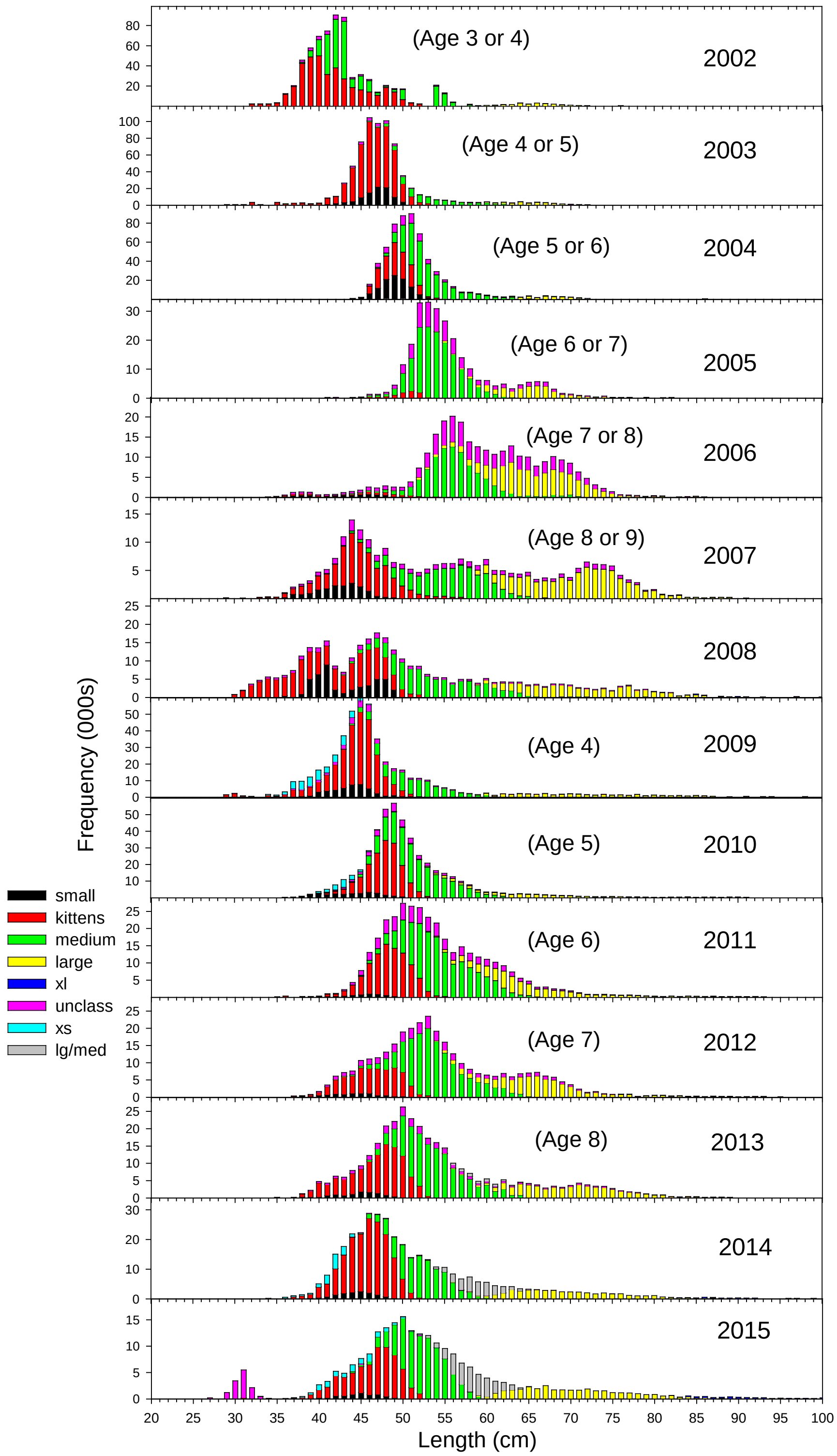


Figure 9. Expanded length frequency distributions from 2002 to 2015. Kittens lengths were used to characterize the extra small category in 2013. Y-axis is allowed to rescale.

