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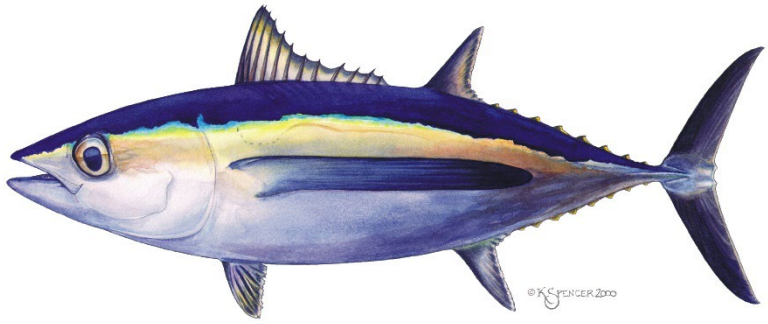
Preliminary catch and size composition time series of the U.S. pelagic longline fleets for the 2023 north Pacific albacore tuna assessment[1]

Steven L. H. Teo[2]

[2] NOAA Fisheries
Southwest Fisheries Science Center
8901 La Jolla Shores Drive
La Jolla, CA 92037, U.S.A.

Email: Steve.teo@noaa.gov



[1] This working paper was submitted to the ISC Albacore Working Group Intercessional Workshop, 06-12 December 2022, held at the National Research Institute of Fisheries Science, Yokohama, Japan.

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 U.S. pelagic longline fleets based in the north Pacific Ocean, for use in the 2023 assessment. Noting that the ALBWG has not yet finalized the fleet structure for the assessment, the fleet structure and methods for this study were the same as that used for the 2020 assessment. Two U.S. pelagic longline fleets were defined, based on the consistency of size compositions within areas. Fleet 1 consists of vessels fishing in a northern area with mostly juvenile and sub-adult albacore, using primarily shallow-set fishing gear. Fleet 2 consists of vessels fishing in a southern area with mostly large, adult albacore, using primarily deep-set fishing gear. Size composition data in 1 cm bins from an observer sampling program were 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 initial input sample sizes for the size compositions were calculated as the weighted average of the number of trips of all stratas in each fleet by year and season. The total annual landings by U.S. 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 U.S. pelagic longline fishery in the north Pacific Ocean are shown. Most of the albacore catch occurred in the area defined for Fleet 2. Seasonal size compositions (raised to the catch) for Fleets 1 and 2 of the U.S. pelagic longline fishery are shown. Input sample sizes ranged from 3 to 16 for Fleet 1, and 3 to 20.9 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 2023 stock assessment of north Pacific albacore tuna. As in the 2020 assessment, it is also recommended that the ALBWG rescale the initial input sample size of the size composition data of this and other fleets in the assessment (i.e., reweighting the size composition data) and set a minimum input sample size and/or number of fish sampled, before fitting the size compositions in the assessment model.

INTRODUCTION

The objective of this paper is to describe the data sources and methods used to develop preliminary catch and size composition time series from U.S. pelagic longline fleets based in the north Pacific Ocean in preparation for the 2023 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). The ALBWG is expected to review the data sources and methods described in this paper during the data preparation workshop. Recommendations by the ALBWG will be incorporated into the catch and size composition time series submitted for the 2023 assessment.

For the 2017 and 2020 assessments, the ALBWG used spatial definitions proposed by Teo (2016) for the U.S. 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). Noting that the ALBWG has not yet finalized the fleet structure for the 2023 assessment, this paper has continued with those spatial definitions and has used the same data sources and methods described in Teo (2019).

In this paper, the data sources and methods used to develop time series of: 1) catch in

metric tons, and 2) size compositions for two U.S. longline fleets in the north Pacific are described. Fleet 1 (F1_USLL_N) consists of vessels fishing in the northern area with mostly juvenile and sub-adult albacore, using primarily shallow-set fishing gear. Fleet 2 (F2_USLL_S) consists of vessels fishing in the southern area with mostly large, adult albacore, using primarily deep-set fishing gear.

MATERIALS AND METHODS

Data sources

Three main sources of data were used in this paper: 1) annual landings of albacore tuna in metric tons by the U.S. longline and handline fisheries in the north Pacific Ocean reported to the ISC (1966 – 2021); 2) catch-effort information from fishermen logbooks (1991-2021); and 3) biological (fork length) information from an observer sampling program (1994-2021).

Annual albacore tuna landings by the U.S. longline fishery are reported to the ISC by the National Oceanic and Atmospheric Administration (NOAA) and represent the landings from the entire U.S. longline fishery in the north Pacific Ocean. The U.S. longline fishery consists of longline vessels operating out of: 1) the U.S. West Coast (primarily California) and, 2) Hawaii. The vast majority of U.S. longline vessels operate out of and land fish in Hawaii, and Hawaii-based landings represent >95% of the total north Pacific albacore catch from U.S. longline vessels (McDaniel et al. 2006).

