# S82_WP_06: Evaluation and Limitations of MRIP Intercept Data for Developing a Gray Triggerfish Abundance Index

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## Introduction

The Marine Recreational Information Program (MRIP) dockside intercept program dataset was explored to develop recreational catch per unit effort (CPUE) as an index of abundance for gray triggerfish. Three methods of sub-setting were explored: Stephens and MacCall (2004), the Jaccard method and directed trips. The Stephens and MacCall method is an objective approach in which a logistic regression is used to estimate the probability that the target species could have been encountered given the presence or absence of other species reported from the trip. The Jaccard method was explored using the Jaccard package in R (Chung et al. 2018), a species guild approach, where "gray triggerfish trips" were identified on the basis of the presence of species that were caught most frequently with gray triggerfish.

Prior to moving forward with indices development, exploratory analysis and a literature review were conducted focusing on whether these data are appropriate to use for indices. Maunder et al (2006) states that despite being one of the most common pieces of information used in assessing the status of fish stocks, relative abundance indices based on catch per unit effort (cpue) data are notoriously problematic. An important and often overlooked assumption for CPUE data is that the proportionality between stock abundance and CPUE remains constant through time. This is rarely the case. Changing regulations, changing targeting, advances in fishing technology, and changing environmental conditions through time render this assumption invalid. In recent years fishery dependent indices have been increasingly scrutinized by reviewers which has led to a call for more detailed analysis to ensure these data are reflecting trends in abundance opposed to reflecting other changes that may be occurring in the fishery (regulations, fleet behavior, etc).

## Background

The limitations of developing an index of abundance from the MRIP data were documented in the review of these data in 2006 (National Research Council 2006). In 2017, an ad hoc NRC committee assessed the progress of MRIP and how the program addressed the recommendations from the 2006 review but this latest review did not reexamine the potential limitations of these data as a CPUE index that was previously addressed in the 2006 review (National Academies of Science, Engineering and Medicine 2017). Excerpts from the 2006 review of the MRFSS/MRIP program pertaining to CPUE indices are listed below:

- "Obtaining a measure of catch per unit effort (CPUE) that is a true measure of relative abundance is challenging since the measures for these different data sources are compiled with different purposes in mind." (page 84)
- "For these surveys, recreational CPUE typically is not associated with specific areas or even with specific target species; thus its applicability as a relative abundance measure is clouded by its design as a means to obtain total catch in the survey." (page 86)
- "Population assessment scientists must be aware of the presence of these three different types of effort in the database and understand how they relate to the problem of estimating relative abundance." (page 87)
    - Target effort- anglers identification of their primary or secondary target species
    - Catch effort- successful catch of the species
    - Directed effort - effort associated with all catch of a particular species whether targeted or not.
- "Stephens and MacCall (2004) describe a logistic regression approach based on multispecies presence-absence information that predicts the probability that the target species would be present based on other species caught, even if no catch of the target species was recorded. Methods that depend upon species-complex indices to determine targeted non-catch trips may be confounded by differential targeting of the fishery from year-to-year (or season-to-season) on more desirable species or by changes in the complex arising from different dynamics of the component species." (page 88)
- "Also, Jagielo et al. (2003) find that "recreational CPUE data sets are often problematic for use as unbiased indices of abundance because catch rates may be affected by (1) variable target species by boat, (2) undocumented search time, (3) unreported discards, (4) unknown spatial effort shifts, and (5) bag limit effects.". (page 167)

Effective Effort

The primary concern for using these data for abundance indices is identifying effective effort, defined as fishing effort that has a positive chance of catching the target species. The three types of effort captured in the survey (target, catch and directed) do not fully capture this particular metric in relation to indices of abundance. Being able to catch the target species on a given fishing trip depends on fishing in the right area, at the right time, and using a gear/fishing method that is appropriate for the target species. Immediately we run into problems with the multi-species snapper-grouper complex, where species have different geographic footprints that sometimes overlap and sometimes do not. Add on top of that some species show seasonal movements. Without detailed spatial information and amount of time spent using specific fishing gear/tactics, the hope for recovering effective effort based solely on species caught is nearly hopeless.

Using species alone as a discriminatory factor can run afowl quite quickly. One species that has the potential to render a species centric effort construct useless is Black Sea Bass. Black Sea Bass is one of the most common reef fish species caught by recreational anglers in the South Atlantic and along the whole U.S. East Coast. This is because Black Sea Bass are abundant and found in a wide range of habitats, including in estuaries, in some fairly deep waters, and as far north as the Gulf of Maine. They have the potential to be caught with nearly every member of the snapper-grouper complex with exception of some of the deepwater species. If a ubiquitous species like Black Sea Bass gets included in effort calculations with a more rare, geographically isolated species, then the associated effort for the rarer species has the potential to be grossly overestimated without careful control for other variables.

Fishermen are optimal foragers and have a keen ability to judge conditions on the water and make adjustments to maximize catch of all fish. Effective effort measures can be severely biased without knowledge of changing fishing tactics during the course of a fishing trip. The MRIP survey does not capture this type of information, rather just a total amount of hours devoted to the trip (and does not include a clear distinction between fishing time and transit time). For example, if a fishing trip includes Dolphinfish and Gray Triggerfish what is the proper assumption about fishing effort devoted to each species? It is almost impossible to catch these two species with the same fishing gear/tactics. But mixed species complex trips are common in the MRIP database.

## Methods

*Stephens and MacCall*

Effective effort is based on those trips from areas where Gray Triggerfish were available to be caught. Without fine-scale geographic information on fishing location, trips to be included in the analysis must be inferred. The method of Stephens and MacCall (2004) is one way to do this. This method uses multiple logistic regression to estimate a probability for each trip that the focal species was caught, given other species caught on that trip. The species associations are listed in Figure 1. The MRIP intercept data has an array of species reported and this list was narrowed down by filtering the data to only include waters 3 miles or greater offshore for the private and charter boat modes in the Southeast region (VA-FL). A large proportion of positive Gray Triggerfish trips were dropped resulting in very few trips remaining for indices development (Figure 2 - Figure 5). The negatively associated species were typically species encountered using  trolling techniques but also had a Gray Triggerfish encounter which implies that the angler changed fishing tactics within the trip to target pelagic species as well as bottom fished for Gray Triggerfish (split effort).  Split effort (either bottom fishing or trolling) is not clearly defined in the MRIP intercept data which proves problematic for this subsetting procedure.

*Directed trips and Jaccard*

Both the directed trips and the Jaccard  methods are biased by including trips that encountered Gray Triggerfish that may have been incidental or non-targeted due the the presence of pelagic species on the trip (split effort). In the working paper for SEDAR 32, it was recommended that caution be used when interpreting and using this subsetting procedure when developing an index of abundance.  The species associations and summary of trips are presented in Figures 6 and 7.