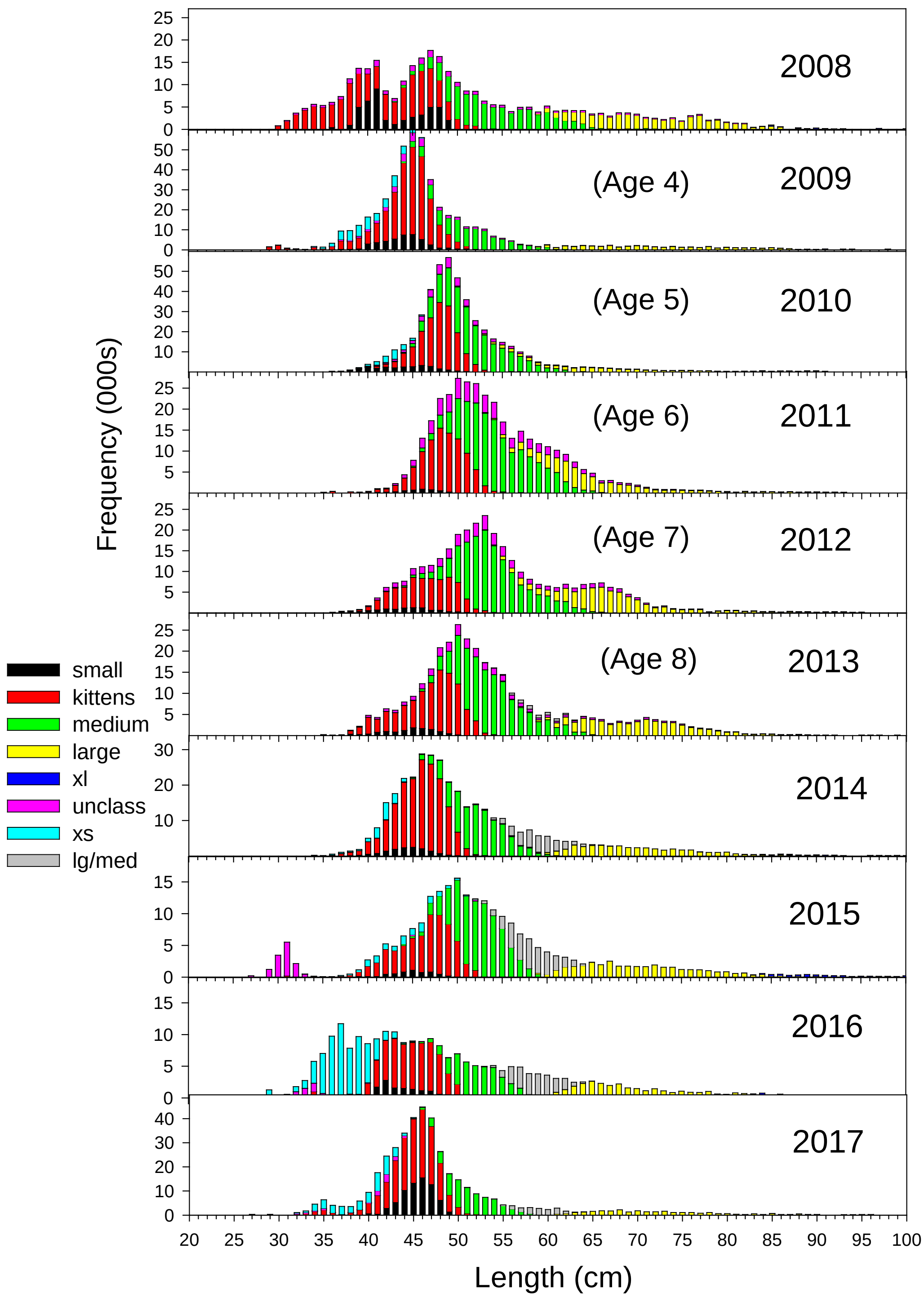


Figure 10. Expanded length frequency distributions from 2007 to 2017. No lengths for extra small (xs) exist in 2013. Kittens lengths were used to characterize the extra small category in 2013. No length samples for unclassified were used from 2007-2014. Unclassifieds in 2015 are based on two samples. Y-axis is allowed to rescale.

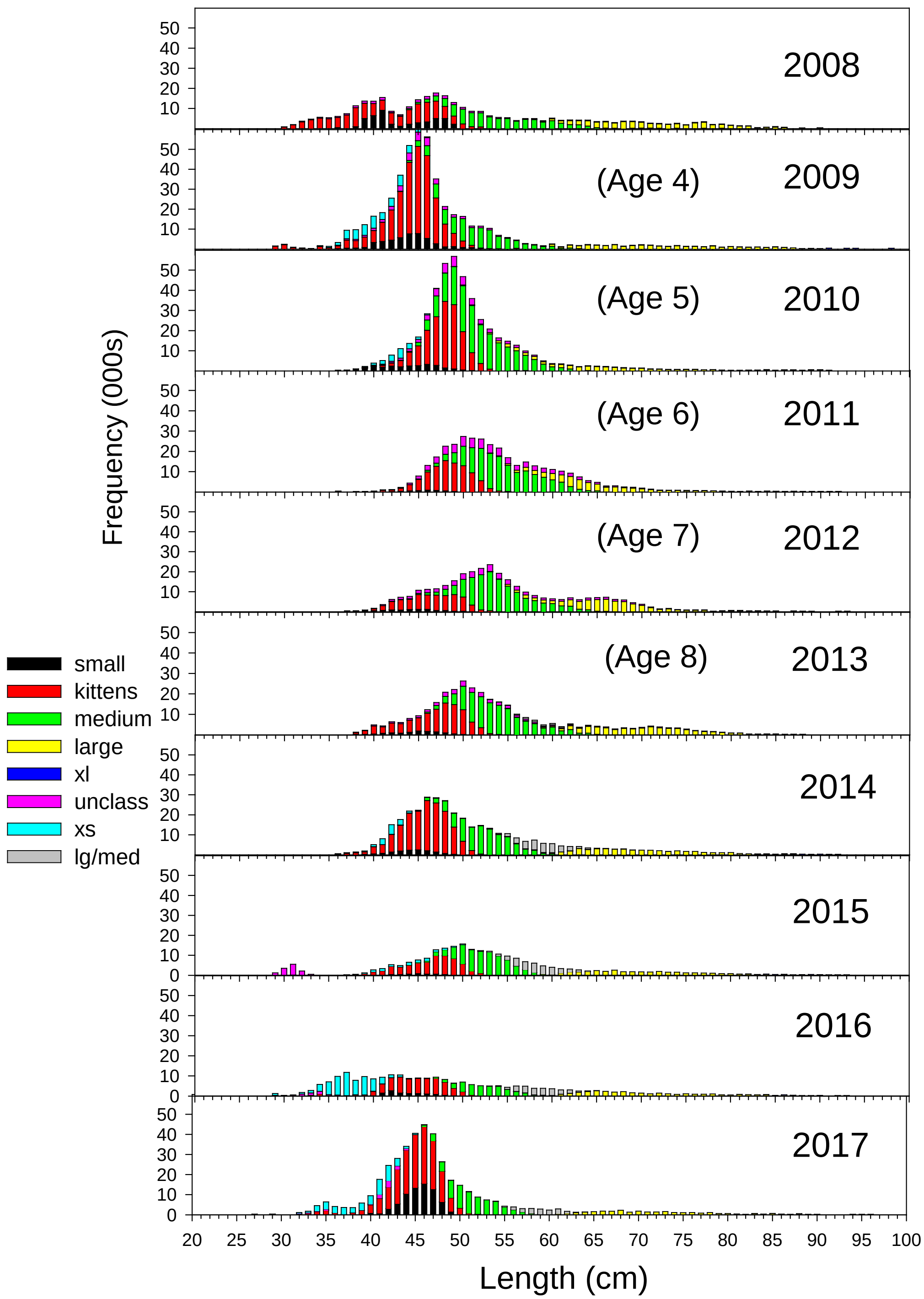
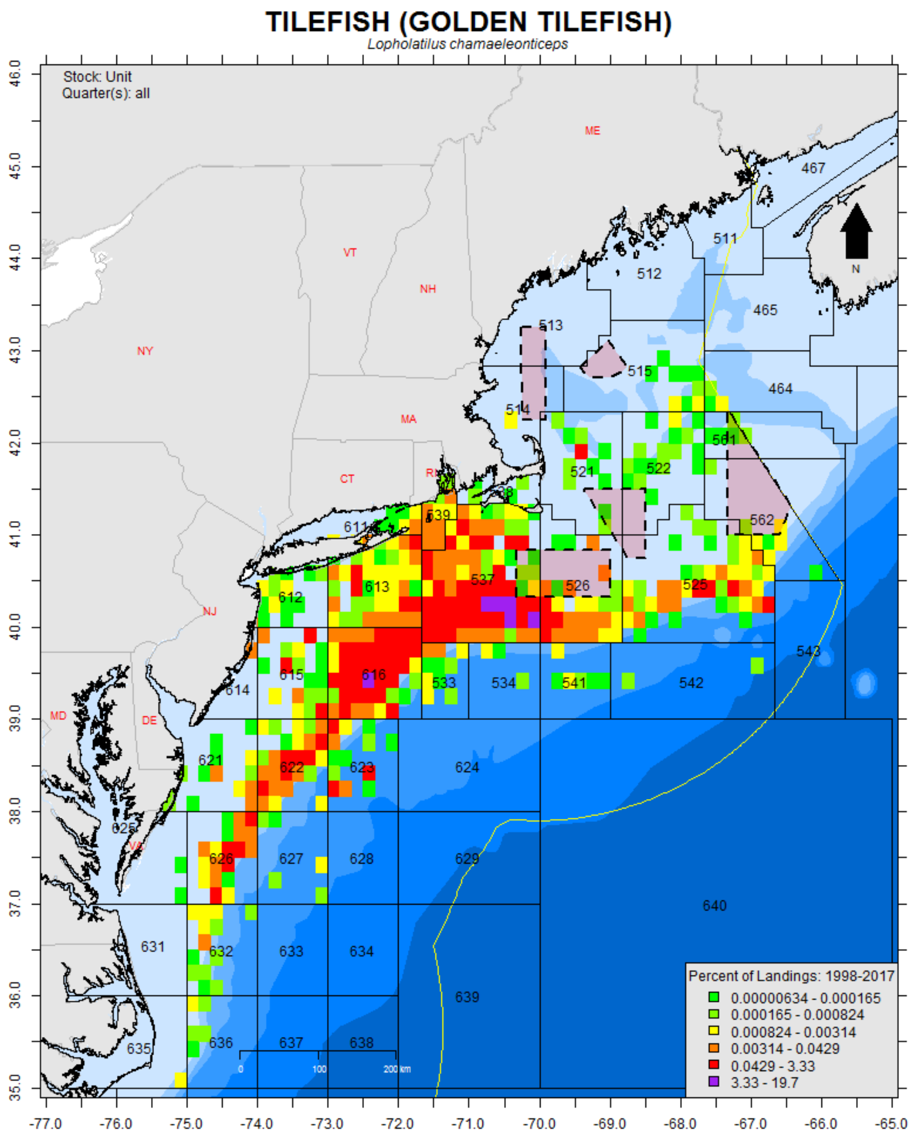