Catch-effort and fork length information were obtained from logbooks and observer data, respectively, from longline vessels operating out of Hawaii and California. 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 U.S. pelagic longline fishery were developed from spatial definitions defined by Teo (2016) and agreed to by the ALBWG for the 2017 and 2020 assessments (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 reduced the 'spikiness' of 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 2020 assessment and in this study, the initial input sample sizes were calculated as the weighted average of the number of trips of all stratas in each fleet by year and season. The weights of each strata were calculated in the same way as the size composition data.

Catch

Total annual catch of the U.S. longline fishery is considered to be well represented by the reported landings from NOAA to ISC (Table 1). However, landings data are 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 et al. 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 U.S. 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 – 2021 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 U.S. handline albacore fishery is based in Hawaii and predominantly catch large, adult albacore tuna, and all albacore catch from the U.S. 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,

$$C_{1,j,k} = p_{1,j,k} \times C_{LL,k},$$

where $C_{LL,k}$ is the total U.S. longline albacore catch in year *k*.

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

$$C_{2,j,k} = p_{2,j,k} \times C_{LL,k} + C_{HL,j,k} ,$$

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

RESULTS AND DISCU.S.SION

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

Seasonal size compositions (raised to the catch) for Fleets 1 and 2 of the U.S. pelagic longline fishery are shown in Figure 2. The input sample sizes ranged from 3 to 16 (mean = 8.1) for Fleet 1 (north area; predominantly juvenile and subadult), and 3 to 20.9 (mean = 9.1) for Fleet 2 (south area; predominantly large adult). Some of the seasonal size compositions exhibit large spikes because of the small number of fish sampled, even though a minimum sample size of 3 trips was used for each strata.

It is recommended that the ALBWG use the catch and size composition time series described in this working paper for the 2023 stock assessment of north Pacific albacore tuna. In addition, it is recommended that the ALBWG rescale the initial input sample size of the size composition data of this and other fleets in the assessment (i.e., reweighting the size composition data) and set a minimum input sample size and/or number of fish sampled, before fitting the size compositions in the assessment model.

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Table 1. Seasonal catch in metric tons for Fleets 1 and 2 of the U.S. pelagic longline fishery, and the total annual U.S. 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	1.2	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	1.4	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	1.4	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	11.1
1976	23	0.5	0.2	0.2	4.2	3.3	4.4	2.4	7.8
1977	37	0.8	0.4	0.3	6.8	5.4	7.1	3.8	12.5
1978	54	1.2	0.5	0.4	9.9	7.8	10.4	5.5	18.2
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	50	8.8	0.2	10.3	11.6	3.6	4.8	2.6	8.4
1982	147	26.4	1.0	14.0	24.3	15.2	20.1	10.8	35.5
1983	12	0.1	0.1	1.0	6.1	0.9	1.2	0.6	2.0
1984	4	0.2	0.7	0.1	1.7	0.3	0.4	0.2	0.7
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	27.6	21.7	28.8	15.4	50.7
1988	307	6.8	2.9	2.1	56.5	44.5	58.9	31.5	103.7
1989	248	5.5	2.3	1.7	45.7	35.9	47.6	25.5	83.8
1990	177	3.9	1.7	1.2	32.6	25.6	34.0	18.2	59.8
1991	312	7.1	6.2	1.6	55.3	43.8	99.2	45.9	53.1
1992	334	13.2	3.8	1.8	92.7	48.1	72.5	30.7	71.4
1993	440	7.0	5.2	1.0	80.5	56.0	96.4	39.2	154.3
1994	565	11.2	3.2	8.3	89.8	89.2	49.6	55.3	258.3