*Multidimensional scaling*

MRIP intercept data from 2021 including all catch and discards for the whole east coast were examined.  We used nonmetric multidimensional scaling (NMDS) with a binary (presence-absence) measure of distance to identify patterns with similarity in the species composition of catches.  Multidimensional scaling on presence-absence data by trip using the cluster package and pam() function in R with 10 clusters for color coding (Figure 8) indicates lots of overlap and poor isolation. If fishing trips were targeting specific species for the whole duration of the trip, then we would expect to see better isolation of species groups, reflecting fishing trip types. Evidence for this can be seen when noting the freshwater species group. This group shows isolation because a fishing trip into freshwater is geographically unique (e.g. same set of species in the same location) and not very likely to mix with many of the saltwater and offshore species. Compare this to offshore fishing habitats where in the same geographic location both pelagic and bottomfish could be caught by using very different fishing tactics and gear (e.g. different effort). In conclusion, species alone cannot be used to classify trip types for many offshore saltwater species.

*Spatial and Temporal patterns in sampling*

MRIP intercept data were examined by year and latitude to identify potential patterns in sampling intensity as well as positive intercepts for Gray Triggerfish (Figure 9-11).  What this shows is the relative percentage of intercepts for each year by latitude (e.g. if you summed down the year column it would add up to 1). This limits inferences about distribution shifts for species, but also suggests that not including latitude in a CPUE model would invalidate that analysis as well. Adding latitude to a CPUE standardization model might not be sufficient to 'eliminate' the temporal patterns being shown here.

## Discussion

A cautionary approach should be taken when developing a fishery dependent index for use in the stock assessment process. In times of increased regulations, a reasonable assumption is that fishery dependent indices may no longer be tracking abundance due to effects of increased management regulations on the fishery (i.e. shifts in behavior, targeted, avoidance, hyperstability, hyperdepletion, etc.). The burden of proof should be providing evidence that these fishery dependent indices are reflecting trends in abundance (i.e., compared to fishery independent indices from surveys designed specifically for abundance tracking).

In previous SEDARs the burden of proof has been to provide an index of abundance for the stock assessment and document any potential issues that may prove problematic for the assessment. With increased management actions and other shifts in how the fisheries are executed the utility of fishery dependent indices in stock assessments should be thoroughly evaluated during periods of increased management actions. A discussion is warranted to shift the burden of proof regarding these fishery dependent indices in an attempt to limit the use of these indices that may be decoupled from stock abundance.

Recommendation

Due to the evidence identified (difficulty identifying effective effort, split effort on a trip, shifts in sampling intensity, desirability), the recommendation for the SEDAR 82 DW is to not pursue the development of a gray triggerfish index of abundance from the MRIP intercept data.

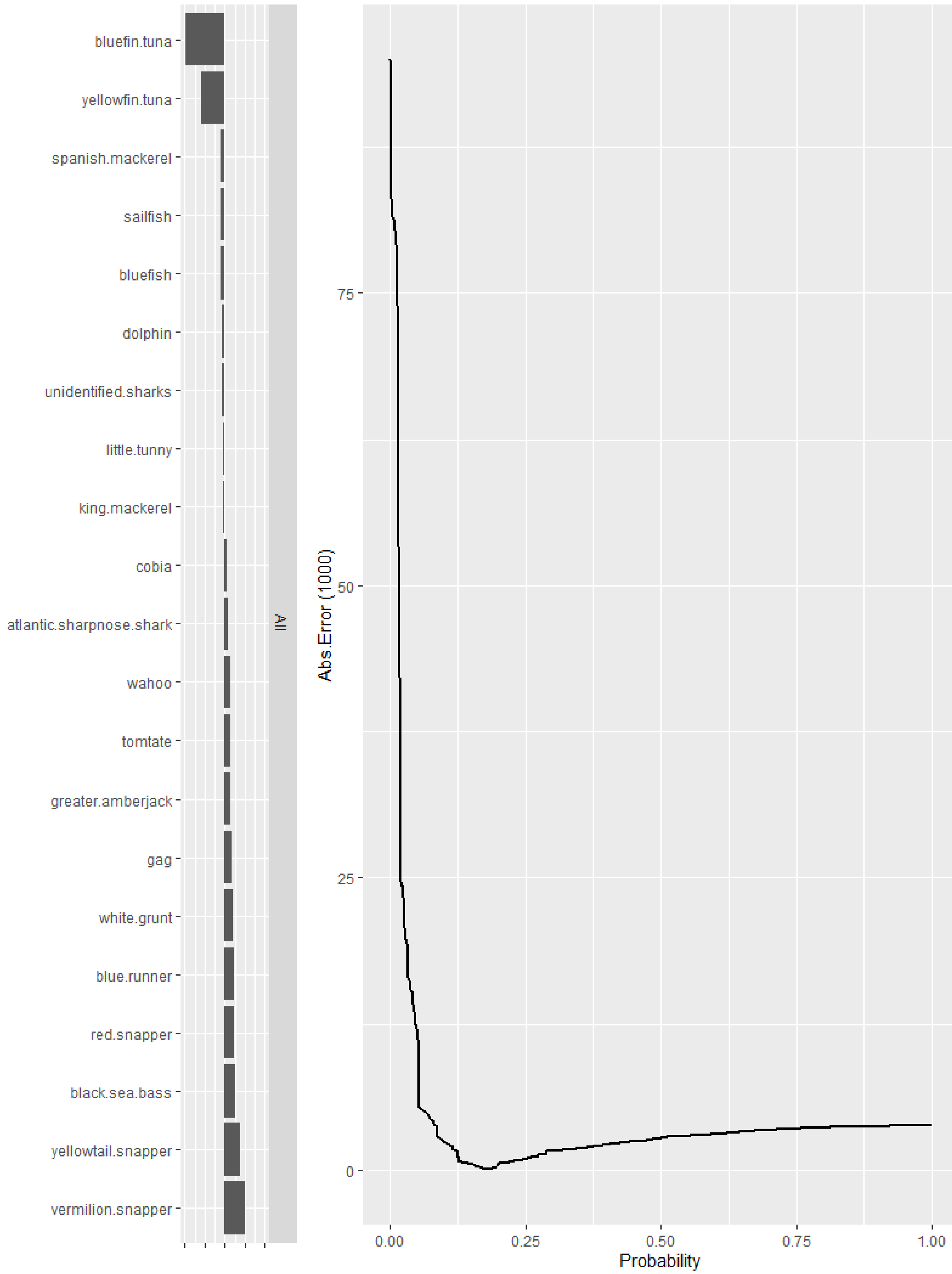


Figure 1. Positive (bottom species in left panel) and negative (top species in left panel) species associated with Gray Triggerfish from the MRIP intercept data in the Southeast region.

