Draft 2022 Monkfish Management Track Assessment Report

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TOR 1. Estimate catch from all sources including landings and discards.

Catch (landings and discards) were updated from 1989, when observer data first became available for discard estimation, to 2021. The Northeast Fisheries Science Center estimates discards by fleet (gear), half year (semester), and management area using observer data (NMFS 2014). For otter trawls and gillnets, the observed monkfish discard-per-kept-monkfish ratio is used to expand the sampled observations to total monkfish discards, while for scallop dredges and shrimp trawls the observed monkfish discard-per-all-kept-catch ratio is used. Several changes were made to the discard estimation methods. The ratio estimator used for discard estimation was changed from a simple ratio (D1) to a combined ratio (D2), which is the regional norm used by the Standardized Bycatch Reporting Methodology (NMFS 2014). Also, some observations that were previously excluded from the discard estimation were added back to the dataset. These observations were returned to the dataset because the reasons for their exclusion were not clear and avoiding manual deletions of observations makes the discard time series more easily reproducible. Switching the ratio estimator had a negligible effect on the discard time series, but adding the observations that were previously excluded caused some significant changes in a few years, most notably 2001 for both areas (Figure 1). The increase in discards in 2001 in both regions can be traced to 1-2 observations with unusually large discards. The fact that this increase in estimated discards occurred in 2001 in both regions appears to be a coincidence because the observations occurred in different fleets in each region (gillnet in semester 2 in the North but trawl in semester 1 in the South). The statistical areas used to define each management area for discard estimation were discovered to be in error during this management track assessment. The areas were corrected and made consistent with the stock definitions used for landings and the Catch Accounting and Monitoring System (NEFMC 1998; https://www.fisheries.noaa.gov/resource/map/monkfish-fishery-management-areas). Correcting the areas had a relatively minor effect on the discard estimates (Figure 2). The most notable change made to the discard estimation was a downward revision of the assumed discard mortality rate in the scallop dredge fleet from 100% to 64%. This revision was based on Weissman et al., 2021. While Weissman et al., 2021 reported a range of possible discard mortality rates from 28% to 64% depending on assumptions about the causes of post-release mortality, consultation with the monkfish Plan Development Team suggested a preference for using a more conservative value on the higher end, rather than make a larger change based on a single study with a relatively small sample size that only occurred in one management area (Table 1; Figures 3-6). Consequently, a value of 64% was used.

Table 1: Total monkfish landings, discards, and total catch (MT), assuming a 64% discard mortality rate in the scallop dredge fleet.

YEAR	Landings	Discards	Region	TotCatch
1989	6396	364	North	6760
1990	5842	240	North	6081
1991	5727	491	North	6218
1992	6925	703	North	7628
1993	10645	638	North	11283
1994	10847	325	North	11172

YEAR	Landings	Discards	Region	TotCatch
1995	12020	1655	North	13675
1996	10769	1886	North	12654
1997	9659	857	North	10516
1998	7482	722	North	8204
1999	8898	726	North	9625
2000	10681	870	North	11551
2001	13224	3066	North	16290
2002	13634	1159	North	14794
2003	14398	1117	North	15515
2004	12796	516	North	13312
2005	10097	624	North	10722
2006	7016	578	North	7594
2007	5093	575	North	5668
2008	3875	317	North	4192
2009	3321	455	North	3777
2010	2923	294	North	3217
2011	3328	370	North	3698
2012	4081	493	North	4574
2013	3355	459	North	3814
2014	3434	484	North	3918
2015	4086	572	North	4658
2016	4723	734	North	5457
2017	7105	840	North	7945
2018	6009	1253	North	7262
2019	6084	1080	North	7163
2020	5587	723	North	6310
2021	5121	802	North	5923
1989	8296	3401	South	11697
1990	7142	197	South	7339
1991	9800	252	South	10052
1992	13925	600	South	14525
1993	15061	918	South	15979
1994	12052	1764	South	13816
1995	14311	2359	South	16671
1996	15729	1932	South	17661
1997	18508	1480	South	19987
1998	19128	1148	South	20276
1999	16300	1797	South	18097
2000	10188	1706	South	11895
2001	10074	9210	South	19285
2002	9259	2682	South	11941
2003	11679	2886	South	14565
2004	8374	2515	South	10889
2005	8917	2222	South	11140
2006	7565	1683	South	9248
2007	7055	2023	South	9078
2008	7139	1390	South	8529
2009	5260	1139	South	6399
2010	4330	1476	South	5806
2011	5271	1566	South	6837
2012	5674	1962	South	7636
2013	5207	1372	South	6579

YEAR	Landings	Discards	Region	TotCatch
2014	5099	1188	South	6287
2015	4550	919	South	5468
2016	4331	2114	South	6445
2017	3796	3544	South	7339
2018	4388	3476	South	7864
2019	4373	3358	South	7732
2020	2593	2295	South	4887
2021	2005	2340	South	4346

TOR 2. Evaluate indices used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.).

All indices and length frequencies were updated through 2021, with the exception of National Marine Fisheries Service (NMFS) spring bottom trawl surveys (BTS), which were updated through 2022 (Figures 7-13). Recruitment indices were also updated using the same surveys and length cut-offs to define age-0 monkfish as in previous assessments (Table 2; Figures 14-15). An absolute measure of biomass estimated using paired tows between a chainsweep and rockhopper sweep was also updated for the fall NMFS BTS survey (Figure 16; Miller et al., in review).

Table 2: Range of lengths used to define age-0 recruitment indices.

Stock	Survey	Lengths
North	NMFS Fall BTS	6-18cm
South	NMFS Fall BTS	12-28cm
South	Scallop	7-15cm

TOR 3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) as possible (depending on the assessment method) for the time series using the approved assessment method and estimate their uncertainty. Include retrospective analyses if possible (both historical and within-model) to allow a comparison with previous assessment results and projections, and to examine model fit.

No analytical assessment was available due to a lack of reliable aging methodology.

a. Include bridge runs to sequentially document each change from the previously accepted model to the updated model proposed for this peer review.

N/A

b. Prepare a backup assessment approach that would serve as an alternative for providing scientific advice to management if the analytical assessment were to not pass review.

The "Ismooth" (previously planBsmooth; Legault et al. in press; https://github.com/cmlegault/PlanBsmooth) backup approach used in the previous assessment was updated for this management track. This Ismooth approach re-scales the NMFS spring and fall BTS by their respective means (i.e., so each time series has mean equal to one), and averages the fall observation in year y with the spring observation in year *y+1* to create a single time series for analysis. A LOESS-smooth is then applied to the combined time series, and a log-linear regression fit to the most recent three years of index predictions from the LOESS fit. The slope of the regression provides a direction and rate of change in the indices that is multiplied by recent catch to provide catch advice.

For this management track, neither the spring or fall BTS were conducted in 2020. The Ismooth approach can function normally with these missing values, but consideration was given to replacing the missing 2020 observations with the average of the observations from 2019 and 2021. To evaluate a preferred method, the Ismooth approach was repeatedly applied with 10 different terminal years (2010-2019), and the multipliers compared between using all data, having a missing observation in the year before the terminal year, or replacing the observations in the year before the terminal year with the mean of the surrounding years. This entire analysis was also repeated using only the fall BTS because it is considered more reliable than the spring BTS and consideration was given in previous assessments to using only the fall BTS, as opposed to combining it with spring. In the North region using the spring and fall time series combined, the multipliers were similar and not significantly different from using all the data whether a missing value was present or imputed (Figures 17-18). In the South, however, the multipliers estimated in the presence of a missing value were often significantly lower than using the full data, but replacing the missing value with the surrounding average resolved the disparity (Figures 19-20). Regardless of management area or whether a missing value was present or imputed, using only the fall survey produced more imprecise estimates for the multipliers, and they were systematically different than the multipliers produced from using all data (Figures 21-24). Consequently, the preferred approach was to use a combined spring and fall BTS time series with the missing 2020 observations replaced with the mean of the 2019 and 2021 observations. Using this method, the multiplier was 0.829 in the North 0.646 in the South (Figures 25-26).

TOR 4. Re-estimate or update the BRP's as defined by the management track level and recommend stock status. Also, provide qualitative descriptions of stock status based on simple indicators/metrics (e.g., age-and size-structure, temporal trends in population size or recruitment indices, etc.).

Biological reference points are unavailable for these stocks and stock status is unknown. Survey length frequencies and indices of recruitment suggest increasing and above average recruitment in the North in recent years, but continued low or decreasing recruitment in the South (Figures 8-15). Thus, the stock in the Northern area seems relatively high and is likely to remain so, while abundance in the Southern area seems low and is also likely to remain so, if not continue to decline.

TOR 5. Conduct short-term stock projections when appropriate.

N/A

TOR 6. Respond to any review panel comments or SSC concerns from the most recent prior research or management track assessment.

Below is a list of the research topics included in the previous assessment (NEFSC 2020) and an update on progress.

- A benchmark assessment should consider the feasibility of using both observer and port samples in estimating length composition of commercial landings.
  - No progress
- Ongoing research on age and growth of monkfish may lead to an acceptable growth curve, even if not an aging method that could be used for routine aging. If so, age structured models could be explored assuming static growth.

  - Finding a routine aging method seems unlikely. The growth and maturity characteristics of monkfish, however, make attempts at delay-difference type models likely worth trying.

- A better understanding of monkfish movements and stock structure would be helpful to interpretation of monkfish population data.
  - No progress
- Future modeling efforts may want to consider the possible role of cannibalism in stock dynamics of monkfish in light of the strong negative relationship observed in the north between median size of monkfish in the population and recruitment indices.
  - No progress

References

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Miller, T. J., Richardson, D. E., Politis, P. J., Manderson, J. P, Roebuck, C. D., Martin, M. H., Jones, A. W. In review. Estimation of survey efficiency and biomass for commercially important flatfish species from industry-based paired gear experiments. Fisheries Research.

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NMFS (National Marine Fisheries Service). 2014. Standardized Bycatch Reporting Methodology: An Omnibus Amendment to the Fishery Management Plans of the Mid-Atlantic and New England Regional Fishery Management Councils. https://s3.us-east-1.amazonaws.com/nefmc.org/SBRM-Omnibus-Amendment.pdf

Weissman, A., Knoteck, R., Mandelman, J., Rudders, D., Roman, S., and Sulikowski, J. 2021. Determining discard mortality of monkfish in a sea scallop dredge fishery. North American Journal of Fisheries Management 41: 856-870.

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Susan Wigley, Leonaa Burgess, and the StockEff team contributed analyses and data preparation that made completing this management track assessment more efficient and timely than it otherwise would have been.

