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Review of North Carolina Kingfishes (Sea Mullet) Stock Complex Data

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Background

The 2007 North Carolina Kingfishes Fishery Management Plan (FMP) developed management strategies that ensure a long-term sustainable harvest for recreational and commercial fisheries in North Carolina (NCDMF 2007). The plan established the use of trend analysis and management triggers to monitor the viability of the stock. The N.C. Marine Fisheries Commission (NCMFC) also adopted a rule which included proclamation authority for the North Carolina Division of Marine Fisheries (NCDMF) Director to impose restrictions on season, areas, quantity, means and methods, or size of kingfish (NCMFC Rule 15A NCAC 03M .0518), if needed. An Information Update was completed for the Kingfishes FMP in November 2015 (NCDMF 2015). An Information Update only incorporates changes in factual and background data that do not alter management strategies or management measures contained in the FMP and does not introduce or address new management issues. The best available data and techniques used for the trend analysis and management triggers were refined and modified to better assess population trends as part of the 2015 Information Update. The trend analysis incorporates management triggers to alert the NCDMF and NCMFC to the potential need for management action based on stock conditions. In 2020, the annual FMP Update served as the formal review of the Kingfishes FMP (NCDMF 2020).

The scheduled 5-year review of the Kingfishes FMP began in 2025. The Kingfishes FMP designated seven management triggers used to monitor the stock. The triggers are updated annually and if two triggers exceed or fall below established thresholds two years in a row (regardless of trigger category), further evaluation of available data will occur, and potential management will be considered. The analysis is updated each year and all trends relative to management triggers are provided as part of the annual FMP Review. Current management triggers based on Southern Kingfish use fishery-independent indices of relative abundance for young-of-year (YOY) and adult fish, the proportion of adults greater than size at 50% maturity (L_{50}, 8.25 inches), and a relative fishing mortality (*F*) index. Young-of-year fish includes new fish that enter the population that year. Relative fishing mortality is the rate of fish death associated with harvest as opposed to natural mortality factors, calculated by dividing total North Carolina recreational and commercial harvest by the SEAMAP Spring adult abundance index. In 2024, three management triggers exceeded or fell below established thresholds for two consecutive years, mandating further review of available data. As the prescribed data review aligns with the scheduled 5-year FMP review, the two processes are taking place concurrently.

Management Trigger Effectiveness

A description of triggers with notes about effectiveness is shown in Table 1. Internal surveys are conducted by NCDMF and include the Pamlico Sound Survey (P195) and the Independent Gill Net Survey (P915). The SEAMAP Coastal Trawl Survey (SEAMAP) is an external survey conducted by the South Carolina Department of Natural Resources (SCDNR). In summary, most management triggers were either set too conservatively, survey changes have limited effectiveness, or survey changes have eliminated the ability to use specific triggers moving forward.

P195 thresholds are set at 2/3 of the average of the base years 1987–2017, the P915 threshold is set at 2/3 of the average of the base years 2001–2017, SEAMAP thresholds are set at 2/3 of the average of the base years 1989–2017, and the relative *F* threshold is set at 1/3 of the average of the base years 1990–2017. Southern Kingfish is designated as the indicator species for the current management triggers. In 2023, SEAMAP changed from three sampling seasons: Spring (April–May), Summer (July–August), and Fall (late September–November) to two sampling seasons: Spring/Summer (April–June) and Summer/Fall (August–October).

The SEAMAP Fall young-of-year (YOY) trigger, the SEAMAP Summer adult trigger, and relative *F* all triggered in 2023 and 2024 (Table 2). The P195 September YOY index triggered in 2024 but did not trigger in 2023.

Table 1. Description of the seven management triggers from the Kingfishes FMP including notes about why triggers may no longer be effective to monitor the Kingfishes stock complex.

Internal Surveys (P195, P915)		External Survey (SEAMAP)
P195 June proportion of adults • Program ended, triggers will no longer be informative		Spring abundance index used to calculate relative *F* • Sampling can extend into June when abundance tends to be lower
P195 September juvenile index • Program ended, triggers will no longer be informative		Summer adult index • Sampling no longer occurs during the summer
P915 proportion of adults • Threshold is too conservative and will likely never trigger • Proportions are not informative without a sample size minimum		Summer proportion of adults • Sampling no longer occurs during the summer
		Fall juvenile index • Sampling no longer occurs in November, the month when abundance is highest

Proportion mature from P915 is a very conservative trigger. There are no bounds with this trigger including minimum sample size limitations. If one Kingfish is captured at a size greater than L_{50}, the proportion of mature adults would be 100%. The minimum threshold is set at 65% mature with the lowest value ever observed being 95%.

SEAMAP has undergone methodology changes which affect management triggers. In 2017, SEAMAP reduced the number of samples, and some regions are now sampled more than others. In addition, the survey design was changed in 2023 reorganizing sampling seasons from spring, summer, and fall to longer spring and fall seasons and eliminating the summer months. The spring season now extends into June and in recent years has only occurred in June.

Because of SEAMAP survey changes, the summer adult index is now calculated using only data from August. The change in SEAMAP sampling seasons has altered fall sampling to end in October, excluding November, which is the month Kingfish abundance in the survey is typically highest.

An updated analysis of current Kingfish triggers is included in the 2026 FMP Review report (NCDMF 2026). Updated trigger analysis indicates none of the seven triggers, including those calculated using SEAMAP data would have triggered in 2025 (Pamlico Sound Survey sampling did not occur in 2025). The updated analysis also indicates the SEAMAP summer adult index would not have triggered in 2022, 2023, or 2024. This discrepancy highlights the issue of using model-based indices in the trigger exercise in that inclusion of new data can change previous estimates.

Table 2. Kingfish management trigger values, 2015–2024. Shaded cells are values that fell below or above thresholds.

	Biological Monitoring			Fisheries-Independent Surveys			Other
	Proportion Adults ≥L50			YOY Indices		Adult Index	
Year	P195 June	P195 Sept	SEAMAP Summer	P195 Sept	SEAMAP Fall	SEAMAP Summer	Relative *F*
2015	0.53	0.98	0.56	7.81	325.06	24.56	12,124
2016	**0.36**	0.95	**0.34**	**1.88**	28.45	22.01	3,790
2017	0.5	0.95	0.68	3.75	26.23	10.84	2,468
2018	0.64	1	0.4	5.39	**6.6**	11.99	5,765
2019	0.53	0.97	0.45	5.45	32.91	34.22	6,417
2020	*	*	*	*	*	*	*
2021	*	1	*	*	32.6	*	*
2022	0.79	1	0.77	4.43	35.58	**8.95**	15,256
2023	0.47	1	0.73	5.31	**2.97**	**7.98**	**156,027**
2024	0.73	0.98	0.75	**1.6**	**1.3**	**1.5**	**1,009,650**
Threshold	< 0.39	< 0.65	< 0.39	< 3.48	< 17.73	< 10.36	>40,723

* Sampling did not occur

Biological Profile

Three species of Kingfishes occur in North Carolina waters: Southern *Menticirrhus americanus*, Gulf *Menticirrhus littoralis*, and Northern *Menticirrhus saxatilis*. Kingfish refers to a single species, while Kingfishes refers to multiple species. The Kingfishes have several regional names including sea mullet, king whiting, king croaker, sea mink, roundhead, hard head, whiting, hake, Carolina whiting, and Virginia mullet. Kingfishes are demersal (live near and feed on the bottom) members of the drum family. Southern Kingfish is the most abundant Kingfish species from North Carolina to the east coast of Florida and Gulf of Mexico with a range extending as far as Cape May, New Jersey southward to Buenos Aires, Argentina (Welsh & Breder 1923; Hildebrand & Cable 1934; Bearden 1963; Clardy et al. 2014). Northern Kingfish is the most abundant Kingfish species from Massachusetts to North Carolina, with a range extending from the Gulf of Maine to Brazil (Welsh & Breder 1923; Bearden 1963). Gulf Kingfish is the most abundant Kingfish species in the surf zone south of Cape Hatteras, North Carolina, and has a range extending from Virginia to Rio Grande, Brazil (Welsh & Breder 1923; Braun & Fontoura 2004; Anderson et al. 2012). The Northern and Southern Kingfishes prefer mud or sand-mud bottom types while Gulf Kingfish prefer the sandy bottoms of the surf zone (Reid 1954; Bearden 1963; Crowe 1984; Chao 2002; Clardy et al. 2014; Collier 2017).

Spawning takes place in the ocean from April to October, and individuals will spawn multiple times throughout the season (Hildebrand & Cable 1934; McDowell & Robillard 2013; Clardy et al. 2014). Prior to the spawning season, Kingfishes move closer to shore and northward (Hildbrand & Cable 1934; Collier 2017). Following the spawning season and as water temperatures cool, Kingfishes move from estuarine and nearshore ocean waters to deeper offshore waters (Hildebrand & Cable 1934; Bearden 1963; Fritzsche & Crowe 1981; Lagarde 1981; Crowe 1984; Clardy et al. 2014). All Kingfishes have been noted to show rapid growth rates in the first few months of life and generally reach maturity by their second summer (Collier 2017). Using Southern Kingfish as a proxy, about 50% of Kingfish will reach maturity by 8.25 inches total length (L_{50}; NCDMF 2020) while all should reach maturity by 10 inches total length (L_{100}; NCDMF 2007). Kingfishes are sexually dimorphic with females growing larger than males. In North Carolina, Southern Kingfish up to 8 years of age have been observed, but Kingfish from ages 0 to 4 years are most common.