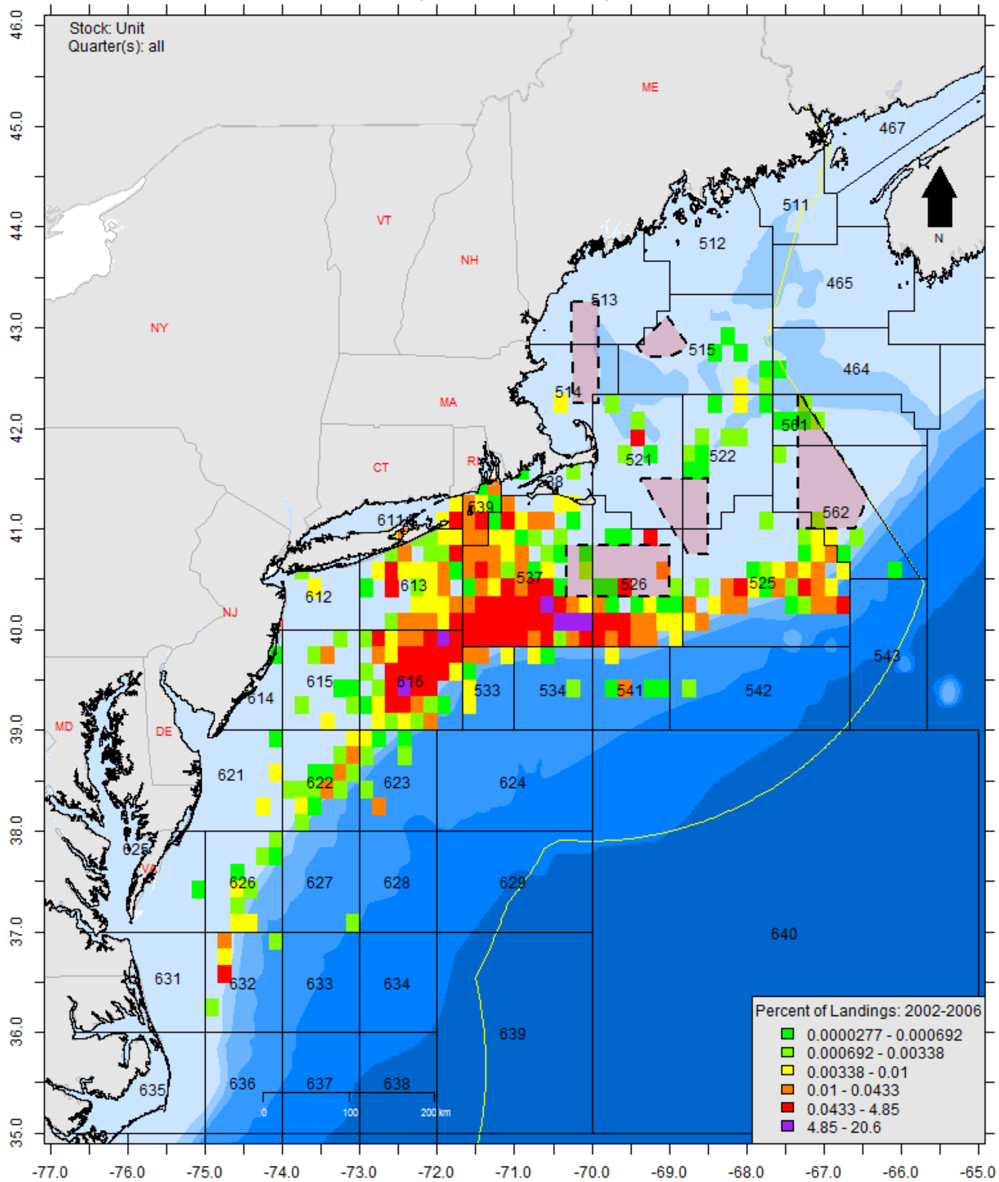
Figure 11. Expanded length frequency distributions from 2002 to 2017. Kittens lengths were used to characterize the extra small category in 2013. No length samples for unclassified were used from 2007-2014. Unclassifieds in 2015 are based on two samples. Y-axis scales is fixed.