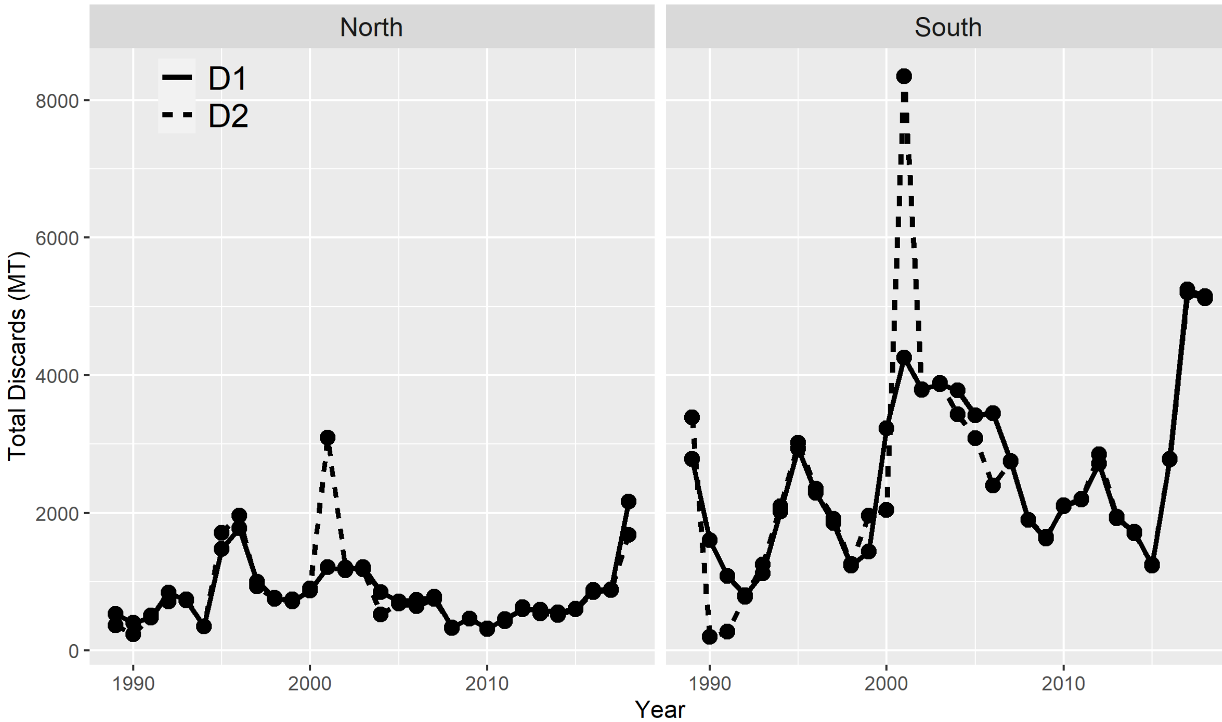

Figure 1: Time Series of total monkfish discards with some observations manually deleted and using a simple ratio estimator (D1) as in the previous assessment, and the time series with no observations deleted and using a combined ratio estimator (D2)

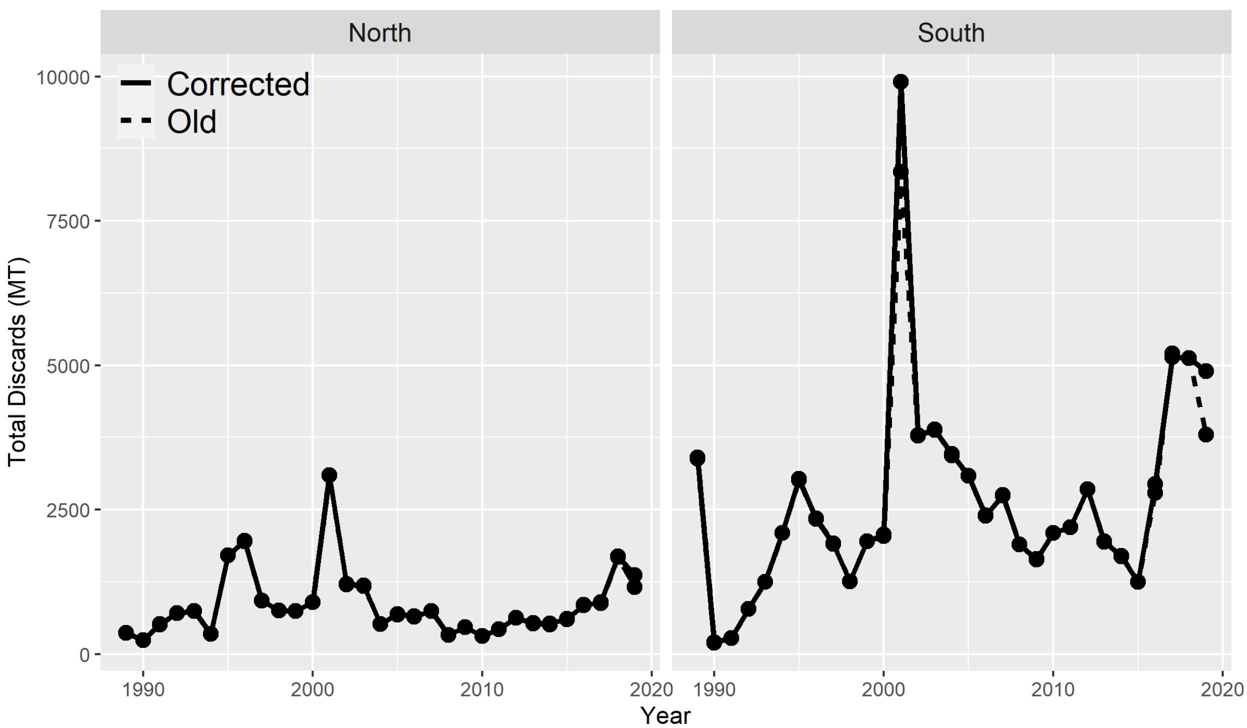

Figure 2: Time Series of total monkfish discards using the incorrect statistical area definitions (Old) and with the areas corrected.

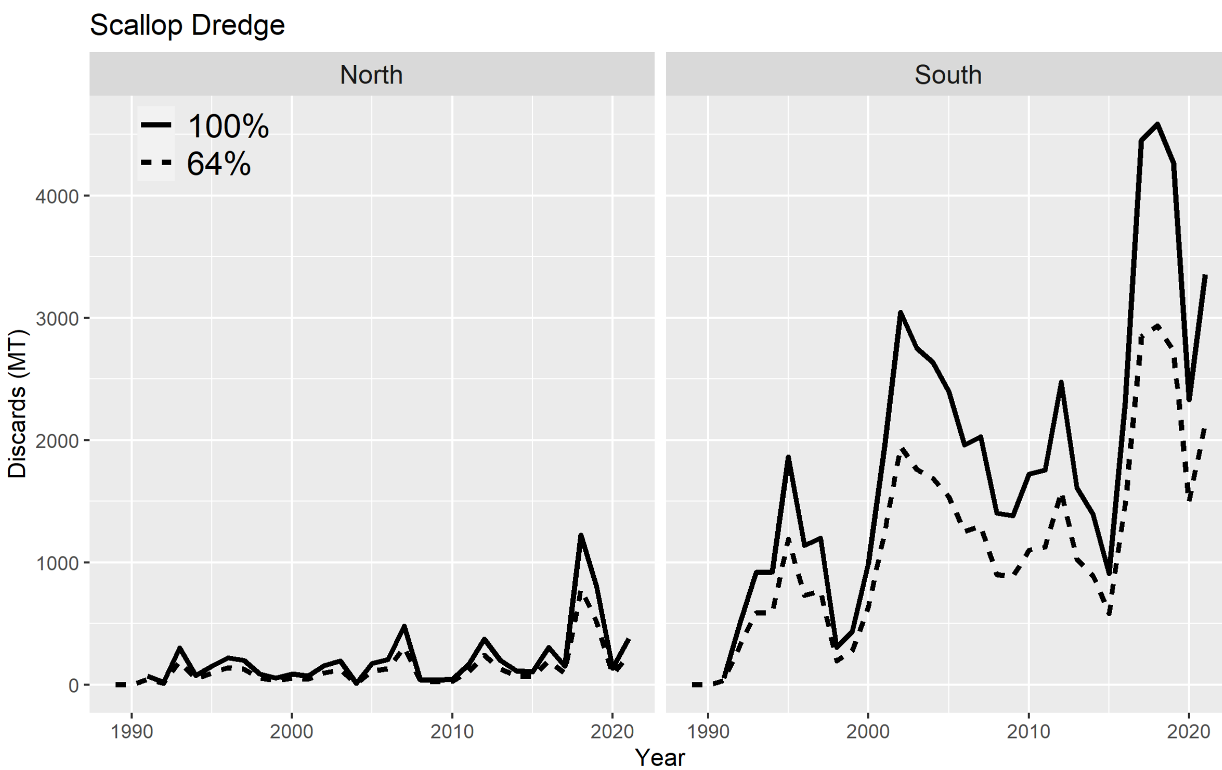

Figure 3: Scallop Dredge monkfish discards using a mortality rate of 100percent or 64percent

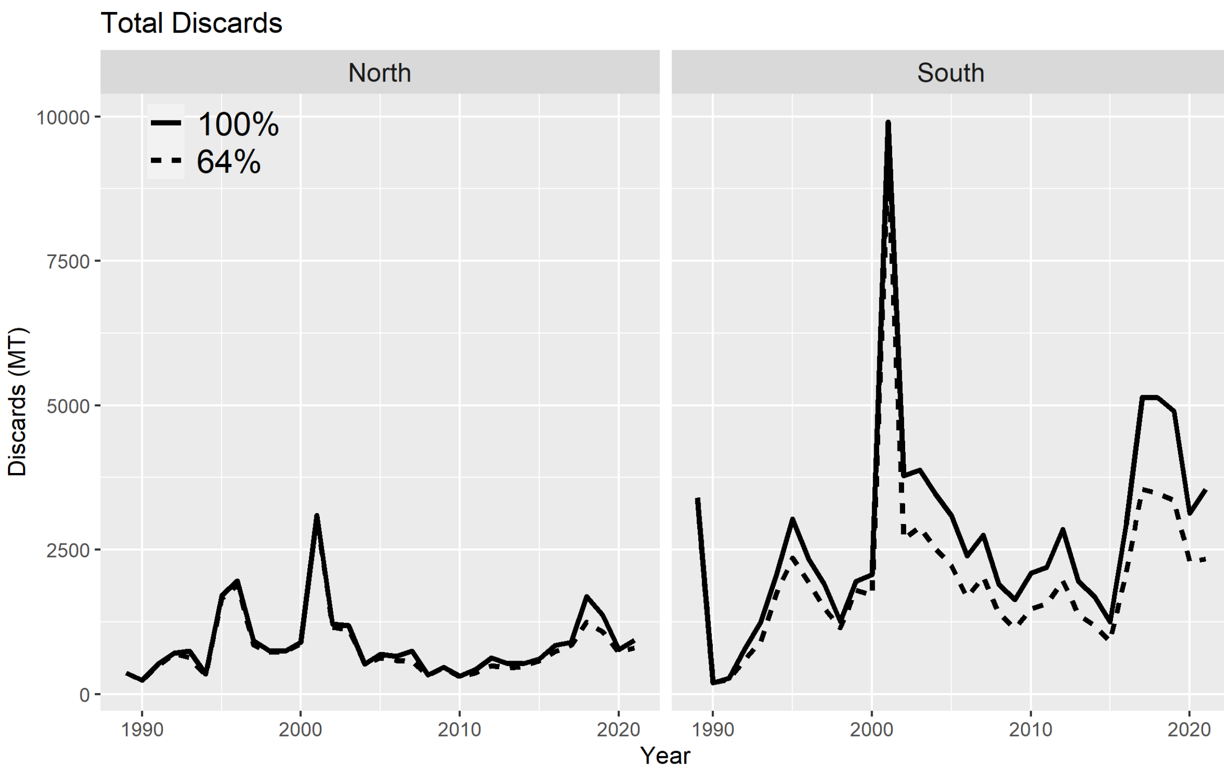

Figure 4: Total discards using a discard mortality rate of 100percent or 64percent for the scallop dredge fleet.