Stock Assessment

An attempt to complete a stock assessment during development of the 2007 FMP was not successful, primarily due to limited data. All assessment reviewers noted a lack of migration (mixing) data to determine the movement patterns of Kingfishes along the North Carolina coast and the entire Atlantic coast. A regional (multi-state) stock assessment approach is likely needed to best determine the stock status for Kingfishes along the Atlantic coast including North Carolina. In 2008 and 2014, the Atlantic States Marine Fisheries Commission (ASMFC) South Atlantic Board met to consider regional management by reviewing data on Kingfishes. Due to no major concerns with Kingfish stocks, it was decided no further action was necessary. As a result, Kingfishes management in North Carolina continues to fall solely within the framework of the state FMP process.

As part of the current data review, attempts were made to fit two stock assessment model frameworks to available data. First, the Stock Assessment Continuum (SAC) tool (Cope 2024) was used to fit a length-based statistical catch-at-age model in Stock Synthesis 3.0 (SS3) to commercial landings, Marine Recreational Information Program (MRIP) landings, fishery-dependent composition information, the P195 survey, the combined NEAMAP/SEAMAP survey indices of relative abundance, and the associated fishery-independent (FI) composition information. Second, JABBA-Select (Winker et al. 2018, 2020) was fit to total landings summed over sectors, and the two indices of relative abundance.

Both models were fit using a simple to complex approach. Using SS3, the model was fit using only commercial landings and composition information, then commercial landings and P195 data, then commercial landings and recreational landings, then commercial landings, recreational landings, and P195. Attempts were also made to fit the model to commercial landings, recreational landings, and the NEAMAP/SEAMAP combined index. For JABBA-Select, data used included commercial and recreational landings, P195, the NEAMAP/SEAMAP index, selectivity by fleet, and life history parameters. Neither model produced estimates or reference points that would be suitable for use in management.

While attempts to develop a stock assessment model for the Kingfishes stock complex were not successful, the process of reviewing data and attempting to fit stock assessment models was beneficial for identifying data needs and research recommendations. All models were sensitive to life history parameters, specifically growth. Kingfish growth is sexually dimorphic, and ideally sexes should be modeled separately with sex-specific composition, landings, and growth data, or with a sex ratio, sex specific growth models, and combined composition data.

The NCDMF does not currently conduct a sampling program to provide a fishery-independent index of abundance for the Kingfishes stock complex. Program 915 has very low Kingfish catch and does not sample areas considered to be Kingfish habitat. Program 195 samples a different size distribution than the commercial and recreational fisheries and selectivity from this program was difficult to model. In general, the mismatch between growth parameters and the size of fish caught in P195 caused issues with model fitting using SS3 (Jason Cope, Northwest Fisheries Science Center, personal communication). Pending replacement of P195 and/or an assessment model with an alternate growth sub-model, data from this survey is questionable for use in a future stock assessment.

NEAMAP and SEAMAP provide a better index for fitting SS3 models, but age composition data for Kingfish are not collected in these surveys, though length composition data from these surveys are still informative. If a stock assessment is pursued in the future, a statistical catch-at-age model capable of being fit to age and length composition data and using an alternate growth model is recommended.

The exploratory stock assessment work resulted in a prioritized list of research recommendations that should be addressed to complete a stock assessment.

Stock Assessment Priorities

- Fishery-independent sampling for catch-per-unit-effort (CPUE), sex-specific age and length data
    - Consider full range of SEAMAP

    - Prioritize collection of immature Kingfish
- Movement data, migration timing, duration, distance (with intent of moving toward defining a relevant stock boundary for N.C.)
    - Better understanding of composition of species complex throughout the year
- Growth models
    - Biphasic – best model requires age and maturity to be estimated in a single model
    - Timing of spawning by species
- Commercial fishing: landings, sex-specific age and size composition, effort
- Relevant market effects of fishing

Data Review

To further investigate status of the Kingfishes stock complex recreational and commercial landings data, fishery-independent indices, and age and length composition data were explored. Data from several fishery-independent programs were explored including the Juvenile Anadromous Survey (P100), the Estuarine Trawl Survey (P120), the Red Drum Seine Survey (P123), and the Beaufort Ichthyoplankton Survey, all of which were ultimately not considered further because of very few Kingfish observations (Table 3). Programs including the Independent Gill-Net Survey (P915/P916), the Southeast Fishery Observer Program (SEFOP), and the Northeast Fishery Observer Program (NEFOP) were also explored but it was ultimately concluded these programs did not produce enough consistent Kingfish stock complex data to be informative.

Table 3. Fishery-independent and fishery-dependent sampling programs considered for analysis of the Kingfish stock complex but not included, with notes about reason for exclusion.

Program	Notes
<u>Fishery-Independent</u>	
Juvenile Anadromous (P100)	<1% of samples with Kingfish
Estuarine Trawl Survey (P120)	<1% of samples with Kingfish
Red Drum Seine Survey (P123)	<5% of samples with Kingfish; cannot standardize based on time
Beaufort Ichthyoplankton	10 Kingfish in 37 years
Independent Gill-Net Survey (P915/P916)	P915: ~10% of samples with Kingfish; catch is inconsistent, flat trend in catch rate P916: ~41% of samples with Kingfish; but program discontinued in 2015
<u>Fishery-Dependent</u>	
Estuarine Gill-Net Observer Program (P466)	~14% of samples with Kingfish; not a priority species for program because rarely discarded
Shrimp Trawl Observer Program (P570)	4,187 lengths, but limited spatially and temporally
Southeast Fishery Observer Program (SEFOP)	92% of samples with Kingfish; primarily provides discard data
Northeast Fishery Observer Program (NEFOP)	~30% of samples with Kingfish; primarily provides discard data; did not provide unique information

The following fishery-independent surveys were identified as potentially providing useful Kingfish stock complex information: the Pamlico Sound Survey (P195), the Northeast Area Monitoring and Assessment Program (NEAMAP), and the Southeast Area Monitoring and Assessment Program (SEAMAP). Various fish house sampling programs, MRIP, N.C. Trip Ticket, and Comprehensive Life History Sampling (P930) were also identified as potentially providing useful Kingfish information.

<u>Index Standardization and Weighted Quantile Analysis</u>

Methods

Data from P195, SEAMAP, and NEAMAP were identified for further evaluation. For P195, years modeled included 1987–2024 and CPUE was calculated as number caught divided by tow duration in minutes (number caught/minute trawled). Units for CPUE are selected such that data could be combined in the index standardization modelling. The years modeled for SEAMAP were 1989–2024 and 2007–2024 for NEAMAP. Both NEAMAP and SEAMAP data were limited to samples collected in North Carolina waters. Samples from both programs record counts and area swept, and CPUE was calculated as number caught divided by area swept in hectares (number caught/hectare). Samples with missing latitude and longitude from any survey were excluded, and samples with incorrect coordinates were visually identified by plotting and removed from subsequent analyses.

Modelling Approach

Models were built and fit using the sdmTMB package (Anderson et al. 2025) in R (R Core Team 2025). This modeling framework allows for the combination of multiple surveys (Thompson et al. 2022), and standardization to generate an index of relative abundance (Freshwater et al. 2024). The spatiotemporal modeling framework assumes that CPUE is spatially autocorrelated, allowing estimation of a surface that represents spatial variation in CPUE. Models successfully converged if the Hessian matrix was positive definite and the maximum gradient of the likelihood estimation was less than 0.0001. For reference, these spatiotemporal models are essentially delta-generalized linear mixed model (GLMMs) that model random effects as Gaussian Markov Random Fields (GMRFs).

Model Configuration

The index models (P195 and combined NEAMAP/SEAMAP) were fit as sex aggregated with an annual timestep. Year was modeled as a fixed effect, while spatial and spatiotemporal variation were modeled as independent and identically distributed (IID) random effects. The fit of each model was evaluated with DHARMa residuals using the sdmTMB package in R (Anderson et al. 2025). Delta/hurdle model configurations were fit for both indices, but the combined index did not converge. The Tweedie distribution provided a better fit for both indices after evaluating residual diagnostics. Delta models consist of two linear predictors, one for positive encounters and one for positive catches. Both the delta model and Tweedie distribution are approaches meant to handle zero-inflated data and recent research suggests the Tweedie distribution can be sufficient over delta models (Zheng et al. 2023). In general, the delta model and Tweedie distribution are more common in spatiotemporal index standardization than other distributions such as the negative binomial.

Weighted Quantile Analysis

The weighted length quantiles track the size distribution of the fish caught in the respective program over time: this can be a useful exercise to determine the effect of fishing on the size distribution of the population. Trends in size of catch provide a valuable indicator of the health of the stock as declines and condensing of length quantiles indicate smaller fish are available, likely as a function of fishing. Conversely, larger and expanding length quantiles indicate larger fish are available. Differences in sample sizes across length bins are controlled in the weighting to create more robust estimates of the length quantiles. For an in-depth explanation, see Akinshin (2023). The weighted quantile method was implemented with the cNORM package (Lenhard et al. 2018) in R (R Core Team 2025). Length composition data were taken from the following sampling programs, P195, NEAMAP, SEAMAP, MRIP, and commercial fish house sampling programs. For MRIP, only observed lengths were used and imputed lengths were excluded. All programs were evaluated individually except for NEAMAP and SEAMAP, which were combined to match the index model for these two sources. Weighted quantiles were also calculated for NEAMAP and SEAMAP individually to explain the effect of more recent data on estimates of earlier quantiles. Similar analyses were conducted for age compositions from commercial and recreational fisheries and P195. Kingfish ages are not available from the NEAMAP or SEAMAP surveys.