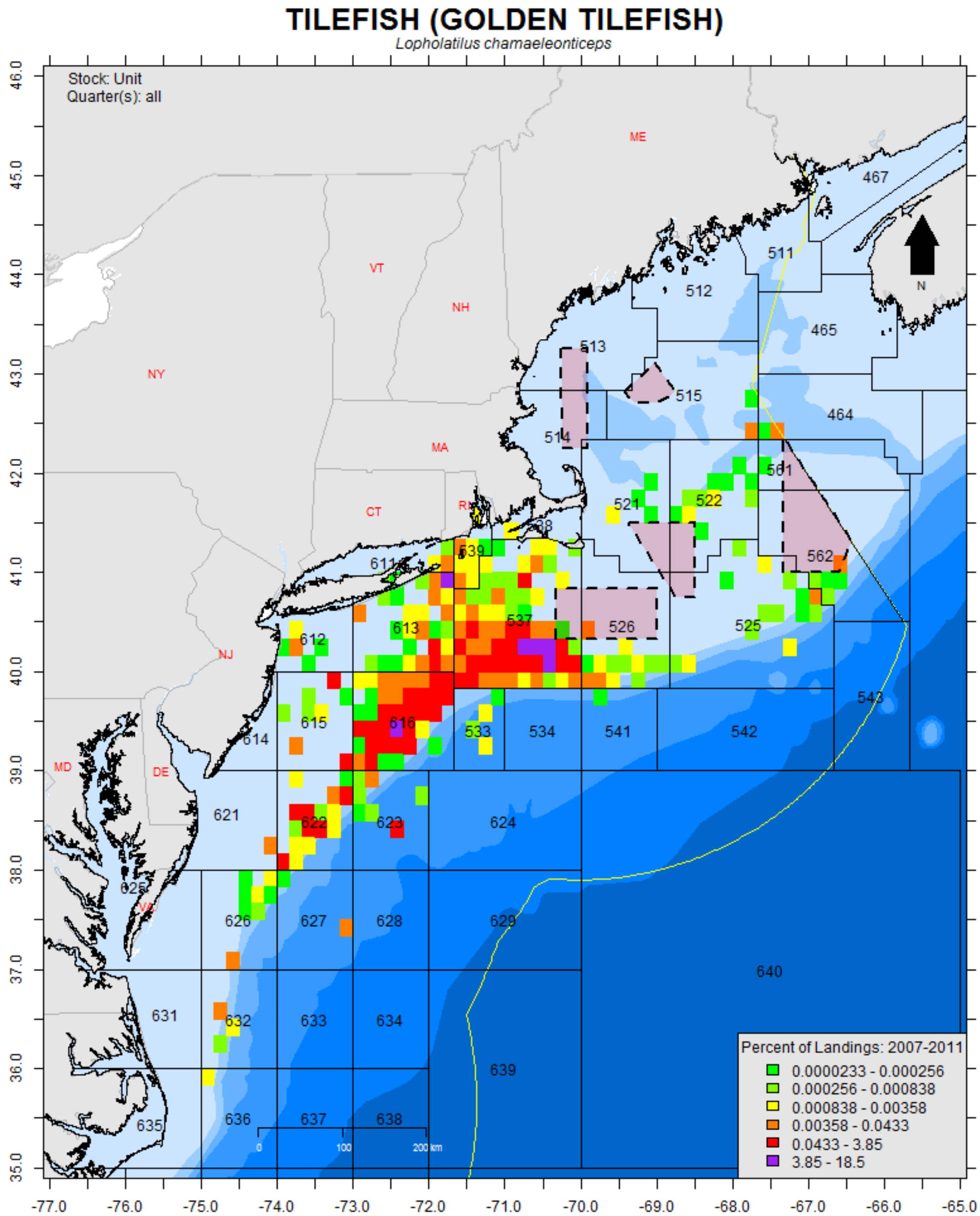
Appendix 1. Golden tilefish 1998-2017 commercial landing (vessel trip reports) distributions maps (1998-2017, 2002-2006, 2007-2011, 2012-2016, 2012, 2013, 2014, 2015 & 2016). See map legend for specified years. Northeast Fisheries Science Center statistical areas are represented by numbered polygons and bathymetry is depicted in blue shading. Groundfish closed areas (dashed borders), and the Exclusive Economic Zone (yellow line) have been overlaid for your reference. Special thanks to Chris Kholke for providing these maps.