1995	885	33.9	3.1	9.5	78.7	109.8	279.5	169.8	201.2
1996	1187	74.0	0.2	1.5	61.1	198.7	482.6	182.5	186.8
1997	1660	35.1	2.2	0.6	28.5	524.3	760.1	252.9	55.9
1998	1130	16.4	0.8	7.5	38.2	157.9	414.7	337.8	156.5
1999	1553	53.8	3.8	10.7	63.4	273.3	445.4	311.6	390.4
2000	955	37.9	3.7	3.0	14.4	97.5	316.6	183.6	298.8
2001	1305	5.7	7.5	0.5	2.0	281.7	642.9	255.5	109.6
2002	525	3.2	0.0	2.4	0.0	74.0	317.1	71.3	56.9
2003	526	1.2	2.6	3.0	0.0	104.5	378.8	22.2	13.4
2004	361	0.0	0.0	6.1	3.8	76.0	38.7	160.9	75.6
2005	296	9.4	0.4	1.8	5.4	96.1	132.2	23.5	27.1
2006	270	6.2	4.0	5.1	0.0	84.3	101.1	51.6	17.8
2007	344	13.5	0.1	1.9	3.0	106.3	54.3	26.8	138.0
2008	383	20.4	4.8	30.7	18.8	169.1	89.1	9.2	41.4
2009	301	27.5	11.0	15.8	2.0	94.5	57.2	73.5	19.8
2010	476	15.6	5.5	6.0	32.3	215.9	106.1	67.2	27.1
2011	809	28.5	13.5	89.8	24.0	359.3	115.1	97.1	81.7
2012	933	14.5	42.2	54.0	5.6	341.6	270.1	73.8	130.8
2013	365	19.5	4.5	5.8	4.7	164.6	111.7	13.7	40.3
2014	262	11.4	8.8	5.3	0.6	80.1	71.3	27.2	57.1
2015	308	4.9	7.4	3.1	0.1	142.5	121.7	12.9	15.5
2016	272	2.0	3.6	4.0	0.9	82.6	150.0	24.5	4.5
2017	130	8.8	1.1	2.7	3.3	73.8	20.4	13.6	6.3
2018	107	1.9	4.2	27.6	3.8	8.7	17.3	17.6	25.9
2019	114	1.9	5.6	13.3	2.6	20.7	18.3	39.3	12.3
2020	166	10.4	101.6	1.5	8.9	13.7	4.0	22.8	3.1
2021	241	39.1	23.7	59.9	22.4	27.8	8.1	36.1	24.0

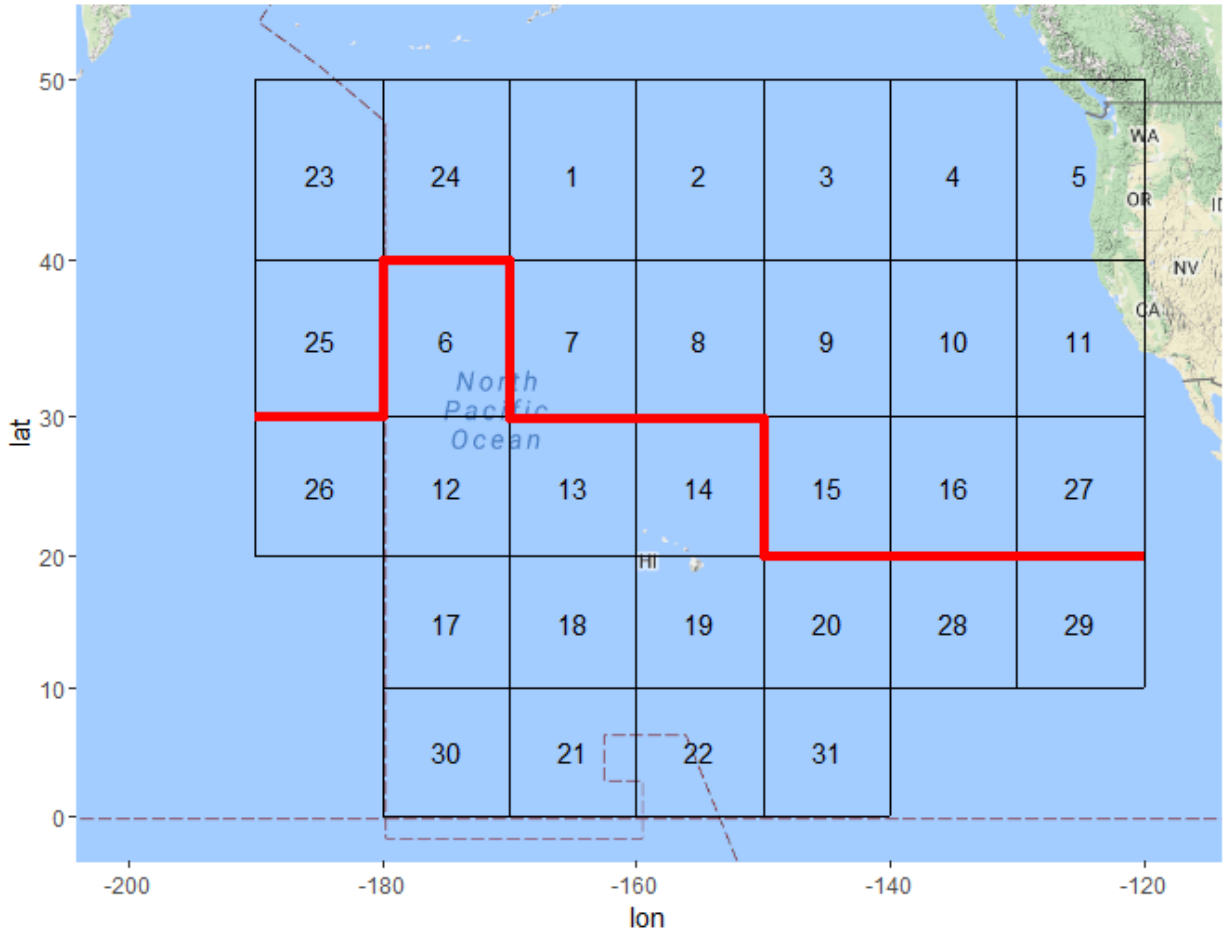


Figure 1. Spatial definition of Fleet 1 (above red line) and 2 (below red line) of the U.S. pelagic longline fishery, based on Teo (2016). Numbers indicate the 10x10° subareas used for assembling the size composition data. Subareas 1 – 22 have both observer (fork length) and logbook (catch-effort) data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