Recreational Fishery

Most Kingfish harvested recreationally come from fishing structures like piers, jetties, or bridges, but also from surf fishing (Figure 1). A smaller number are captured from vessels in estuarine waters. Harvest was generally low early in the time series but has been increasing since the early 2000s (Figure 2). Recently, the recreational fishery has harvested around two million pounds per year with around six million pounds harvested in 2021 and over three million pounds harvested in 2022.

Pounds of Kingfish harvested in 2021 is noticeably higher than in any other year. MRIP estimates are the summed product of angler's landing and fishing effort estimates, meaning high estimates could be products of a large number of interviews, an average number of interviews with large numbers of fish captured, high fishing effort estimates or interactions of any of the previously listed reasons. The high estimates in 2021 were linked back to interviews conducted by a single interviewer on Veterans Day 2021. The interviewer recorded 15 interviews with high landings documented as well as high effort, and when estimates were expanded this led to pronounced Kingfish harvest estimates, greatly inflating estimates for 2021 as a whole. These estimates were also from interviews where the interviewer was not granted access to the fish, meaning the high numbers documented could not be visually confirmed. Removal of these fifteen interviews brings the 2021 estimates back to a peak more consistent with other successful fishing years like 2014 (Figure 3). Evaluation of Kingfishes harvest data found that the circumstances leading to the high harvest estimate in 2021 were highly unusual. Similar situations will continue to be evaluated on a case-by-case basis. Discards of Kingfishes exhibited a pattern similar to harvest, with relatively higher estimates occurring in 2009, 2010, 2013, and 2014 (Figure 4).

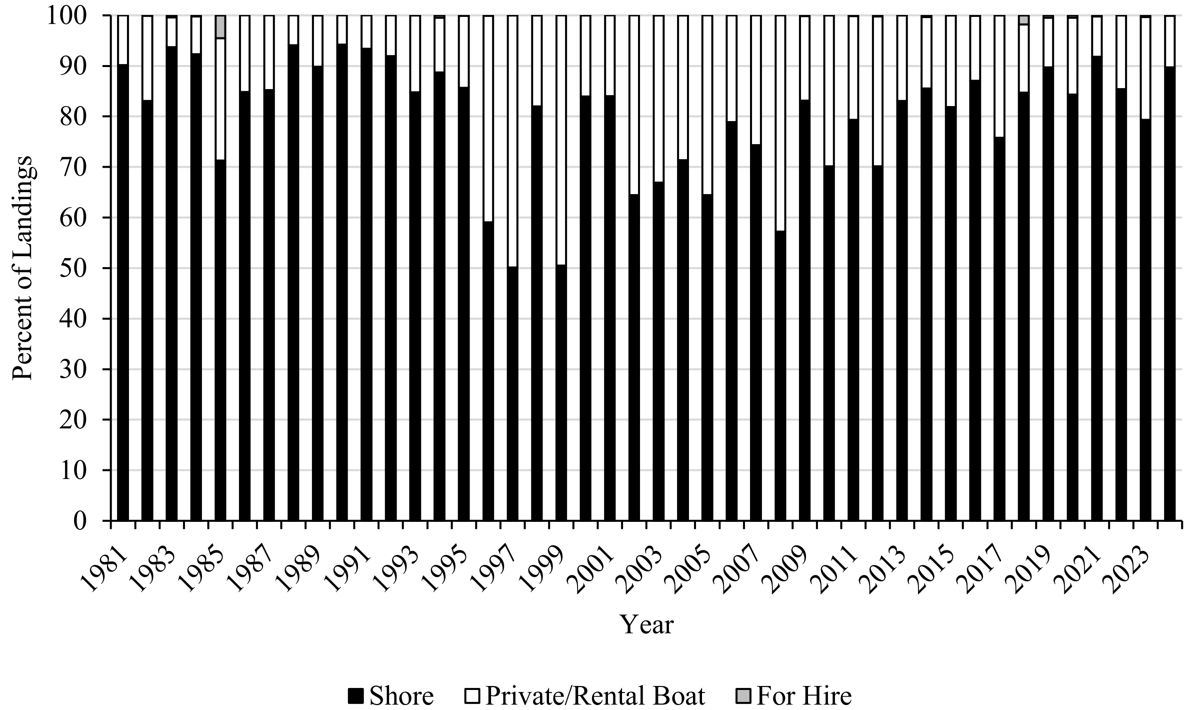

Figure 1. North Carolina Kingfishes stock complex recreational harvest by year and percent landings by fishing mode, 1981- 2024.

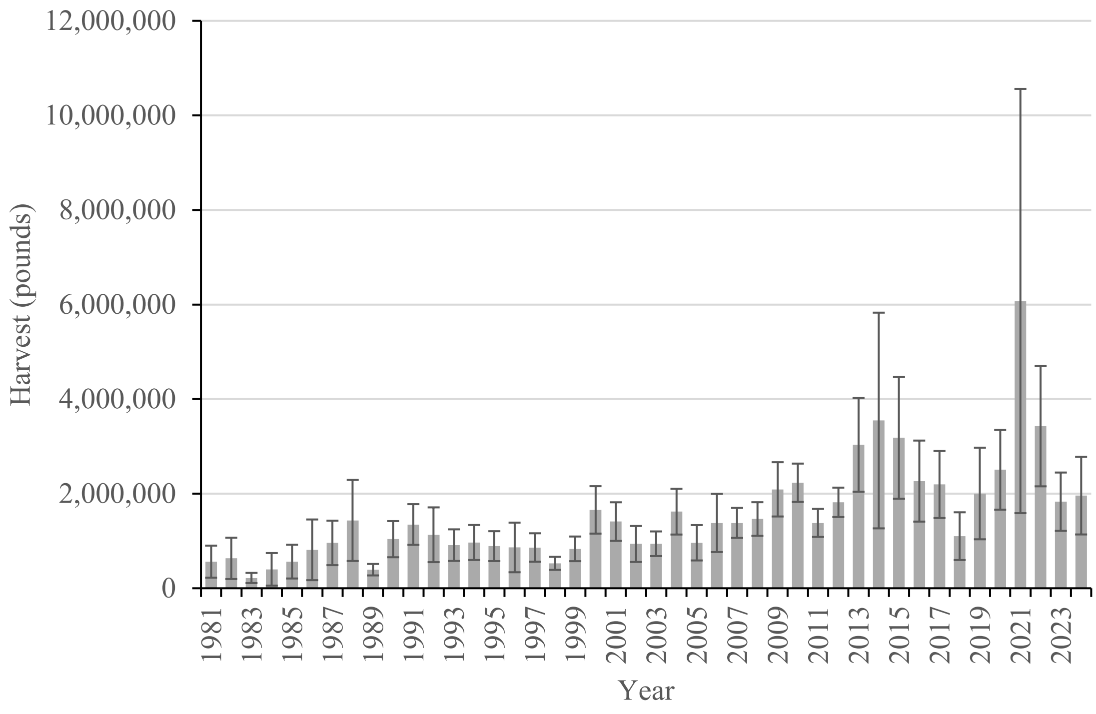

Figure 2. North Carolina Kingfishes stock complex total recreational harvest by year, 1981–2024. The lines through each bar indicate the 95% confidence interval for the harvest estimate.

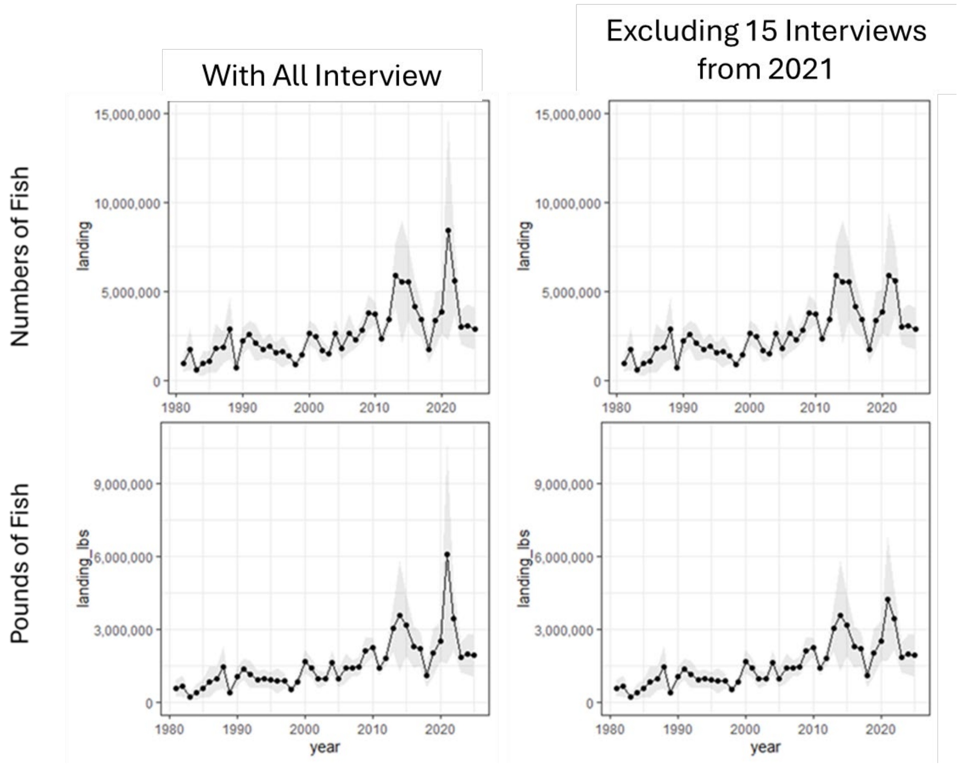

Figure 3. Marine Recreational Information Program estimates of numbers of fish and pounds of fish harvested showing data with and without the fifteen interviews with high Kingfish harvest from 2021. The shaded area represents the 95% confidence intervals around the value.

