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Catch and size composition time series of the US pelagic longline fleets for the 2017 north Pacific albacore tuna assessment[1]

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ABSTRACT

The objective of this paper is to describe the data sources and methods used to develop seasonal catch (in metric tons) and size composition (raised to the catch) time series for two US pelagic longline fleets based in the north Pacific Ocean, for use in the 2017 assessment. In a previous study, two US pelagic longline fleets were defined, based on the consistency of size compositions within areas. Fleet 1 consists of a northern area with mostly juvenile and sub-adult albacore. Fleet 2 consists of a southern area with mostly large, adult albacore. Size composition data in 1 cm bins from an observer sampling program was subdivided into 10x10° area/month/year strata. Strata with <3 observed trips were discarded. Size compositions of stratas in each fleet were combined into seasonal size compositions by performing a weighted average of the size compositions of all stratas in each fleet by year and season. The input sample sizes for the size compositions were considered to be the weighted average of the number of trips of all stratas in each fleet by year and season. The total annual landings by US pelagic longline fishery were subdivided into the seasonal landings for Fleets 1 and 2, based on the relative proportion of albacore catch in each area and season using logbook data, and the size composition of albacore in each area and season. Seasonal albacore catch in metric tons for Fleets 1 and 2 of the US pelagic longline fishery in the north Pacific Ocean are shown. Most of the albacore catch occurs in the area defined for Fleet 2. Seasonal size compositions (raised to the catch) for Fleets 1 and 2 of the US pelagic longline fishery are shown. Input sample sizes ranged from 3 to 16 for Fleet 1, and 3 to 20.7 for Fleet 2. It is recommended that the ALBWG use the seasonal catch and size composition time series described in this working paper for the 2017 stock assessment of north Pacific albacore tuna.

INTRODUCTION

The objective of this paper is to describe the data sources and methods used to develop catch and size composition time series from US pelagic longline fleets based in the north Pacific Ocean that are important for the 2017 stock assessment of north Pacific albacore tuna conducted by the albacore working group (ALBWG) of the International Scientific Committee on Tuna and Tuna-like Species in the North Pacific (ISC). Teo (2016) proposed two spatial definitions for the US longline fleets based on the consistency of size compositions within areas. A northern area had primarily juvenile and sub-adult albacore tuna while a southern area had predominantly large, adult albacore (Figure 1). The ALBWG agreed to use these definitions for the US longline fleets for the 2017 assessment.

In this paper, the methods used to develop time series of: 1) catch in metric tons, and 2) size compositions for two US longline fleets in the north Pacific for use in the 2017 assessment are described. Fleet 1 (F1_USLL_N) consists of the northern area with mostly juvenile and sub-adult albacore. Fleet 2 (F2_USLL_S) consists of the southern area with mostly large, adult albacore.

MATERIALS AND METHODS

Data sources

Four main sources of data were used in this paper: 1) annual landings of albacore tuna in metric tons by the US longline and handline fisheries in the north Pacific Ocean reported to the ISC (1952 – 2015) (Table 1); 2) monthly landings of north Pacific albacore tuna in metric tons by US longline vessels based along the US West Coast (1981 – 2015); 3) catch-effort information from fishermen logbooks (1991-2015); and 4) biological (fork length) information from an observer sampling program (1994-2015).

Annual albacore tuna landings by the US longline fishery are reported to the ISC by the National Oceanic and Atmospheric Administration (NOAA) (Table 1) and represent the landings from the entire US longline fishery in the north Pacific Ocean. The US longline fishery consists of longline vessels operating out of: 1) the US West Coast (California, Oregon, and Washington) and, 2) Hawaii. However, the vast majority of US longline vessels operate out of and land fish in Hawaii, and Hawaii-based landings represent >95% of the total north Pacific albacore catch from US longline vessels (McDaniel, Crone, & Dorval, 2006). There is limited size information on the albacore caught by US longline vessels operating out of the US West Coast but these vessels are likely to catch mostly juvenile and sub-adult albacore because of their area of operations. The monthly landings of north Pacific albacore along the US West Coast by US longline vessels were obtained from PacFIN (the Pacific Fisheries Information Network; http://pacfin.psmfc.org/), and aggregated into seasonal landings (season 1: Jan – Mar; 2: Apr – Jun; 3: Jul – Sep; 4: Oct – Dec).

Catch-effort and fork length information were obtained from logbooks and observer data, respectively, from longline vessels operating out of Hawaii. A logbook monitoring program for the Hawaii-based longline fishery has been managed by the NOAA since 1990. However, the logbook data from 1990 were not used in this study because data collection only started near the end of the year. Importantly, the logbooks generally recorded set-by-set information on the location (latitude and longitude) of the vessel, the number of albacore caught and discarded, target species, and the number of hooks deployed. Since 1995, logbooks have also recorded the number of hooks per float that were deployed. An observer sampling program has also been in operation for the Hawaii-based pelagic longline fishery since 1994. Albacore tuna were measured to the nearest cm (fork length) by observers onboard the vessel. As with previous studies, the size compositions were developed from the observer program rather than a port-side sampling program at 'fish auction' sites to eliminate the potential of the size composition data being biased due to at-sea discards of smaller fish (McDaniel et al., 2006).