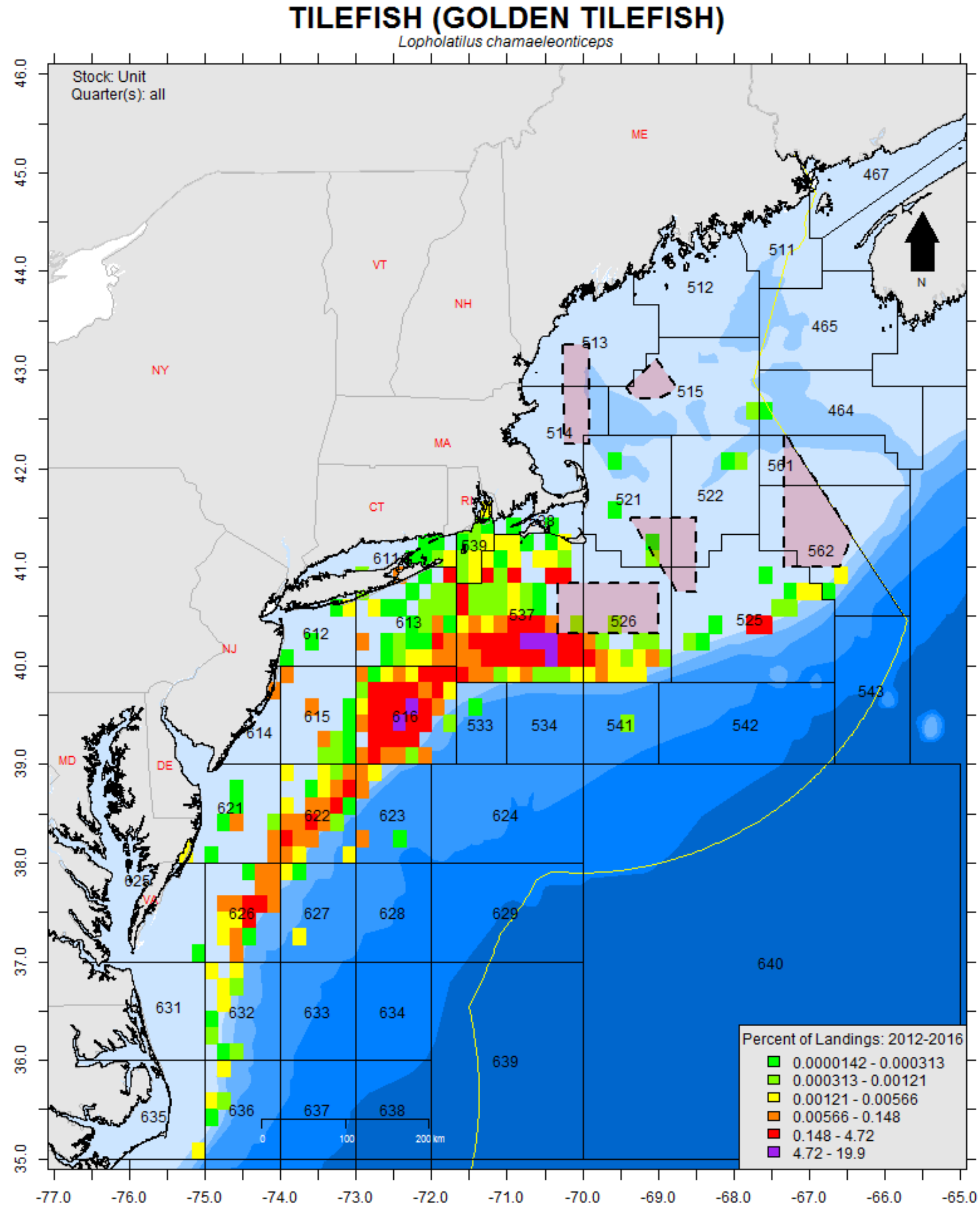


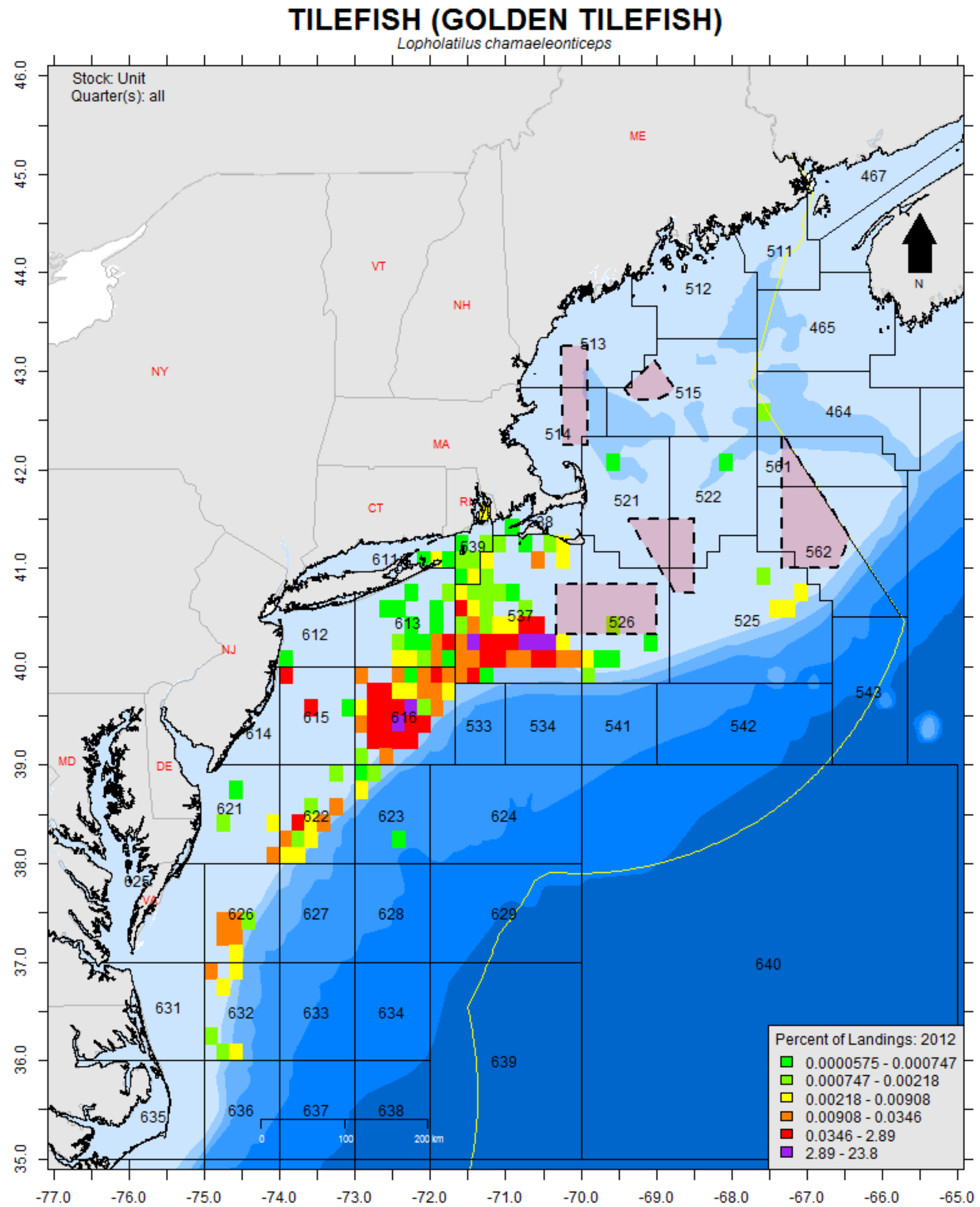
TILEFISH (GOLDEN TILEFISH)