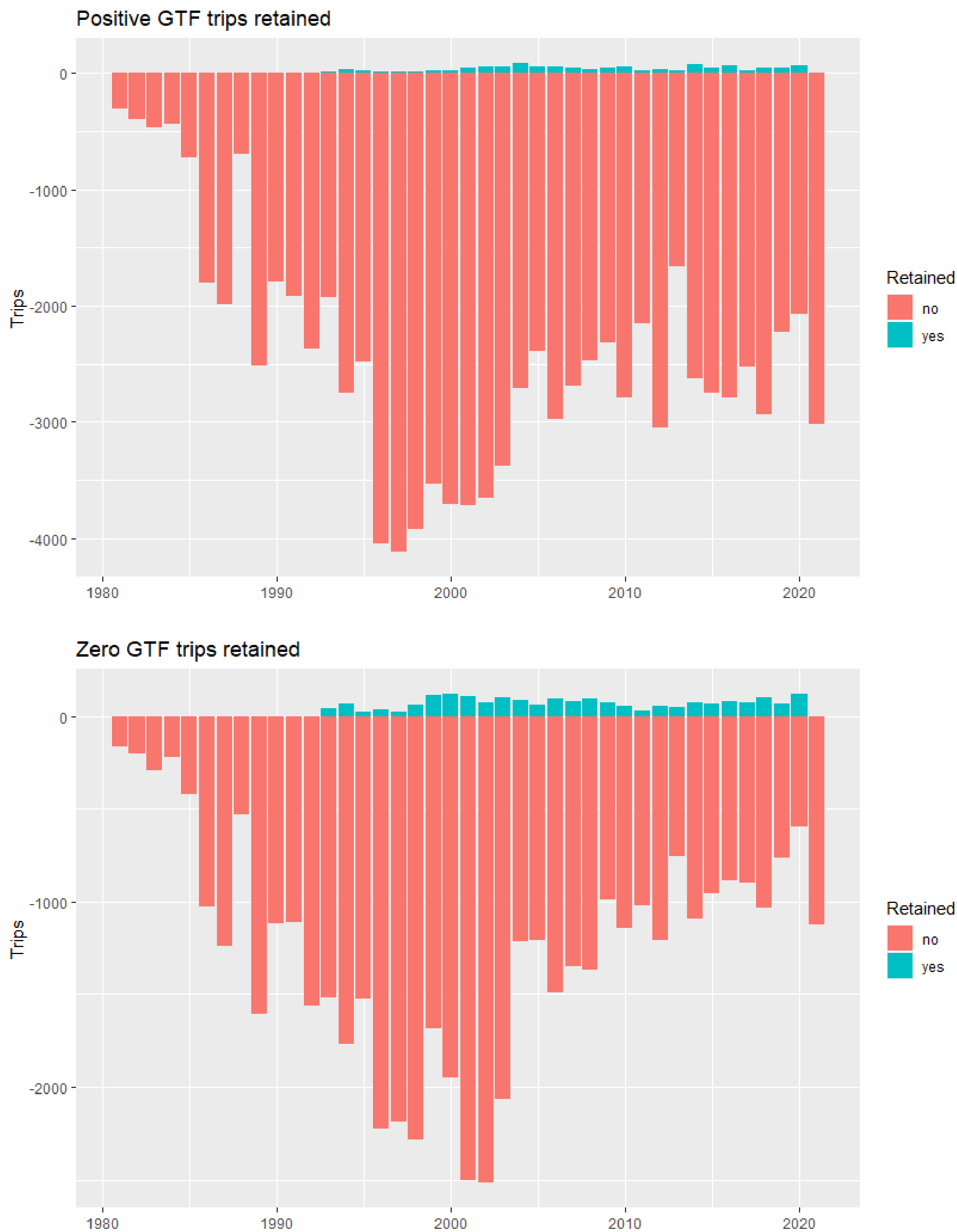


Figure 2. Number of positive and zero trips retained and dropped following the Stephens and MacCall subsetting method.