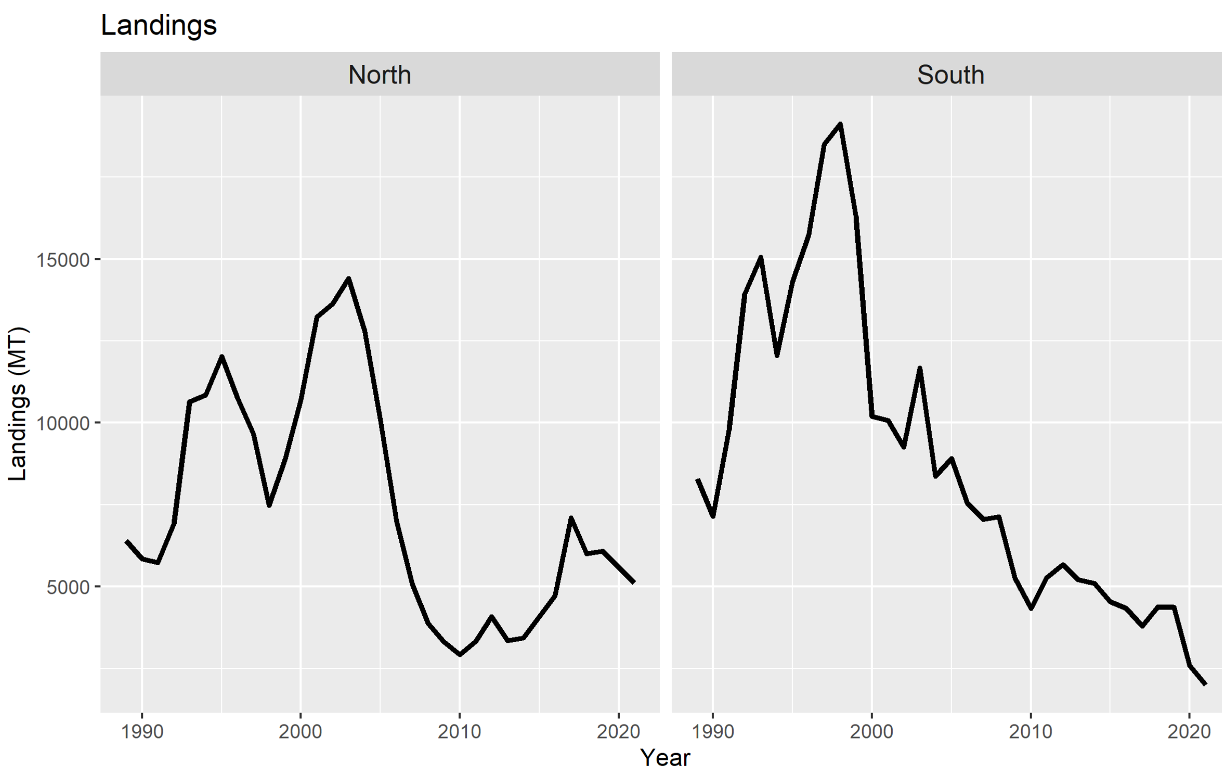

Figure 5: Total monkfish landings.

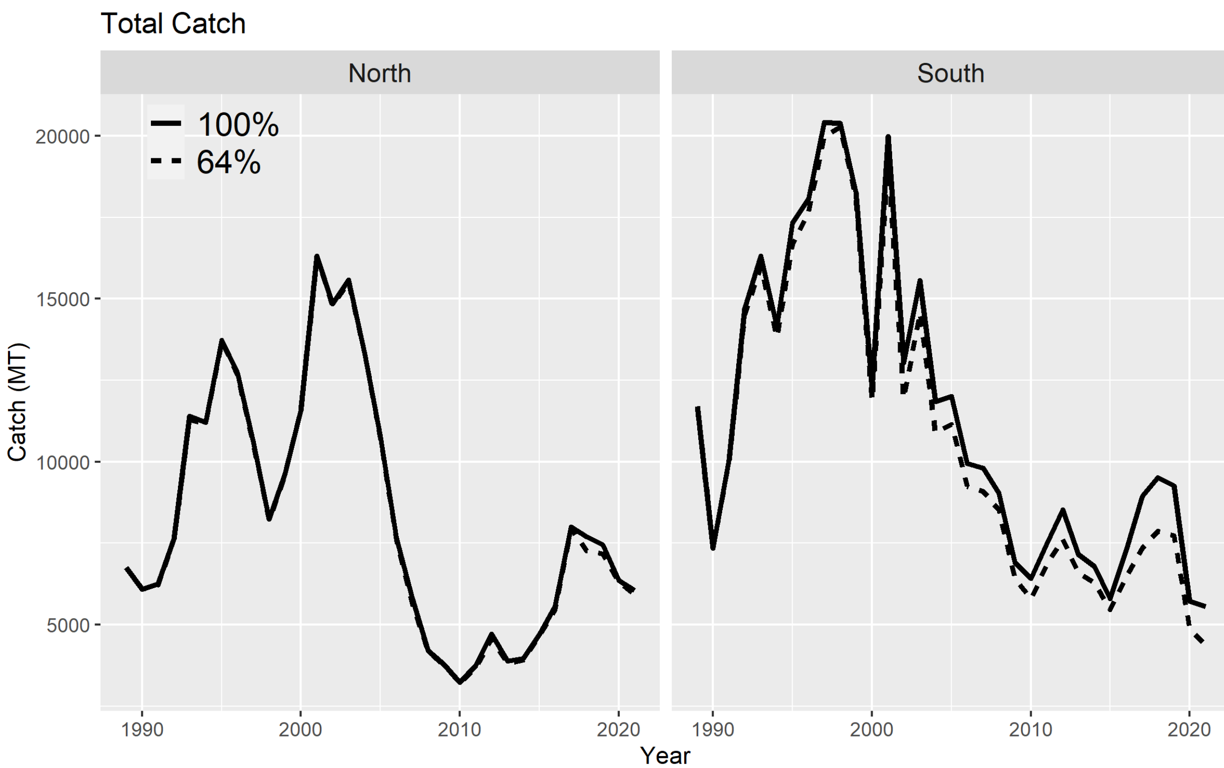

Figure 6: Total monkfish catch (landings and discards) using a discard mortality rate of 100percent or 64percent for the scallop dredge fleet.

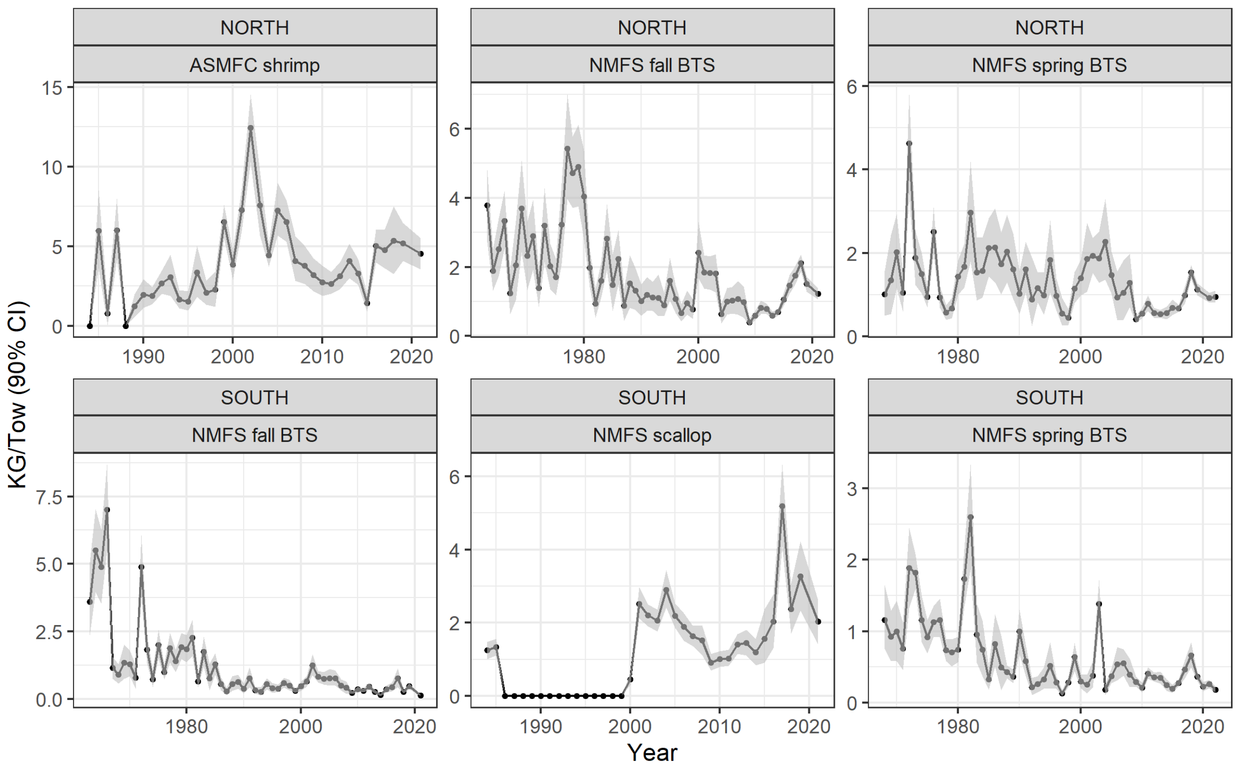

Figure 7: Survey Indices of Abundance.

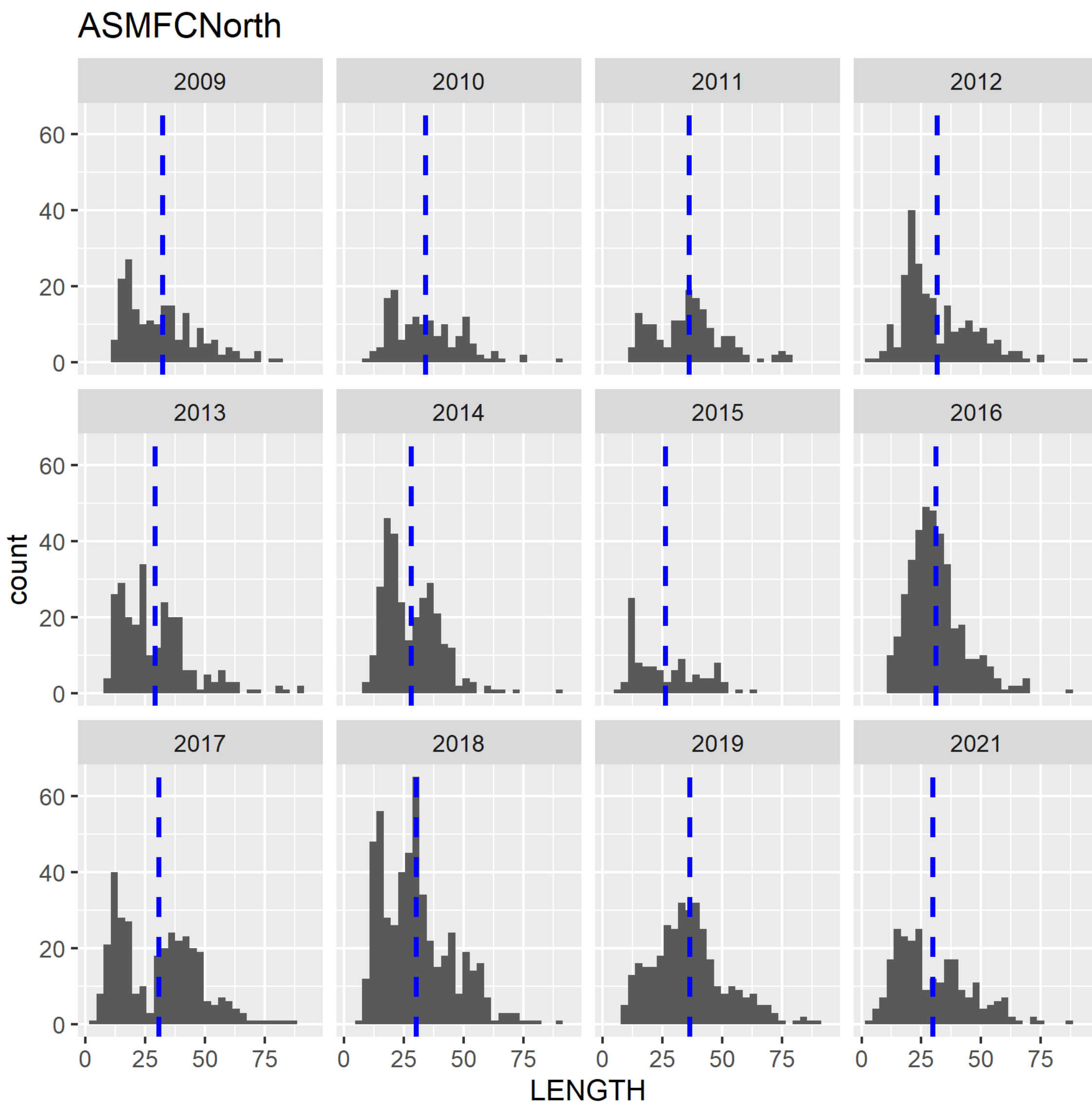

Figure 8: ASMFC survey length frequency in the North. The vertical, dashed, blue line is the mean.

