Weighted Length Compositions for U.S. Yellowtail Snapper (*Ocyurus chrysurus*) from 1981-2017

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Weighted Length Compositions for U.S. Yellowtail Snapper (*Ocyurus chrysurus*) from 1981-2017

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Introduction

Sampled length compositions for SEDAR 64 were compiled for catch (landings and discards) of Yellowtail Snapper (*Ocyurus chrysurus*) in Florida waters from each fleet (commercial, headboat, MRIP), as well as fishery independent sources. Raw length composition data from fishery dependent sources may be a biased reflection of the length composition of the catch due to uneven sampling. Therefore when calculating landings- and discards-at-length (LAL/DAL, fish landed or discarded per length bin in either numbers or weight), it is recommended to weight the sampled lengths of landed or discarded fish at the finest possible scale by the inverse of sampling proportion. Weighting the sampled lengths at the finest possible strata ensures the LAL and DAL are as representative of the landings as possible. However, if the number of fish sampled is very low, the LAL may be extremely imprecise at the chosen scale or could result in the loss of data (e.g. landings with no associated length samples). One way to resolve this is to aggregate the sampled lengths across strata and then weight the sampled lengths.

This document describes methods to determine the scale of aggregation by calculating an acceptable minimum sample size for each stratum akin to a power analysis. If the number of fish sampled for length is less than this number, strata are aggregated in a defined order. However limits are imposed on the level of aggregation, that is, data are not combined across fleets, years, and some regions, in order to limit the amount of bias in estimated length compositions. The assumptions for determining the minimum sample size are described in detail by Allen-Moran et al. (2013).

This document then presents weighted length composition data for Yellowtail Snapper from the following separate sampling programs:

1. Trip Interview Program (TIP)/ Creel Survey and Biological Sampling Plan (CSBSP)
2. Commercial Reef Fish Observer Program (RFOP)/ Shark Observer Program (SOP)
3. Southeast Region Headboat Survey (SRHS)
4. Headboat and Charter Florida At-Sea Observer Program
5. Marine Recreational Information Program (MRIP)

6. Reef Fish Visual Census (RVC)

Methods

Minimum sample sizes for the finest considered scale of fleet, year, month, and for-hire survey region (see definitions below) are determined by limiting the coefficient of variation of the estimated proportion at length, $\hat{p}$. Differentiating among geartypes was also considered, however Yellowtail Snapper are predominately caught by hook and line gears.

The estimated proportion at length is defined as the number of Yellowtail Snapper of a given length in the sample, *Y*, divided by the sample size, *n*. The proportion of Yellowtail Snapper of a given length in the landings (i.e. the population proportion) is denoted as *p*.

To calculate the sample size *n* that satisfies this objective, it is necessary to specify the sampling distribution of *Y* that the estimated proportion is based on. The sampling distribution of *Y* in turn depends on whether sampling is with or without replacement, and secondly the type of selection scheme. This analysis assumes sampling is done without replacement and the selection scheme is "simple random" (i.e. all individuals have an equal probability of being included in the sample). Hence the sampling distribution of *Y* is hypergeometric (*N*, *n*, *p*), such that *N* denotes the total number of Yellowtail Snapper of a given length landed or discarded and $\hat{p}$ is an unbiased estimator of *p*. Note that at sampling fractions less than approximately 5%, the statistical properties of without replacement sampling are very closely approximated by those of with replacement sampling (i.e. a binomial sampling distribution).

The stated objective is that *n* be sufficient to ensure the coefficient of variation of $\hat{p}$, defined as $CV_{\hat{p}} = \sigma_{\hat{p}}/p$, which is a measure of relative precision, does not exceed a specified level. That is, the standard error of $\hat{p}$ does not exceed $(100 \cdot CV_{\hat{p}})\%$ of *p.* For hypergeometric sampling this implies

$$n = \frac{N}{1+CV_{\hat{p}}{}^2\left(\frac{(N-1)p}{1-p}\right)}.$$

Minimum sample sizes are calculated such that the coefficient of variation $CV_{\hat{p}}$ is at most 0.25 for all $p \geq 0.10$. A reasonable lower limit for the population proportion *p* may be 10%, meaning that by sampling at least *n* Yellowtail Snapper out of *N* available, this method may precisely capture the central 80% of lengths in the landings or discards (*N*).

An important caveat to this method is that the assumption of random selection is unrealistic. Presumably, fish sizes are correlated within trips due to fishing practices and fish schooling behavior. The minimum recommended sample sizes presented herein should therefore be considered lower bounds and sample sizes should be increased to account for some non-randomness, the degree of which is unknown.

In addition to providing minimum sample sizes, methods such as this can also provide guidance on model resolution by elucidating the level at which data are informative.

Yellowtail Snapper regions

Yellowtail Snapper regions are unique geographic areas delineating proportional trends in historically observed landings of Yellowtail Snapper, as defined by the data compilation guidelines for SEDAR 64. Methods and results presented herein apply to regions within Florida, as per the data workshop decision to use Florida-only data. There are a total of 5 of these regions within Florida; NW FL, SW FL, FL Keys, SE FL, NE FL. NW FL contains the Florida panhandle, from Escambia south to Dixie County, and includes FHS survey area 1. SW FL is from Levy to Collier County, and includes FHS survey area 2. FL Keys contains most of the Florida Keys and Monroe County (with the exception of the Dry Tortugas) and FHS survey area 3. SE FL, from Miami-Dade north to Indian River County, includes FHS survey area 4, and NE FL, from Brevard north to Nassau County, includes FHS survey area 5.

Commercial

Landings

Sampled lengths of commercial landings of Yellowtail Snapper were obtained from dockside sampling under the Trip Interview Program (TIP) and Creel Survey and Biological Sampling Plan (CSBSP; 1985-1992). A distribution of sampled Yellowtail Snapper fork lengths from commercial landings in Florida waters from 1981-2017 is shown in Figure 1. The central 80% of sampled fork lengths correspond to 26 – 37 cm. This range may not align with the central 80% of fork lengths in the landings, especially at finer scales, however it is a global approximation. The defined criteria stated above aims to limit the coefficient of variation of the sampling proportion in this length range to at most 0.25.

The number of Yellowtail Snapper sampled by region and year is presented in Table 1. This table includes an additional 3,081 sampled lengths in 1987-1992 from CSBSP data that were added after the data workshop. The estimated number of Yellowtail Snapper landed by region and year are subject to confidentiality concerns, preventing fine scale presentation of this data. Table 2 presents the average minimum sample size per year and region required to satisfy the defined criteria. Table 3 presents the proportion of fished months within each year and region that do not satisfy the criteria. Relatedly Table 4 illustrates the proportion of fished months within each year and region that have no associated samples. Prior to 1989, sampling only occurred primarily in the FL Keys. After that time, sampling occurred in few, if any, fished months in NE FL and NW FL. To remedy this, all regions are combined from 1984-1990 and in the remaining years, landings in NE FL and SE FL are combined and landings in NW FL are combined with SW FL for non-sampled months. Sample sizes in some years (e.g. 1998-1999, 2002, and 2014-2017) in the FL Keys are adequate in all months, however Yellowtail Snapper are not adequately sampled in SE FL and on the periphery of their distribution at this fine scale.

The next level of aggregation combines months within seasons (Jan- June, July – December) when at least one month is inadequately sampled. This level of aggregation helped to alleviate sample size issues in the FL Keys, but sample sizes in SE FL are lacking in 1991, and areas beyond FL Keys and SE FL generally do not have sufficient samples (Table 5).

The final level is to aggregate by year and region when at least one season is under sampled. This results in most of the core area for Yellowtail Snapper being adequately sampled at this level (Table 6), however regions outside of FL Keys and SE FL are mostly undersampled.

This analysis may suggest that an area-season specific model may be too fine scale for the data to be representative. The next step is to weight these aggregated sampled length frequencies by the proportion of landings sampled to obtain landings-at-length, and then to aggregate at the level required for model inputs. Figure 2 illustrates minor differences between weighted and unweighted length frequencies by year. Figure 3 presents a bubble plot of annual weighted length frequencies (i.e. landings-at-length) for the commercial fleet at two centimeter bins for 1984-2017.

Research recommendation: Increase commercial sampling in areas outside of the FL Keys, particularly NE and NW FL. According to this analysis and landings in the past three years, the average monthly minimum sample sizes range from 6 in NW FL to 140 in SE FL. Since there is evidence of multiple growth patterns for Yellowtail Snapper caught outside of the FL Keys, this information may help to increase model resolution.

Discards

Data from the Southeast Fisheries Science Center (SEFSC) coastal fisheries logbook program were used to estimate the number of yellowtail snapper discards from commercial vertical line vessels. The average number of Yellowtail Snapper released per year is approximately 75,000. At this aggregated level, the minimum sample size required per year is equivalent to assuming sampling with replacement, i.e., 144 released Yellowtail Snapper.

Two datasets, the commercial Reef Fish Observer Program (RFOP) and Shark Observer Program (SOP), were used to compile commercial discard length frequencies (histogram of all lengths presented in Figure 4). According to this method, the size distribution is not well informed in most years (Table 7). However the distribution is very stable over time (Figure 5), suggesting that sample sizes may be adequate.

Due to the low number of samples and the majority occurring in the FL Keys, discard lengths are weighted by estimated discards at an annual Florida-wide scale. The relative frequencies of sampled length proportions are therefore equivalent to the weighted length relative frequencies used as model inputs.

Headboat

Landings

Sampled lengths for landed Yellowtail Snapper in the headboat fleet are collected by the Southeast Region Headboat Survey (SRHS). Figure 6 presents a histogram of sampled lengths from all Florida regions 1981-2017. The associated central 80% of sampled fork lengths correspond to 25 – 36 cm.

The number of Yellowtail Snapper sampled by region and year is presented in Table 8. The estimated number of Yellowtail Snapper landed by region and year are subject to confidentiality concerns, preventing fine scale presentation of this data. Table 9 presents the average minimum sample size per year and region required to limit the coefficient of variation of the sampling proportions in the central 80% range to at most 0.25.