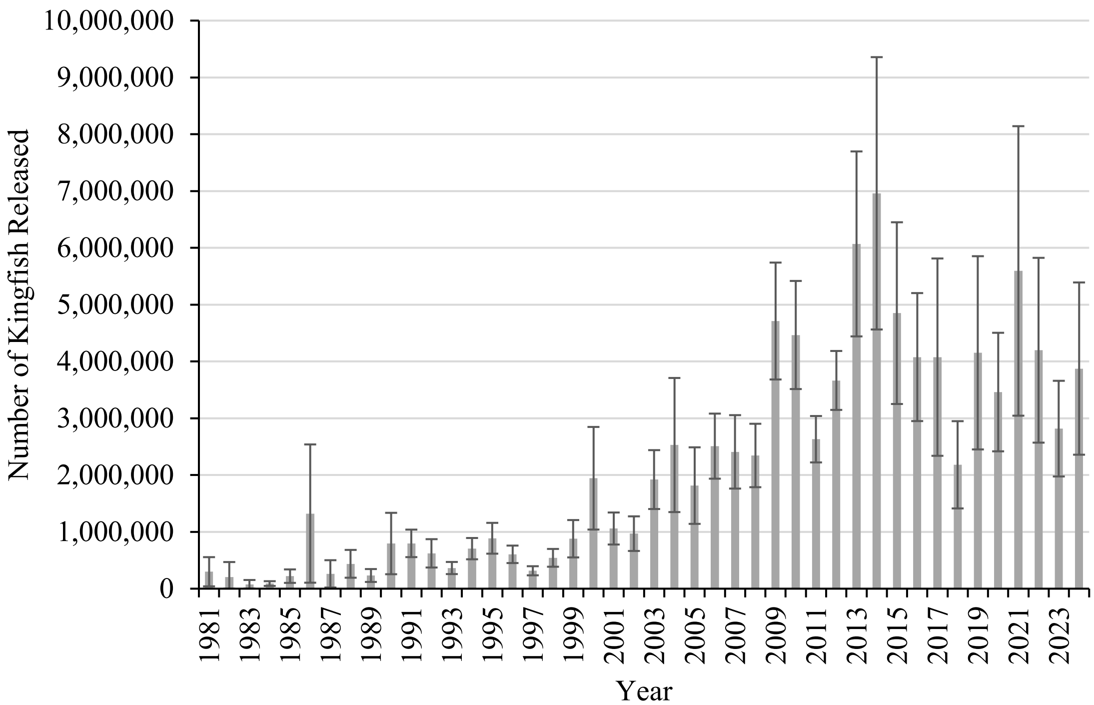

Figure 4. North Carolina Kingfishes stock complex total recreational discards by year, 1981-2024. The lines through each bar indicate the 95% confidence interval for the discard estimate.

Recreational length composition is consistent throughout the time series from 1994 through 2024 (Figure 5). Overall, the 50th and 75th quantiles are lower than the commercial fishery, and the 75th quantile in the recreational fishery is comparable to the 50th quantile in the commercial fishery (Figure 10). This means smaller fish are captured in the recreational fishery than in the commercial fishery. Recreational age composition shows an increasing trend throughout the time series from 1994 to 2024, indicating more older fish were sampled over time (Figure 6). Overall, the 50th and 75th quantiles for ages follow the same generally increasing trend as the commercial fishery (Figure 11).

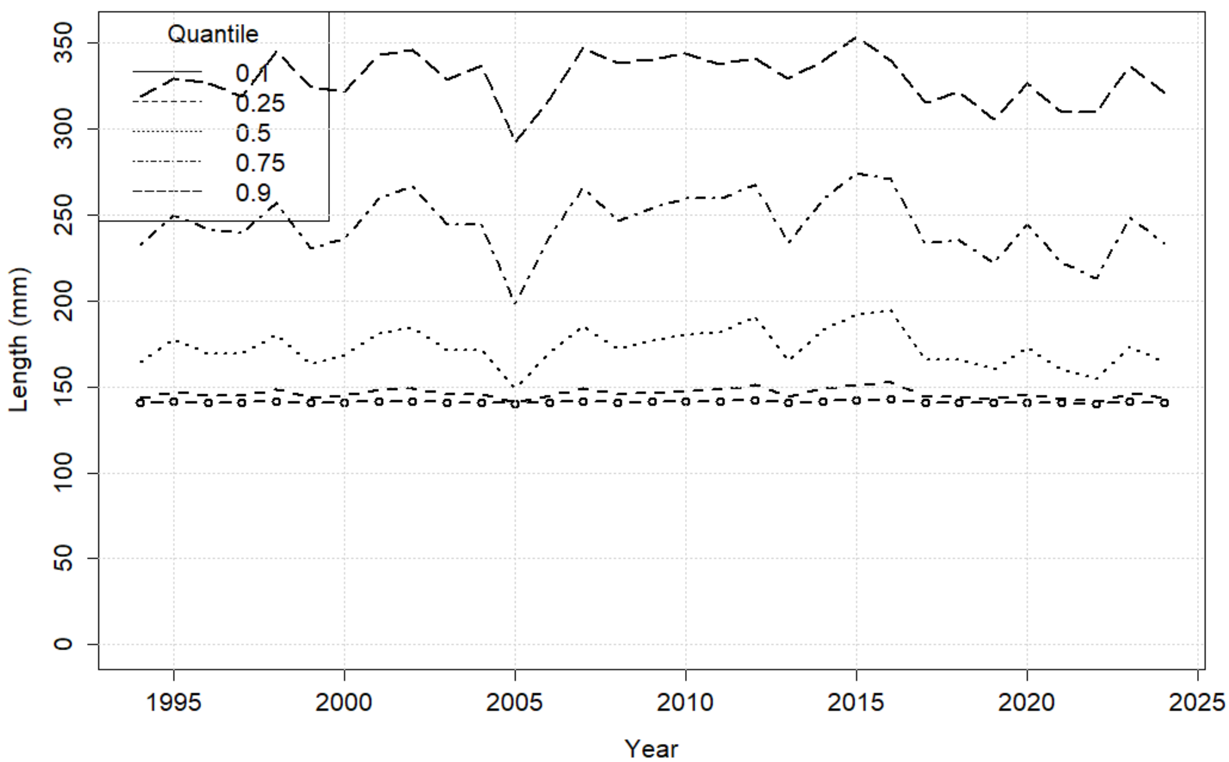

Figure 5. Recreational weighted length quantiles (mm) for the Kingfishes stock complex from the Marine Recreational Information Program, 1994–2024.

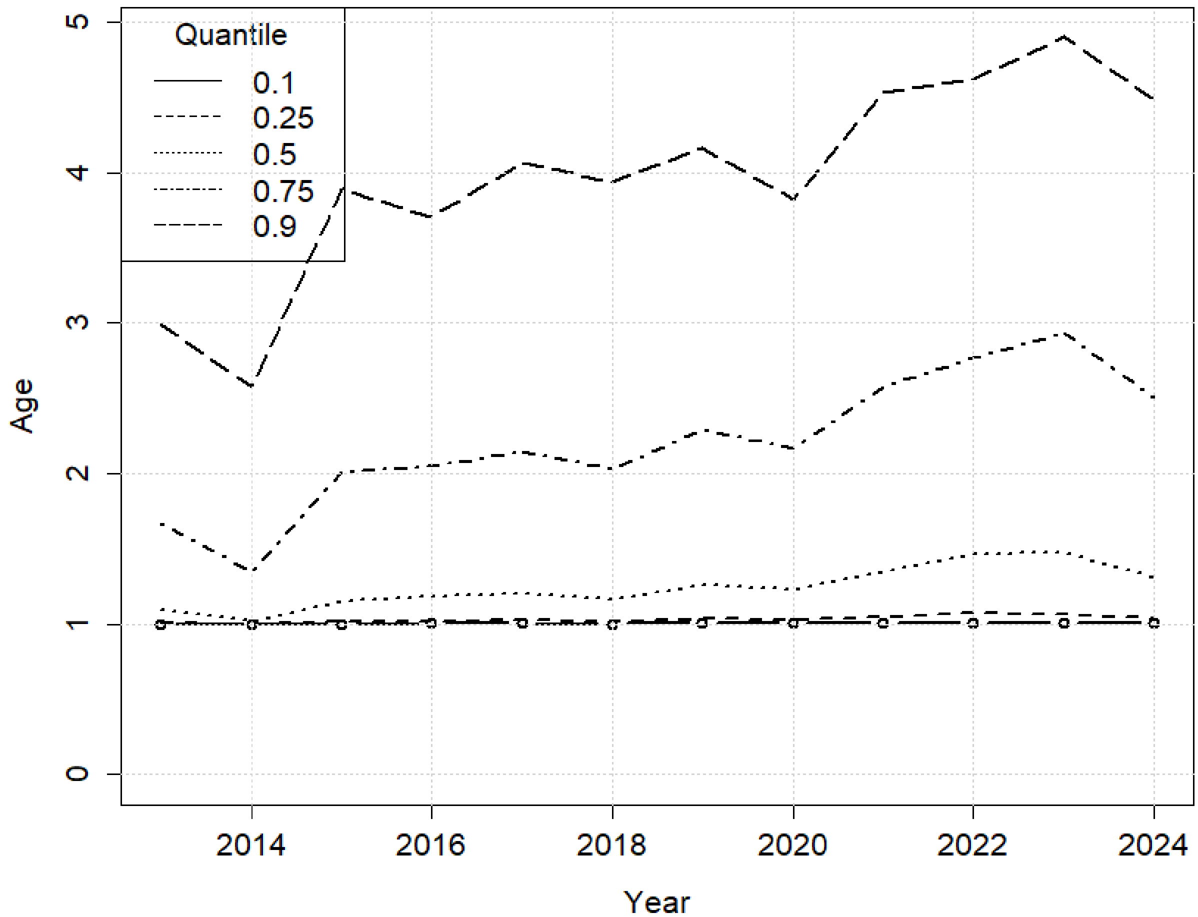

Figure 6. Quantile analysis for ages of the Kingfishes stock complex from the recreational hook-and-line fishery, 2013–2024 (ages from 2005–2012 currently unavailable).