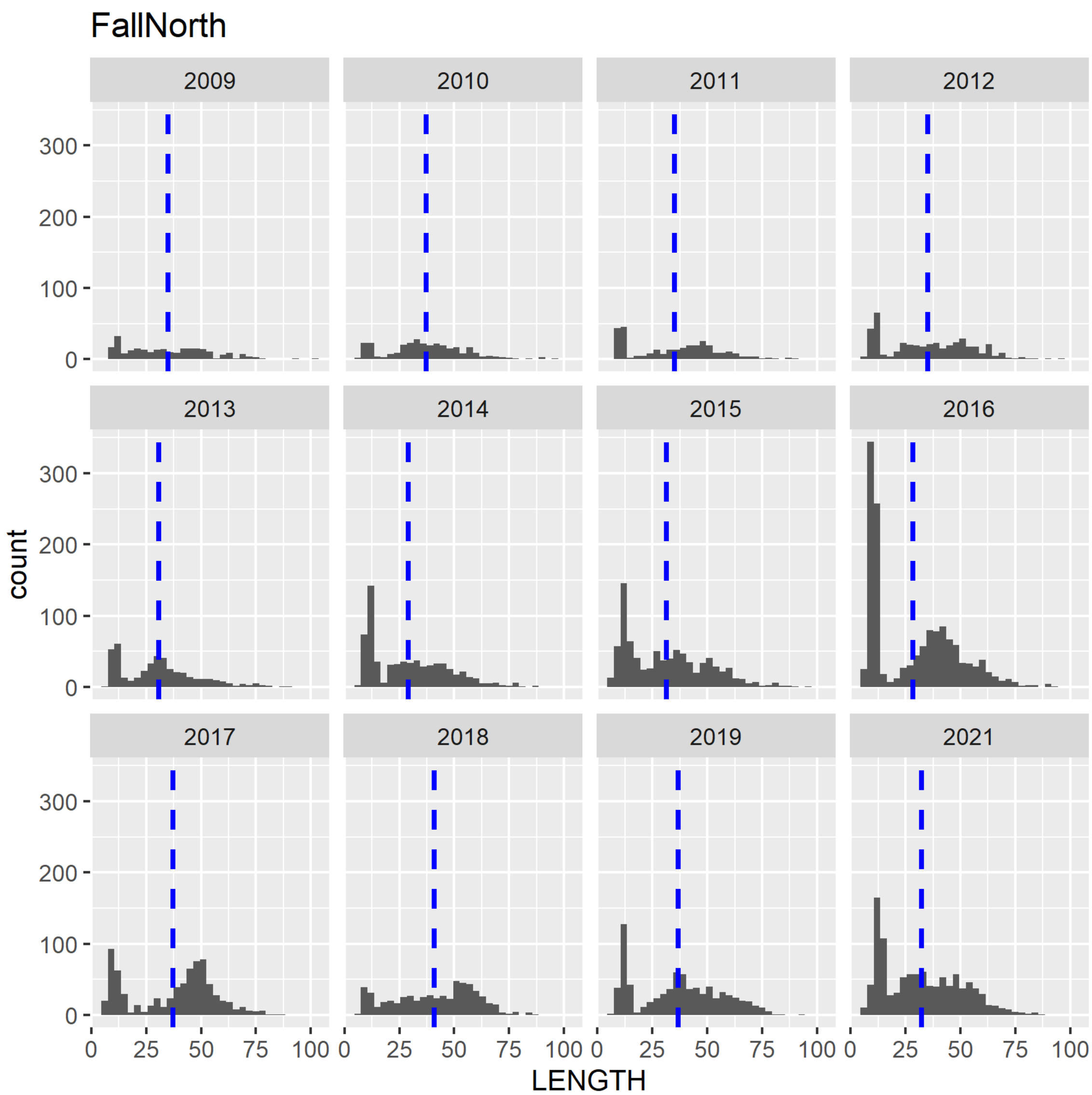

Figure 9: NMFS fall BTS length frequency in the North. The vertical, dashed, blue line is the mean.

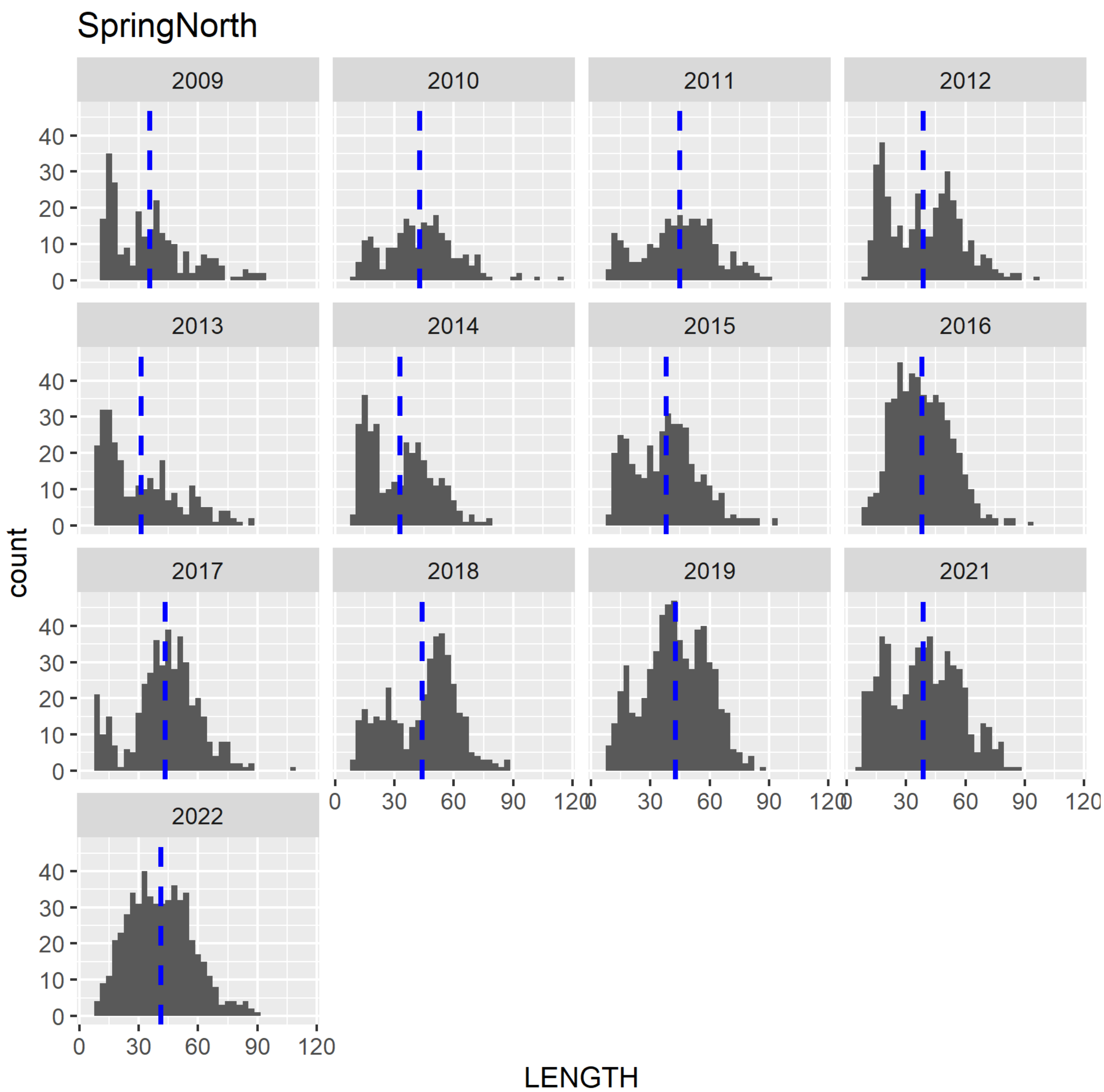

Figure 10: NMFS spring BTS length frequency in the North. The vertical, dashed, blue line is the mean.

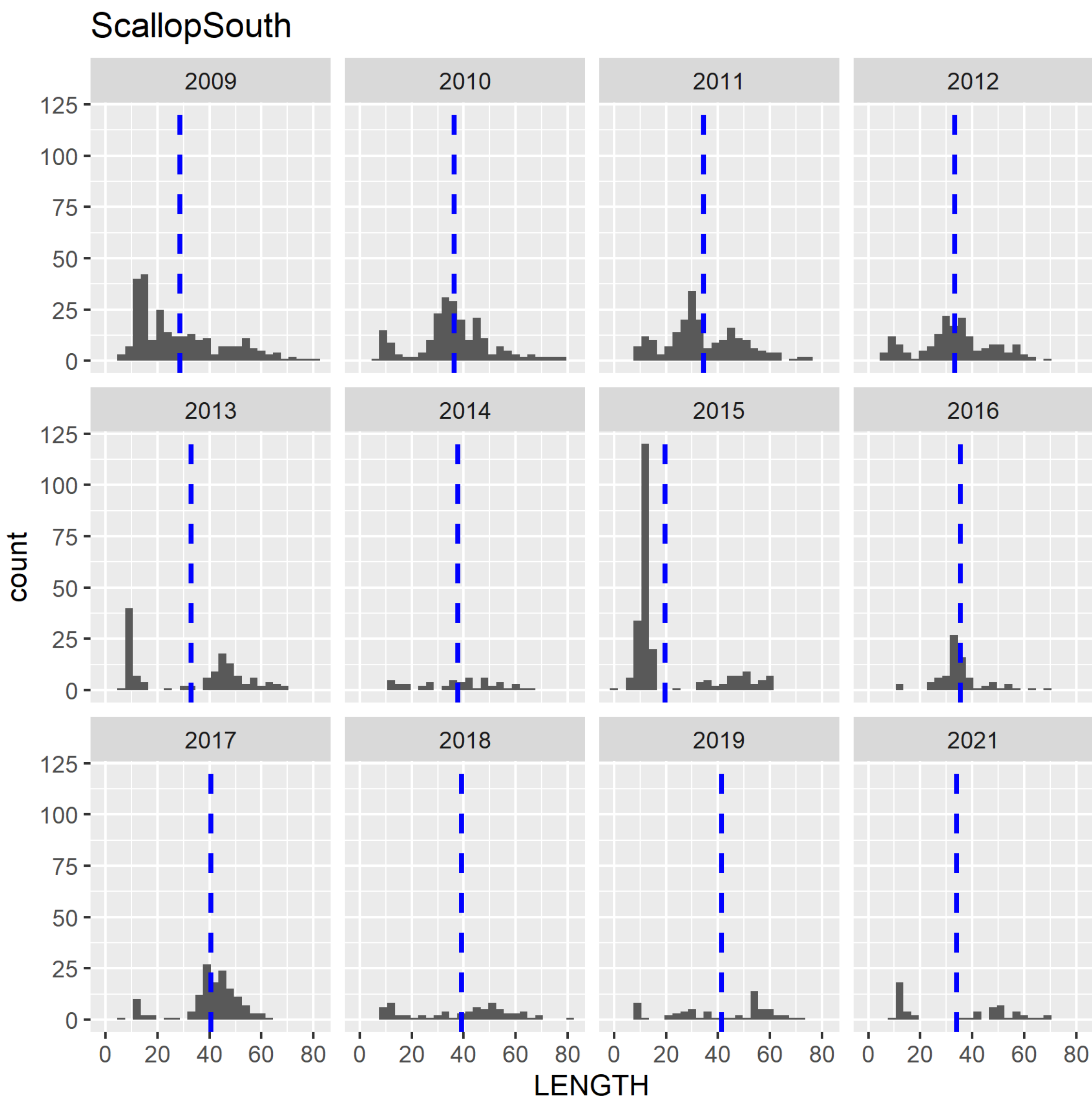

Figure 11: Scallop survey length frequency in the South. The vertical, dashed, blue line is the mean.