Size compositions

Size composition data for Fleets 1 and 2 of the US pelagic longline fishery were developed from spatial definitions defined by Teo (2016) and agreed to by the ALBWG for the 2017 assessment (Figure 1). Size composition data in 1 cm bins from the abovementioned observer sampling program were aggregated into 10x10° area/month/year strata. Strata with <3 observed trips were discarded because large spikes were evident in preliminary size compositions. Visual examination of the size compositions suggested that a minimum sample size of 3 trips de-spiked the data without altering the overall shape of the size compositions.

The size compositions of stratas in each fleet were combined into seasonal size compositions by performing a weighted average of the size compositions of all stratas in each fleet by year and season (season 1: Jan – Mar; season 2: Apr – Jun; season 3: Jul – Sep; season 4: Oct – Dec). The weights of each strata were calculated as the relative proportion of albacore catch in each strata within each fleet, season, and year, using the albacore catch in number recorded in the abovementioned logbook program.

In the last assessment, the number of trips was used as the input sample size of the size compositions of the deep-set and shallow-set US pelagic longline fleets in the assessment model. Here, I instead used the weighted average of the number of trips of all stratas in each fleet by year and season in order to be consistent with the size composition data. The weights of each strata were calculated in the same way as the size composition data.

Catch

Total annual catch of the US longline fishery is considered to be well represented by the reported landings from NOAA to ISC (Table 1). However, landings data is not available on a spatial scale that is fine enough to be separated into landings for Fleets 1 and 2. Therefore, the total annual landings was subdivided into the seasonal landings for Fleets 1 and 2, based on the relative proportion of albacore catch for each fleet and season using logbook data, and the size composition of albacore for each fleet and season.

The average weights of albacore caught in each season within the areas defined for Fleets 1 and 2 were calculated from the seasonal size compositions described in the "Size compositions" section. Seasonal size compositions were first converted into weight compositions based on the length-weight relationships estimated by Watanabe et al. (2006). A previous study (Teo, Lee, & Kohin, 2010) found that using the relationship,

$$w = 7 \times 10^{-5} \times l^{2.71} ,$$

where w is the weight in kg and l is the fork length in cm, was appropriate for the albacore caught by the US pelagic longline fishery, and is the length-weight relationship estimated by Watanabe et al (2006) in Area 4 and Quarter 1. The average weight for each fleet and season was calculated as the average of the weight composition in kg for the respective fleet and season. For periods with missing size compositions, the average weight was assumed to be the average weight for that fleet and season for all years with observed size compositions.

For the 1991 – 2015 period, the relative proportions of albacore catch in weight was calculated from the number of albacore and average weight of albacore in each season and fleet using,

$$p_{i,j,k} = (n_{i,j,k} \times w_{i,j,k}) / \sum_i \sum_j (n_{i,j,k} \times w_{i,j,k}),$$

where $p_{i,j,k}$, $n_{i,j,k}$, and $w_{i,j,k}$ are the relative proportions, numbers of albacore, and average weight of albacore caught in Fleet *i*, season *j*, and year *k* respectively. Prior to 1991, $p_{i,j,k}$, could not be calculated for each year because of the lack of logbook data. It was instead assumed that,

$$p_{i,j,1966-1990} = (\bar{n}_{i,j,1991-1994} \times \bar{w}_{i,j,1991-1994}) / \sum_i \sum_j \left(\bar{n}_{i,j,1991-1994} \times \bar{w}_{i,j,1991-1994}\right).$$

where $\bar{n}_{i,j,1991-1994}$, and $\bar{w}_{i,j,1991-1994}$ are the average numbers of albacore, and average weight of albacore caught in Fleet *i*, and season *j*, during 1991 – 1994.

The albacore catch of longline vessels operating out of the US West Coast was assumed to catch mostly juvenile and sub-adult albacore due to their area of operations. Therefore, all the albacore catch from these vessels were assigned to Fleet 1. On the other hand, the US handline albacore fishery is based in Hawaii and predominantly catch large, adult albacore tuna, and all albacore catch from the US handline fishery was therefore assigned to Fleet 2. The catch in metric tons of Fleet 1 during season *j* and year *k*, $C_{1,j,k}$, was therefore calculated as,

$$C_{1,j,k} = p_{1,j,k} \times \left(C_{LL,k} - C_{LLW,k}\right) + C_{LLW,j,k} ,$$

where $C_{LL,k}$ and $C_{LLW,k}$ are the total US longline albacore catch and the albacore catch of longline vessels operating out of the US West Coast in year *k*, respectively.