Trends in recreational harvest were also examined by fishing mode (e.g., charter boat, head boat, private/rental boat, and shore; Figure 1). Of the charter boat interviews conducted through the Access Point Angler Intercept Survey (APAIS), only 0.3% have intercepted Kingfish, while 9% of interviews of shore-based fishermen intercept Kingfish.

Commercial Fishery

Commercial landings ranged from roughly 200,000 to 1.2 million pounds from 1981 through 2024 but recently have been around 600,000 to 800,000 pounds (Figure 7). This trend has occurred alongside long-term declines in both the number of commercial trips catching Kingfishes (Figure 8) and the number of commercial participants on those trips (Figure 9).

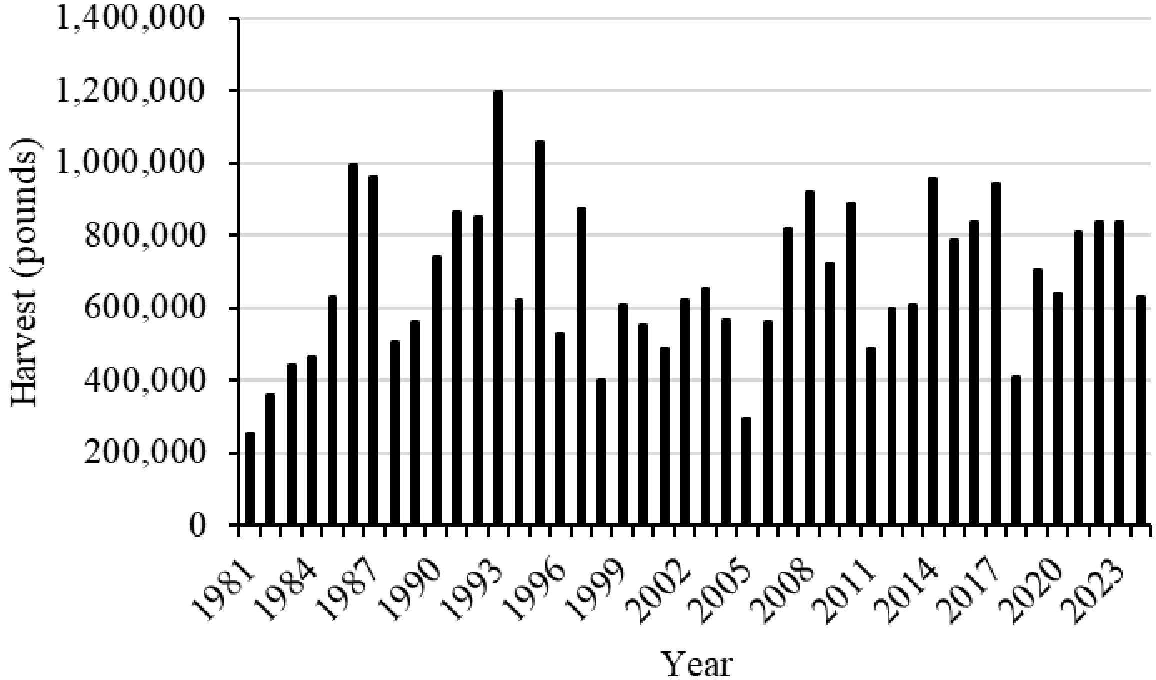

Figure 7. North Carolina commercial Kingfishes stock complex harvest (pounds) by year, 1981–2024.

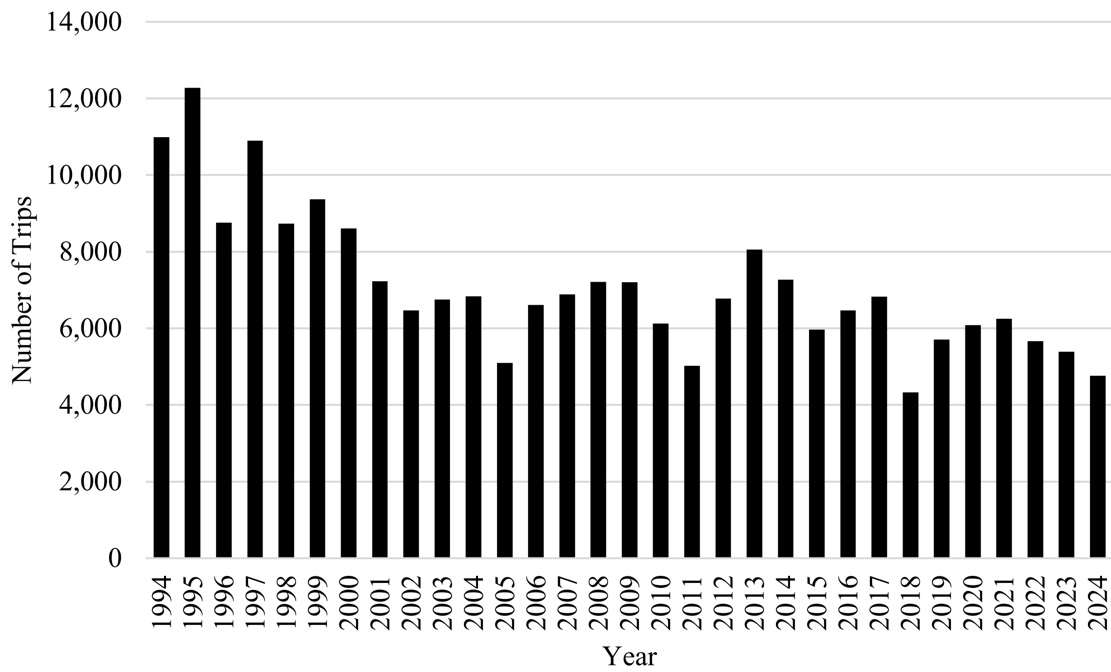

Figure 8. North Carolina commercial trips that caught Kingfishes by year, 1994-2024.

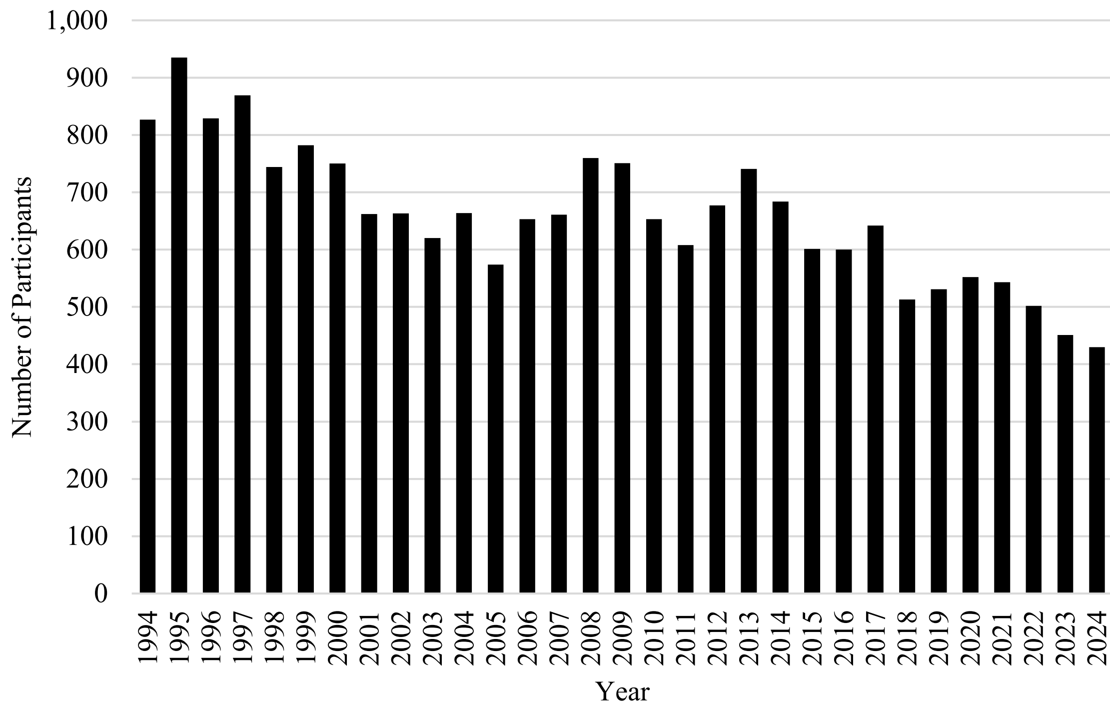

Figure 9. North Carolina commercial participants that caught Kingfishes by year, 1994-2024.