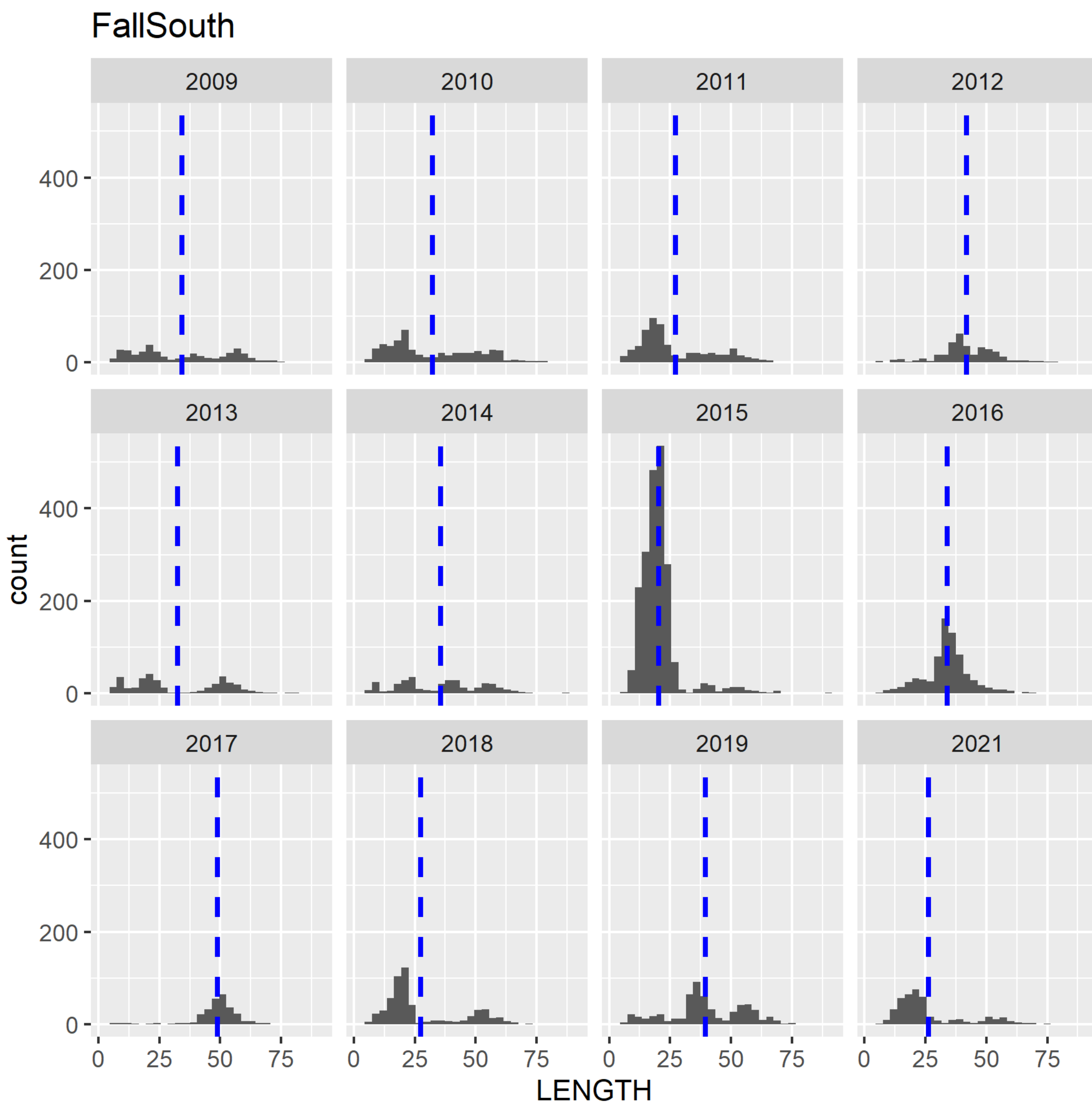

Figure 12: NMFS fall BTS length frequency in the South. The vertical, dashed, blue line is the mean.

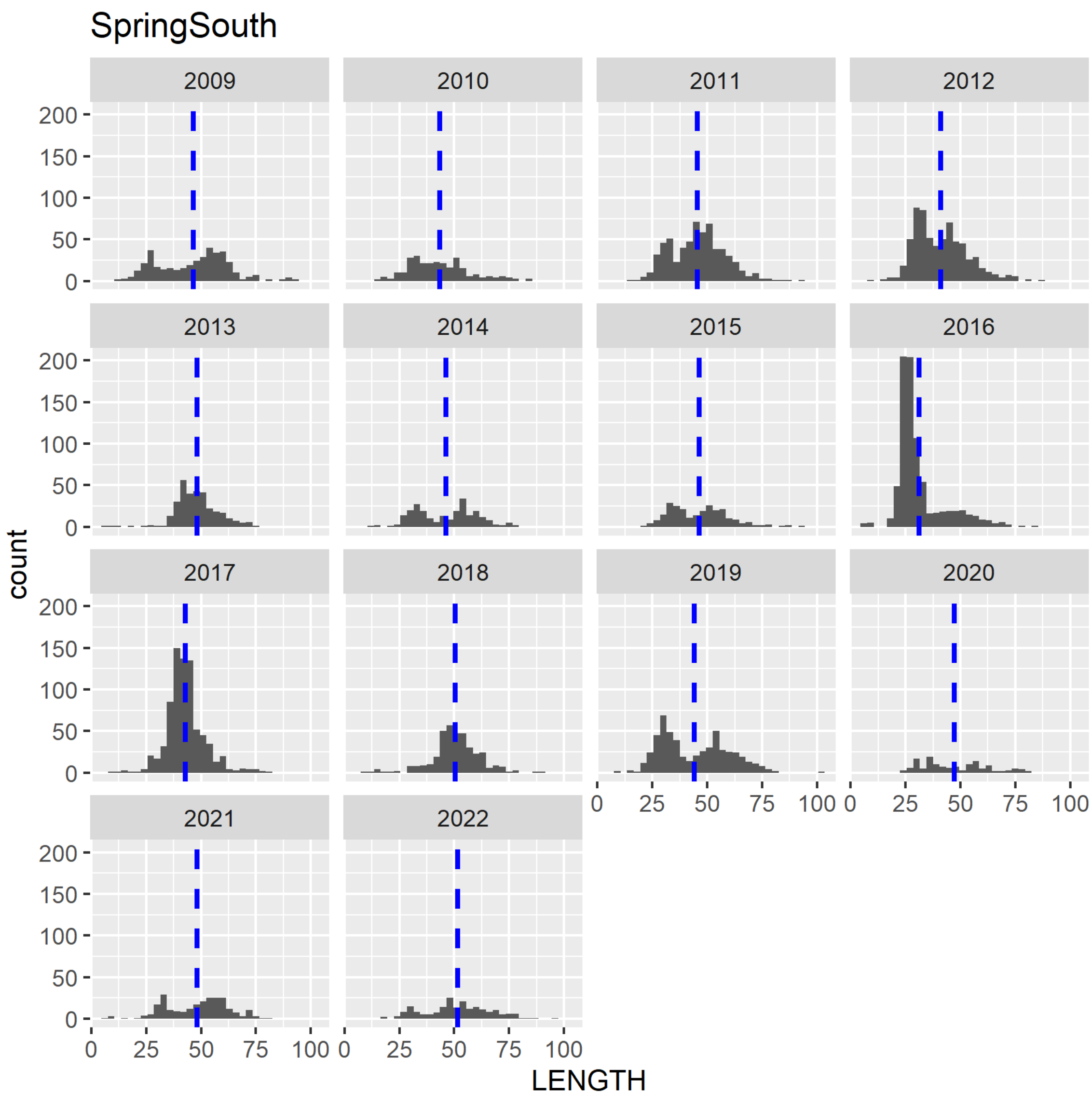

Figure 13: NMFS spring BTS length frequency in the South. The vertical, dashed, blue line is the mean.

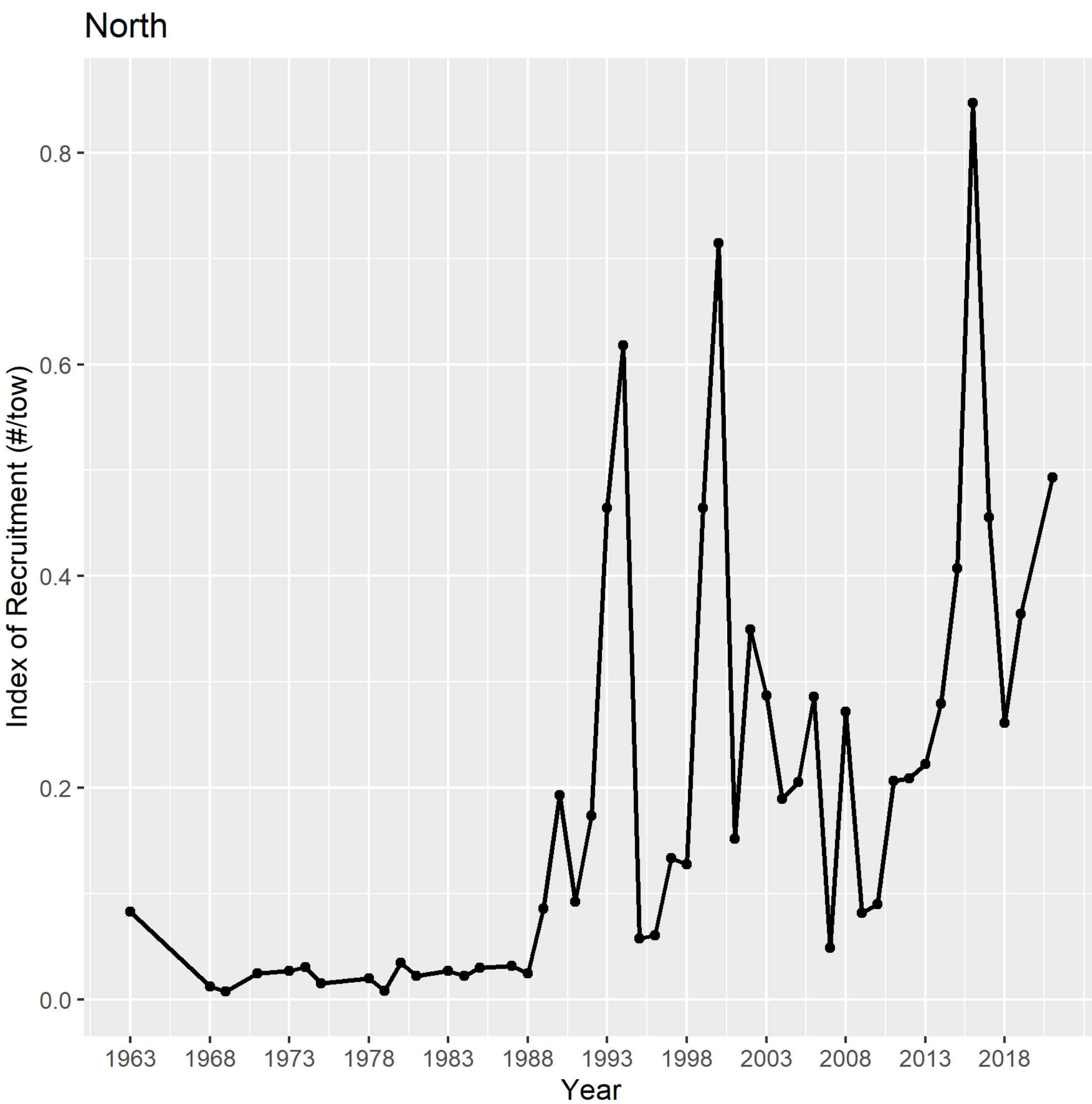

Figure 14: Northern monkfish age-0 recruitment indices of abundance from the NMFS fall BTS.