Official landings for the headboat fleet are not available by month, only by year and region. Estimates of landings by month are available but are not subject to QA/QC procedures. A comparison of estimates of landings by month and sampled lengths by month reveals strata that were sampled for lengths but did not have associated estimates of monthly landings. This may be due to unreliable monthly landings estimates. To reduce instances of mismatches between samples and landings, regions were grouped to a coarser scale: SE FL and NE FL were grouped into an 'East of the Keys' region and SW FL and NW FL were grouped into a 'West of Keys' region.

Table 10 presents the proportion of fished months within each year and region that do not satisfy the criteria. Relatedly Table 11 illustrates the proportion of fished months within each year and region that have no associated samples. As shown, most fished months were sampled in FL Keys and regions east of the Keys, however most fished months west of the Keys were not sampled. At this fine scale, only sample sizes in the FL Keys have been adequate in most months in 2012, 2013, and 2015-2017. Yellowtail Snapper were not adequately sampled prior to 2012 or on the periphery of their distribution at this fine scale.

The first level of aggregation is to combine months within seasons for strata that are not adequately sampled. This level of aggregation satisfies the sample size criteria for most years in FL Keys and SE FL (Table 12), however regions west of Keys are not sufficiently sampled in any year. Even after aggregating over seasons in which at least one season was inadequately sampled, regions west of the Keys remain insufficiently sampled in all years (Table 13).

This analysis highlights data gaps in regions west of the Keys. Regions west of the Keys are not combined with the FL Keys, as it is not the core area for Yellowtail Snapper and length distributions west of the Keys may not be representative of the majority of the stock.

Figure 7 illustrates minor differences between weighted and unweighted length frequencies by year. Figure 8 presents a bubble plot of annual weighted length frequencies (i.e. landings-at-length) for the headboat fleet at two centimeter bins for 1981-2017.

Research recommendation: Increase headboat sampling in areas outside of the FL Keys, particularly NW and SW FL. According to this analysis and landings in the past three years, the average monthly minimum sample sizes is 15 in NE FL, approximately 100 in regions west of the Keys, and 140 per month in FL Keys and SE FL. Since there is evidence of multiple growth patterns for Yellowtail Snapper caught outside of the FL Keys, this information may help to increase model resolution.

Discards

The SRHS logbook includes self-reported discards since 2004 and annual estimates are available by region. Table 14 presents minimum sample sizes of releases per year and region based on estimated number of releases. Releases are not recorded in NW FL in most years. Minimum sample sizes for SW FL, FL Keys, and SE FL are similar (135-144), whereas minimum sample size for NE FL are variable, averaging to about 30 in the last three years.

Data collected from the Florida At-Sea Observer Sampling program were used to compile headboat and charter boat sampled length frequencies of releases. A histograms of overall sampled fork lengths and lengths by fishing mode are presented in Figure 9. As shown, the distributions of sampled fork lengths differ minimally among fishing modes. Thus, the overall distribution of sampled lengths is applied to

both headboat and MRIP (includes charter boat, private, and shore modes) releases. The number of Yellowtail Snapper sampled per year is mostly representative of releases in the FL Keys from 2005 -2007 and 2012 -2017 (Table 15).

From 2005 to 2017, minimum sample sizes were exceeded in most years in the FL Keys, except for 2008 – 2011, but were not met in most years for other regions (Table 16). Therefore, sampled length frequencies are combined across all regions and weighted by the estimated number released. The sampled length frequencies are therefore equivalent to the weighted length frequencies used as model inputs. A bubble plot of length frequencies of releases by year suggests a shift to slightly larger releases after 2008 (Figure 10), however low sample sizes in some years limits any strong conclusions.

Research recommendation: Increase sample sizes in SW FL and SE FL to at least 144 Yellowtail Snapper per year and increase sample sizes in NE FL to at least 30 per year.

MRIP

Landings

The Marine Recreational Information Program (MRIP) provides estimates for three main recreational fishing modes: shore-based fishing (SH), private and rental boat fishing (PR), and for-hire charter and guide fishing (CH). Catch rates from dockside intercept surveys are combined with estimates of effort from telephone interviews to estimate total landings and discards by year, wave (i.e. two month intervals), mode, and area fished (inland, state, and federal waters). MRIP provides sample weights (variable named 'wp_size') following standard design-based probability sampling theory to produce unbiased estimates of size compositions.

The number of Yellowtail Snapper landed and measured for length is presented in Table 17, which highlights minimal sampling across years and regions. These sample sizes do not include imputed lengths (lengths that are predicted from fish measured in similar strata). Sample sizes that include imputed lengths are presented in SEDAR64-DW-12. The average number of Yellowtail Snapper required to be sampled by wave according to the defined criteria is close to 144 Yellowtail Snapper in most regions (Table 18). This suggests that an analysis by wave and region may be too granular for these data to be informative.

The landings-at-length composition for MRIP after weighting imputed and non-imputed sampled lengths by the provided sample weights is presented in Figure 11. Compared to other data sources, there is considerable variability in the length compositions of the landings within and among years.

Discards

As with the Headboat fleet, the length composition of MRIP discards is informed by the Florida At-Sea Observer data. The number of estimated discards by year and region are presented in SEDAR64-DW-12.

RVC

The Reef Fish Visual Census (RVC) is a fishery independent monitoring survey that provides long term data for reef fish populations in south Florida. Weighted length compositions for several indices of abundance are provided in SEDAR64-DW-05. For completeness and ease of comparison to other data sources, bubble plots of length frequencies by year are presented in Figures 12 and 13. Also note that weighted length compositions in 2004 do not sum to the total abundance in that year (SEDAR64-DW-05, Table 3), however the relative error is less than 2%. For this reason, the provided weighted length compositions are used as-is as model inputs.

Literature Cited

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Table 1. Number of Yellowtail Snapper landed by the commercial fleet and sampled for length by year and region.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL	TOTAL
1984	0	0	1,279	0	0	1,279
1985	0	0	2,454	0	0	2,454
1986	0	61	2,759	25	2	2,847
1987	0	0	1,963	0	0	1,963
1988	0	10	1,945	3	0	1,958
1989	0	0	2,906	0	0	2,906
1990	0	5	6,114	31	11	6,161
1991	0	211	7,366	5	8	7,590
1992	0	123	3,990	1,291	21	5,425
1993	0	58	5,260	364	5	5,687
1994	1	37	5,639	264	16	5,957
1995	95	24	6,244	455	82	6,900
1996	0	321	3,697	672	2	4,692
1997	0	104	5,860	1,859	20	7,843
1998	7	25	5,527	1,496	14	7,069
1999	7	147	6,281	2,081	32	8,548
2000	1	105	2,692	2,021	98	4,917
2001	0	110	4,984	3,261	28	8,383
2002	0	42	5,968	1,486	8	7,504
2003	0	44	3,650	621	11	4,326
2004	0	16	3,138	1,014	0	4,168
2005	0	86	2,677	939	2	3,704
2006	0	20	1,351	1,110	23	2,504
2007	0	50	1,712	869	20	2,651
2008	0	161	2,449	685	2	3,297
2009	0	265	3,171	570	12	4,018
2010	0	31	1,598	522	8	2,159
2011	0	22	2,934	1,079	0	4,035
2012	0	24	7,050	496	14	7,584
2013	0	16	4,708	815	2	5,541
2014	1	70	5,022	1,323	3	6,419
2015	1	150	3,946	941	10	5,048
2016	6	74	2,959	482	2	3,523
2017	2	118	3,591	359	1	4,071
TOTALS	121	2,530	132,884	27,139	457	163,131

Table 2. Average monthly minimum sample sizes required to satisfy the defined criteria for the commercial fleet. Dashes indicate that there were no landings.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL
1984	-	135	144	132	32
1985	3	120	144	136	7
1986	16	128	144	140	28
1987	5	126	144	139	23
1988	2	131	144	141	18
1989	8	139	144	143	38
1990	1	136	144	141	36
1991	3	132	144	143	34
1992	53	139	144	143	79
1993	6	136	144	143	67
1994	18	134	144	143	49
1995	71	135	144	143	56
1996	67	124	144	143	70
1997	55	109	144	144	64
1998	62	88	144	143	69
1999	42	108	144	143	54
2000	17	92	144	143	39
2001	53	78	144	143	58
2002	33	68	144	143	50
2003	28	80	144	143	21
2004	29	73	144	143	26
2005	9	73	144	142	14
2006	27	80	144	141	18
2007	17	55	144	142	21
2008	9	67	144	141	34
2009	20	53	144	142	29
2010	-	24	144	142	45
2011	32	77	144	142	18
2012	32	108	144	142	19
2013	4	82	144	140	38
2014	2	101	144	140	33
2015	6	115	144	140	27
2016	6	110	144	140	21
2017	6	113	144	135	6

Table 3. Proportion of months per year and region for which the minimum sample size was **not** met for the commercial fleet (i.e. a 0 indicates that all months were sufficiently sampled while a 1 indicates that all months were insufficiently sampled). Dashes indicate that there were no landings.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL
1984	-	1	0.75	1	1
1985	1	1	0.5	1	1
1986	1	1	0.17	1	1
1987	1	1	0.67	1	1
1988	1	1	0.5	1	1
1989	1	1	0.25	1	1
1990	1	1	0.08	1	1
1991	1	1	0.08	1	1
1992	1	1	0.42	0.67	1
1993	1	1	0.25	0.92	1
1994	1	1	0.08	1	1
1995	0.9	1	0.17	0.92	1
1996	1	1	0.25	0.83	1
1997	1	1	0.17	0.5	1
1998	1	1	0	0.58	1
1999	1	1	0	0.42	1
2000	1	1	0.33	0.42	0.91
2001	1	0.92	0.17	0.5	1
2002	1	1	0	0.58	1
2003	1	1	0.33	0.83	1
2004	1	1	0.25	0.83	1
2005	1	1	0.42	0.83	1
2006	1	1	0.67	0.67	0.9
2007	1	1	0.67	0.92	1
2008	1	0.73	0.42	0.92	1
2009	1	0.67	0.25	0.92	1
2010	-	0.92	0.75	0.92	1
2011	1	1	0.42	0.67	1
2012	1	1	0.08	1	1
2013	1	1	0.17	0.83	1
2014	0.8	1	0	0.75	1
2015	1	1	0	0.7	1
2016	1	1	0.08	1	1
2017	0.91	1	0	1	1

