Exploratory data analysis and qualitative evaluation of the Stephens and MacCall subsetting method following increased management regulations in the South Atlantic headboat fishery

Eric Fitzpatrick

SEDAR82-DW07

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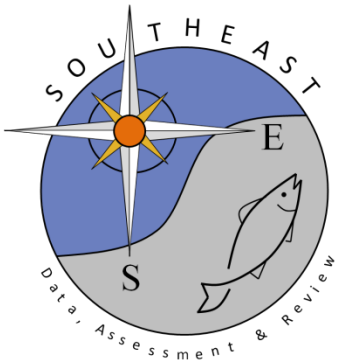

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Project summary:

Exploratory data analysis and qualitative evaluation of the Stephens and MacCall subsetting method following increased management regulations in the South Atlantic headboat fishery

February 2022

OBJECTIVE:

Develop additional exploratory data analysis to examine potential shifts in fishing behavior by investigating how/if Stephens and MacCall subsetting results is changing over time

EXPECTATIONS:

- Identifying a ‘smoking gun’ is unlikely.
- Determining utility and use of an index or truncating an index requires building a body of evidence.
- This analysis attempts to add to this body of evidence to facilitate future discussions in the SEDAR process

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STATUS QUO

- In recent years there has been increased scrutiny in the SEDAR review process and the SSC regarding fishery dependent indices and additional exploration and investigations has become the rule and not the exception.

- A fishery dependent index from Southeast Regional Headboat survey is frequently developed in the SEDAR process for most assessed stocks.

- The current practice is to assume that the methods used (Stephens and MacCall along with dGLM) are producing an index that represents trends in abundance and that if this assumption is thought to be violated then evidence should be provided to refute this assumption.

- Current practice in the South Atlantic is to remove species from the Stephens and MacCall subsetting procedure that have become restricted due to management regulations (red porgy, red snapper, etc.).
    - Is this method enough now that a majority of the snapper-grouper species are under restrictive management or should the index be truncated?

Management Regulations

- 2009
  - 1 gag/trip
  - 3 fish aggregate bag limit
  - ACLs
  - vermilion snapper 5 fish/person)
- 2010
  - Spawning season closure (Jan 1- Apr 30)
  - Red snapper closure
  - BSB ACLs
- 2011
  - Red Grouper ACLs
- 2012
  - BSB 5 fish/person/day

Detloff 2021

- Improvement- Weighting alternative opposed to subjective classification cutoff
- Have management regulations fundamentally changed the fishing behavior and the species reported enough to make Stephens and MacCall an undesirable approach during these heavily managed time periods?

Thorson (2016)

“However, many jurisdictions do not analyze fishery catch rates due to concerns that these data confound changes in fishing behavior (adjustments in fishing location or gear operation) with trends in abundance.”

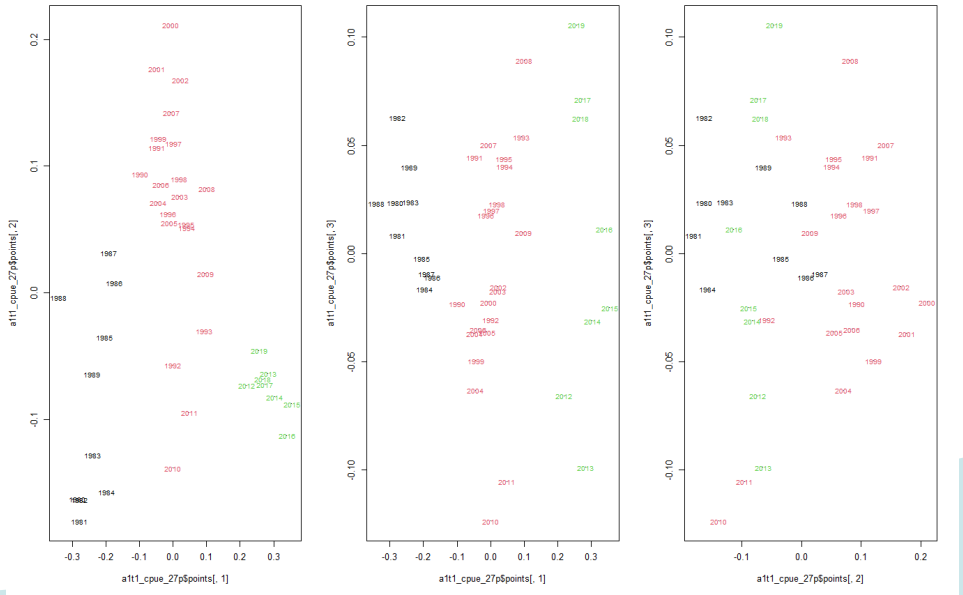
Branch (2006)