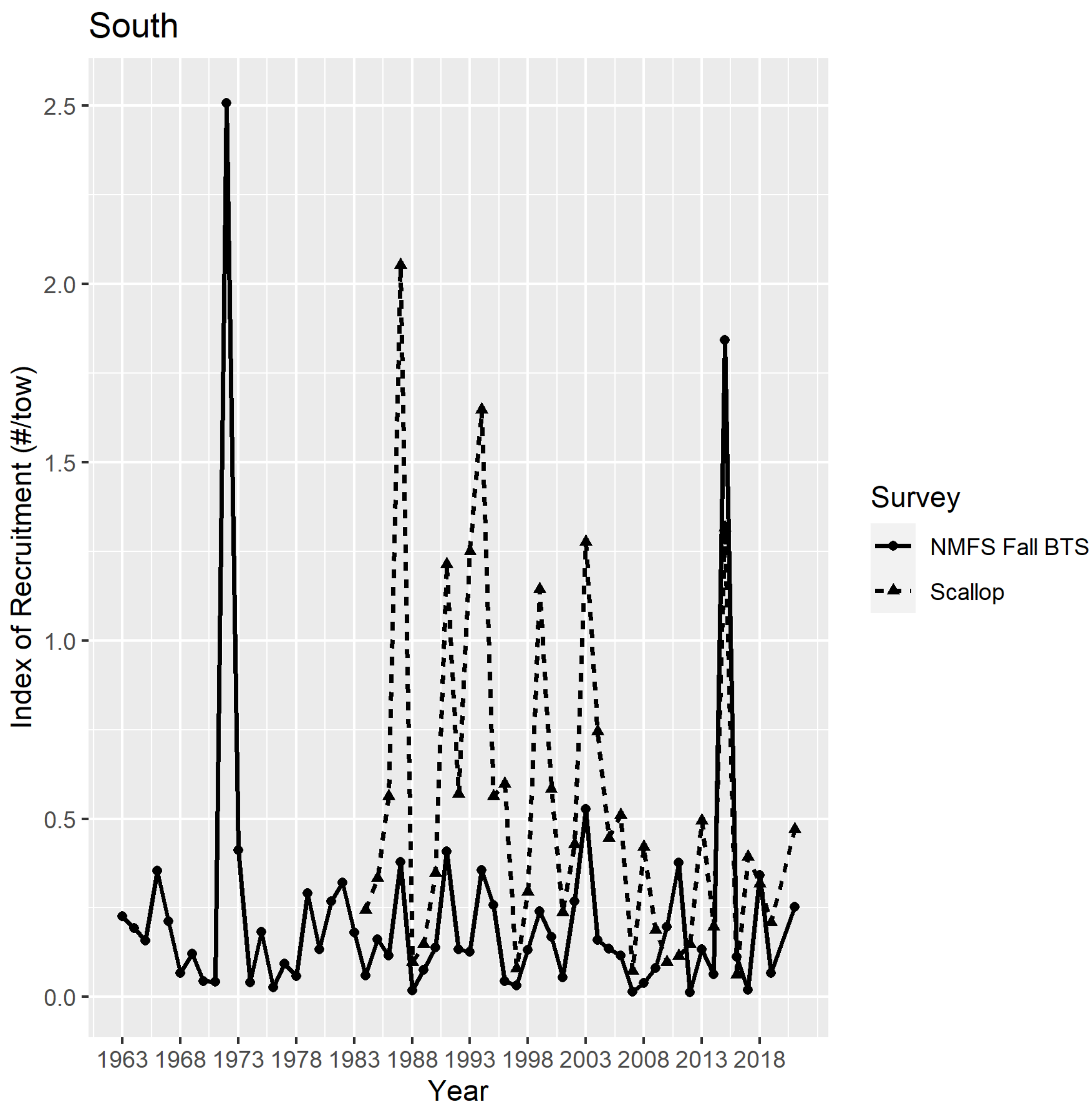

Figure 15: Southern monkfish age-0 recruitment indices of abundance.

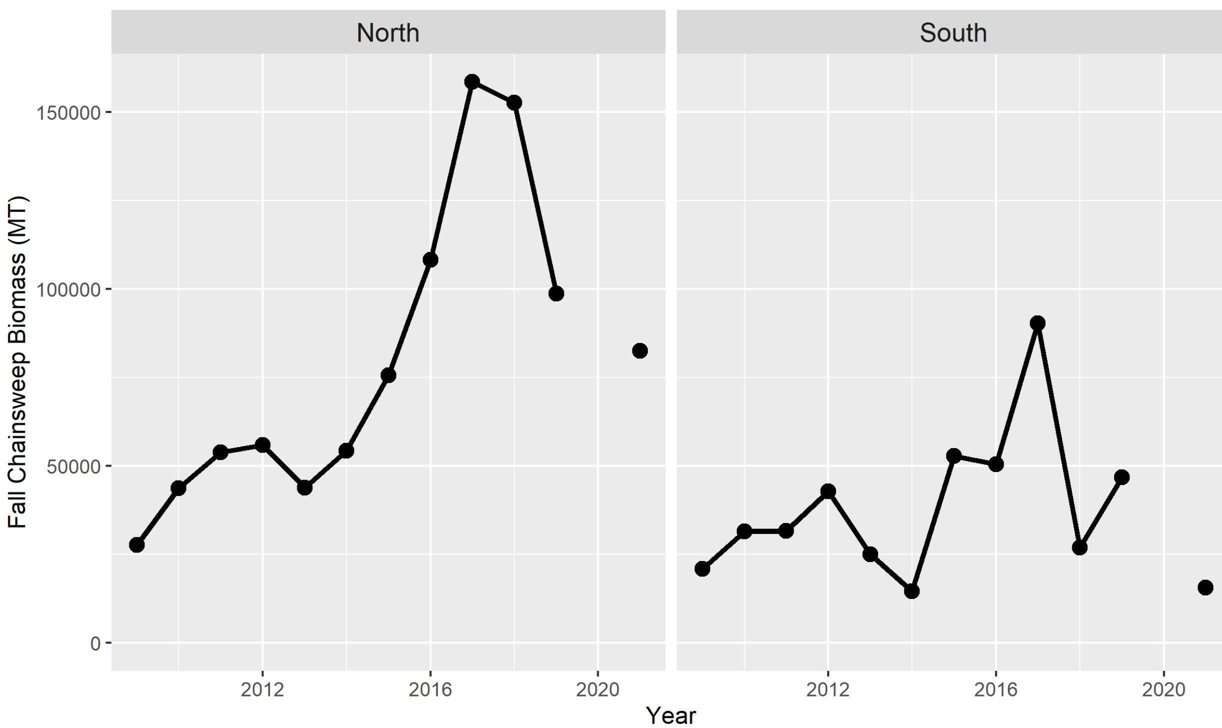

Figure 16: Measure of absolute monkfish biomass based on paired chainsweep and rockhopper sweep for the NMFS fall BTS.

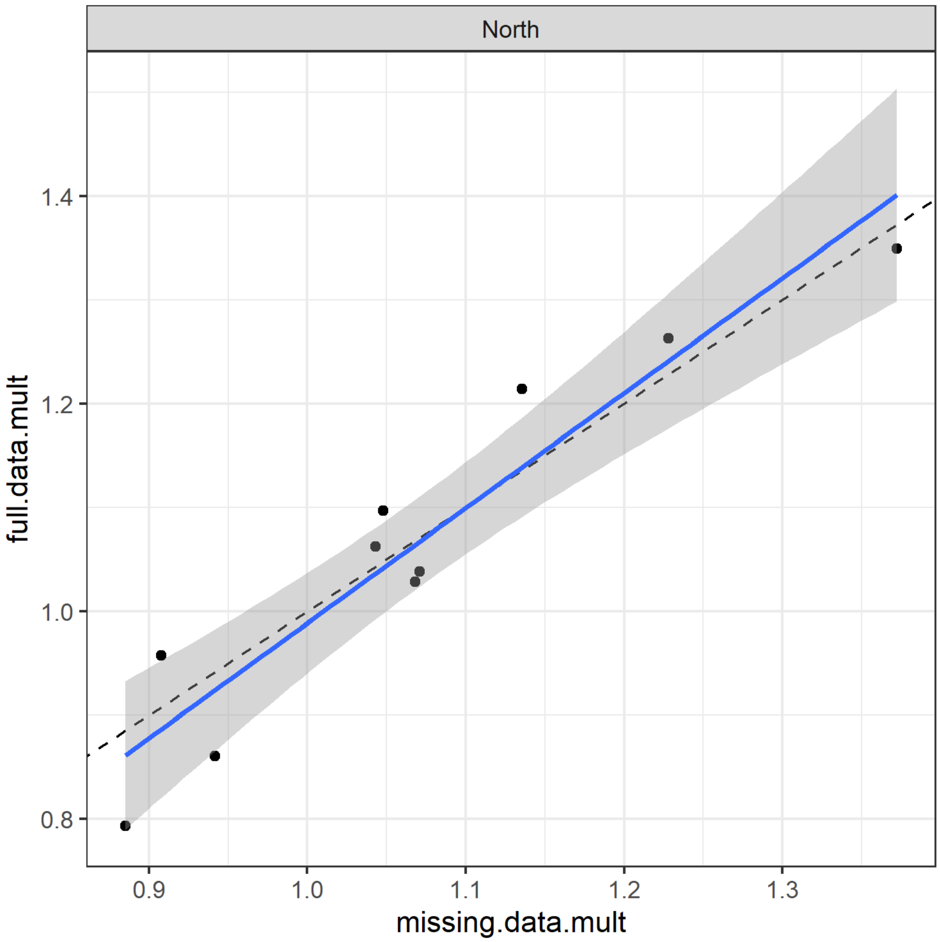

Figure 17: Ismooth applied to data from the North with 10 different terminal years using all data (full.data.mult) and with the year before the terminal year missing (missing.data.mult).

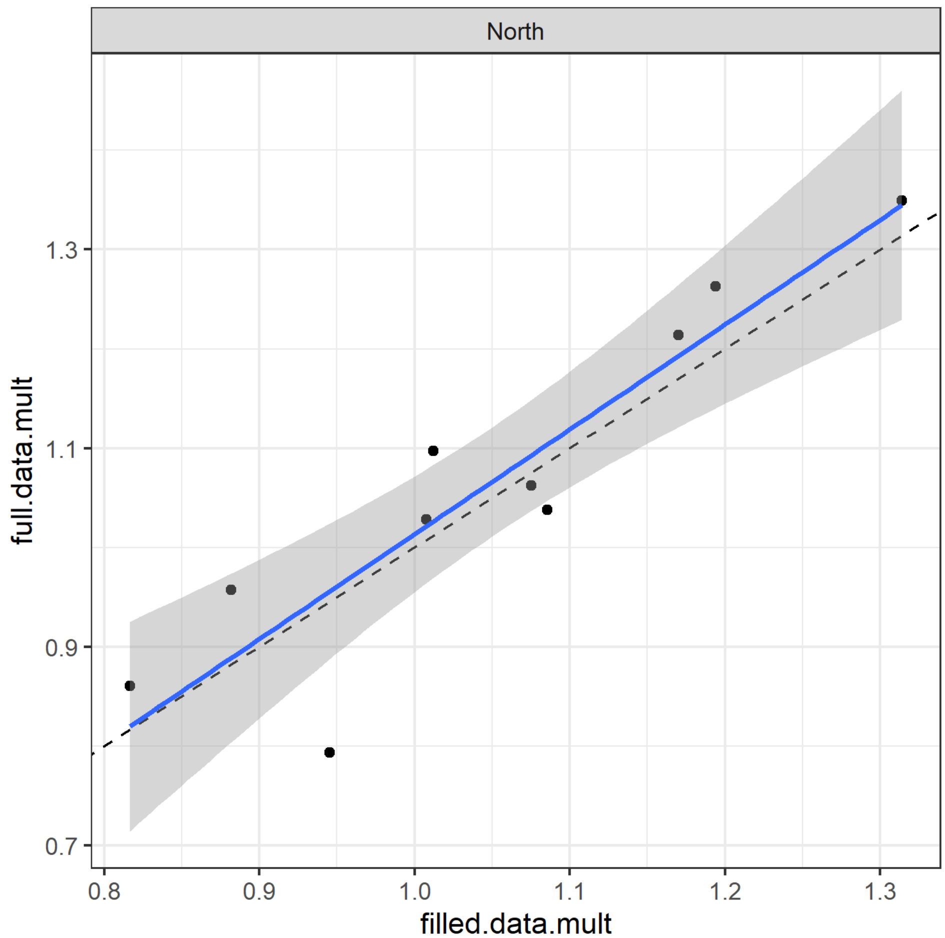

Figure 18: As in Figure 17 except with the missing value imputed using the mean of the surrounding years (filled.data.mult).