Table 4. Proportion of months per year and region for which Yellowtail Snapper was landed but not sampled by the commercial fleet (i.e. a 0 indicates that all fished months were sampled). Dashes indicate that there were no landings.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL
1984	-	1	0.58	1	1
1985	1	1	0.17	1	1
1986	1	0.75	0.08	0.92	0.92
1987	1	1	0	1	1
1988	1	0.92	0.17	0.92	1
1989	1	1	0	1	1
1990	1	0.83	0	0.92	0.92
1991	1	0.25	0	0.92	0.75
1992	1	0.42	0	0.25	0.67
1993	1	0.5	0	0.25	0.75
1994	0.89	0.42	0	0.08	0.67
1995	0.8	0.75	0	0.42	0.17
1996	1	0.17	0	0.42	0.92
1997	1	0.5	0	0.08	0.58
1998	1	0.58	0	0.17	0.58
1999	0.71	0	0	0	0.25
2000	0.89	0.08	0	0	0.09
2001	1	0.25	0	0	0.58
2002	1	0.67	0	0.08	0.75
2003	1	0.33	0	0.33	0.73
2004	1	0.42	0	0.25	1
2005	1	0.33	0	0.33	0.9
2006	1	0.33	0	0.33	0.5
2007	1	0.5	0	0.17	0.6
2008	1	0.09	0	0.42	0.78
2009	1	0.08	0	0.42	0.6
2010	-	0.33	0	0.33	0.75
2011	1	0	0	0.42	1
2012	1	0.42	0	0.25	0.7
2013	1	0.42	0	0.42	0.91
2014	0.8	0.25	0	0.17	0.8
2015	1	0	0	0.3	0.78
2016	0.62	0	0	0.33	0.82
2017	0.82	0.08	0	0.58	0.89

Table 5. Number of seasons per year and region for which the minimum sample size is **not** met after combining months within seasons that were inadequately sampled. Dashes indicate that either there were no commercial landings or the region was combined with another region.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL
1984	-	-	-	-	-
1985	-	-	-	-	-
1986	-	-	-	-	-
1987	-	-	-	-	-
1988	-	-	-	-	-
1989	-	-	-	-	-
1990	-	-	-	-	-
1991	-	1	0	2	-
1992	-	2	0	0	2
1993	-	2	0	1	1
1994	1	2	0	1	2
1995	-	2	0	0	-
1996	-	1	0	1	-
1997	-	2	0	0	1
1998	-	2	0	0	1
1999	2	2	0	0	2
2000	1	2	0	0	1
2001	-	2	0	0	1
2002	-	2	0	0	-
2003	-	2	0	1	1
2004	-	2	0	0	-
2005	-	2	0	0	-
2006	-	2	0	0	-
2007	-	2	0	0	1
2008	-	2	0	0	1
2009	-	1	0	1	1
2010	-	2	0	0	1
2011	-	2	0	0	-
2012	-	2	0	1	1
2013	-	2	0	0	-
2014	-	2	0	0	1
2015	-	2	0	0	1
2016	-	2	0	0	1
2017	-	2	0	1	-

Table 6. Year and region strata for which the minimum sample size is **not** met after combining commercial landings and samples from all months. Dashes indicate that either there were no commercial landings or the region was combined with another region.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL
1984	-	-	-	-	-
1985	-	-	-	-	-
1986	-	-	-	-	-
1987	-	-	-	-	-
1988	-	-	-	-	-
1989	-	-	-	-	-
1990	-	-	-	-	-
1991	-	0	0	1	-
1992	-	1	0	0	1
1993	-	1	0	0	1
1994	1	1	0	0	1
1995	-	1	0	0	-
1996	-	0	0	0	-
1997	-	1	0	0	1
1998	-	1	0	0	1
1999	1	0	0	0	1
2000	1	1	0	0	1
2001	-	1	0	0	1
2002	-	1	0	0	-
2003	-	1	0	0	1
2004	-	1	0	0	-
2005	-	1	0	0	-
2006	-	1	0	0	-
2007	-	1	0	0	1
2008	-	0	0	0	1
2009	-	0	0	0	1
2010	-	1	0	0	1
2011	-	1	0	0	-
2012	-	1	0	0	1
2013	-	1	0	0	-
2014	-	1	0	0	1
2015	-	0	0	0	1
2016	-	1	0	0	1
2017	-	1	0	0	-

Table 7. Number of Yellowtail Snapper discarded by the commercial fleet and sampled for length by year and region.

YEAR	SW FL	FL Keys
2006	0	2
2009	0	80
2010	4	9
2011	0	98
2012	1	116
2013	3	168
2014	0	109
2015	10	70
2016	33	97
2017	0	70
TOTALS	51	819

Table 8. Number of Yellowtail Snapper landed by the headboat fleet and sampled for length by year and region.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL
1981	0	0	1,081	629	27
1982	0	0	2,006	411	52
1983	0	2	1,829	887	69
1984	0	7	1,940	920	20
1985	0	2	1,794	904	46
1986	1	44	2,110	1,014	48
1987	0	31	1,827	1,020	69
1988	0	69	1,102	479	37
1989	0	37	1,503	808	26
1990	0	75	1,048	173	57
1991	0	10	1,328	336	53
1992	0	39	888	270	87
1993	1	1	1,562	250	77
1994	0	1	1,744	487	37
1995	0	1	1,252	395	21
1996	3	9	1,464	22	10
1997	0	1	1,592	815	13
1998	0	6	1,394	856	18
1999	0	27	1,033	548	51
2000	0	4	1,003	507	21
2001	0	1	902	500	13
2002	0	6	1,004	687	73
2003	0	2	1,321	1,293	32
2004	0	2	815	1,509	7
2005	0	17	861	1,548	12
2006	0	77	843	1,783	3
2007	0	3	903	2,301	31
2008	0	30	1,120	917	58
2009	1	16	1,035	654	37
2010	0	57	774	538	9
2011	0	23	1,220	769	20
2012	0	26	2,983	477	19
2013	0	16	3,149	589	122
2014	0	32	2,676	782	120
2015	0	21	3,654	630	82
2016	0	71	4,021	745	28
2017	0	35	3,005	459	28
TOTALS	6	801	59,786	27,912	1,533

Table 9. Average monthly minimum sample sizes required to satisfy the defined criteria for the headboat fleet. Dashes indicate either there were no landings or landings are not available by month (i.e. 1981-1985 for NW FL and SW FL). Note: landings by month are not the final landings estimates.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL
1981	-	-	140	140	61
1982	-	-	139	140	30
1983	-	-	141	135	34
1984	-	-	139	136	27
1985	-	-	139	132	29
1986	23	75	140	135	46
1987	117	69	141	135	59
1988	17	106	138	137	61
1989	-	89	136	138	40
1990	44	81	140	139	41
1991	4	64	138	140	59
1992	59	62	138	139	47
1993	48	90	139	139	35
1994	54	77	138	141	27
1995	3	53	137	138	29
1996	56	75	137	130	5
1997	33	28	134	135	15
1998	20	49	136	129	7
1999	24	80	137	133	11
2000	26	45	130	122	11
2001	6	31	135	87	12
2002	28	16	138	76	18
2003	-	24	133	92	10
2004	4	18	134	100	17
2005	15	45	139	118	26
2006	2	40	133	63	17
2007	13	52	130	120	42
2008	9	46	130	134	24
2009	5	55	131	130	30
2010	2	39	134	133	10
2011	5	44	122	131	13
2012	2	36	123	137	13
2013	1	63	141	136	22
2014	-	95	142	140	24
2015	2	98	142	141	22
2016	-	107	141	142	9
2017	11	113	139	135	15

Table 10. Proportion of months per year and region for which the minimum sample size was **not** met for the headboat fishery (i.e. a 0 indicates that all months were sufficiently sampled while a 1 indicates that all months were insufficiently sampled). Dashes indicate either there were no landings or landings are not available by month (i.e. 1981-1985 for West of Keys region).

YEAR	West of Keys	FL Keys	East of Keys
1981	-	0.83	1
1982	-	0.42	1
1983	-	0.42	0.75
1984	-	0.25	0.83
1985	-	0.33	0.83
1986	1	0.33	0.83
1987	1	0.42	0.92
1988	1	0.67	1
1989	1	0.5	1
1990	1	0.92	1
1991	1	0.75	1
1992	1	1	1
1993	1	0.67	1
1994	1	0.42	1
1995	1	0.92	1
1996	1	0.67	1
1997	1	0.5	0.75
1998	1	0.67	0.92
1999	1	0.92	1
2000	1	1	1
2001	1	1	0.92
2002	1	0.92	0.67
2003	1	0.92	0.42
2004	1	1	0.33
2005	1	1	0.5
2006	1	1	0.42
2007	1	1	0.17
2008	1	0.92	0.83
2009	1	0.92	1
2010	1	1	0.92
2011	1	0.83	0.92
2012	1	0.08	1
2013	1	0.08	1
2014	1	0.42	0.92
2015	1	0.08	1
2016	1	0	0.92
2017	1	0.17	1

Table 11. Proportion of months per year and region for which Yellowtail Snapper was landed but not sampled in the headboat fishery (i.e. a 0 indicates that all fished months were sampled). Dashes indicate either there were no landings or landings are not available by month (i.e. 1981-1985 for West of Keys region).