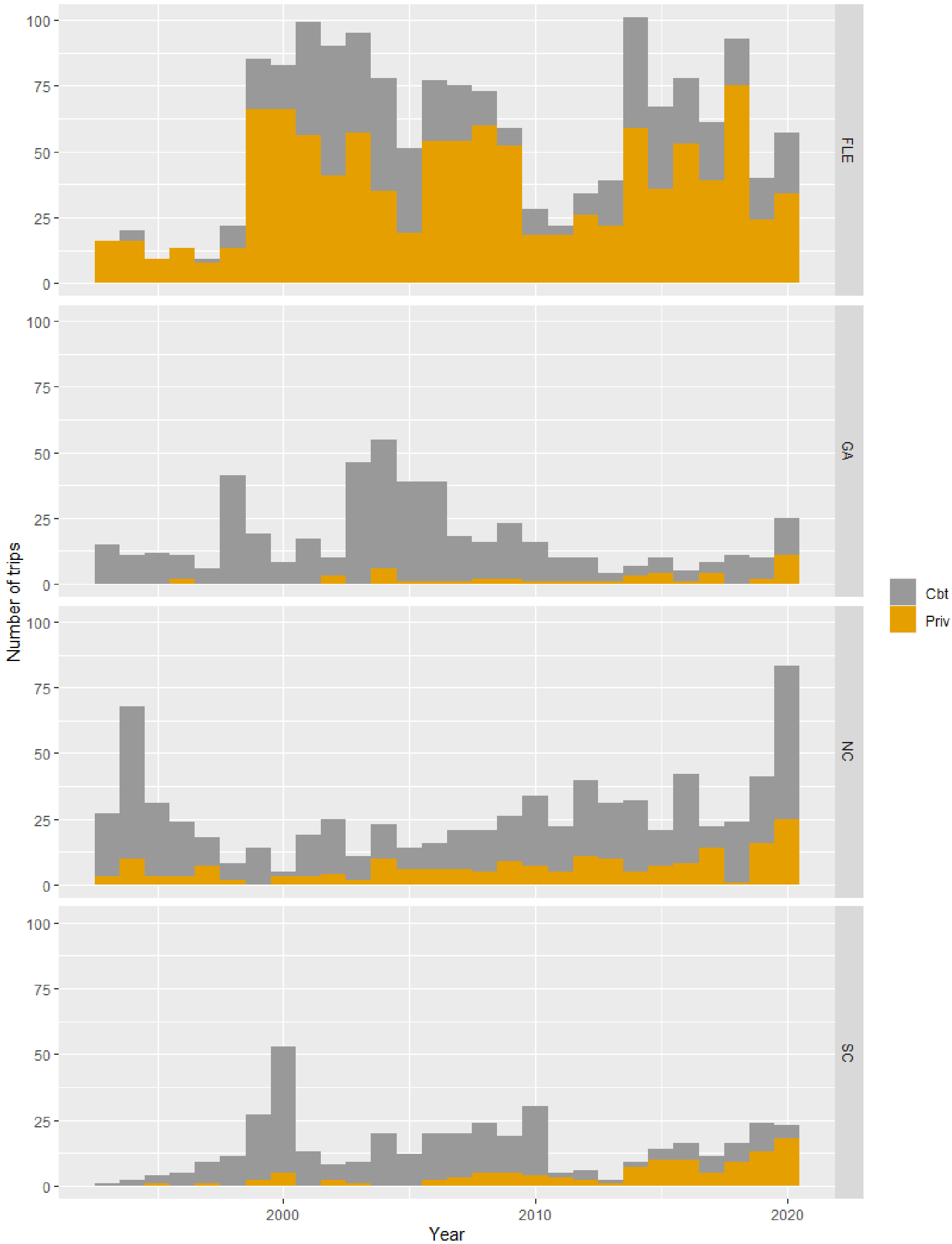


Figure 3. Summary of total Gray Triggerfish trips (positive and zero trips) remaining by state and mode following the Stephens and MacCall subsetting method.

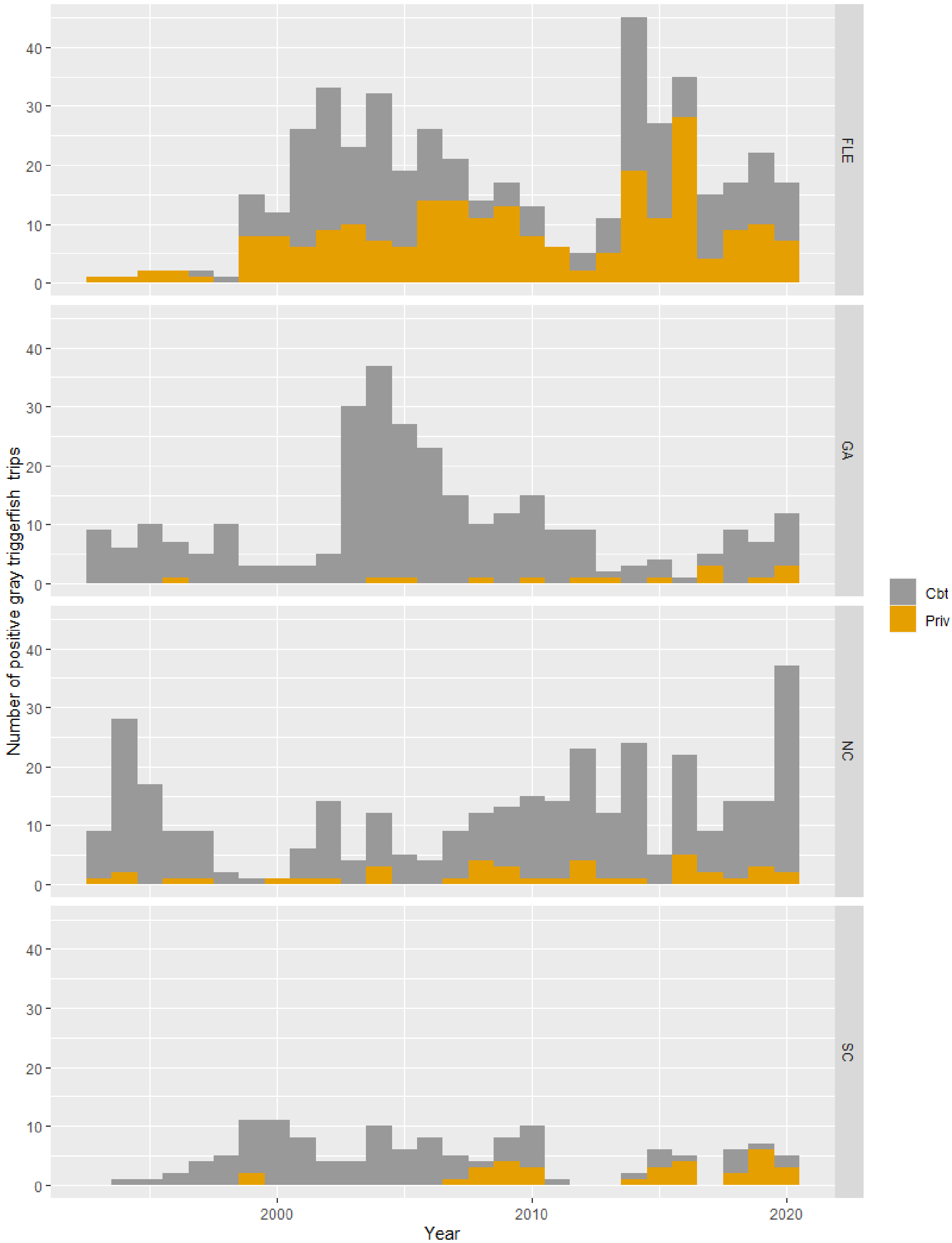


Figure 4. Summary of positive Gray Triggerfish trips remaining by state and mode following the Stephens and MacCall subsetting method.