The seasonal catch in metric tons for Fleet 2 was calculated as,

$$C_{2,j,k} = p_{2,j,k} \times \left(C_{LL,k} - C_{LLW,k}\right) + C_{HL,j,k} \ ,$$

where $C_{HL,j,k}$ is the albacore catch from US handline vessels in season *j* and year *k*.

RESULTS AND DISCUSSION

Seasonal albacore catch in metric tons for Fleets 1 and 2 of the US pelagic longline fishery in the north Pacific Ocean are shown in Table 1. Note that seasonal catch from the US handline fishery are included in Fleet 2. Most of the albacore catch occurs in the area defined for Fleet 2.

Seasonal size compositions (raised to the catch) for Fleets 1 and 2 of the US pelagic longline fishery are shown in Figure 2. The input sample sizes ranged from 3 to 16 for Fleet 1 (north area; predominantly juvenile and subadult), and 3 to 20.7 for Fleet 2 (south area; predominantly large adult).

It is recommended that the ALBWG use the catch and size composition time series described in this working paper for the 2017 stock assessment of north Pacific albacore tuna.

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Table 1. Seasonal catch in metric tons for Fleets 1 and 2 of the US pelagic longline fishery, and the total annual US longline and handline catch reported to the ISC. See Figure 1 for spatial definition of fleets.

		Fleet 1				Fleet 2			
Year	**Total longline and handline**	**Season 1**	**Season 2**	**Season 3**	**Season 4**	**Season 1**	**Season 2**	**Season 3**	**Season 4**
1966	8	0.2	0.1	0.1	1.5	1.2	1.5	0.8	2.7
1967	12	0.3	0.1	0.1	2.2	1.7	2.3	1.3	4.1
1968	11	0.2	0.1	0.1	2.0	1.6	2.1	1.1	3.7
1969	14	0.3	0.1	0.1	2.6	2.0	2.7	1.5	4.7
1970	9	0.2	0.1	0.1	1.7	1.3	1.7	0.9	3.0
1971	11	0.2	0.1	0.1	2.0	1.6	2.1	1.1	3.7
1972	8	0.2	0.1	0.1	1.5	1.2	1.5	0.8	2.7
1973	14	0.3	0.1	0.1	2.6	2.0	2.7	1.5	4.7
1974	9	0.2	0.1	0.1	1.7	1.3	1.7	0.9	3.0
1975	33	0.7	0.3	0.2	6.1	4.8	6.3	3.4	11.2
1976	23	0.5	0.2	0.2	4.2	3.3	4.4	2.4	7.8
1977	37	0.8	0.3	0.3	6.8	5.3	7.1	3.9	12.5
1978	54	1.2	0.5	0.4	10.0	7.8	10.3	5.6	18.3
1979	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1981	25	8.3	0.0	10.1	7.0	0.0	0.0	0.0	0.0
1982	105	25.5	0.6	13.8	16.5	9.0	12.0	6.5	21.2
1983	6	0.0	0.0	0.9	5.0	0.0	0.0	0.0	0.0
1984	2	0.1	0.7	0.1	1.3	0.0	0.0	0.0	0.0
1985	0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
1986	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	150	3.3	1.4	1.2	27.7	21.6	28.6	15.6	50.7
1988	307	6.8	2.8	2.2	56.7	44.2	58.6	32.0	103.8
1989	248	5.5	2.2	1.8	45.8	35.7	47.3	25.8	83.8
1990	177	3.9	1.6	1.3	32.7	25.5	33.8	18.4	59.8
1991	312	7.0	5.9	1.7	55.3	44.0	98.6	46.5	53.0
1992	334	13.0	3.7	1.8	92.7	48.3	72.0	31.1	71.3
1993	438	6.9	5.0	1.0	80.3	56.1	95.4	39.6	153.7
1994	544	10.8	3.2	8.3	87.3	83.8	47.6	54.1	249.0

		Fleet 1				Fleet 2			
Year	**Total longline and handline**	**Season 1**	**Season 2**	**Season 3**	**Season 4**	**Season 1**	**Season 2**	**Season 3**	**Season 4**
1995	882	33.6	2.9	9.4	74.1	110.5	278.0	170.9	202.5
1996	1185	70.8	0.2	0.4	58.6	187.2	492.0	187.2	188.7
1997	1653	35.0	2.1	0.3	23.6	504.3	772.1	259.2	56.4
1998	1120	15.8	0.7	7.4	37.5	154.4	400.7	350.5	153.0
1999	1542	53.6	3.7	10.4	35.0	276.3	450.4	317.9	394.7
2000	940	32.9	3.4	3.0	14.3	104.5	311.2	179.2	291.5
2001	1295	5.7	7.5	0.5	2.0	279.2	637.6	253.5	109.0
2002	525	3.2	0.0	2.5	0.0	73.7	317.1	71.6	56.8
2003	524	1.2	2.5	3.1	0.0	102.6	381.0	20.2	13.3
2004	361	0.0	0.0	6.1	3.8	75.6	38.9	161.5	75.0
2005	296	9.4	0.4	2.2	5.4	95.9	132.5	23.5	26.7
2006	270	6.5	4.0	5.8	0.0	88.5	94.8	57.0	13.5
2007	344	13.5	0.1	2.0	3.1	107.1	53.3	26.6	138.3
2008	382	20.6	4.8	31.0	18.8	167.9	88.2	10.6	40.0
2009	300	26.0	9.3	14.9	1.8	118.3	49.9	63.2	16.6
2010	474	20.2	5.1	5.9	33.5	212.4	104.8	68.9	23.1
2011	792	28.2	13.0	87.9	23.6	349.4	112.5	97.4	79.9
2012	913	14.2	44.4	53.7	6.0	332.9	264.0	69.4	128.4
2013	363	18.1	4.5	5.6	4.4	165.9	109.5	14.6	40.5
2014	257	10.5	4.9	5.4	0.6	78.0	68.6	25.7	63.3
2015	305	4.8	6.2	3.1	0.1	140.8	117.8	13.0	19.2