“In conclusion, either hyperstability or hyperdepletion should be suspected in every fishery because of the interaction between fleet dynamics and the spatial distribution of the resource. At a minimum, fisheries managers and scientists need to standardize CPUE data, to split CPUE series when technology or fleet behavior changes, and to treat the resulting series with a healthy dose of skepticism.”

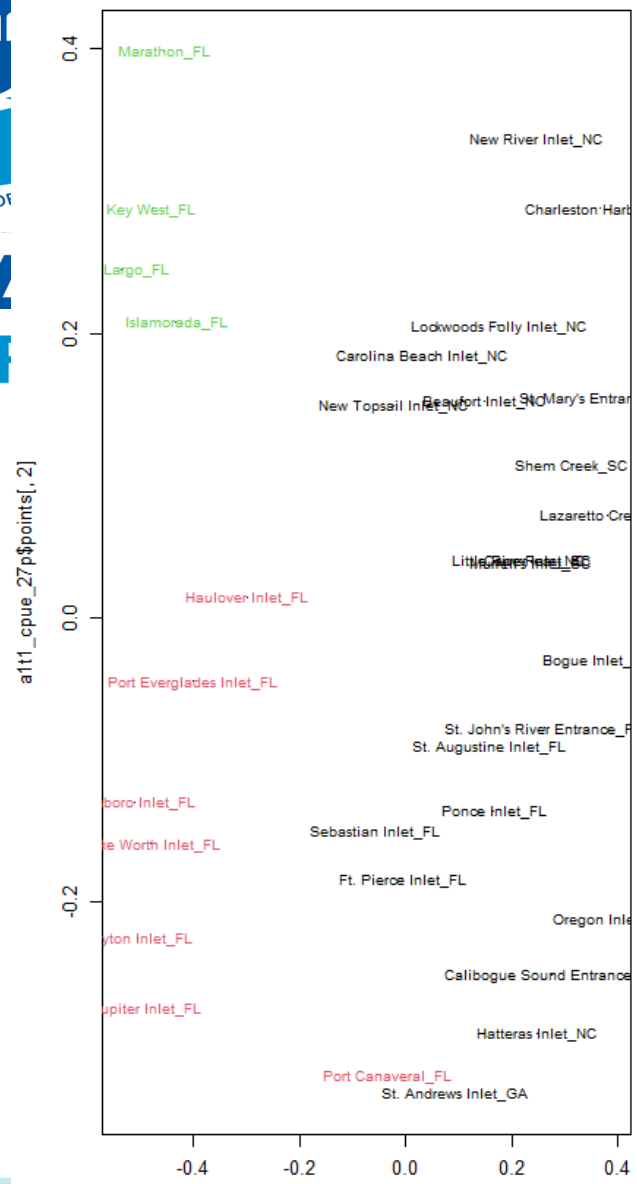
- METHODS:
  - Cluster analysis: Apply methods and lessons learned from the Headboat analysis from SEDAR 41 (identify spatial and temporal blocks)
    - isoMDS-Kruskal's Non-metric multidimensional scaling
      - This method avoids making apriori assumptions about time blocks and area specific cutoffs
    - Identify metrics (temporal shifts, proportion positive, vessels in fleet, mean catch rates, management regulations) to examine shifts in species composition by time blocks and region identified by the isoMDS methods
  - Once time blocks and regions are identified, develop indices of abundance after applying Stephens and MacCall to these time blocks and regions to determine if Stephens and MacCall has become less effective at identifying effective effort (either due to management regulations or an overall decrease in presence/absence of the top suite of species in the snapper grouper complex)
  - (Preliminary- Learn and apply machine learning techniques (RandomForest in R) as an alternative approach to Stephens and MacCall to examine shifts in important species through time
  - Is Stephens and MacCall identifying effective effort consistently?