YEAR	West of Keys	FL Keys	East of Keys
1981	-	0	0
1982	-	0	0.08
1983	-	0	0
1984	-	0	0
1985	-	0	0
1986	0.08	0	0
1987	0.42	0	0
1988	0.08	0.33	0.33
1989	0.25	0	0
1990	0.42	0	0
1991	0.58	0	0
1992	0.5	0	0
1993	0.83	0	0
1994	0.92	0	0
1995	0.92	0	0
1996	0.64	0	0.25
1997	0.92	0	0.25
1998	0.58	0	0
1999	0.58	0	0.08
2000	0.83	0	0
2001	0.92	0	0
2002	0.75	0	0
2003	0.91	0	0
2004	0.92	0	0
2005	0.75	0	0
2006	0.58	0	0
2007	0.75	0	0
2008	0.67	0	0
2009	0.67	0	0
2010	0.67	0	0.08
2011	0.83	0.17	0
2012	0.75	0	0
2013	0.58	0	0
2014	0.67	0	0
2015	0.42	0	0
2016	0.5	0	0
2017	0.33	0	0

Table 12. Number of seasons per year and region for which the minimum sample size is **not** met after combining months within seasons that were inadequately sampled for the headboat fleet. Dashes indicate either there were no landings or landings are not available by month (i.e. 1981-1985 for West of Keys region).

YEAR	West of Keys	FL Keys	East of Keys
1981	-	0	1
1982	-	0	0
1983	-	0	0
1984	-	0	0
1985	-	0	0
1986	2	0	0
1987	2	0	0
1988	2	0	0
1989	2	0	0
1990	2	0	2
1991	2	0	1
1992	2	0	1
1993	2	0	1
1994	2	0	0
1995	2	0	0
1996	2	0	2
1997	2	0	1
1998	2	0	0
1999	2	0	0
2000	2	0	0
2001	2	0	0
2002	2	0	0
2003	2	0	0
2004	2	0	0
2005	2	0	0
2006	2	0	0
2007	2	0	0
2008	2	0	0
2009	2	0	0
2010	2	0	0
2011	2	0	0
2012	2	0	0
2013	2	0	0
2014	2	0	0
2015	2	0	0
2016	2	0	0
2017	2	0	0

Table 13. Year and region strata for which the minimum sample size is **not** met after combining landings and samples across seasons for the headboat fleet. Dashes indicate that there were no headboat landings.

YEAR	West of Keys	FL Keys	East of Keys
1981	-	0	0
1982	1	0	0
1983	1	0	0
1984	1	0	0
1985	1	0	0
1986	1	0	0
1987	1	0	0
1988	1	0	0
1989	1	0	0
1990	1	0	0
1991	1	0	0
1992	1	0	0
1993	1	0	0
1994	1	0	0
1995	1	0	0
1996	1	0	1
1997	1	0	0
1998	1	0	0
1999	1	0	0
2000	1	0	0
2001	1	0	0
2002	1	0	0
2003	1	0	0
2004	1	0	0
2005	1	0	0
2006	1	0	0
2007	1	0	0
2008	1	0	0
2009	1	0	0
2010	1	0	0
2011	1	0	0
2012	1	0	0
2013	1	0	0
2014	1	0	0
2015	1	0	0
2016	1	0	0
2017	1	0	0

Table 14. Monthly minimum sample sizes required to satisfy the defined criteria for estimating length compositions of releases for the headboat fleet. Dashes indicate either there were no estimates of releases.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL
1981	-	-	141	140	27
1982	-	-	140	129	9
1983	-	-	144	142	87
1984	-	97	144	143	66
1985	-	-	132	101	8
1986	-	-	143	136	66
1987	-	-	144	144	135
1988	-	-	144	144	135
1989	-	-	144	143	98
1990	-	-	144	144	134
1991	1	87	144	144	143
1992	13	127	144	143	106
1993	-	-	144	143	79
1994	-	-	144	144	84
1995	-	-	144	143	81
1996	-	-	144	142	13
1997	-	-	144	143	78
1998	21	126	144	143	57
1999	4	95	144	143	62
2000	23	77	144	141	54
2001	31	138	143	126	37
2002	3	12	144	124	75
2003	-	-	144	141	62
2004	-	39	144	31	40
2005	-	88	143	72	38
2006	-	117	143	58	9
2007	-	112	144	113	59
2008	2	120	144	134	93
2009	-	131	144	133	100
2010	-	129	144	138	80
2011	-	108	144	132	76
2012	-	121	144	140	69
2013	-	127	144	142	109
2014	-	125	144	143	34
2015	-	123	144	144	12
2016	-	131	144	144	57
2017	-	135	144	141	20

Table 15. Number of Yellowtail Snapper released by headboats and charter boats and measured by onboard observers, 2005-2017.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL	TOTAL
2005	0	50	400	114	9	573
2006	0	48	544	54	8	654
2007	0	5	579	59	9	652
2008	0	0	0	83	6	89
2009	0	0	0	60	4	64
2010	0	0	70	57	0	127
2011	0	0	65	12	0	77
2012	0	0	411	42	0	453
2013	0	1	726	185	3	915
2014	0	1	617	26	0	644
2015	0	31	323	254	4	612
2016	0	81	979	77	0	1137
2017	0	133	951	158	4	1246
TOTAL	0	350	5665	1181	47	7243

Table 16. Year and region strata for which minimum sample size criteria was **not** met for estimating headboat release sizes. Dashes indicate that there were no reported releases.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL
2005	-	1	0	0	1
2006	-	1	0	1	1
2007	-	1	0	1	1
2008	1	1	1	1	1
2009	-	1	1	1	1
2010	-	1	1	1	1
2011	-	1	1	1	1
2012	-	1	0	1	1
2013	-	1	0	0	1
2014	-	1	0	1	1
2015	-	1	0	0	1
2016	-	1	0	1	1
2017	-	1	0	0	1

Table 17. Number of Yellowtail Snapper landed and sampled by MRIP for length by year and region.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL	TOTALS
1981	0	0	159	55	0	214
1982	0	1	191	27	4	223
1983	0	0	56	43	2	101
1984	0	2	46	47	0	95
1985	3	0	19	9	0	31
1986	0	0	44	36	0	80
1987	0	1	116	16	0	133
1988	0	2	65	75	0	142
1989	0	1	106	19	0	126
1990	0	0	61	13	0	74
1991	0	5	146	9	0	160
1992	0	80	80	45	0	205
1993	0	10	197	57	1	265
1994	0	5	259	27	5	296
1995	0	0	154	21	0	175
1996	0	0	82	51	0	133
1997	0	0	228	17	1	246
1998	0	8	434	67	3	512
1999	0	33	557	55	2	647
2000	0	3	521	55	9	588
2001	0	1	282	219	13	515
2002	0	19	384	196	23	622
2003	0	6	510	376	0	892
2004	0	14	422	443	2	881
2005	0	19	272	392	5	688
2006	0	9	289	651	3	952
2007	0	12	345	585	0	942
2008	0	10	330	360	0	700
2009	0	7	139	285	0	431
2010	0	8	428	221	1	658
2011	0	20	278	218	0	516
2012	0	0	680	211	0	891
2013	0	4	502	345	2	853
2014	0	12	467	400	3	882
2015	0	42	373	564	0	979
2016	0	33	271	373	1	678
2017	0	59	381	153	9	602
TOTALS	3	426	9,874	6,736	89	17,128

Table 18. Average minimum sample sizes by wave required to satisfy the defined criteria for MRIP fishing modes. Dashes indicate that there were no landings.

YEAR	NW FL	SW FL	FL Keys	SE FL	NE FL
1981	-	-	144	144	-
1982	-	75	144	144	141
1983	-	142	144	144	143
1984	-	114	144	143	49
1985	144	92	143	137	85
1986	134	-	144	143	-
1987	143	140	144	143	-
1988	-	139	144	143	-
1989	-	142	144	143	-
1990	-	NA	143	144	-
1991	-	142	144	142	-
1992	-	139	144	143	137
1993	-	142	144	144	125
1994	-	137	144	143	137
1995	-	NA	144	143	-
1996	-	NA	144	143	-
1997	-	128	144	143	116
1998	-	81	144	143	140
1999	-	111	141	143	106
2000	-	105	144	144	104
2001	-	139	143	141	121
2002	-	107	144	142	131
2003	-	120	144	143	88
2004	22	121	144	144	78
2005	22	132	144	144	106
2006	-	141	144	144	103
2007	-	112	144	144	144
2008	-	121	144	144	84
2009	-	118	144	144	96
2010	-	143	144	144	139
2011	-	136	143	141	-
2012	-	57	144	144	-
2013	-	133	144	144	20
2014	-	135	144	144	71
2015	-	139	144	144	-
2016	-	134	144	144	114
2017	-	132	144	144	136

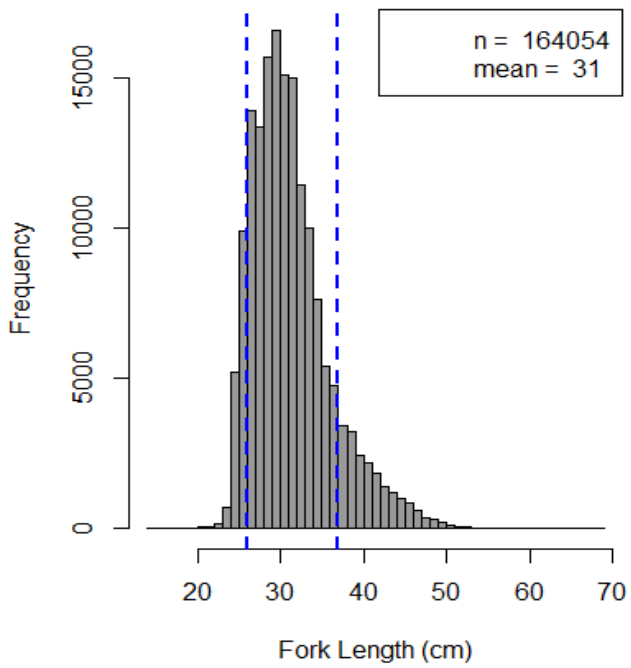


Figure 1. Yellowtail Snapper fork lengths sampled (10th and 90th percentiles shown in blue) from commercial landings by the Trip Interview Program (TIP) and Creel Survey and Biological Sampling Plan (CSBSP) from 1984-2017.