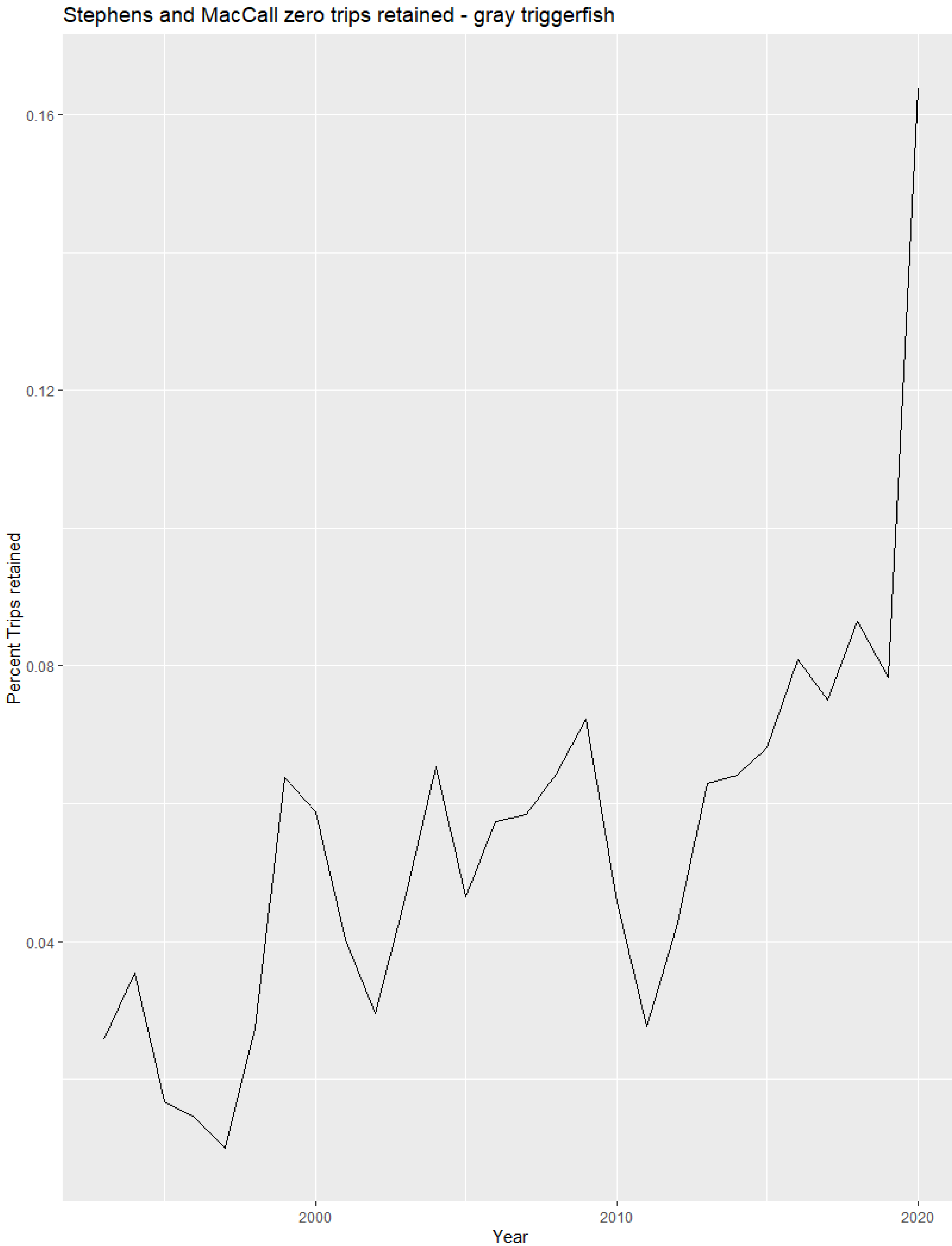


Figure 5. Proportion of zero trips retained by year for Gray Triggerfish using the Stephens and MacCall subsetting method.

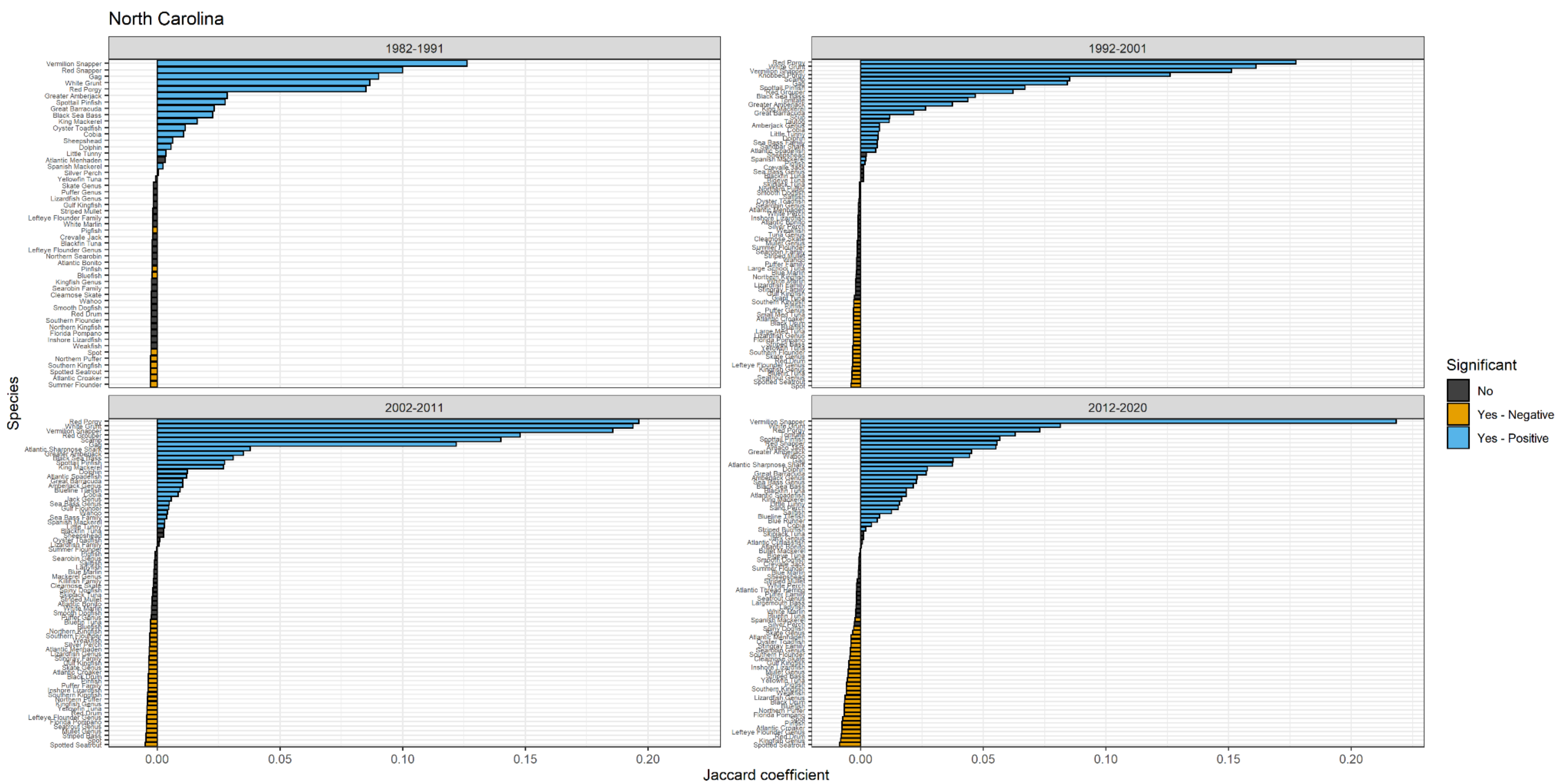


Figure 6. Species associations from the jaccard subsetting method. Example for North Carolina illustrates the large number of positively associated species that are contributing to ‘zero’ trips in the jaccard method.