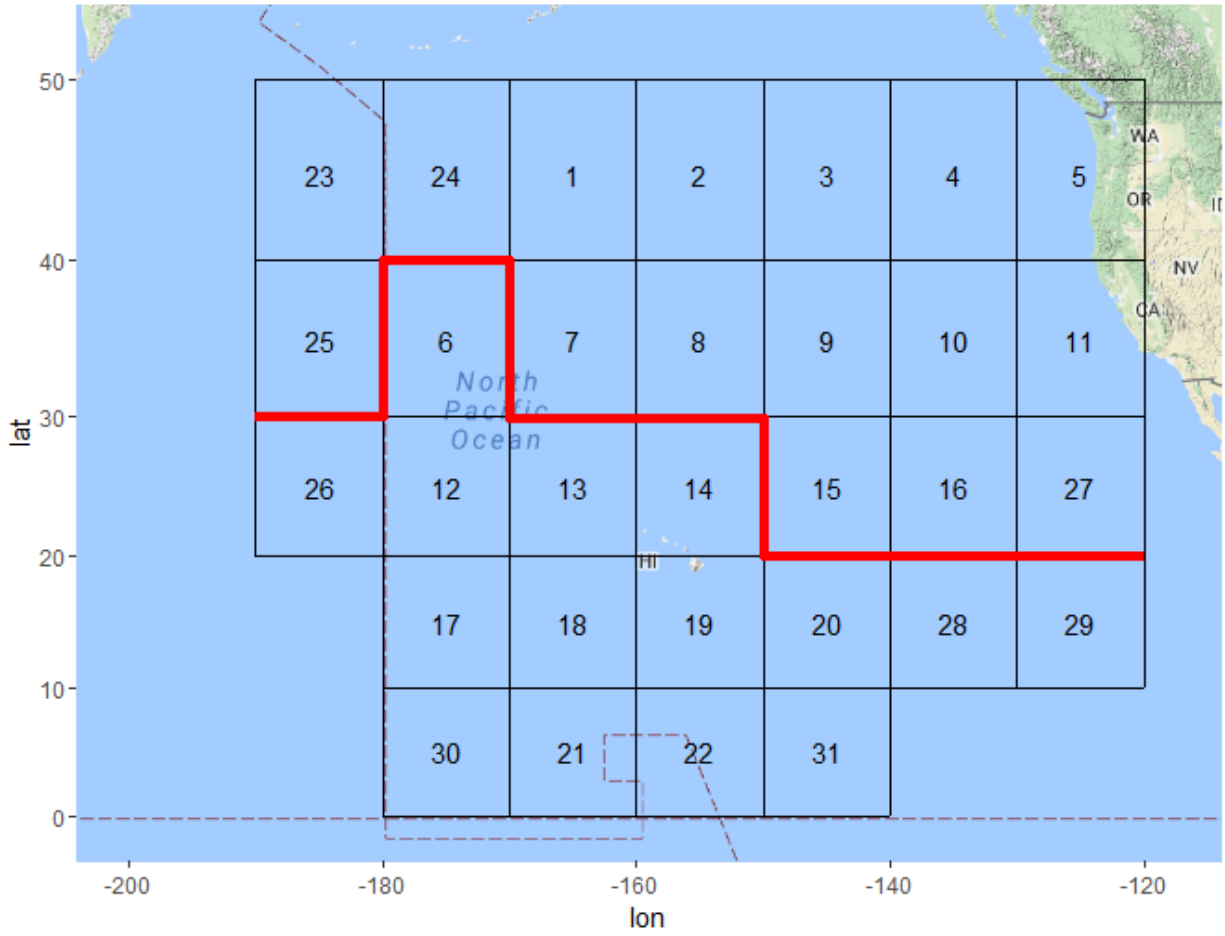


Figure 1. Spatial definition of Fleet 1 (above red line) and 2 (below red line) of the US pelagic longline fishery, based on Teo (2016). Numbers indicate the 10x10° subareas used for assembling the size composition data. Subareas 1 – 22 have both observer (fork length) and logbook (catch-effort) data available while subareas 23 – 31 only have logbook data.