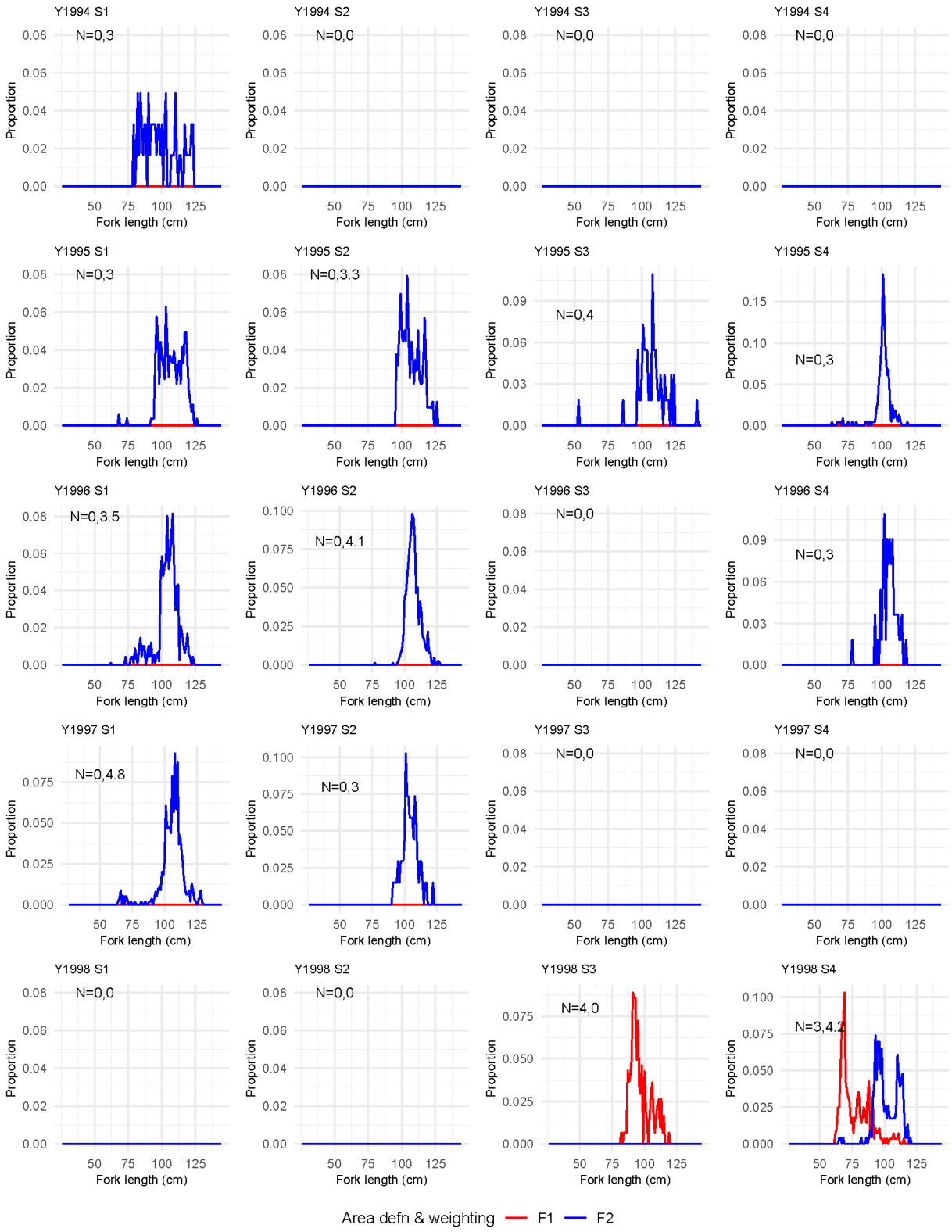
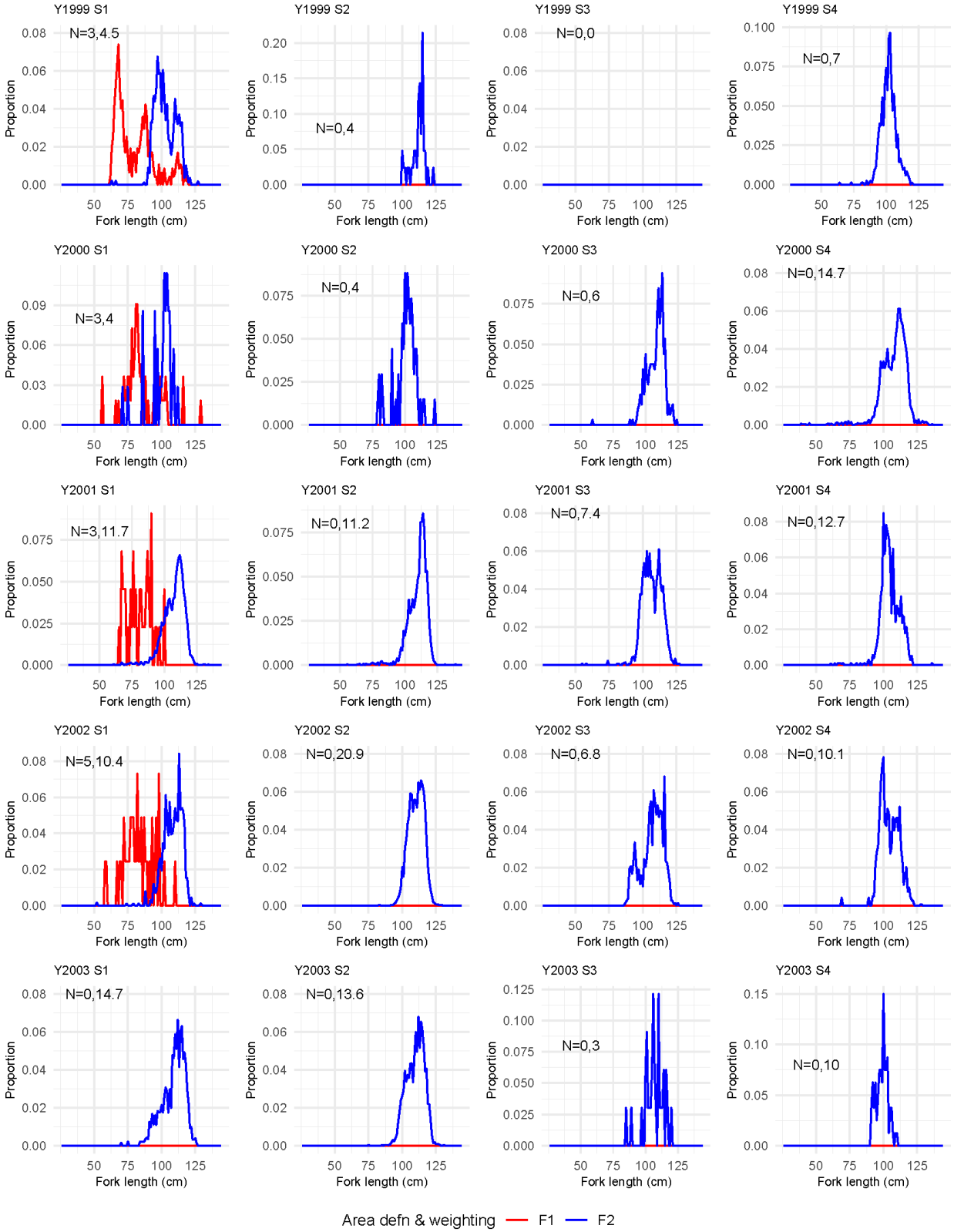