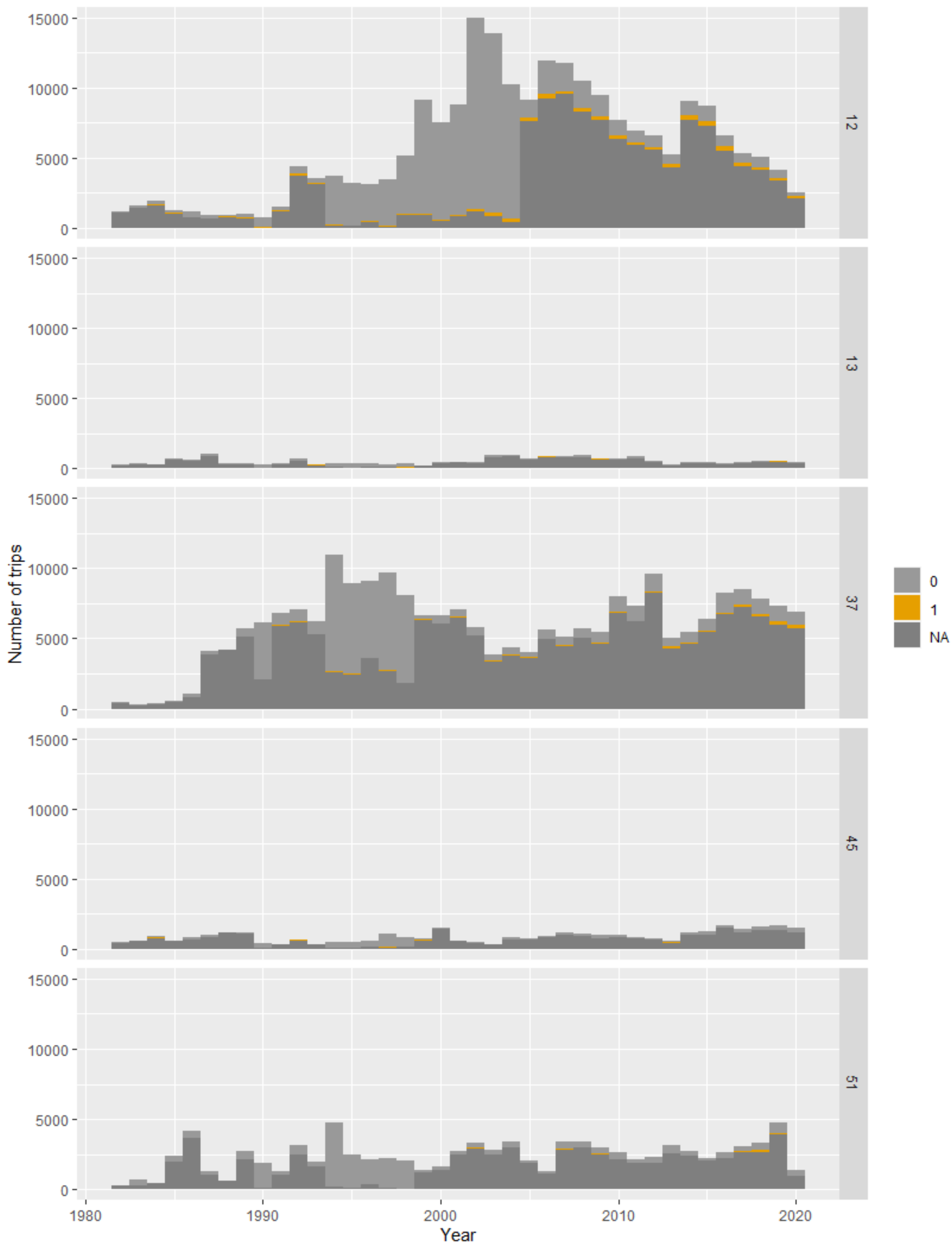


Figure 7. Summary of trips from the jaccard subsetting method.