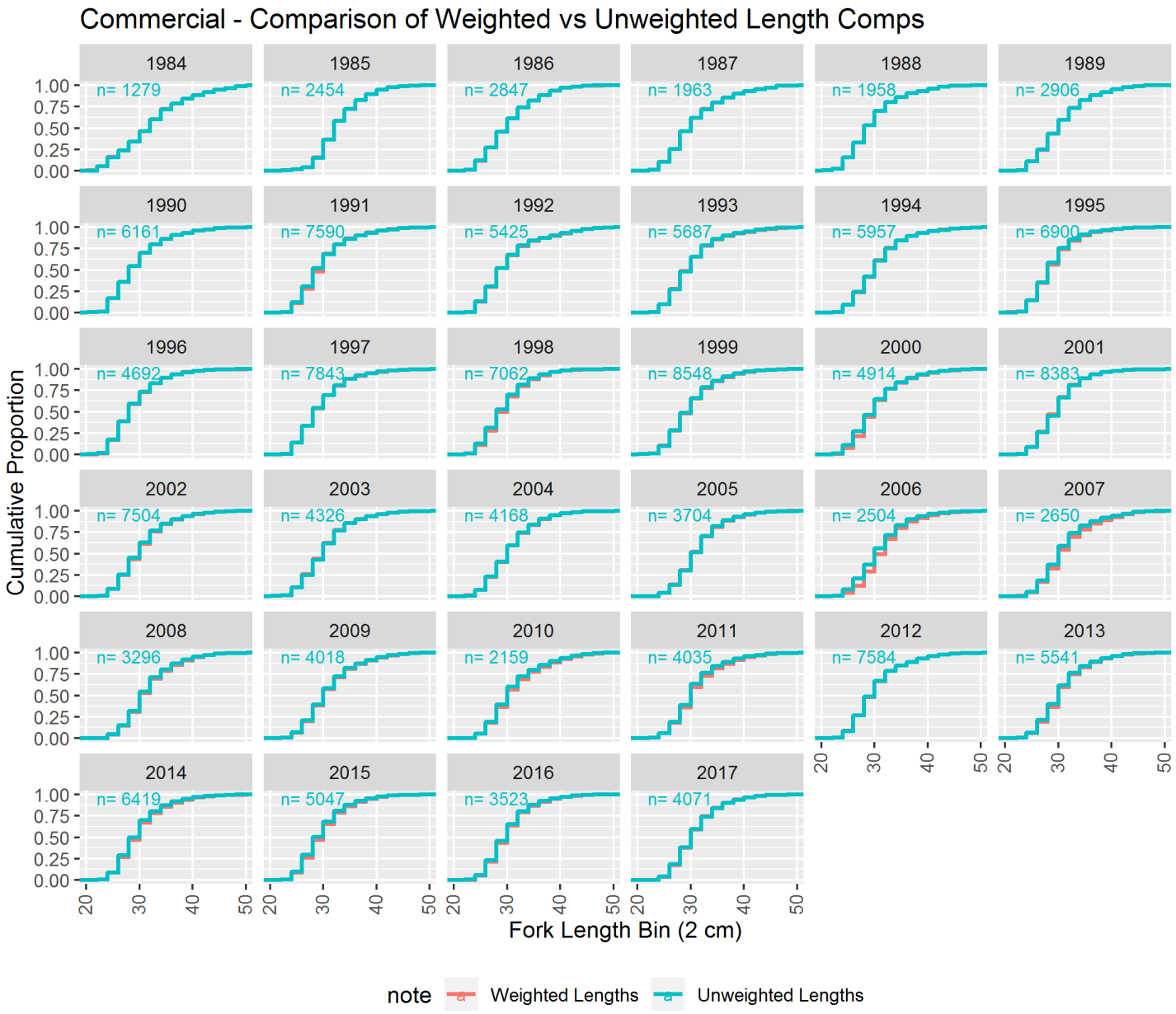


Figure 2. A comparison of unweighted (blue) and weighted (red) sampled Yellowtail Snapper fork lengths for the commercial fleet, 1984 - 2017.

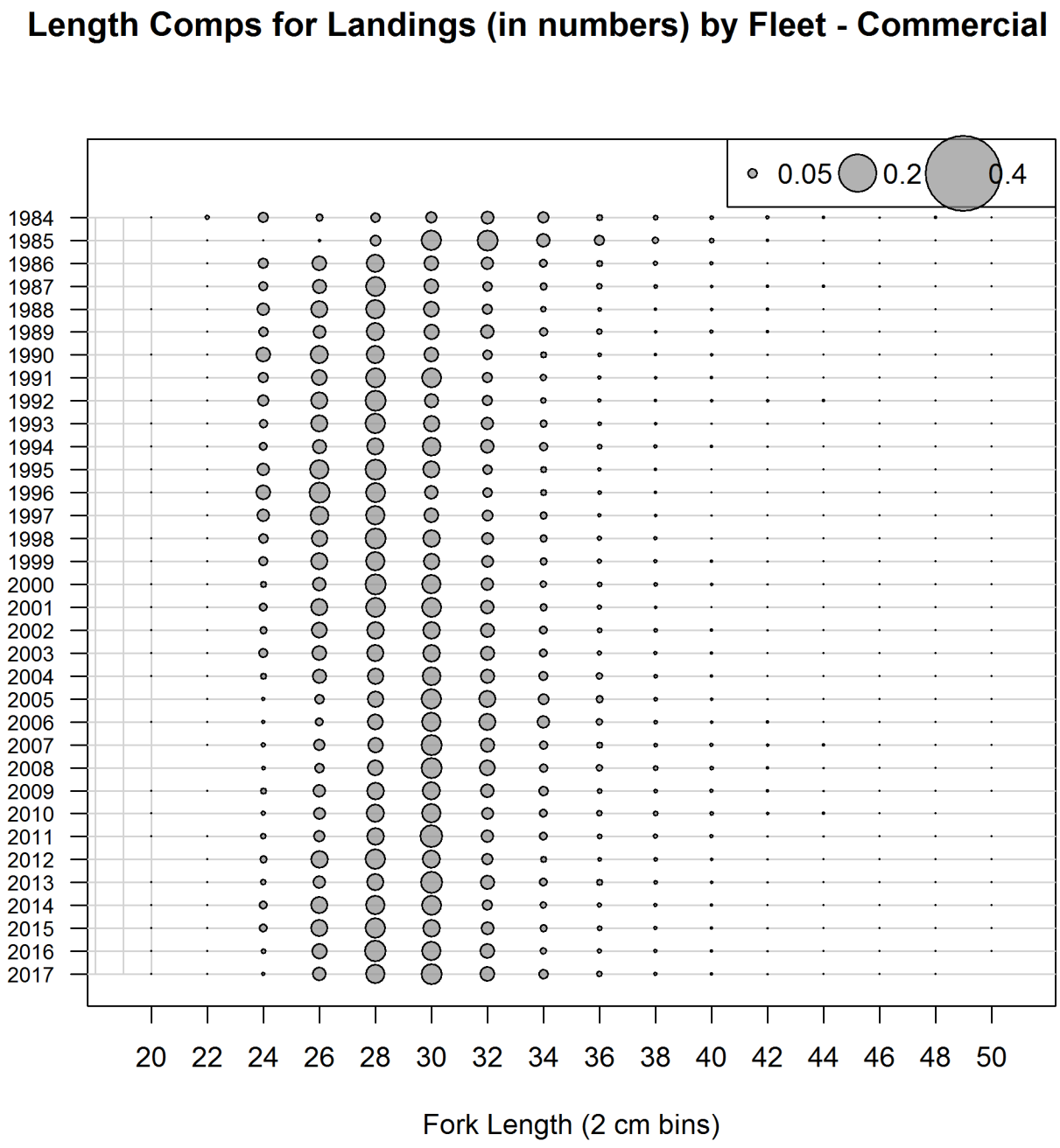


Figure 3. Bubble plot of commercial landings-at-length for Yellowtail Snapper from 1984 to 2017.

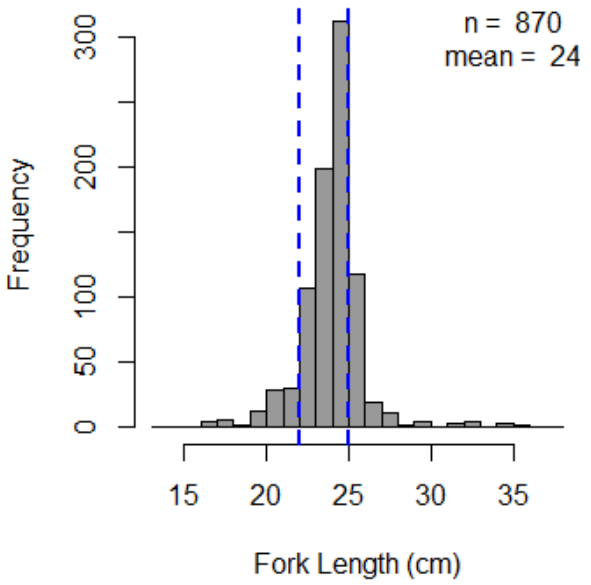


Figure 4. Yellowtail Snapper fork lengths sampled (10th and 90th percentiles shown in blue) from commercial discards by the Commercial Reef Fish Observer Program (RFOP) and Shark Observer Program (SOP), 2006-2017 in Florida waters.