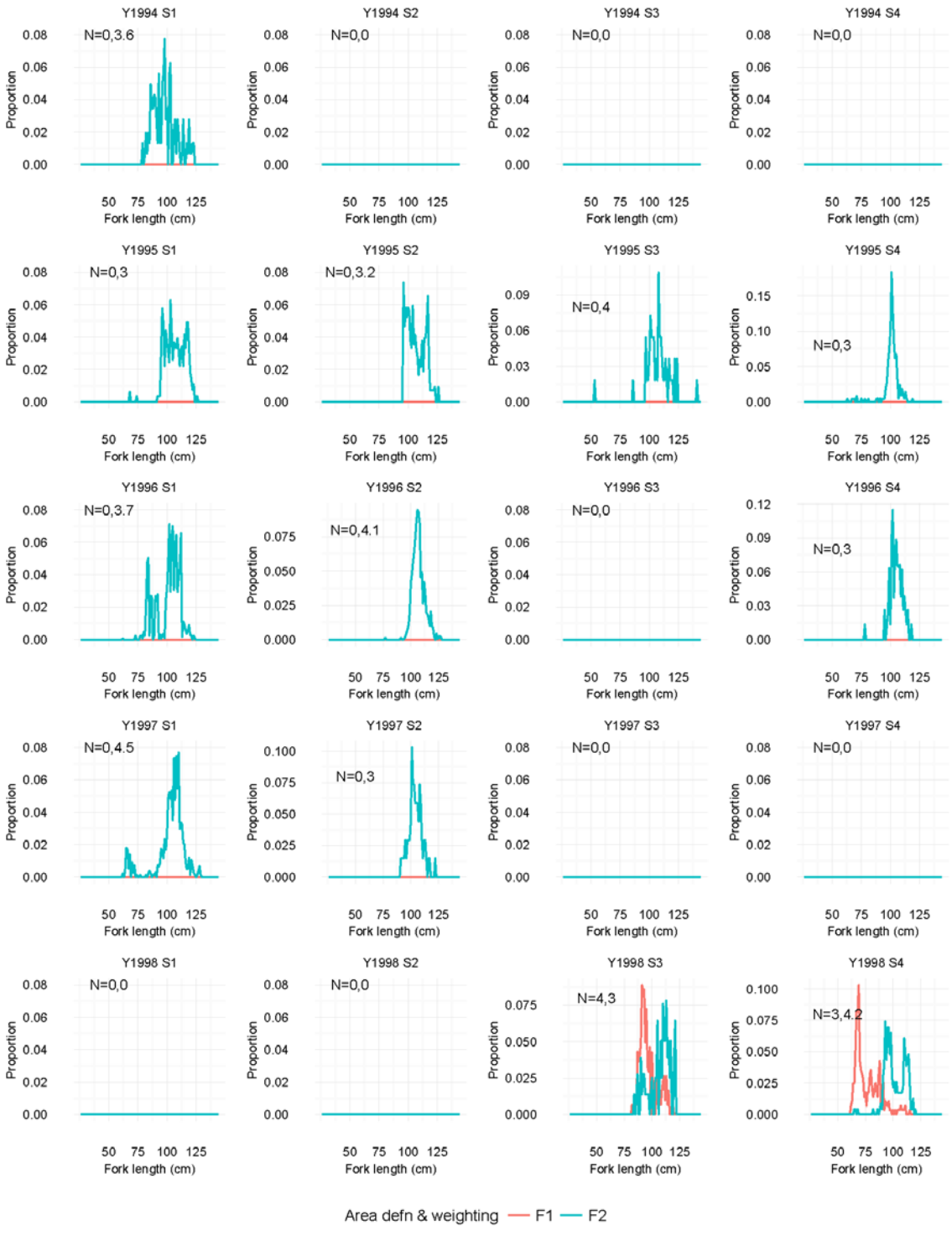
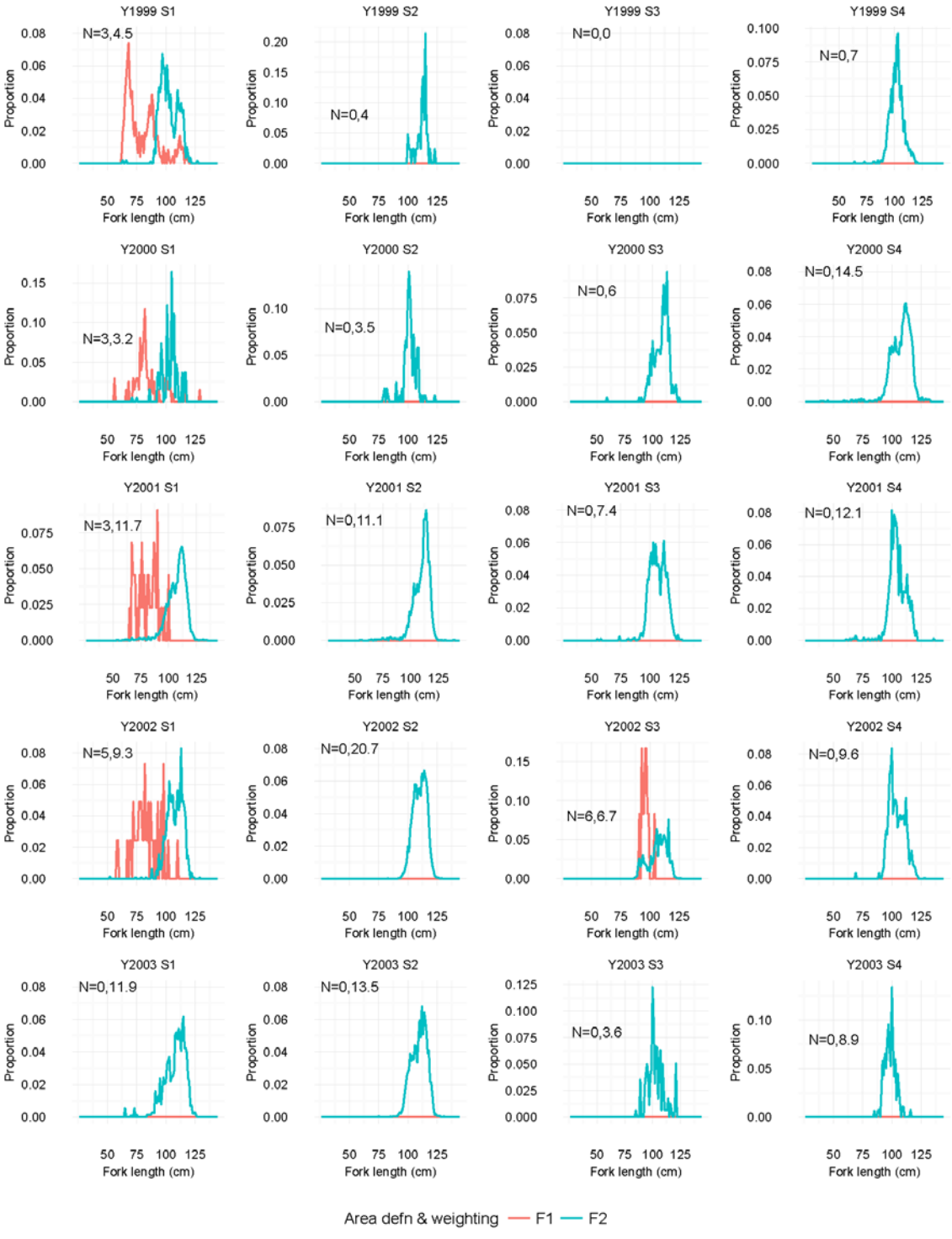