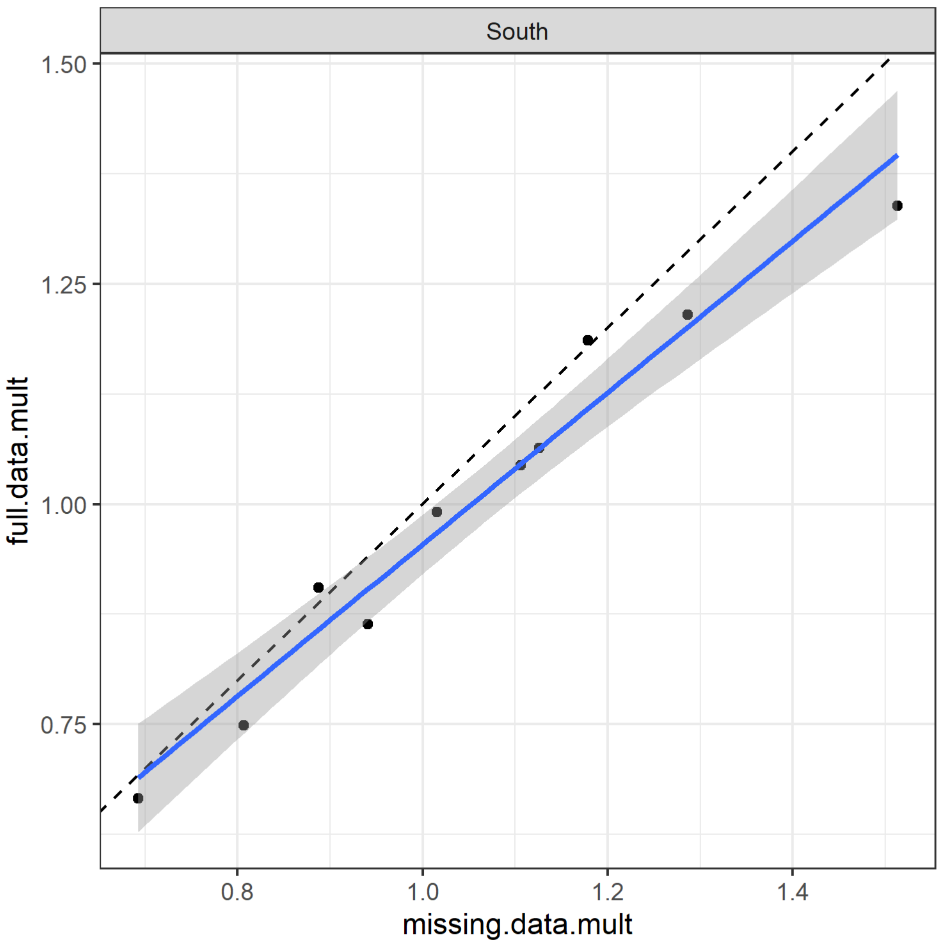

Figure 19: As in Figure 17 except for the South.

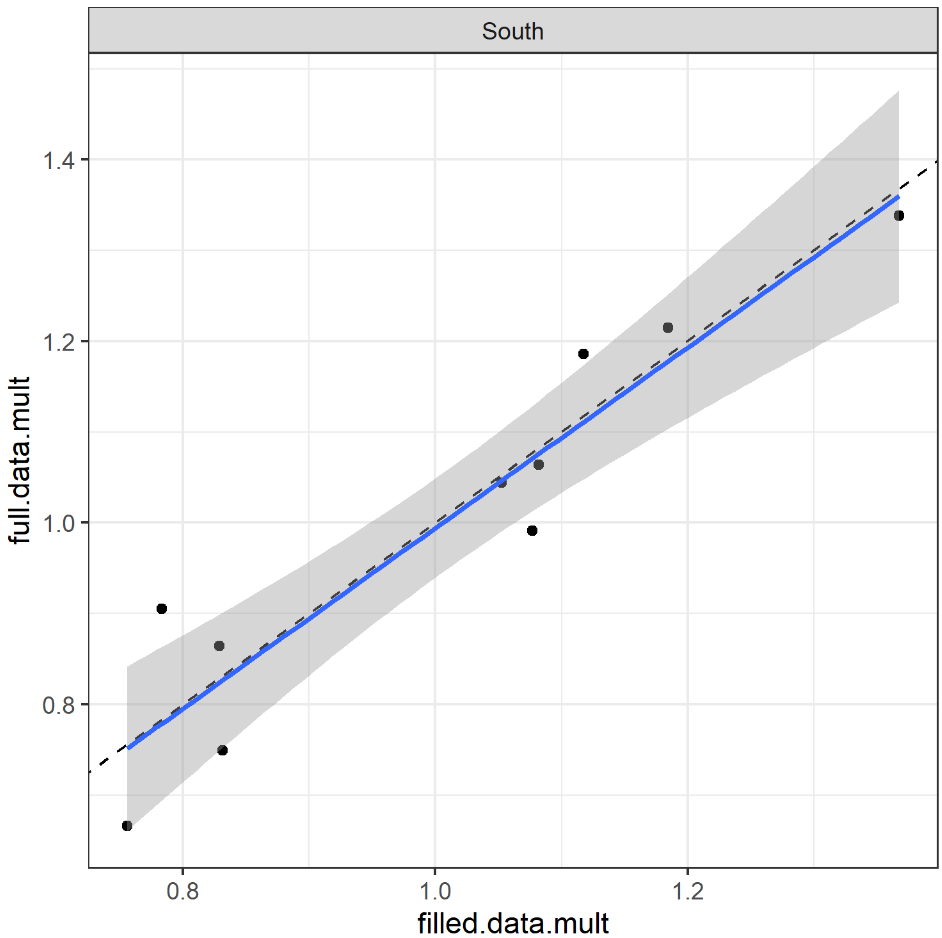

Figure 20: As in Figure 18 except for the South

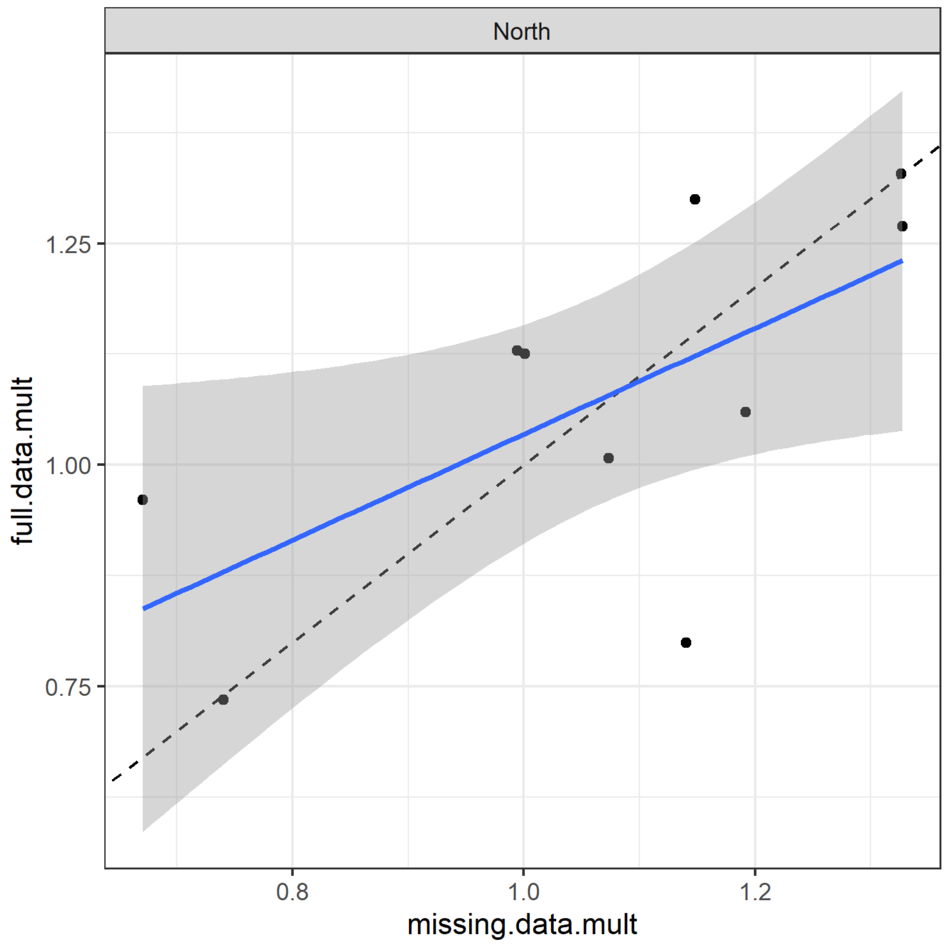

Figure 21: As in Figure 17 but using only the fall survey.

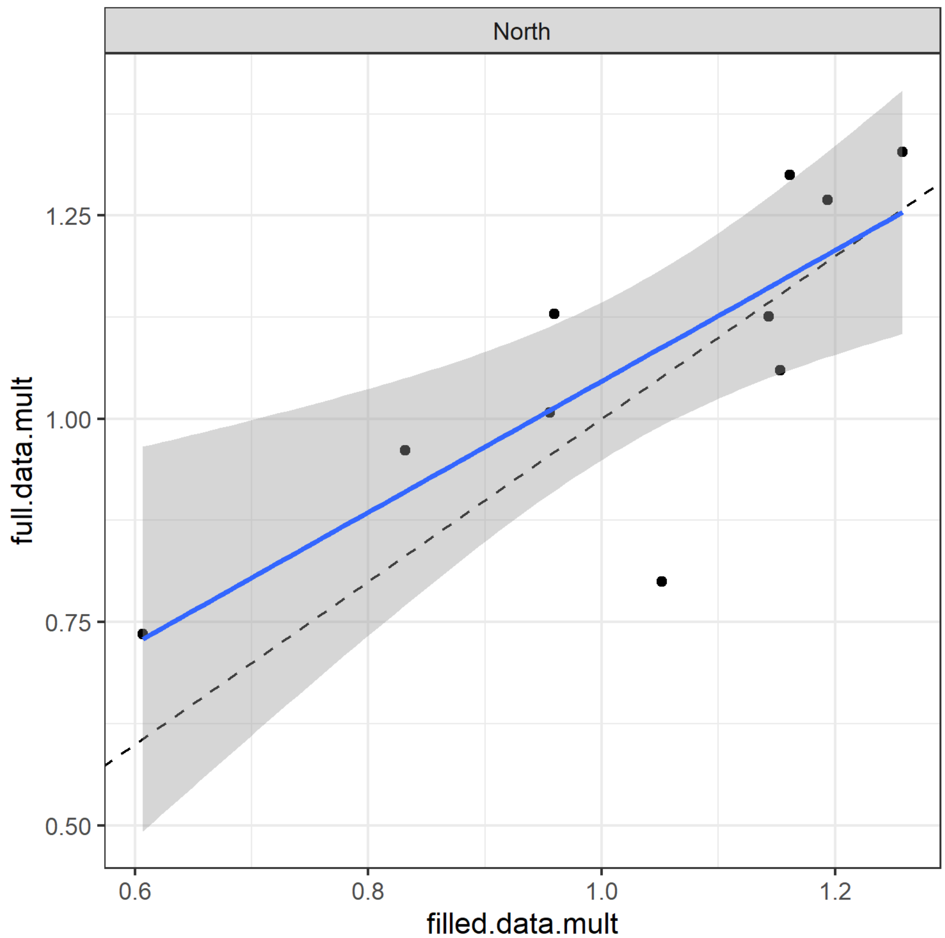

Figure 22: As in Figure 18 but using only the fall survey.