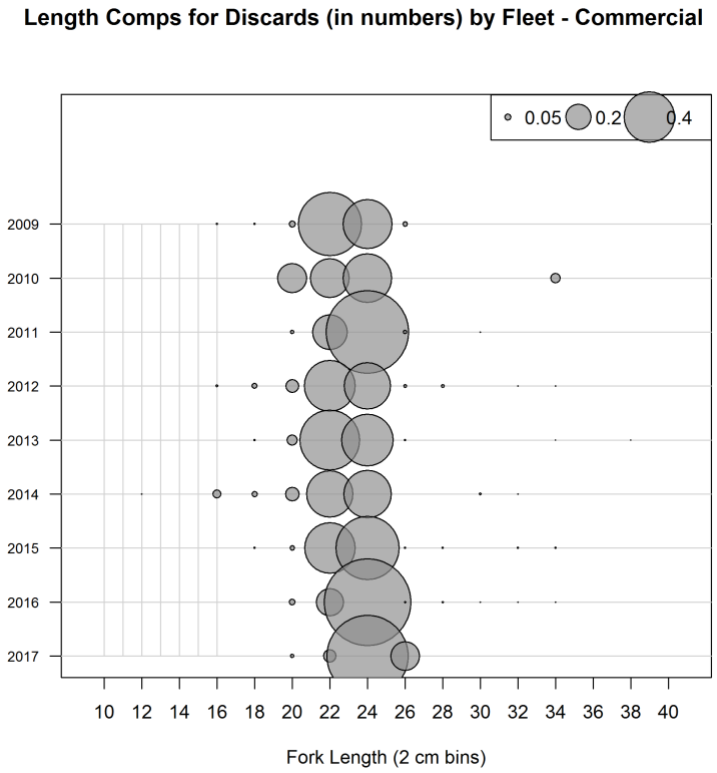


Figure 5. Bubble plot of commercial length frequencies of sampled discards for Yellowtail Snapper, 2009-2017.

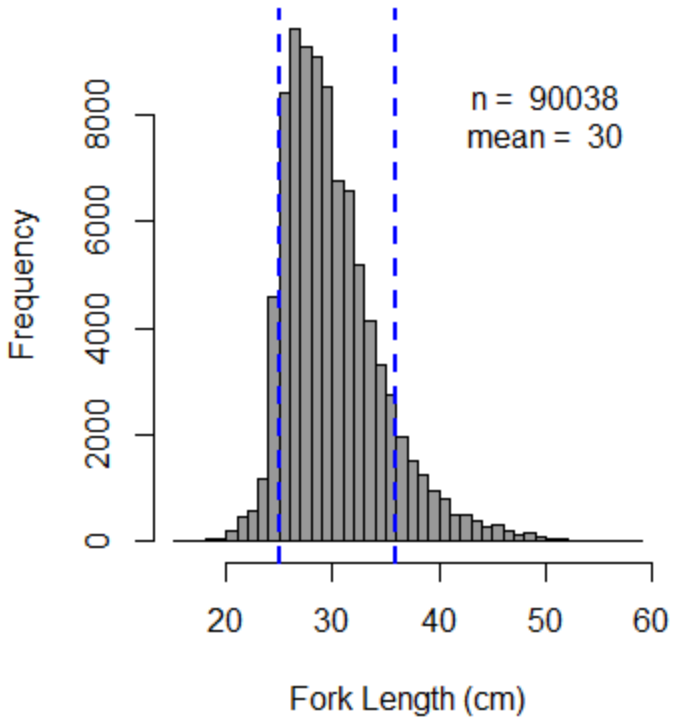


Figure 6. Yellowtail Snapper fork lengths sampled (10th and 90th percentiles shown in blue) from headboat landings by the Southeast Region Headboat Survey (SRHS) from 1981-2017 in Florida waters.

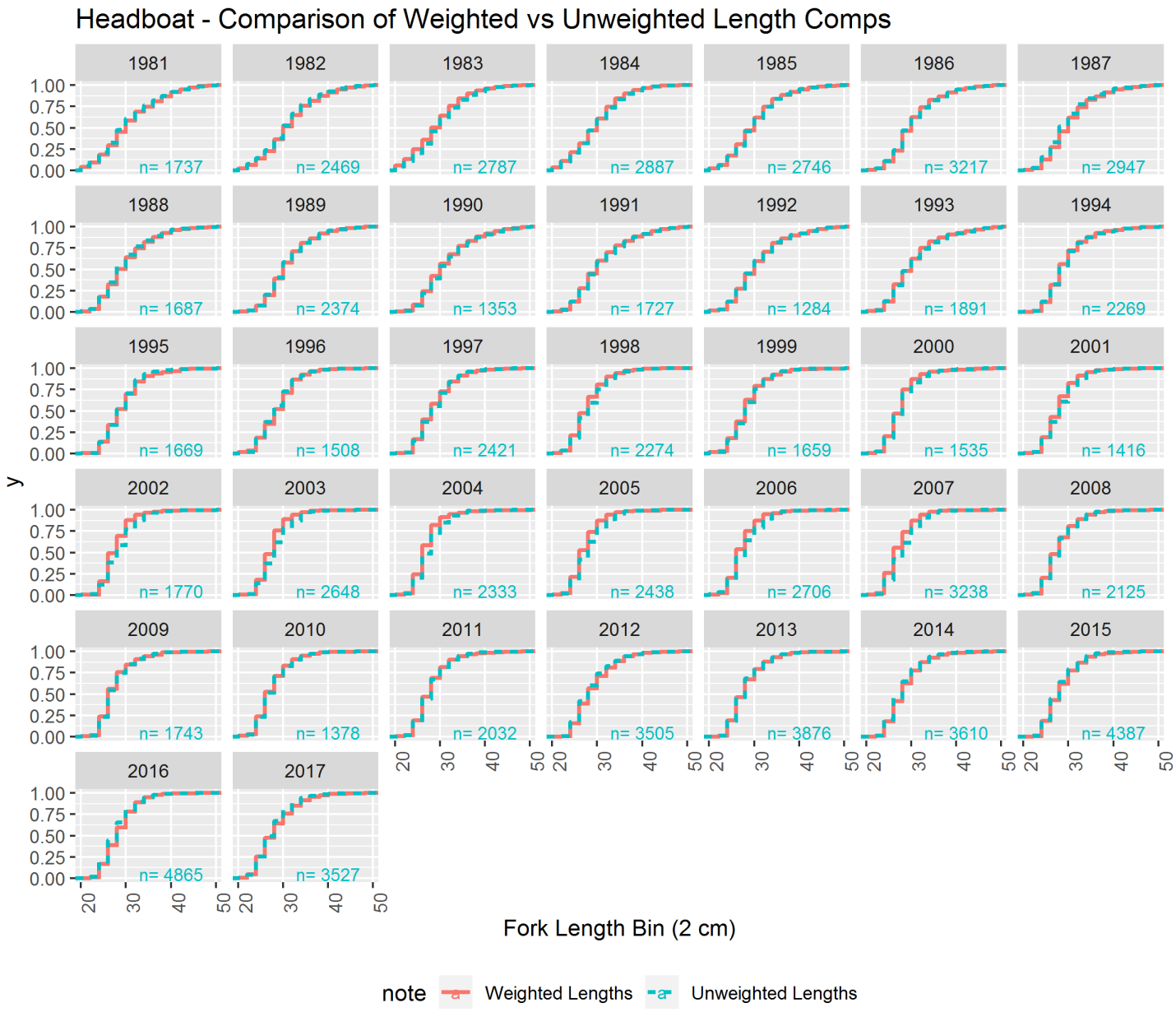


Figure 7. A comparison of unweighted (blue) and weighted (red) sampled Yellowtail Snapper fork lengths for the headboat fleet, 1981-2017.