Figure 2. Seasonal size compositions (raised to the catch) for Fleets 1 (F1; red) and 2 (F2; blue) of the US pelagic longline fishery for 1994 – 2015. N indicate the input sample size for F1 and F2 respectively. See Figure 1 for spatial definition of fleets.



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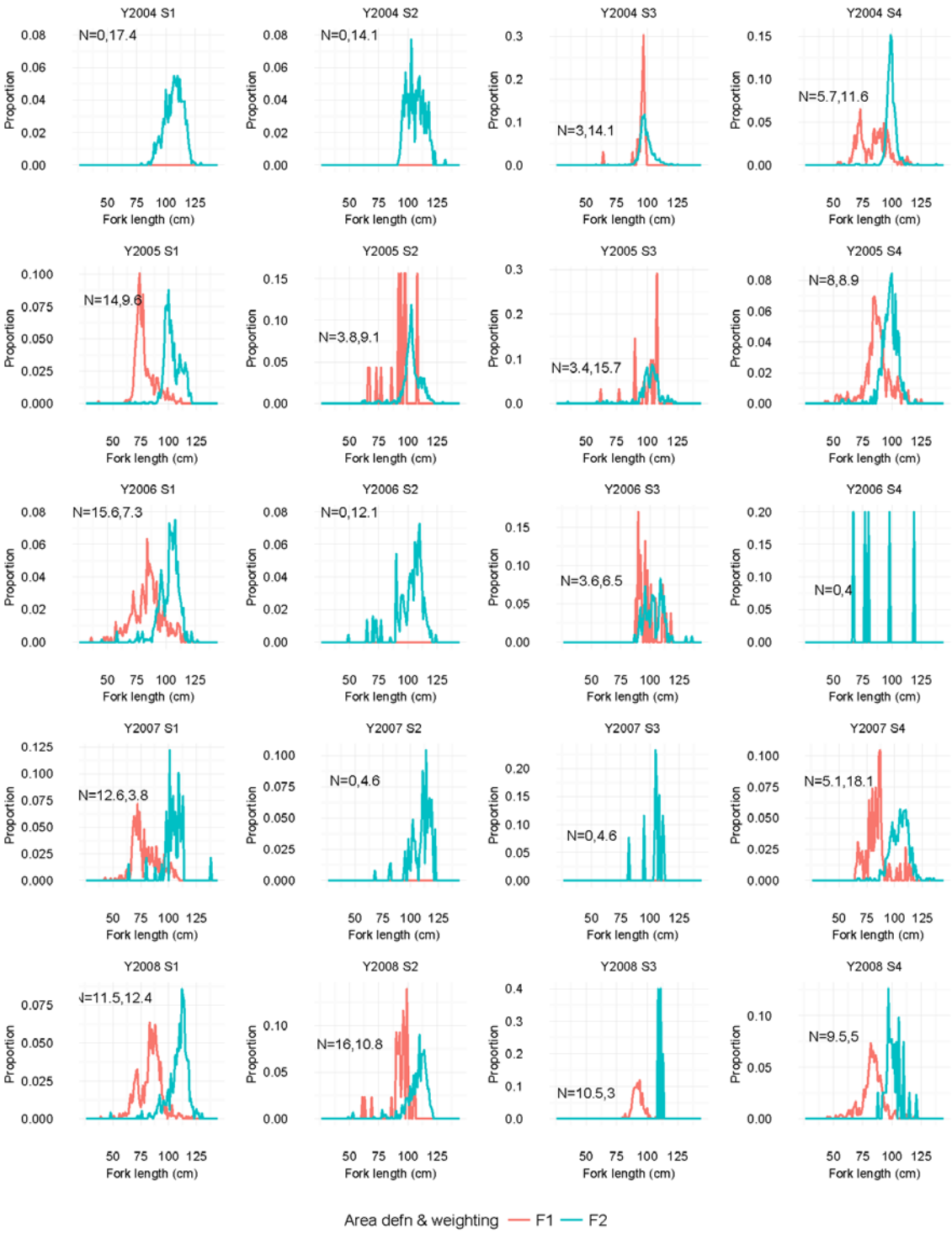

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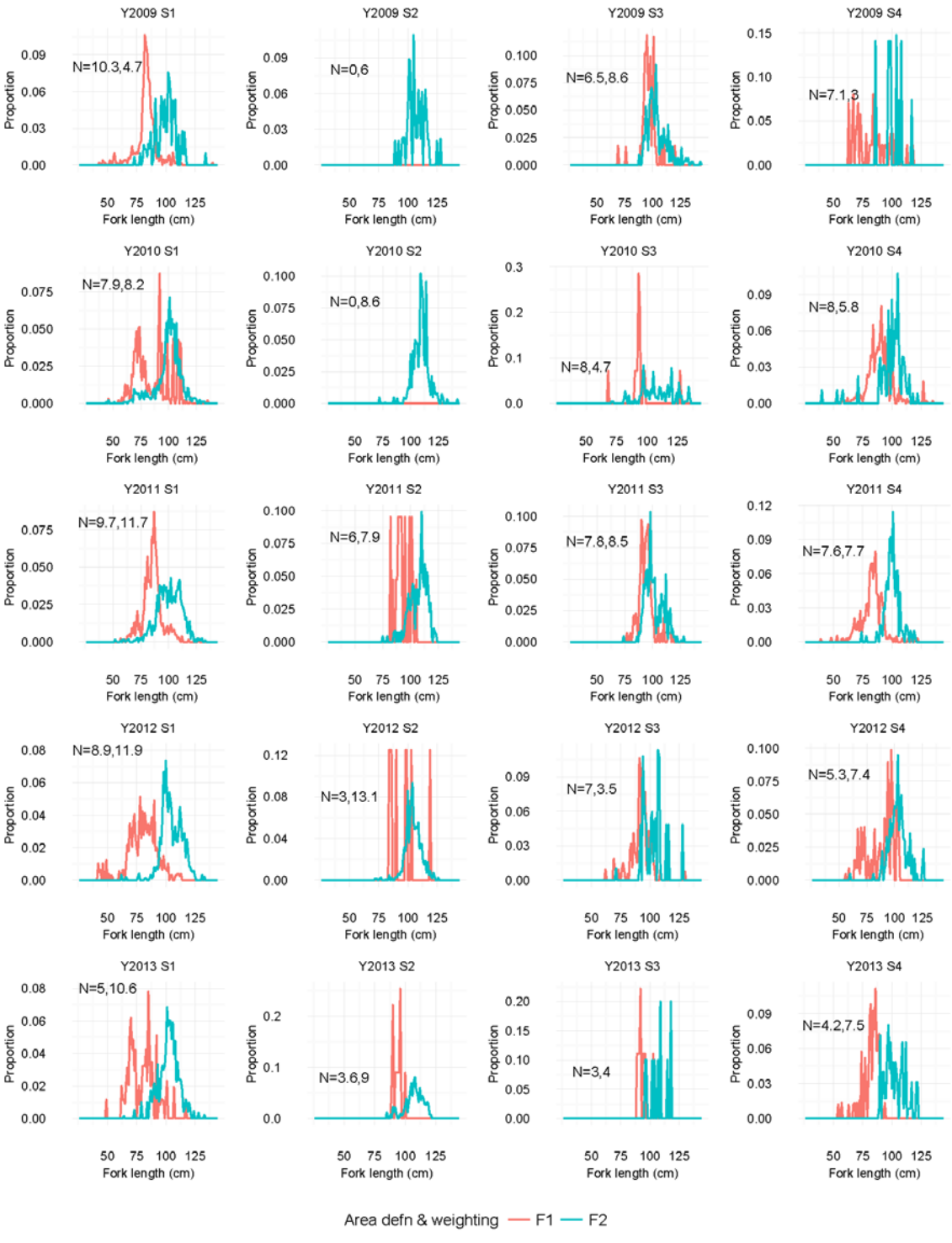