Most commercial landings occur south of Cape Hatteras in near-shore (less than three miles) ocean waters. Kingfish are predominantly landed in the spring and fall corresponding with seasonal inshore and offshore movement.

Commercial length composition is stable overall with recent quantiles comparable to the earlier part of the time series (Figure 10). Commercial catch from the early 2000s to 2015 was characterized by consistently larger Kingfish across all length quantiles. Age quantiles were stable from 2014 to 2020 and began increasing in 2020 (Figure 11) while length composition remained stable. This indicates Kingfish of similar sizes are older in recent years. Although age quantiles declined in 2015 and 2020, these short-term decreases are likely the result of limited sample sizes and do not appear to represent a meaningful change in the population.

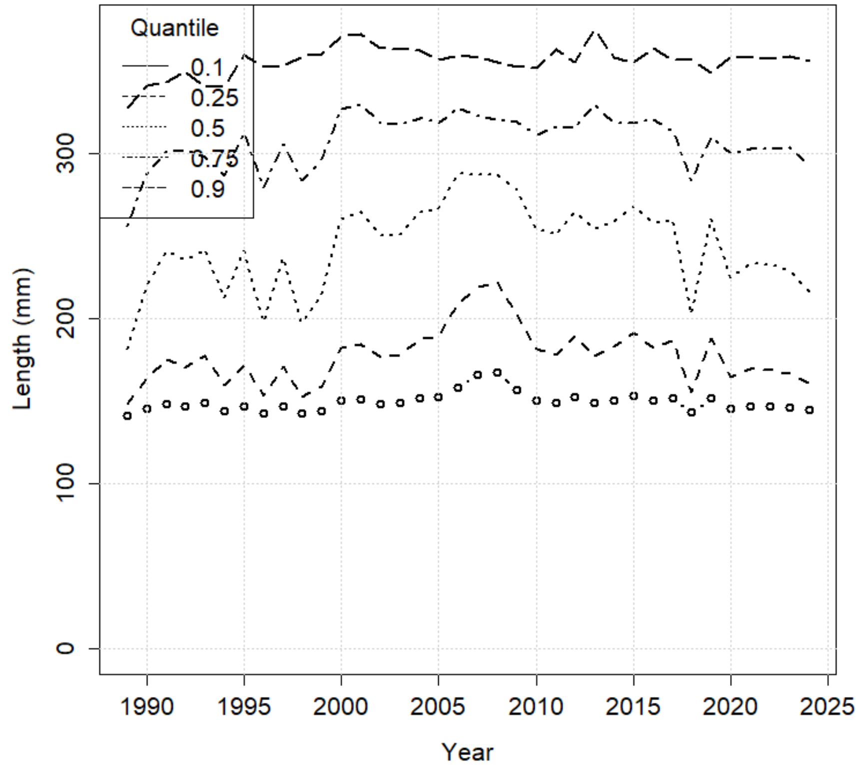

Figure 10. Commercial weighted length (mm) quantiles for the Kingfishes stock complex from commercial fish house sampling programs, 1989–2024.

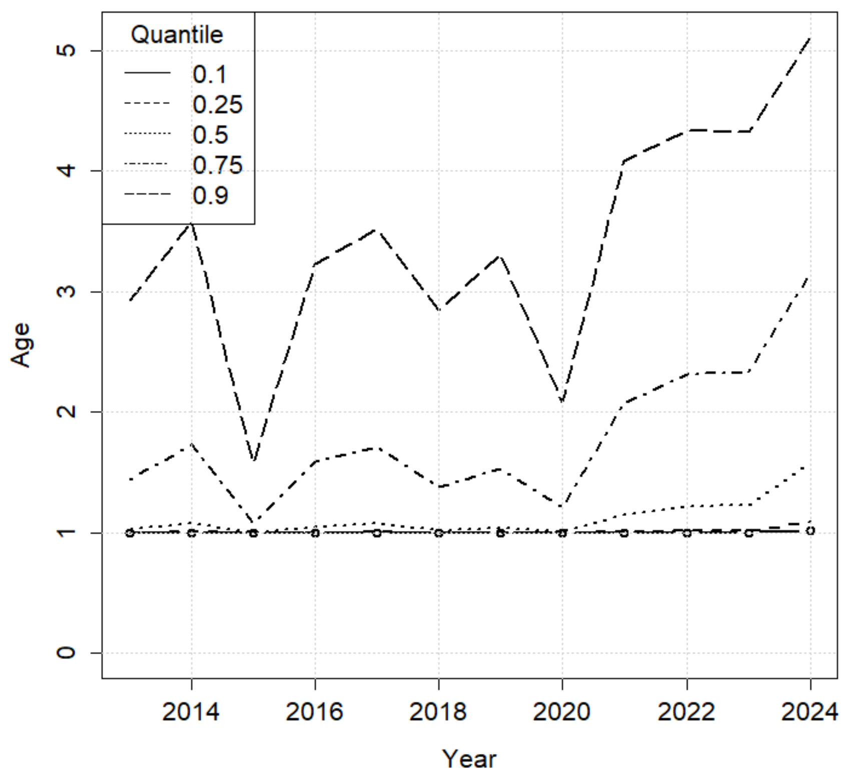

Figure 11. Quantile analysis for the Kingfishes stock complex ages from the commercial fishery, 2013–2024 (ages from 2005–2012 currently unavailable).

Pamlico Sound Survey (P195)

For the index fit, the best model used year as a fixed effect and used spatial random effects. The spatiotemporal random effects implicitly model environmental covariates, which themselves are correlated across space and time. Spatially, Pamlico Sound drove most of the Kingfish catch while the Neuse, Pamlico, and Pungo rivers had minimal catch (Figure 12). From 1987 to 2005, the index of relative abundance showed a slight increase, then a large jump in 2006 followed by a slight decline from 2006 to 2024 (Figure 13). The index in 2024 is comparable to peaks in the index in the 1987–2005 temporal window.

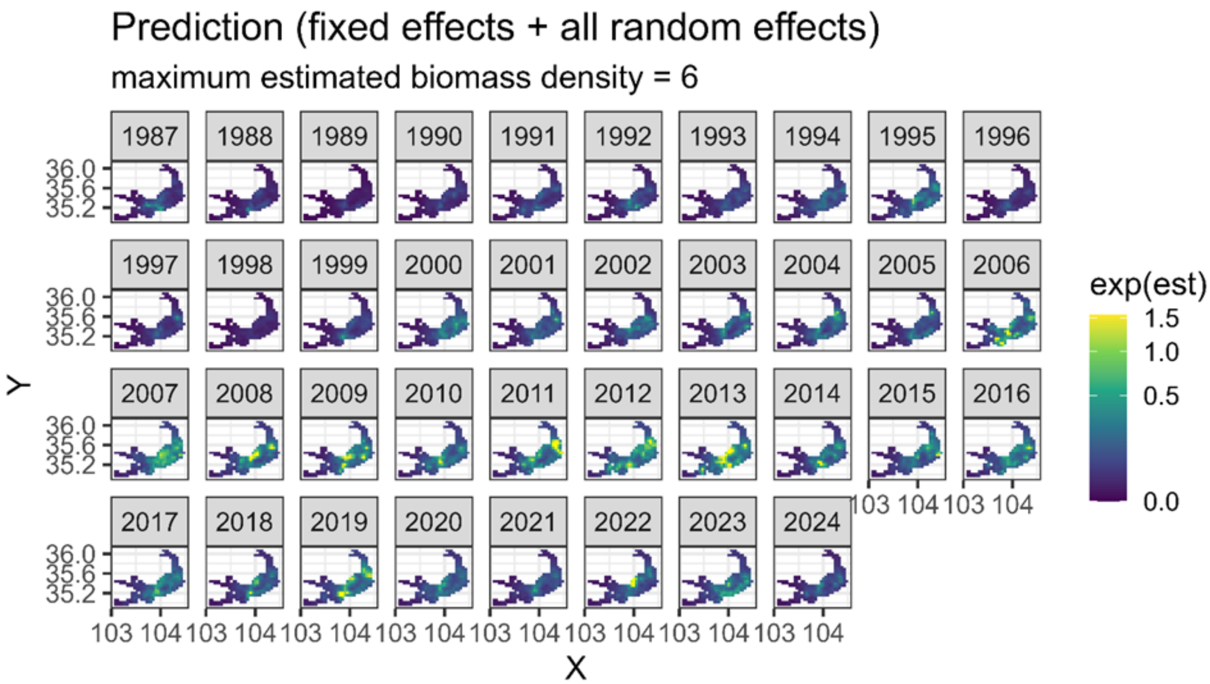

Figure 12. Map of the annual spatial variation of estimated relative density in numbers per minute for Pamlico Sound for the P195 index model, 1987–2024.

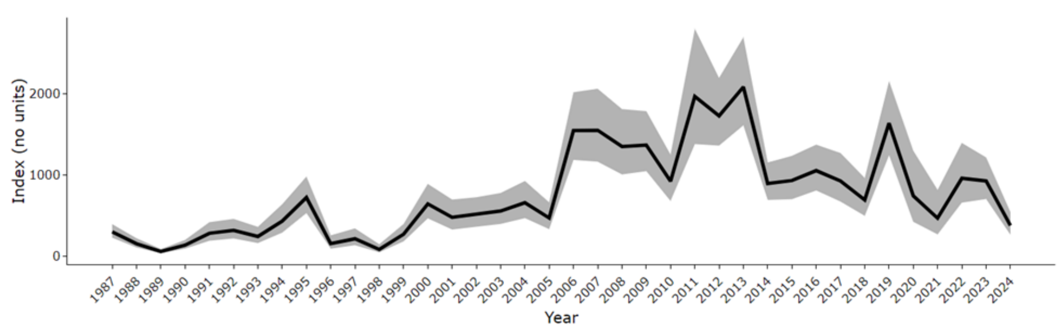

Figure 13. Index of Kingfishes stock complex relative abundance in Pamlico Sound from P195, 1987–2024. The shaded area represents the 95% confidence interval around the value.