Figure 2. Seasonal size compositions (raised to the catch) for Fleets 1 (F1: red) and 2 (F2: blue) of the U.S. pelagic longline fishery for 1994 – 2021. N indicate the initial input sample size for F1 and F2. See Figure 1 for spatial definition of fleets.



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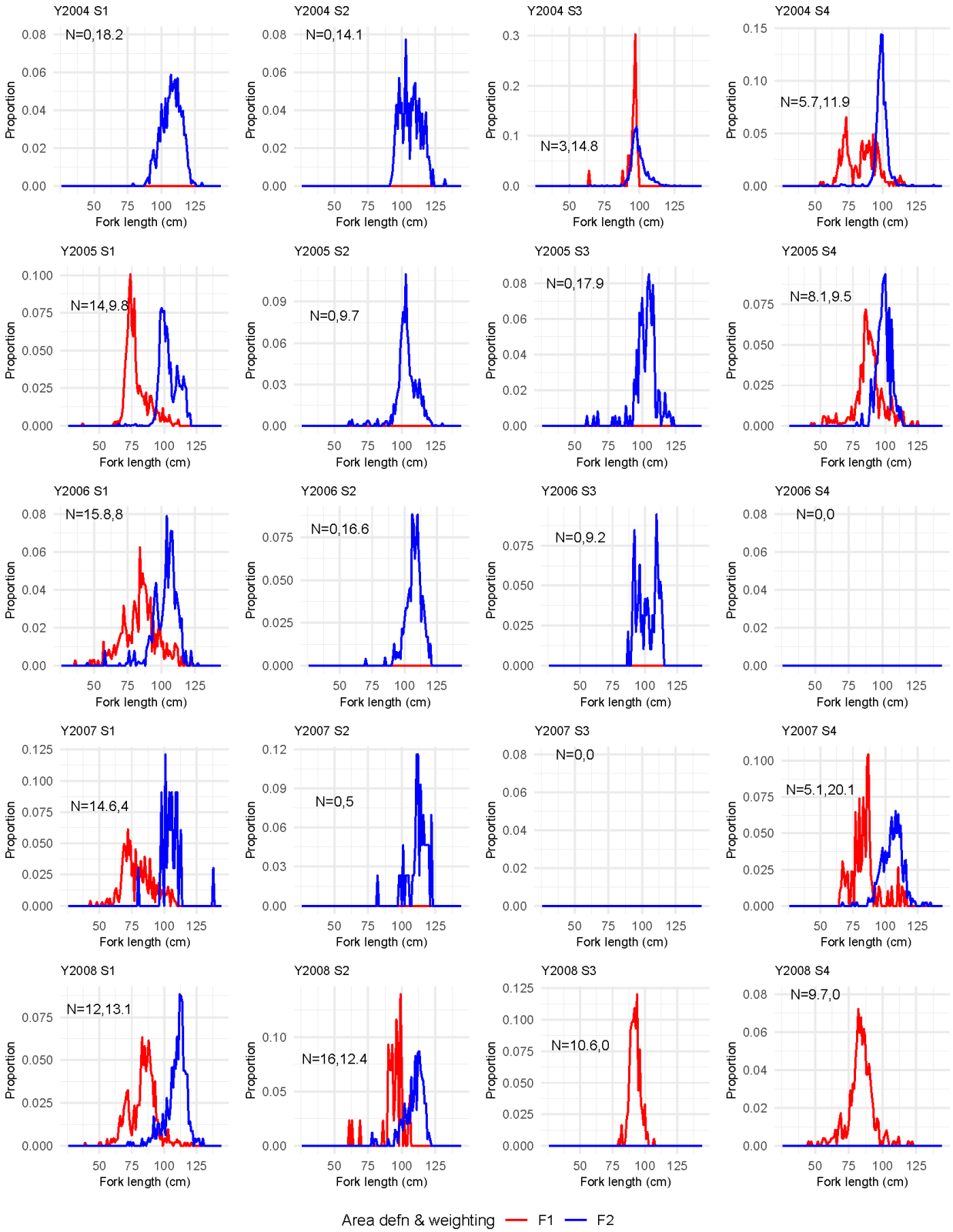

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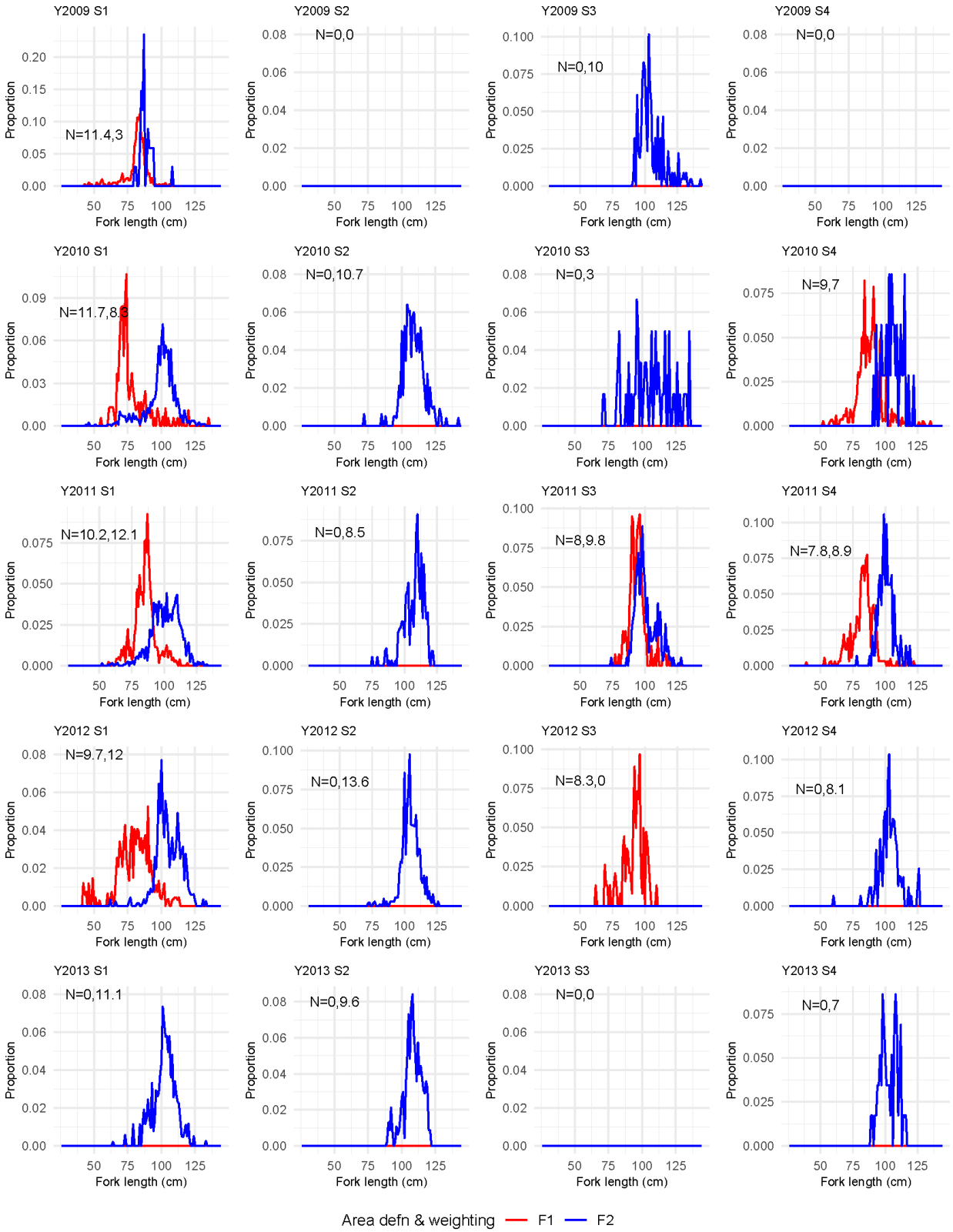