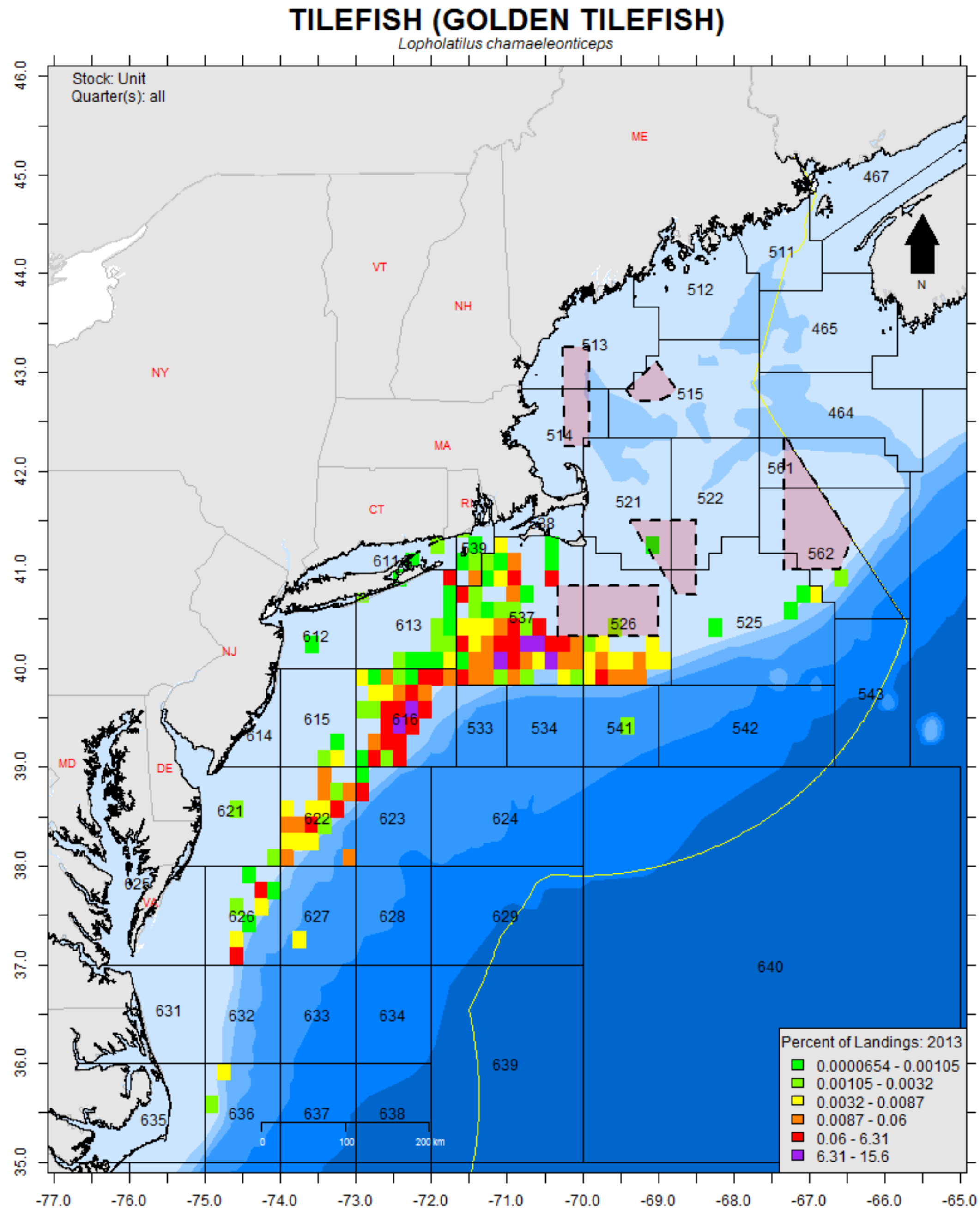
Lopholatilus chamaeleonticeps

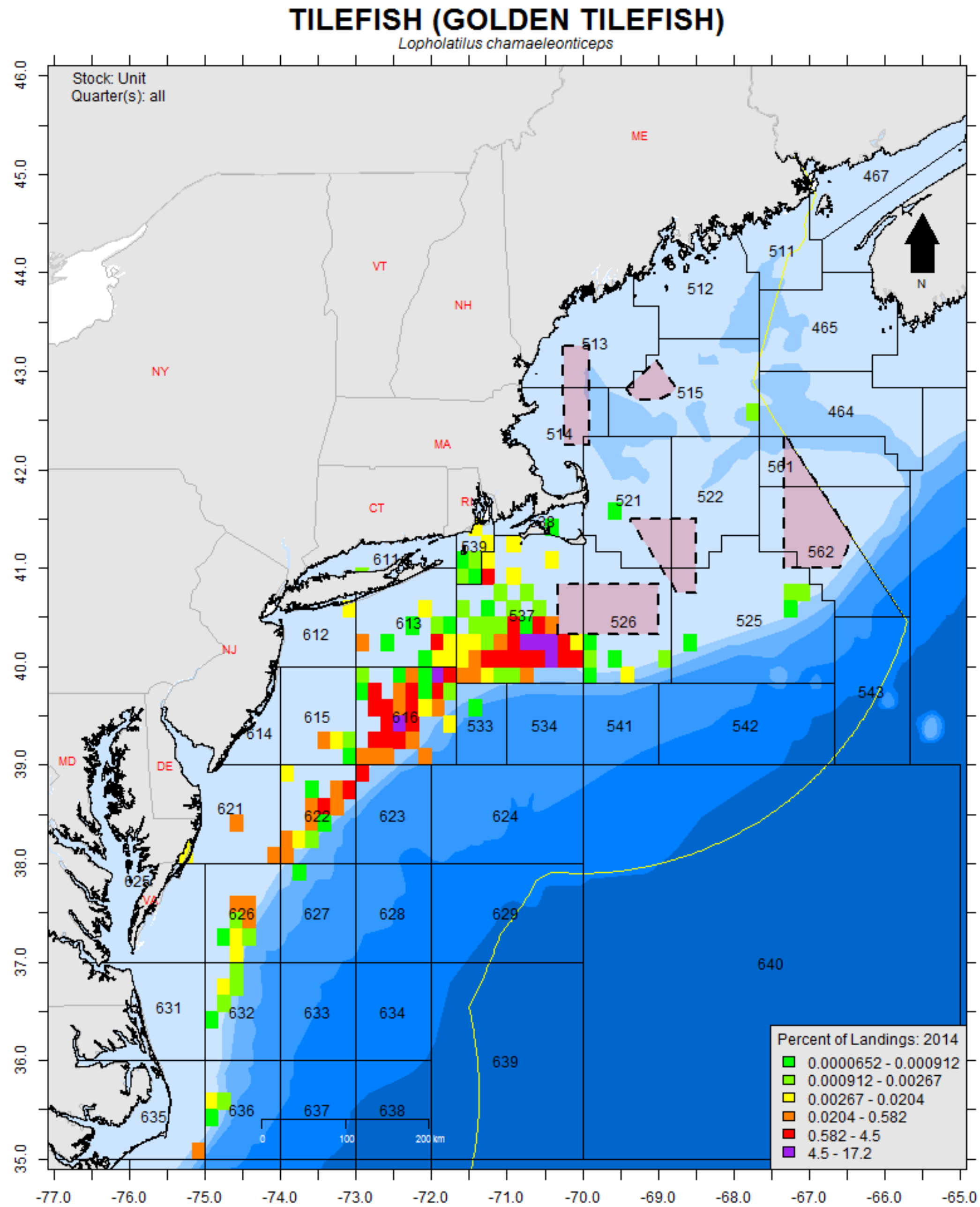



TILEFISH (GOLDEN TILEFISH)
Lopholatilus chamaeleonticeps
Stock: Unit
Quarter(s): all
Percent of Landings: 2007-2011
0.0000233 - 0.000256
0.000256 - 0.000838
0.000838 - 0.00358
0.00358 - 0.0433
0.0433 - 3.85