From 1987 to 2002, the quantiles for Kingfish length composition declined steadily despite a slight increase in the index of abundance through that time (Figure 14). Therefore, while abundance was increasing, the catch consisted of smaller individuals. Length composition quantiles for Kingfish then increased and expanded from the early 2000s through 2020. The expansion in length composition matches the heightened level of the index through that same temporal window. The slight dip in the index from 2020 to 2024 coincides with a level period in the terminal years of the length composition data. Thus, while overall abundance was decreasing the size structure was not impacted. The weighted age quantiles follow a similar pattern to the length quantiles, though ages are only available from 2013 to 2024 (Figure 15).

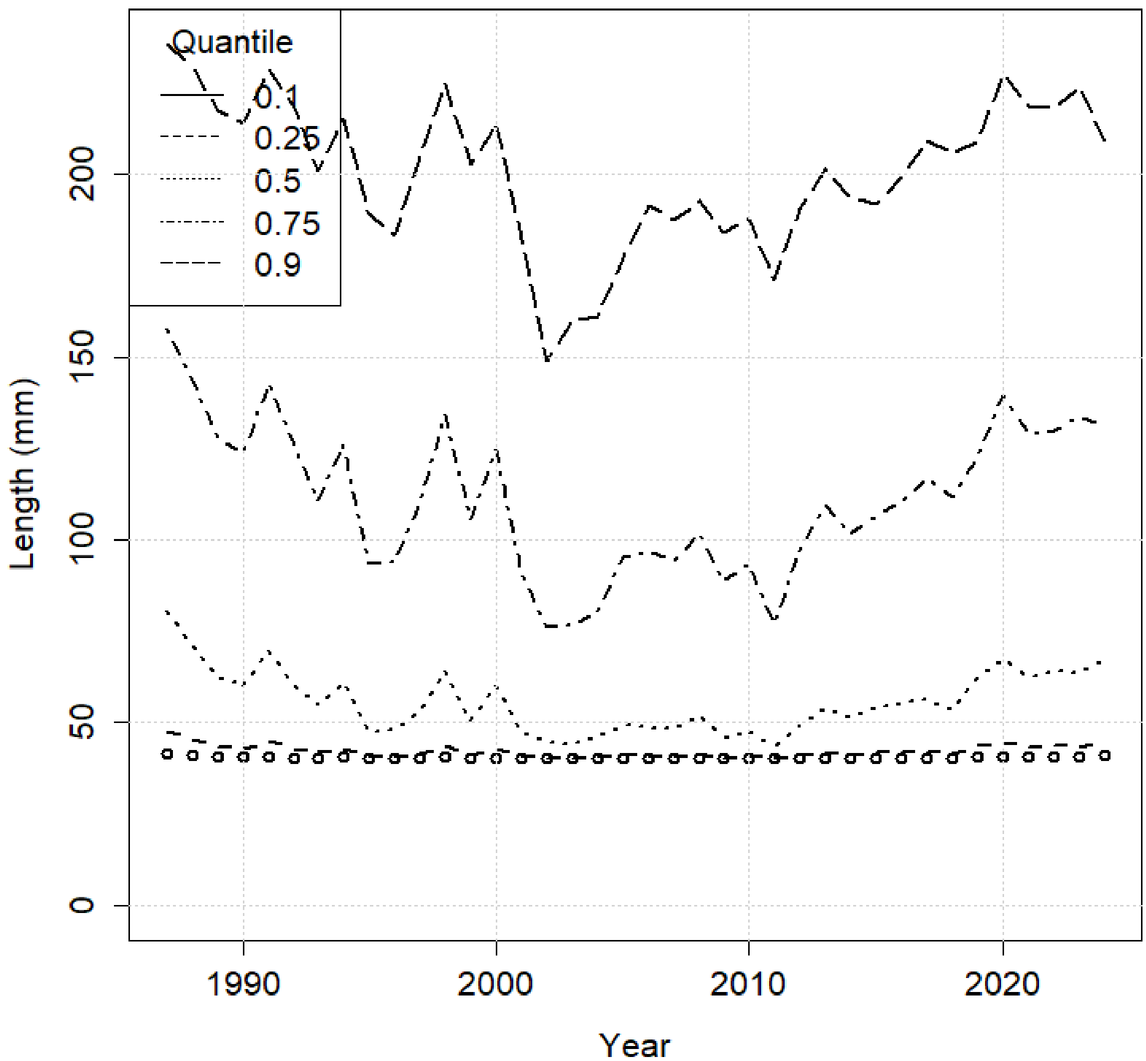

Figure 14. Weighted length (in mm) quantiles for the Kingfishes stock complex caught in P195 sampling, 1987–2024.

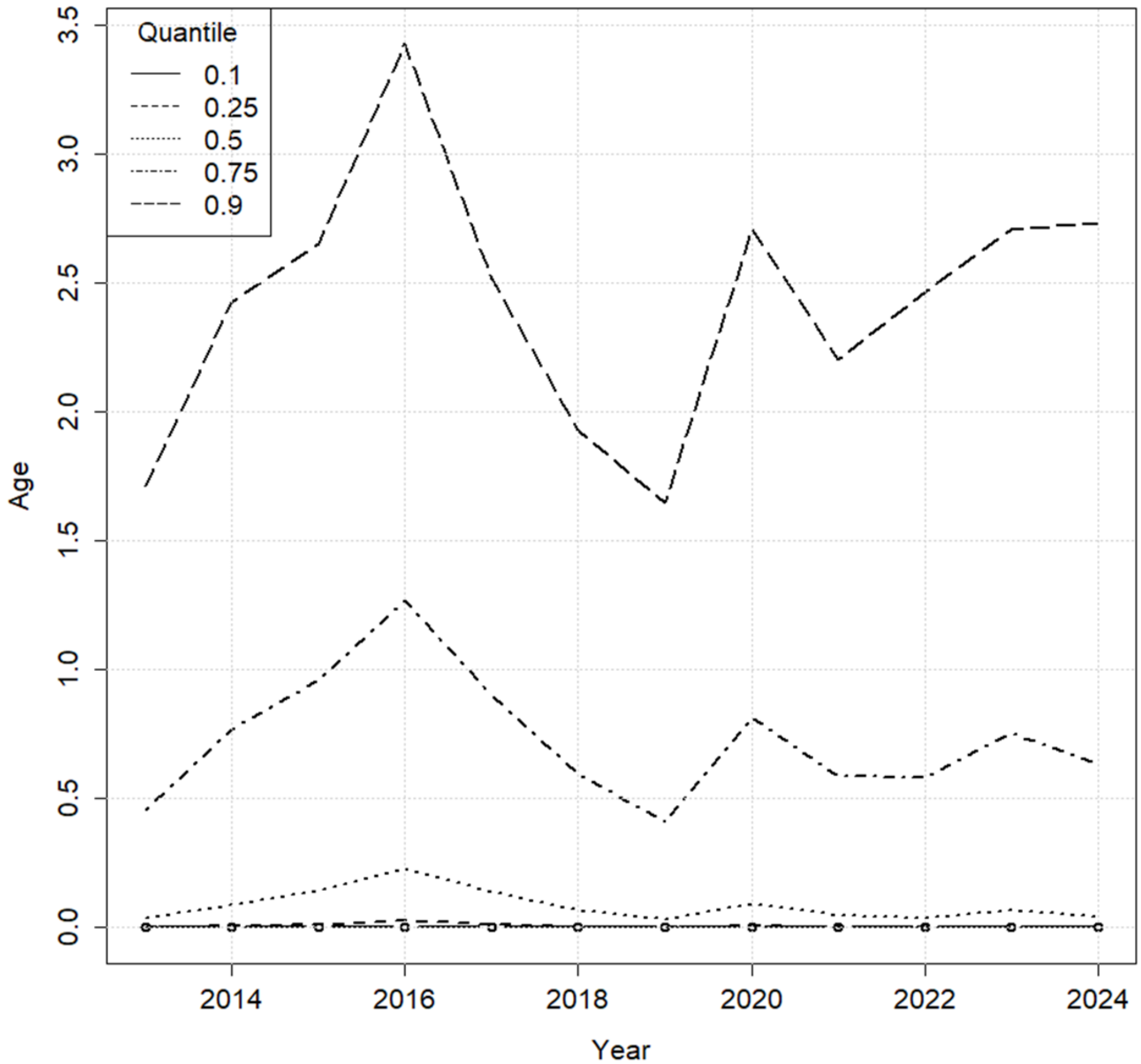

Figure 15. Quantile analysis for the Kingfishes stock complex ages caught in P195 sampling, 2013–2024 (ages from 2005–2012 currently unavailable).

NEAMAP/SEAMAP
The sampling conducted by NEAMAP and SEAMAP caught large numbers and large Kingfish that are similar in size to those caught in the commercial and recreational fisheries. NEAMAP/SEAMAP generally catches larger Kingfish than P195. The best fitting model used year and survey as fixed effects with the SEAMAP survey set as the reference level factor.