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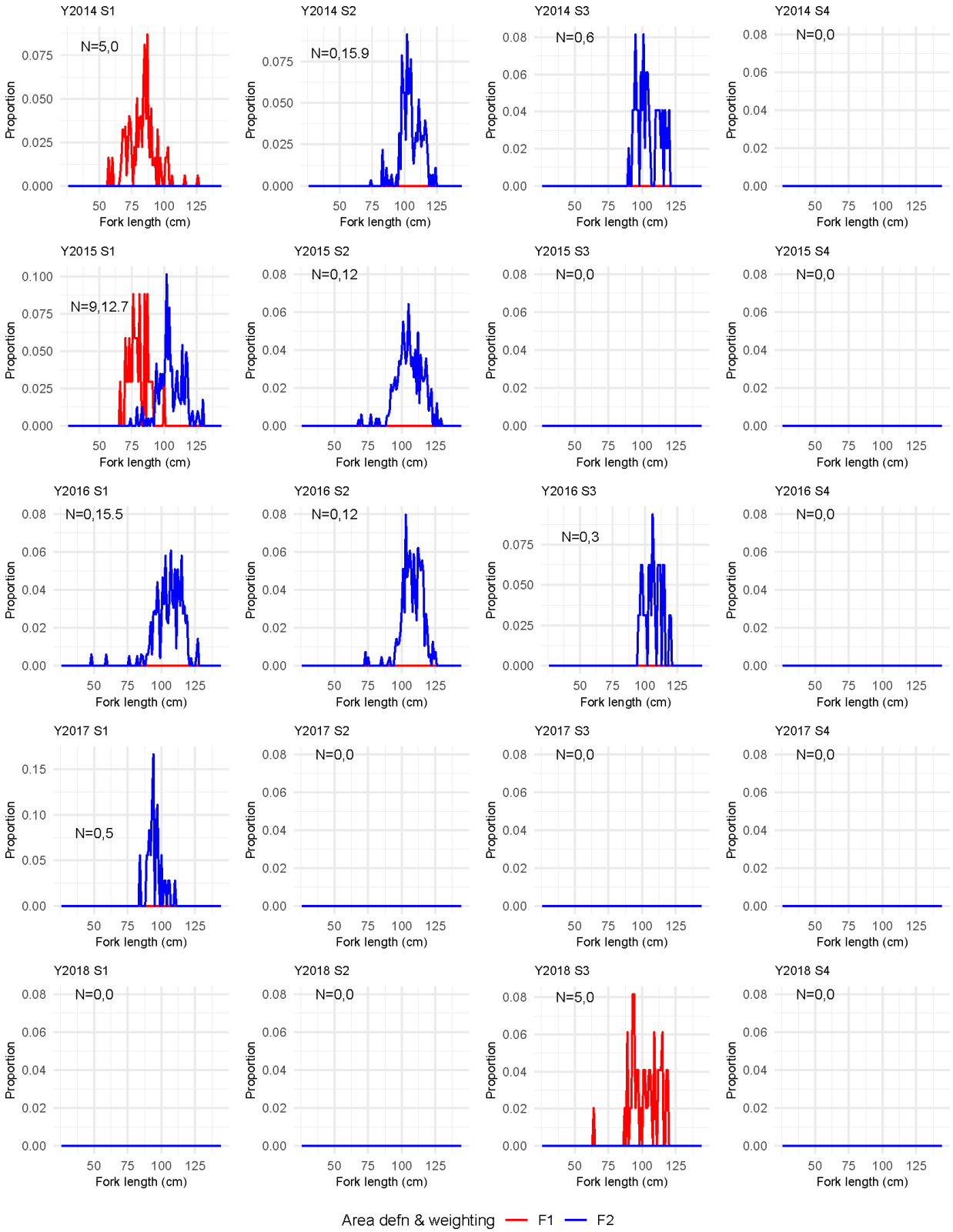