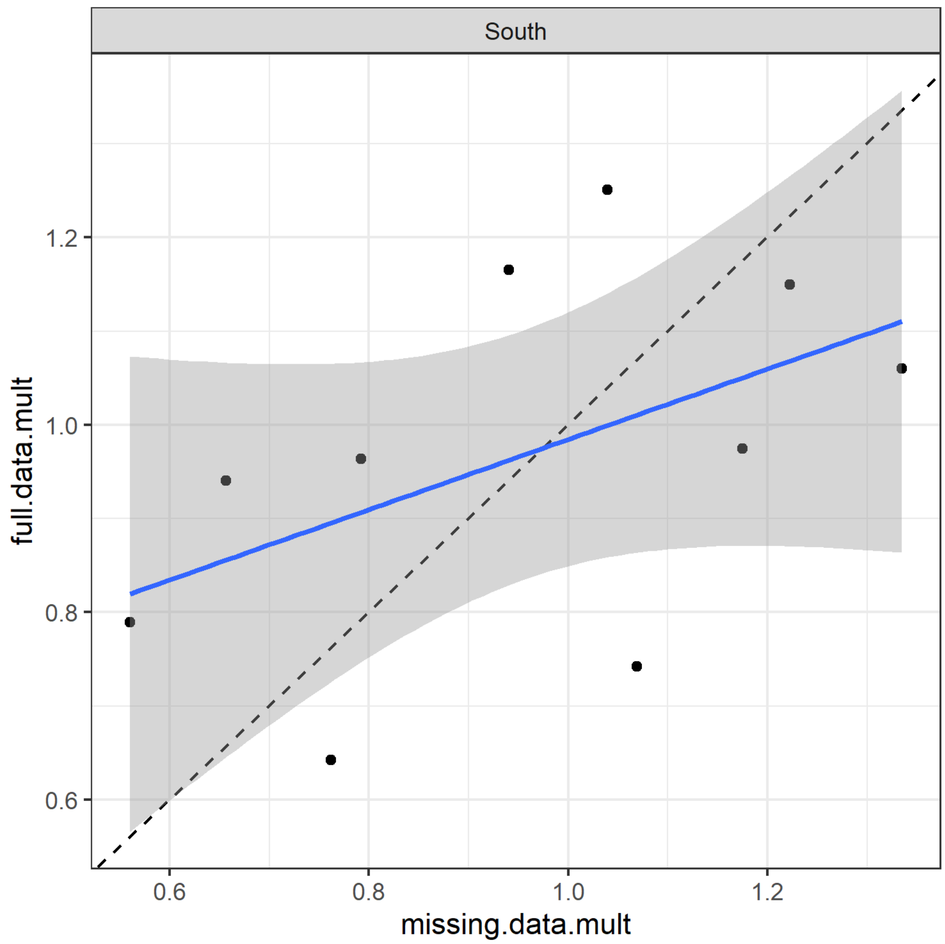

Figure 23: As in Figure 19 but using only the fall survey.

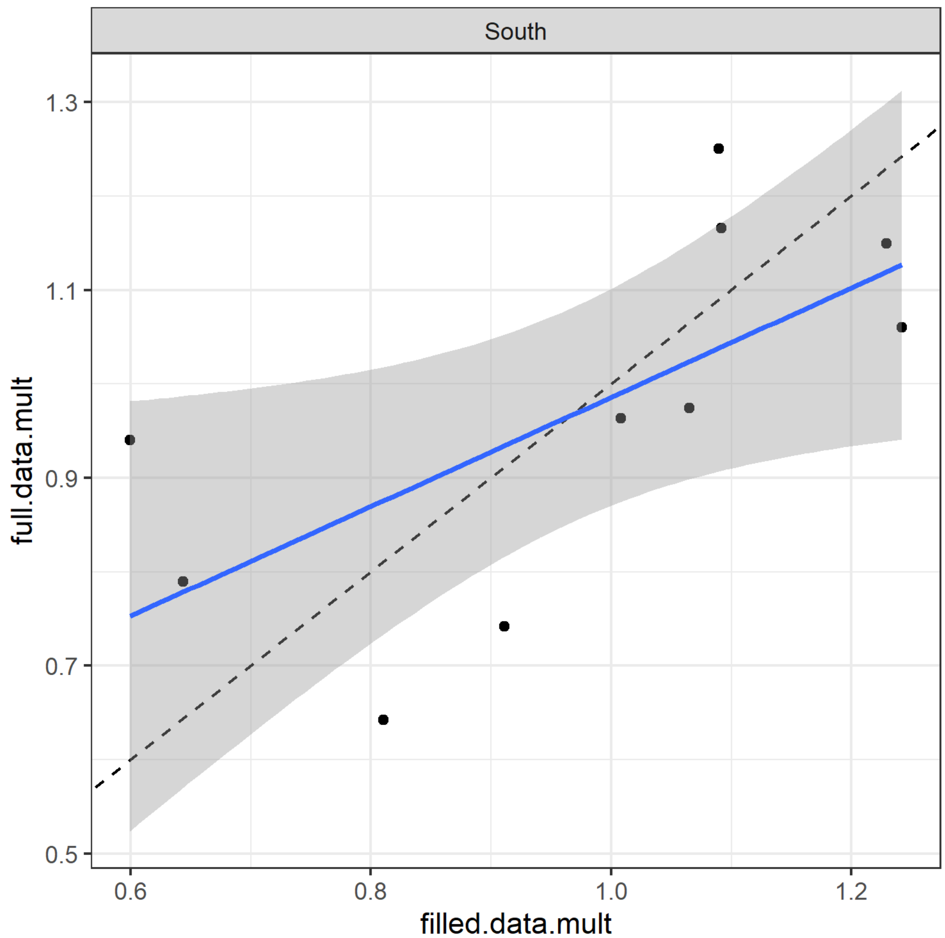

Figure 24: As in Figure 20 but using only the fall survey.

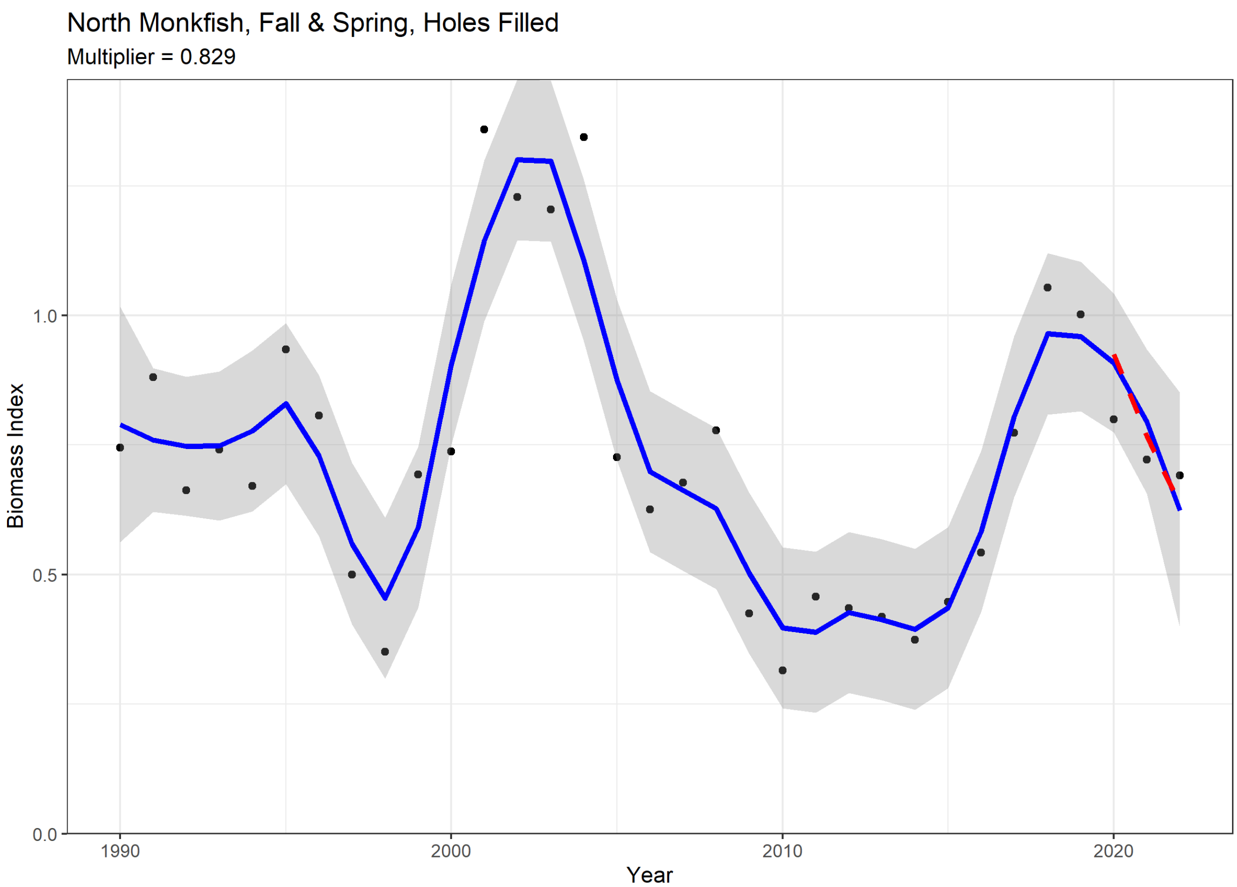

Figure 25: Results of the Ismooth approach in the North.

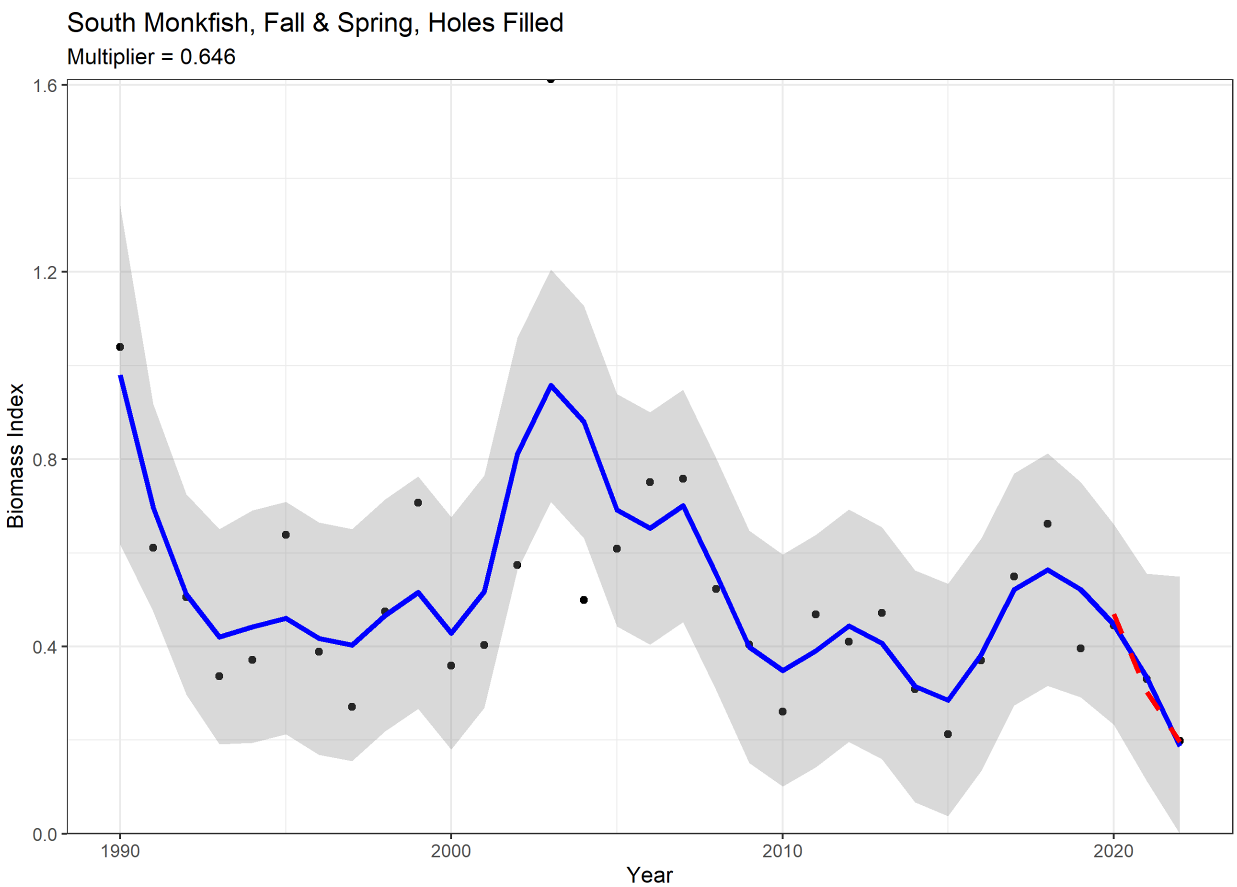

Figure 26: Results of the Ismooth approach in the South.