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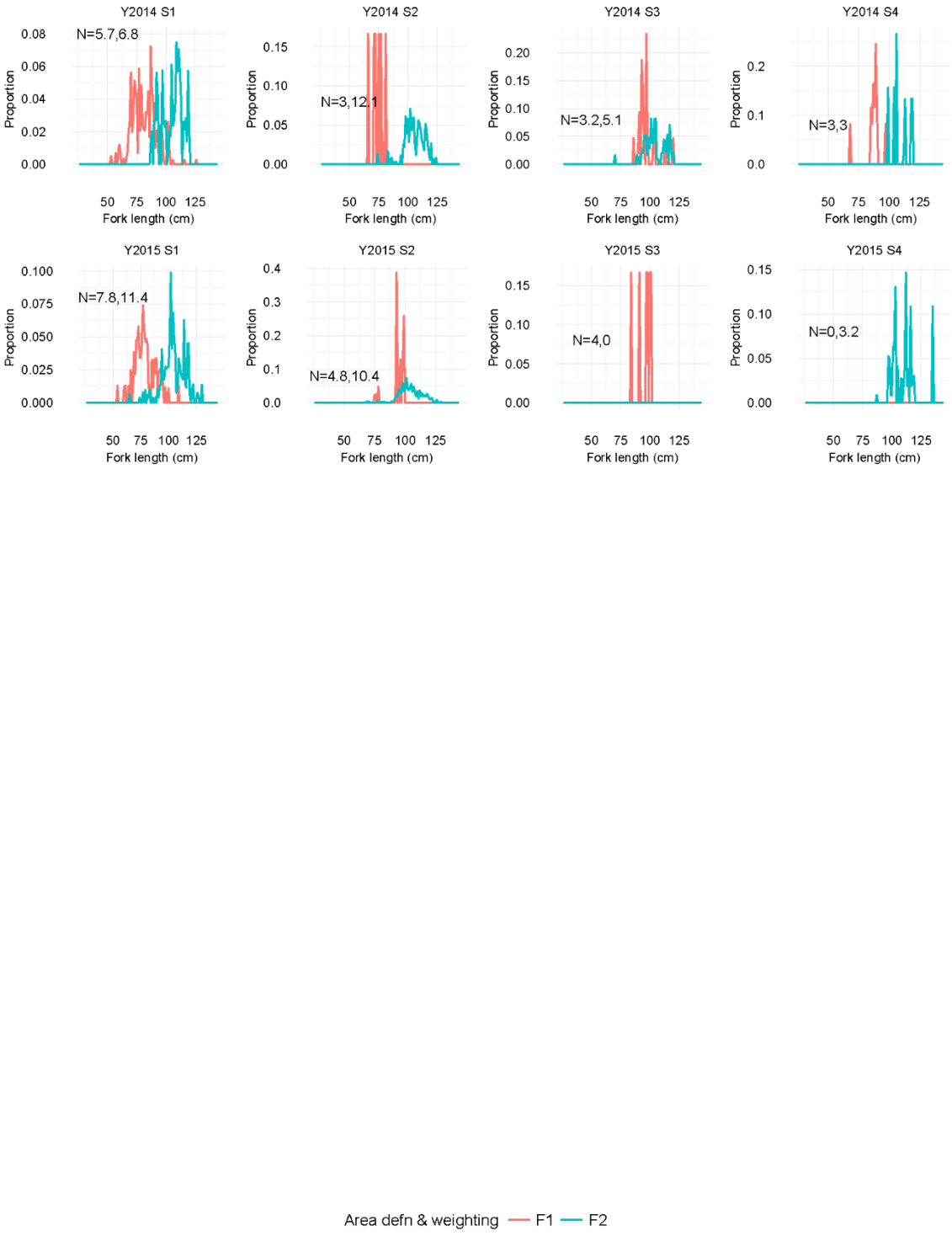

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