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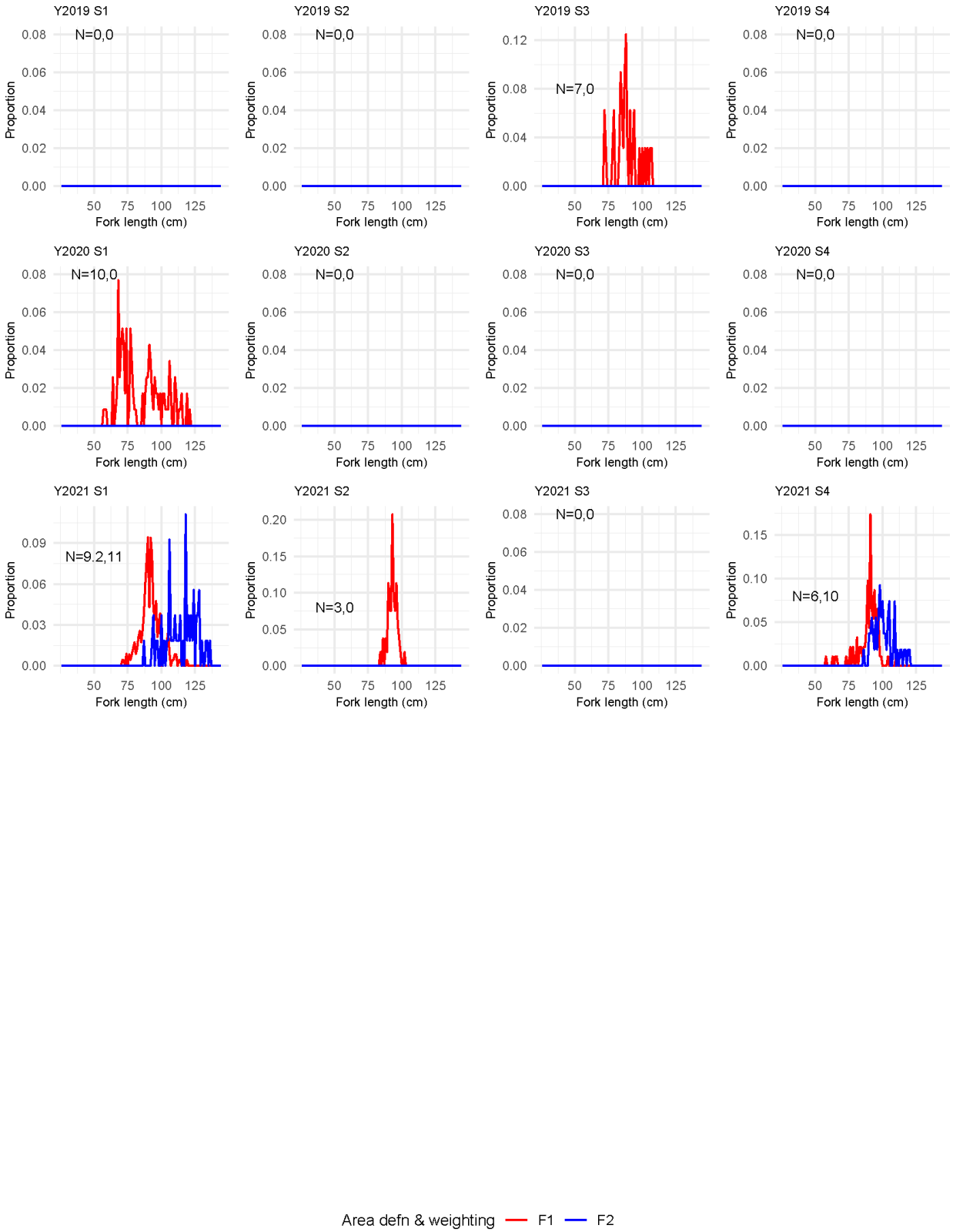

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