Geographically, areas of greater abundance for Kingfishes were concentrated between Hatteras Island and Bald Head Island (Figure 16). The combined index was relatively stable throughout the time series, with abundance peaks from 2003 to 2005, 2010, 2012, and 2015 to 2017 (Figure 17). The terminal year, 2024, was the lowest estimated value of the index (but not significantly so, upper bound overlaps with lower bound in several other years). Given the size selection and spatial coverage of NEAMAP/SEAMAP vs. P195, it is reasonable to connect the pulses of abundance from P195 from 2011 to 2013 to the 2015 to 2017 spike in the combined index.

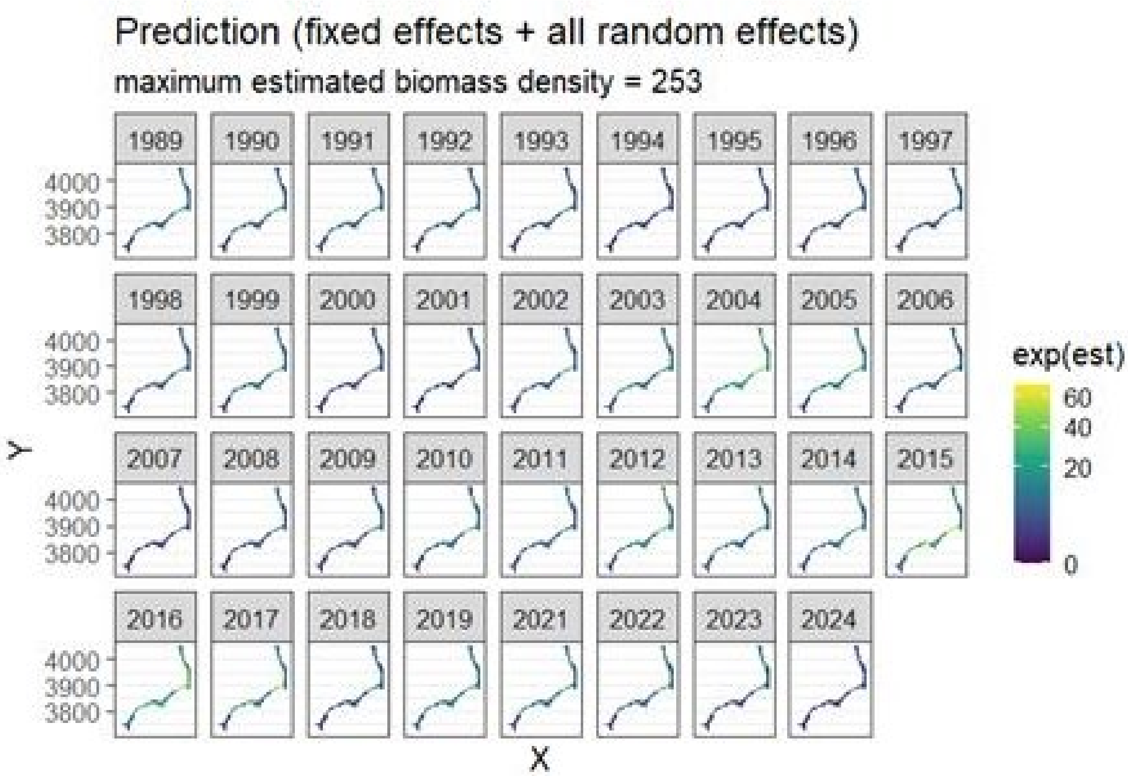

Figure 16. Map of the annual spatial variation of estimated relative density in numbers per hectare off the coast of North Carolina for the combined NEAMAP/SEAMAP index model, 1989–2024.

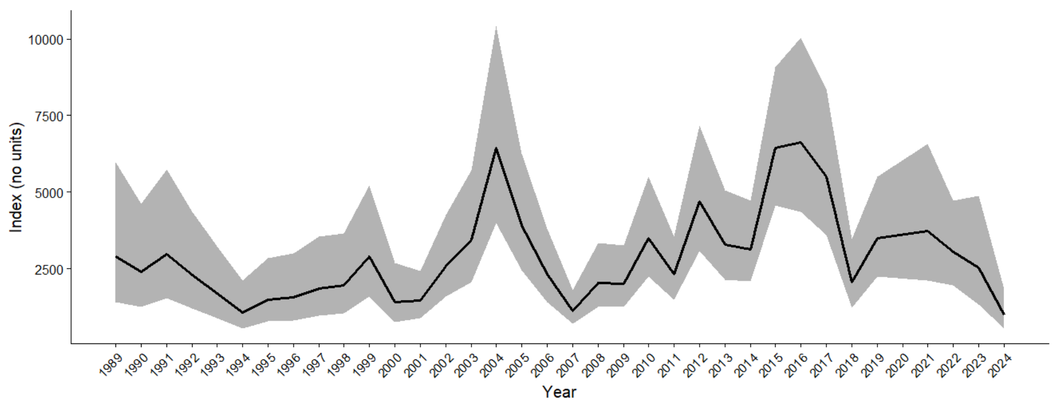

Figure 17. Index of relative abundance of the Kingfishes stock complex off the coast of North Carolina for the combined NEAMAP/SEAMAP index, 1989–2024. The dip in 2007 was likely caused by the addition of the NEAMAP survey which started that year. The shaded area represents the 95% confidence interval around the value.

Quantiles from the combined length composition data for NEAMAP and SEAMAP were stable through most of the time series (Figure 18). NEAMAP sampling started in 2007, driving the dip in observed quantiles. The 25th, 50th, and 75th quantiles generally increased from 2012 to 2020, and then dipped slightly from 2020 to 2024 but remain comparable to the early 1990s through early 2000s period. When these two data streams are combined, the weighting method emphasizes the most recent years of data, thus the effect of combining these two data streams creates the dip in 2007 and attempts to adjust earlier years in the time series using the most recent data.

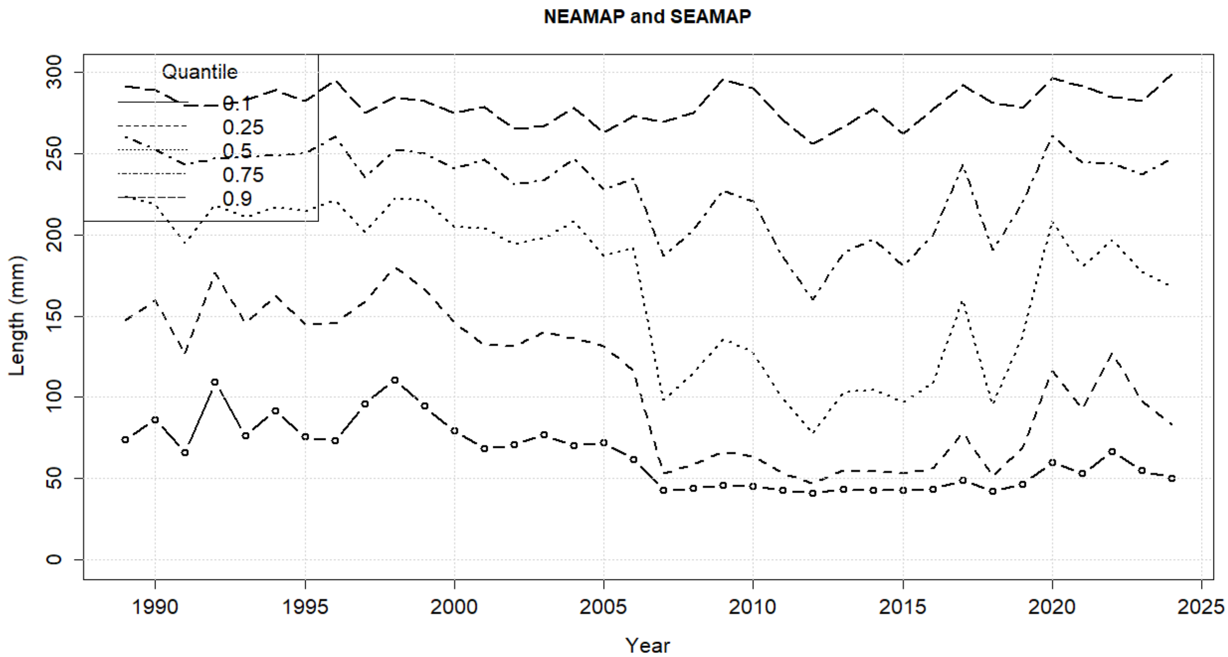

Figure 18. Weighted length (in mm) quantiles of the Kingfish stock complex caught in the NEAMAP/SEAMAP surveys, 1989–2024. NEAMAP sampling began in 2007, driving the dip in quantiles observed in that year.

Division Conclusions

The Kingfishes stock complex is unassessed; thus, overfishing and overfished status cannot be determined. A coast-wide stock assessment is a high research priority that needs to be addressed before biological reference points relative to overfished and overfishing can be determined.

Though stock status relative to overfished or overfishing reference points cannot be determined, available data can be used to inform relative status of the Kingfishes stock complex. While the data are limited, the information provided is informative. Based on the reviewed data, the Division concludes there is no immediate concern for the Kingfishes stock complex but recognizes the data limitations and acknowledges there could be concern in the future if fishing effort shifts occur, which may result in the need for management changes. Results of this data review will inform the ongoing review of the Kingfishes FMP. At a minimum the FMP review will update the trend analysis and management triggers with the best available data and techniques to better assess population trends.

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