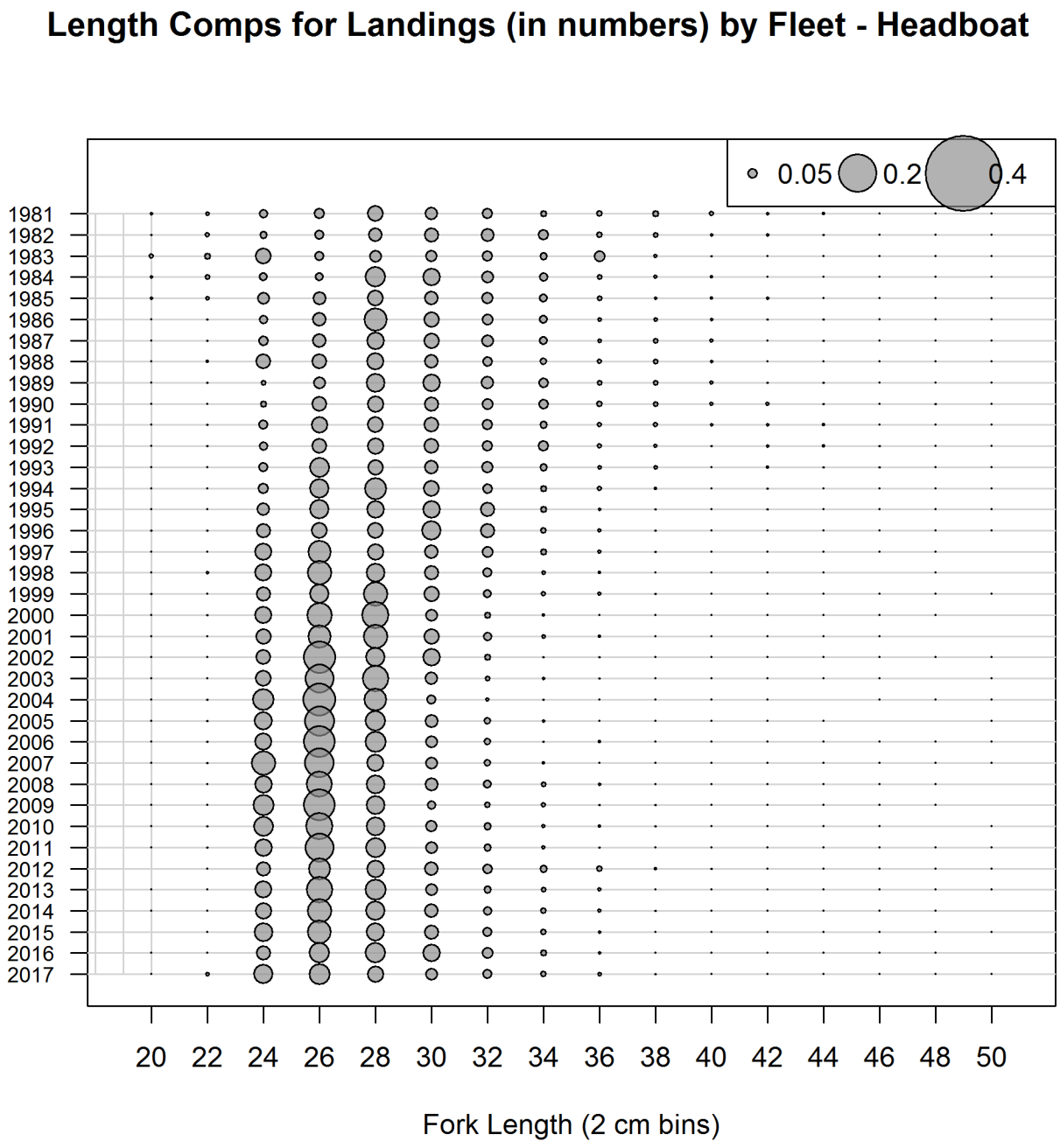
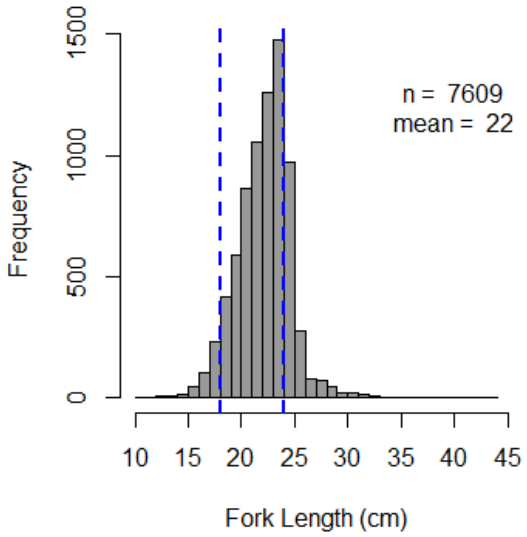
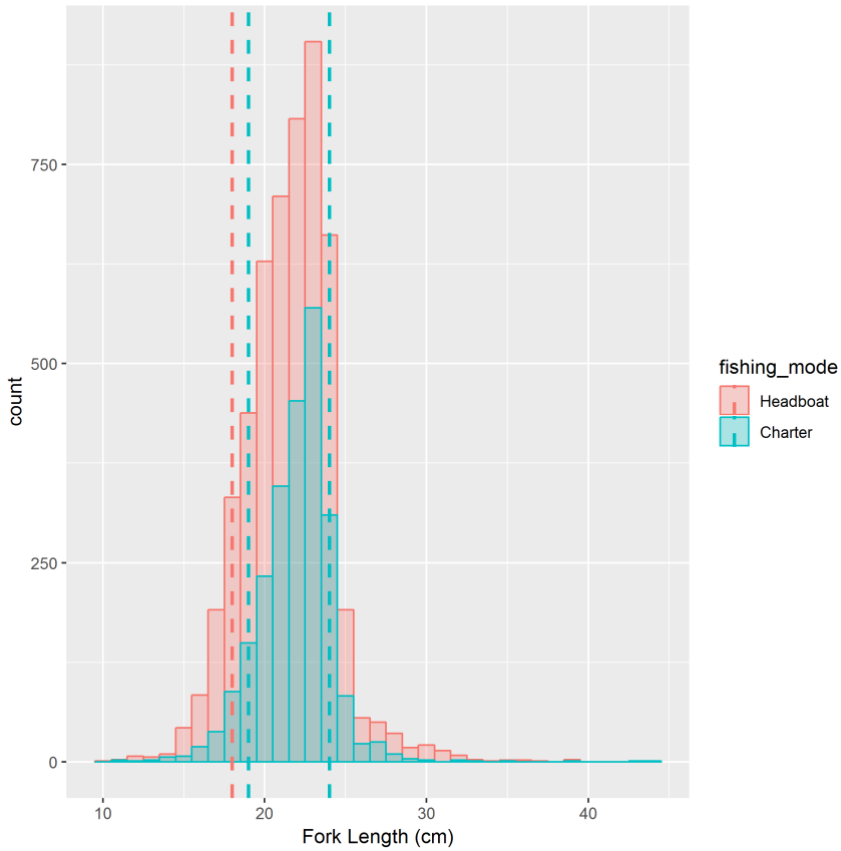


Figure 8. Bubble plot of headboat landings-at-length for Yellowtail Snapper, 1981-2017.



a)



b)

Figure 9. Yellowtail Snapper fork lengths sampled from headboat and charter boat landings by the Florida At-Sea Observer Program from 2005-2017 in Florida waters (lines indicate 10th and 90th percentiles).

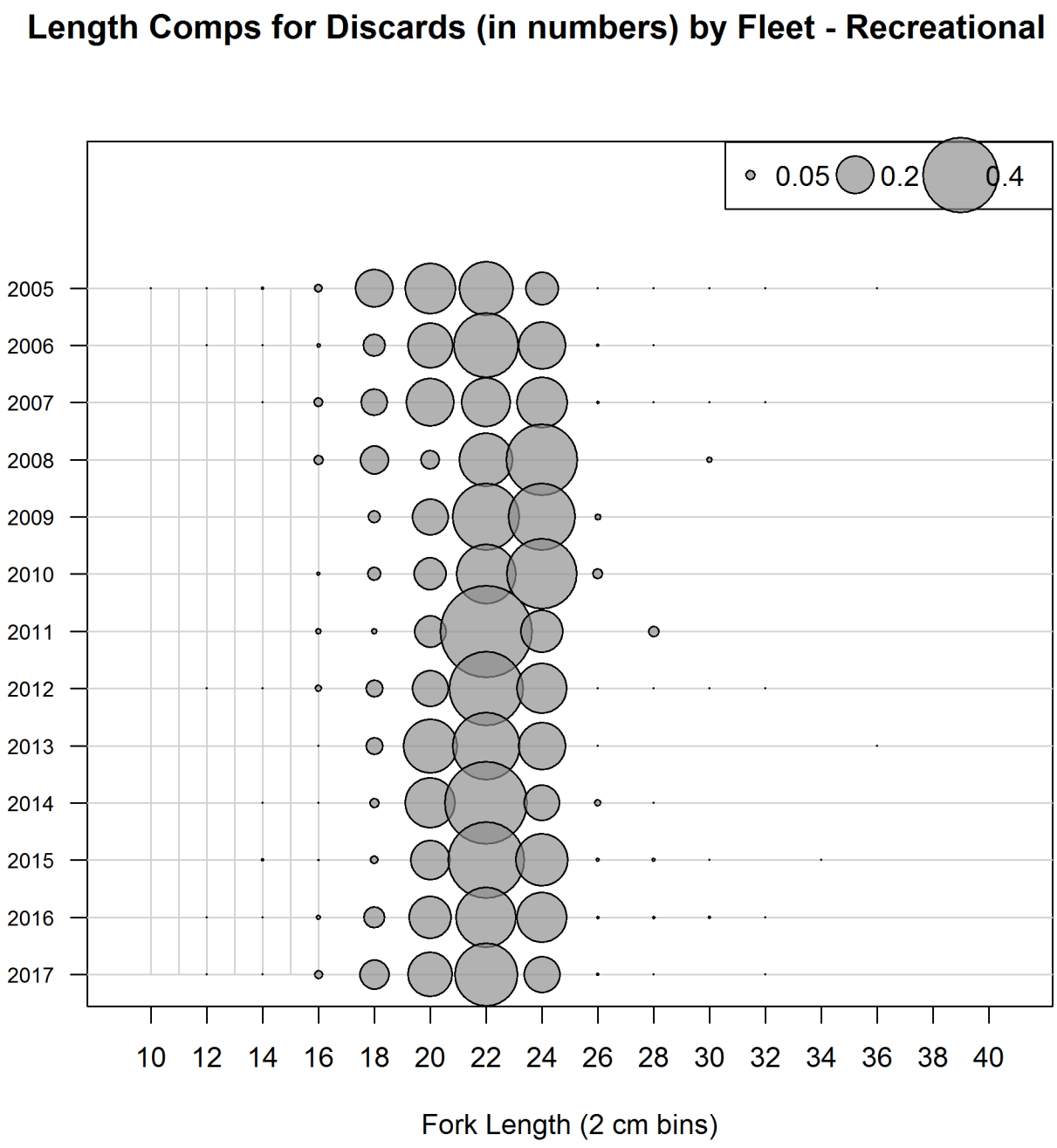


Figure 10. Bubble plot of recreational releases of Yellowtail Snapper in 2 cm length bins, 2005-2017.