3.85 - 18.5

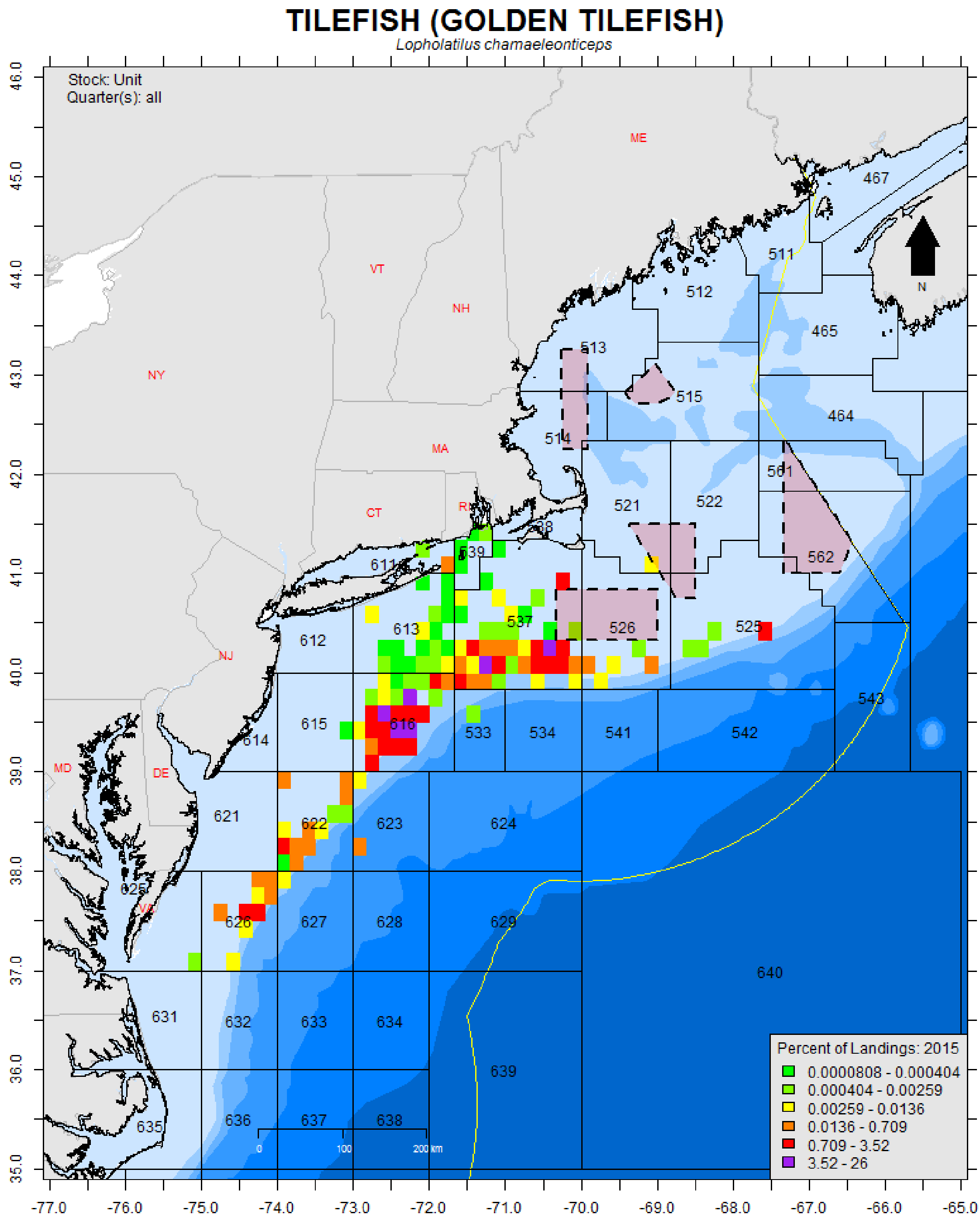

TILEFISH (GOLDEN TILEFISH)
Lopholatilus chamaeleonticeps
Stock: Unit
Quarter(s): all
Percent of Landings: 2012-2016
0.0000142 - 0.000313
0.000313 - 0.00121
0.00121 - 0.00566
0.00566 - 0.148
0.148 - 4.72
4.72 - 19.9
ME
VT
NH
NY
MA
CT
NJ
MD
DE
N
0
100
200 km