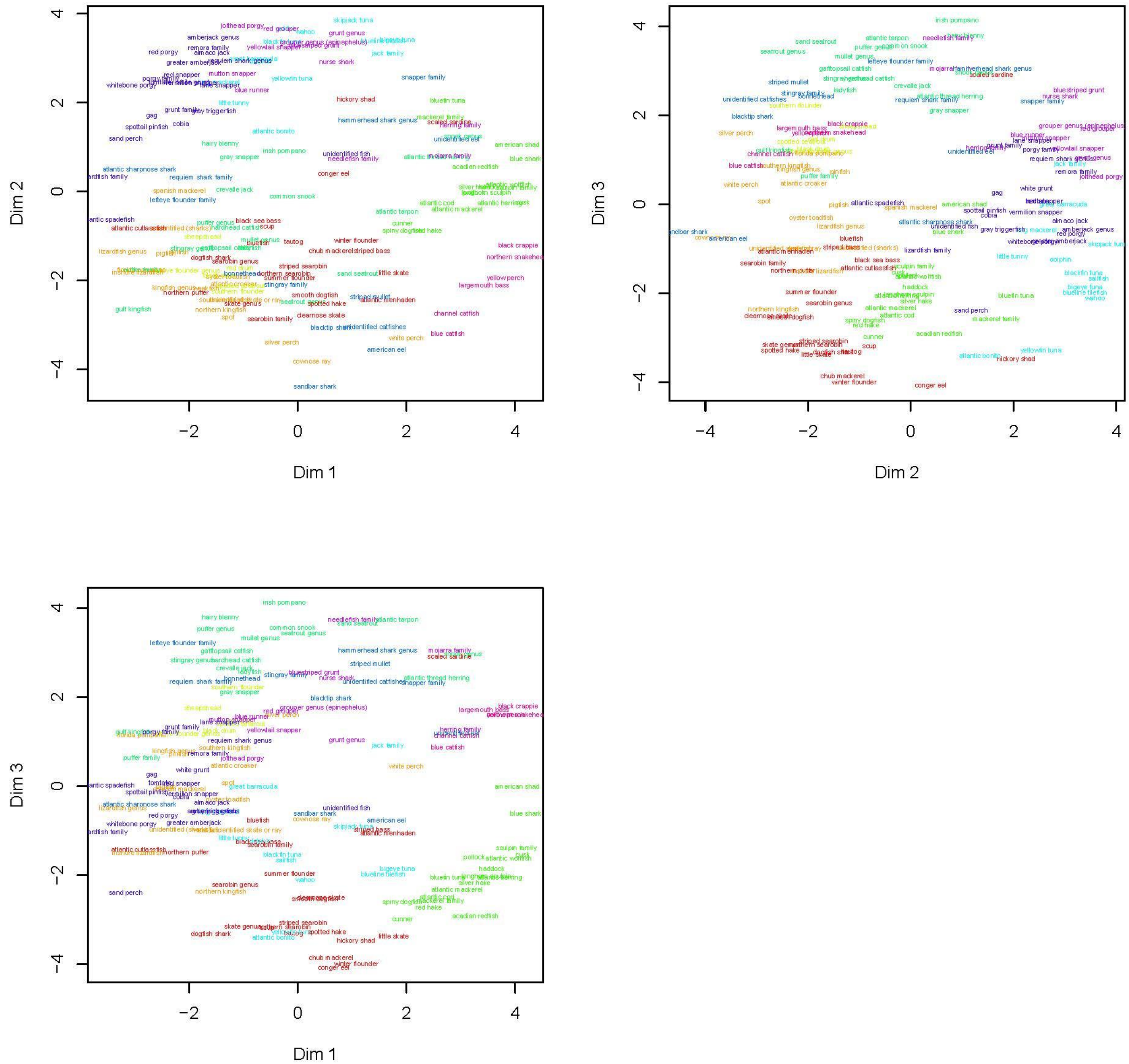


Figure 8. Multidimensional scaling on MRIP presence-absence data from 2021 by trip using pam() function with 10 clusters for color coding.

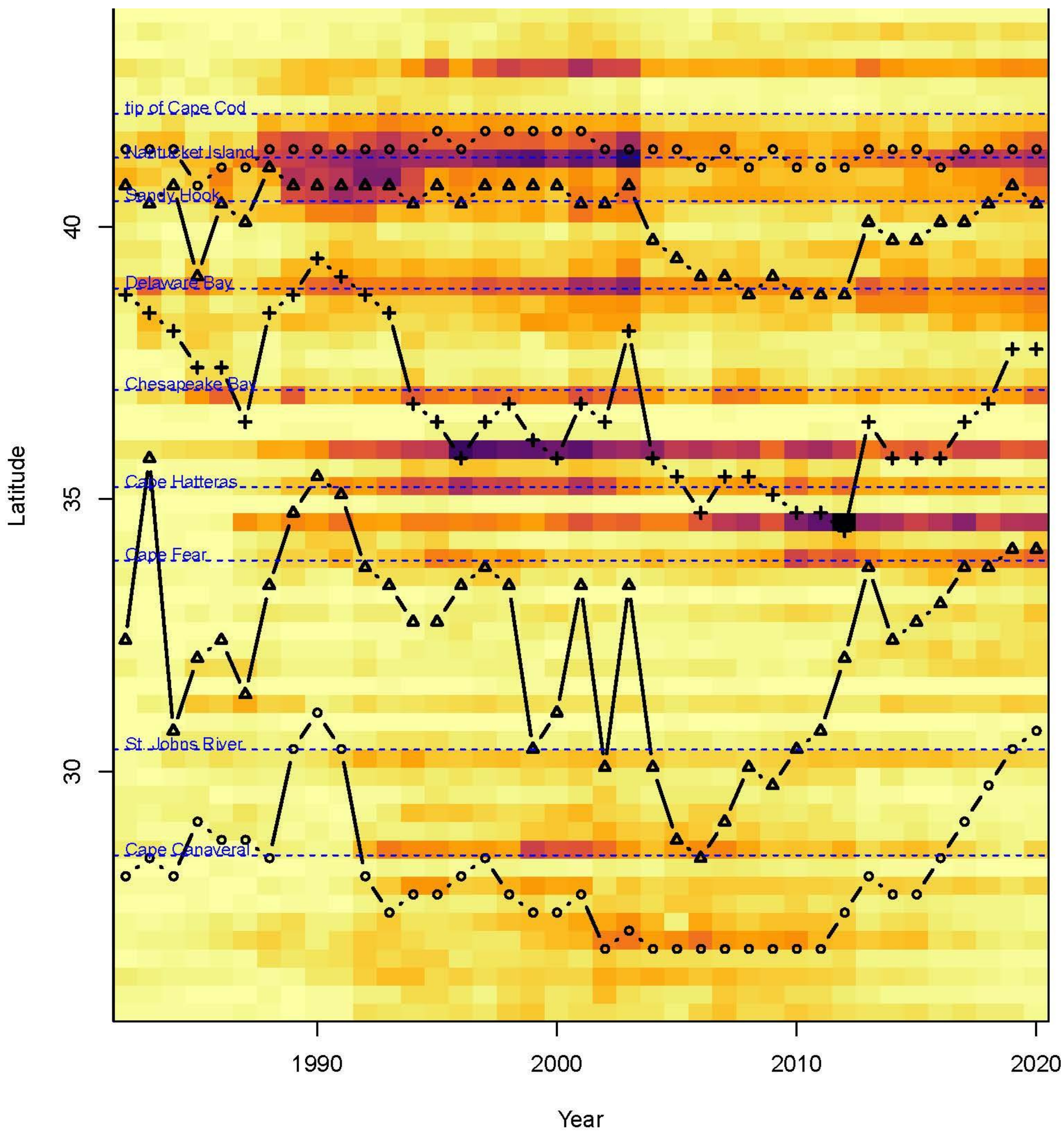


Figure 9. Heat map illustrating areas of MRIP intercept sampling by year and latitude (yellow colors indicate relatively low sampling intensity while the oranges and darker reds indicate relatively high sampling intensity while lines indicate 10th, 25th, 50th, 75th and 90th percentiles from bottom to top).