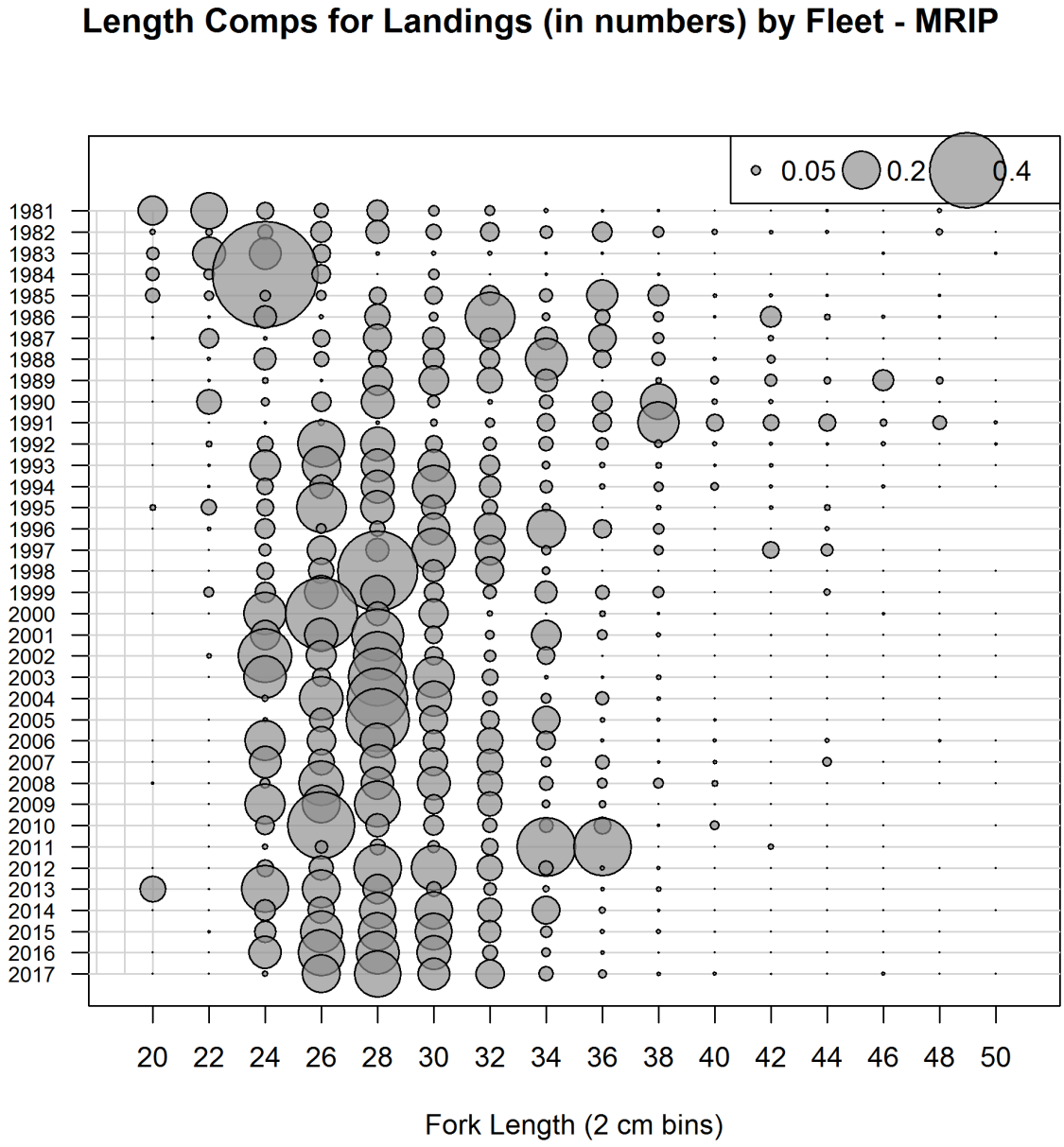


Figure 11. Bubble plot of MRIP landings-at-length for Yellowtail Snapper from 1981 to 2017.

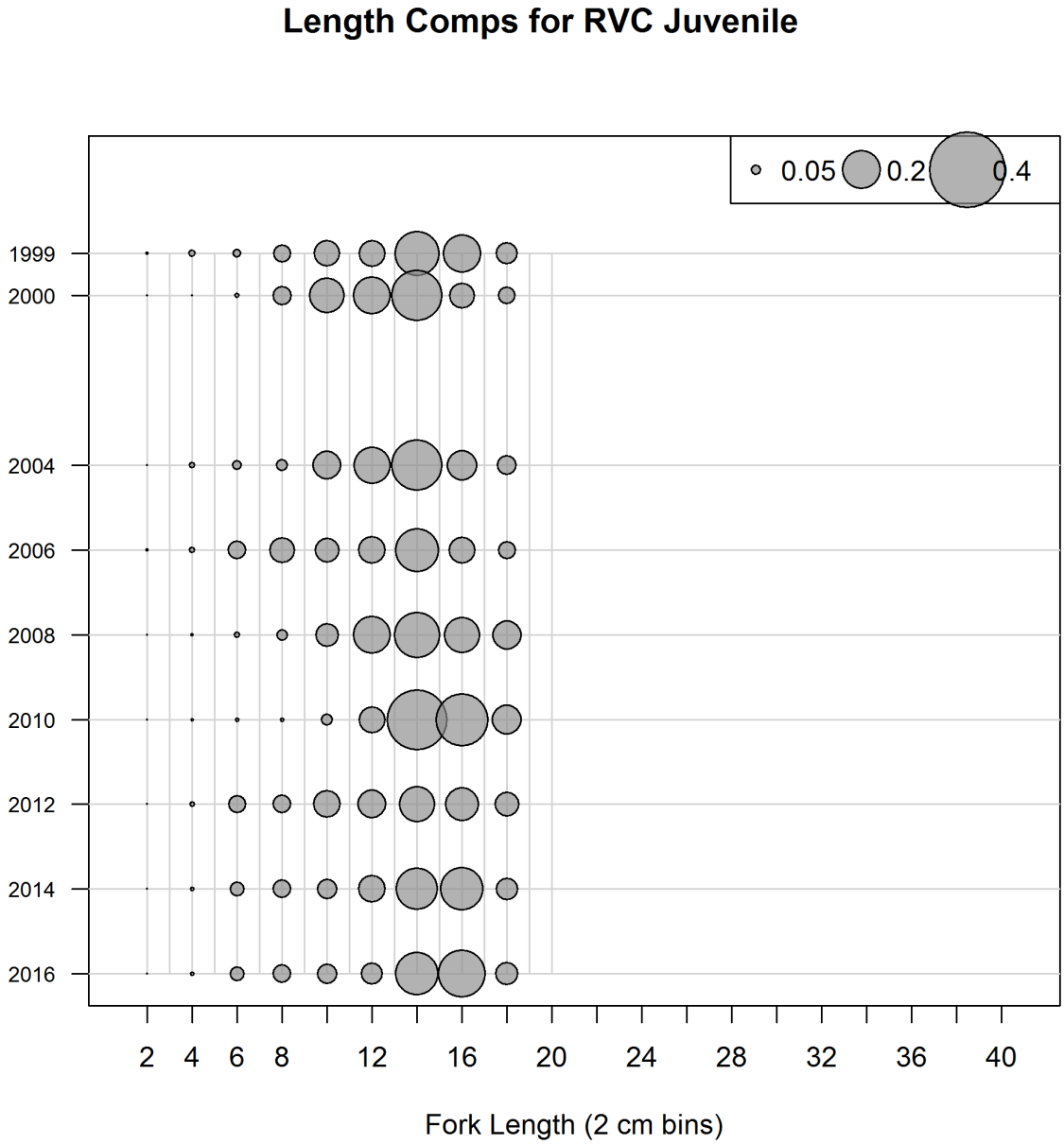


Figure 12. Bubble plot of RVC juvenile length frequencies for Yellowtail Snapper from 1999 to 2016.

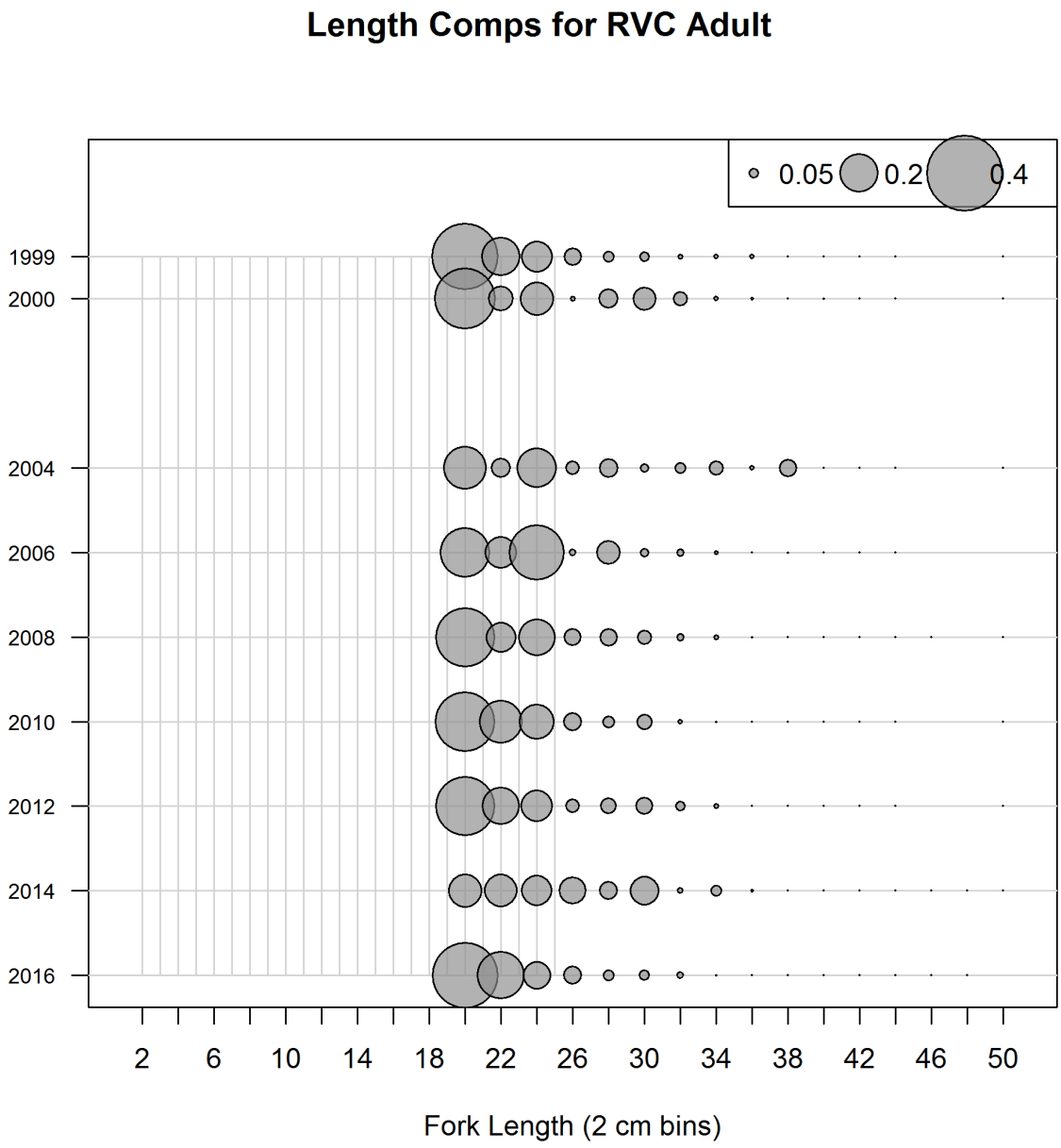


Figure 13. Bubble plot of RVC adult length frequencies for Yellowtail Snapper from 1999 to 2016.