TILEFISH (GOLDEN TILEFISH)
Lopholatilus chamaeleonticeps
Stock: Unit
Quarter(s): all
Percent of Landings: 2012
0.0000575 - 0.000747
0.000747 - 0.00218
0.00218 - 0.00908
0.00908 - 0.0346
0.0346 - 2.89
2.89 - 23.8
N
ME
VT
NH
NY
MA
CT
NJ
MD
DE
0
100
200 km

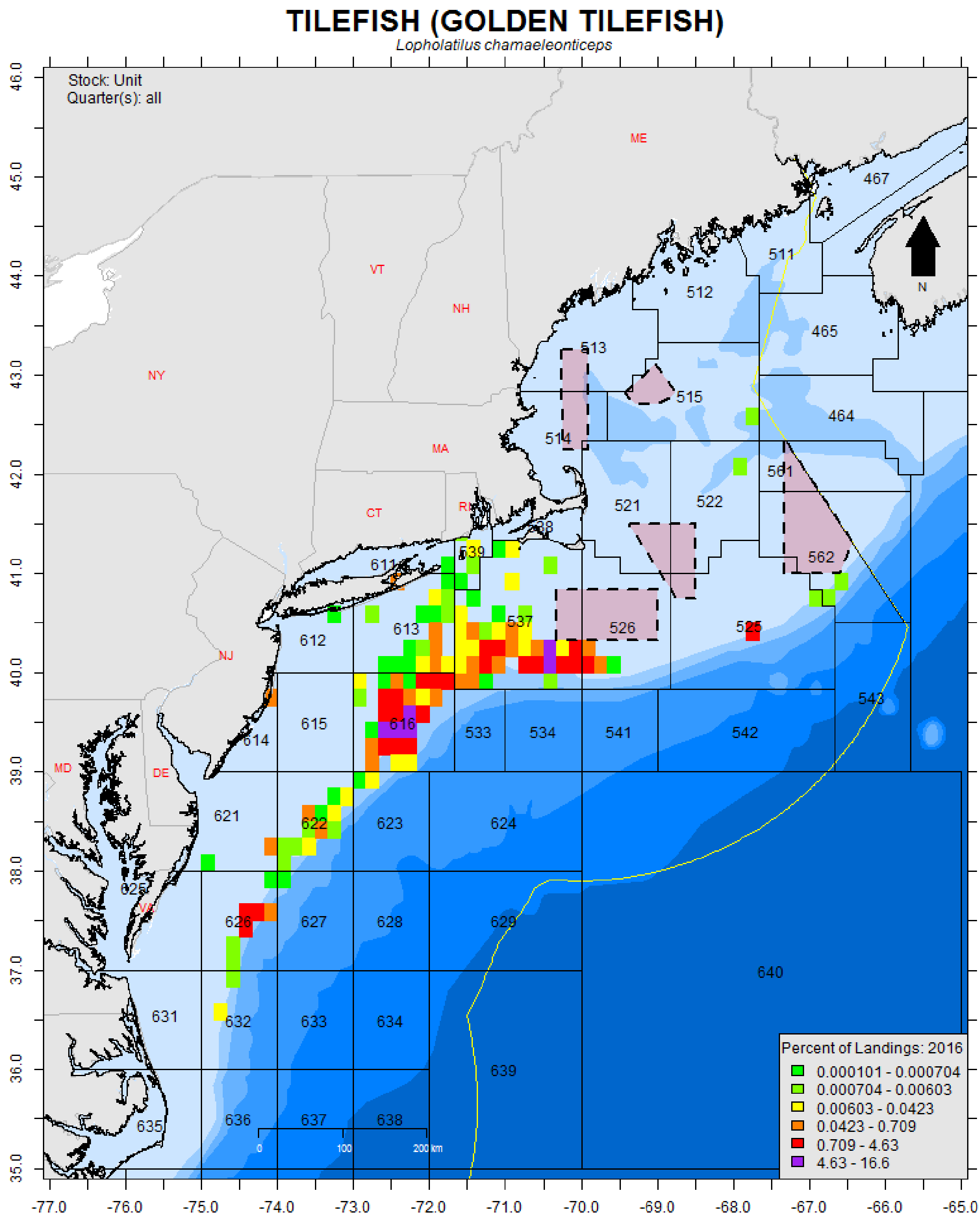

TILEFISH (GOLDEN TILEFISH)
Lopholatilus chamaeleonticeps
Stock: Unit
Quarter(s): all
Percent of Landings: 2013
0.0000654 - 0.00105
0.00105 - 0.0032
0.0032 - 0.0087
0.0087 - 0.06
0.06 - 6.31
6.31 - 15.6



TILEFISH (GOLDEN TILEFISH)
Lopholatilus chamaeleonticeps
Stock: Unit
Quarter(s): all
Percent of Landings: 2014
0.0000652 - 0.000912
0.000912 - 0.00267
0.00267 - 0.0204
0.0204 - 0.582
0.582 - 4.5
4.5 - 17.2



TILEFISH (GOLDEN TILEFISH)
Lopholatilus chamaeleonticeps
Stock: Unit
Quarter(s): all
Percent of Landings: 2015
0.0000808 - 0.000404
0.000404 - 0.00259
0.00259 - 0.0136
0.0136 - 0.709
0.709 - 3.52
3.52 - 26


TILEFISH (GOLDEN TILEFISH)
Lopholatilus chamaeleonticeps
Stock: Unit
Quarter(s): all
Percent of Landings: 2016
0.000101 - 0.000704
0.000704 - 0.00603
0.00603 - 0.0423
0.0423 - 0.709
0.709 - 4.63
4.63 - 16.6