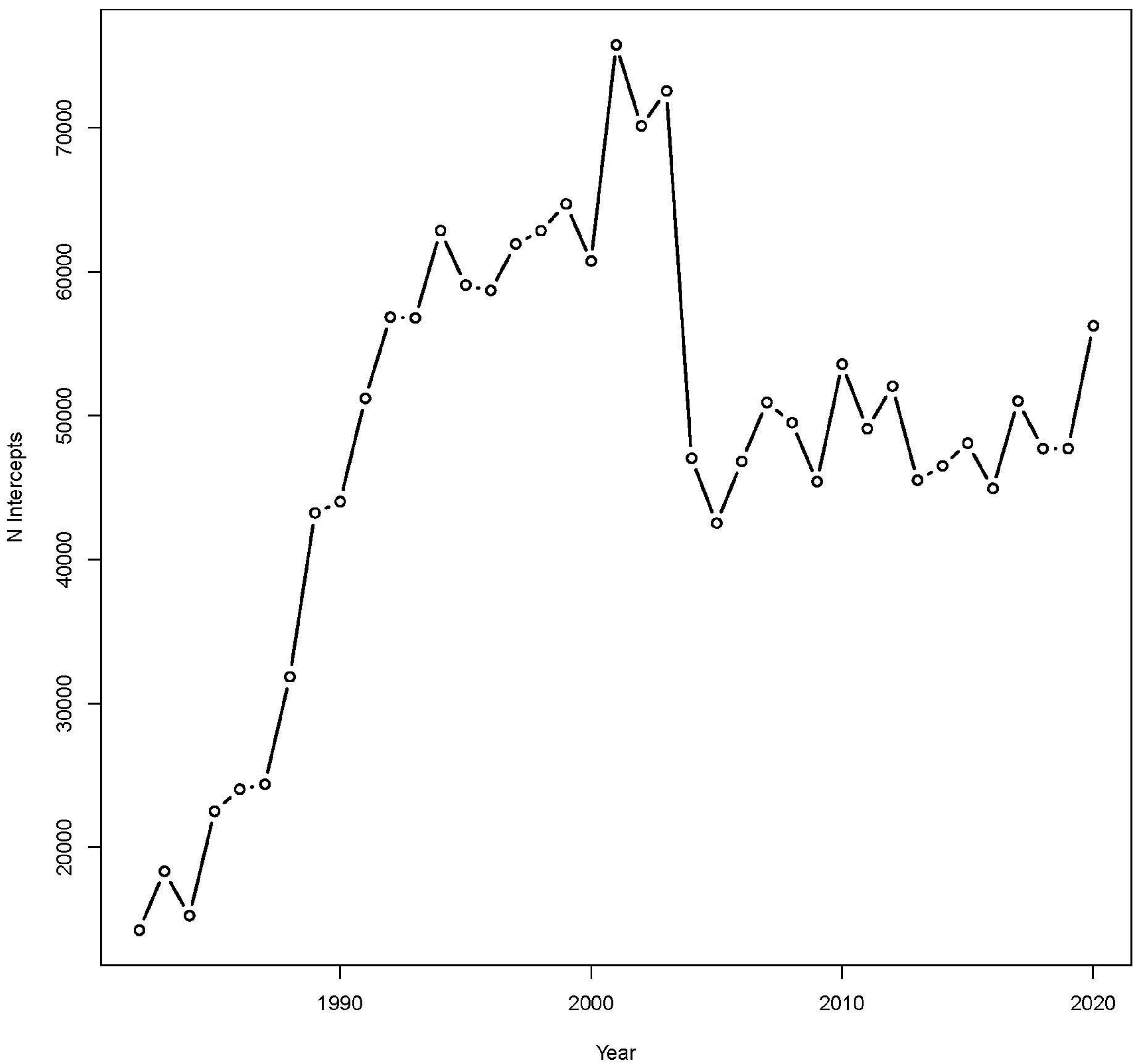


Figure 10.  Number of MRIP intercepts by year. (add more)

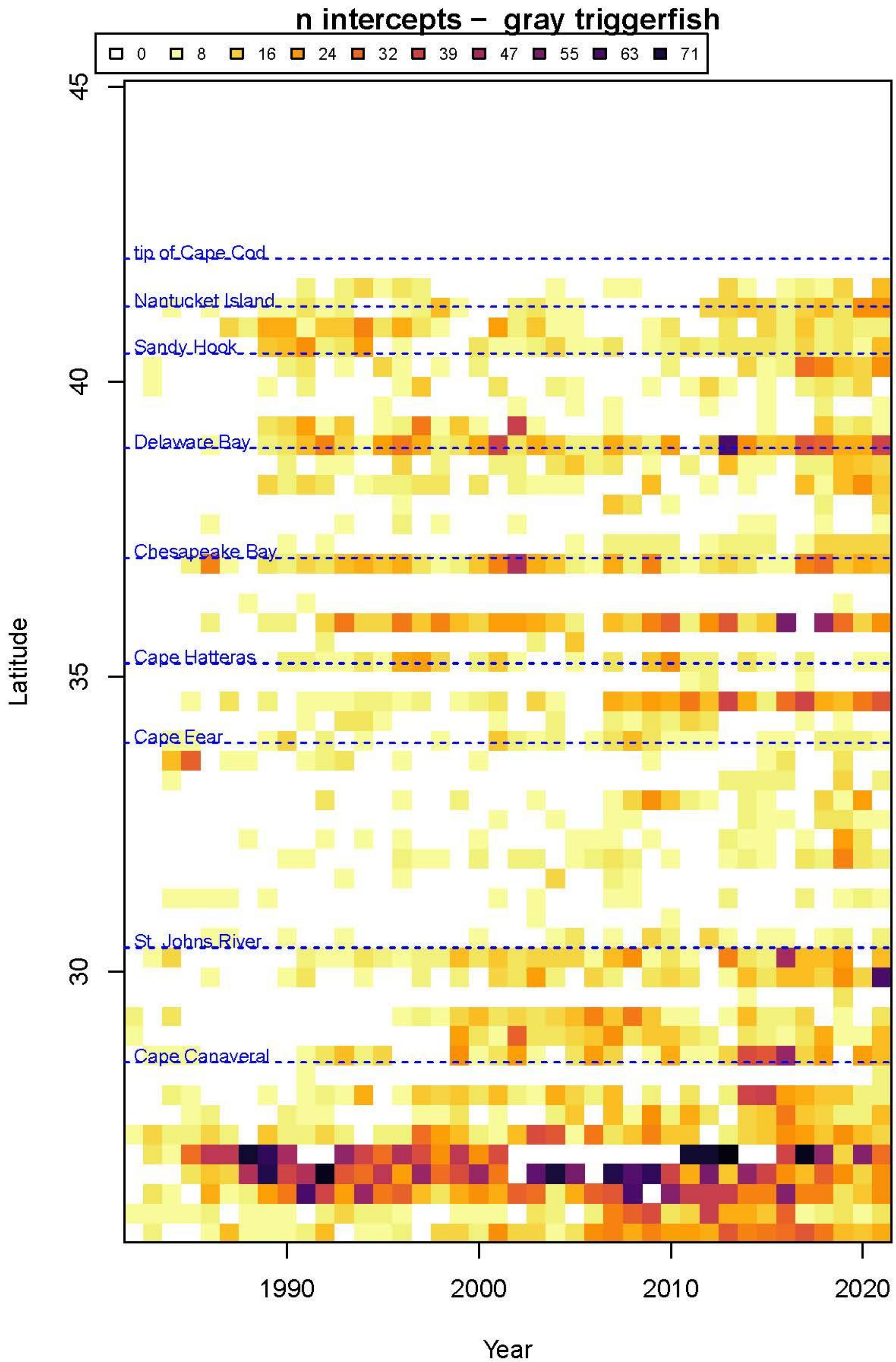


Figure 11. Heat map of positive gray triggerfish MRIP intercepts by latitude and year.

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