Current tasks

- isoMDS-Kruskal's Non-metric multidimensional scaling
  - Example: examine annual shifts in CPUE of the top 8 species
  - Examine annual shifts in CPUE of the top 25 species to test if the added species changes the results of the temporal shift noted above
  - Run isoMDS by port to determine appropriate spatial resolution
  - Run isoMDS by year and port to determine appropriate temporal resolution
- Random Forest
  - Apply a new technique, primarily to learn a new approach, but also to examine an alternative approach to determine variable importance (species)



[3-D plot]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Shem Creek_SC
Haulover Inlet_FL
Port Everglades Inlet_FL
St. John's River Entrance_F
St. Augustine Inlet_FL
Ponce Inlet_FL
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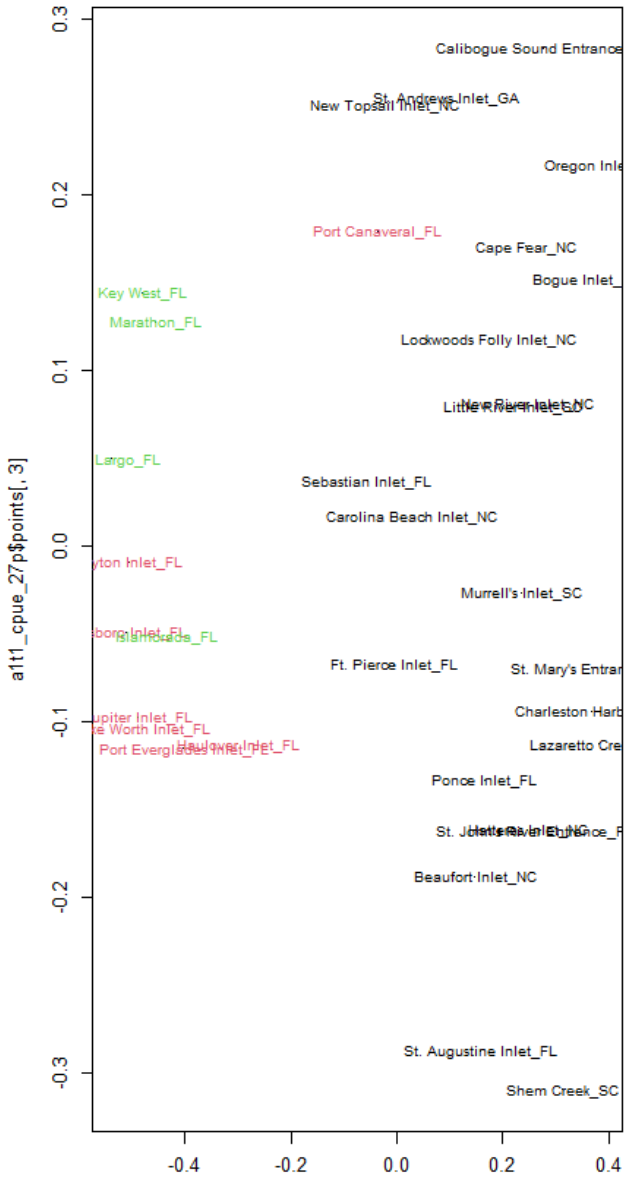
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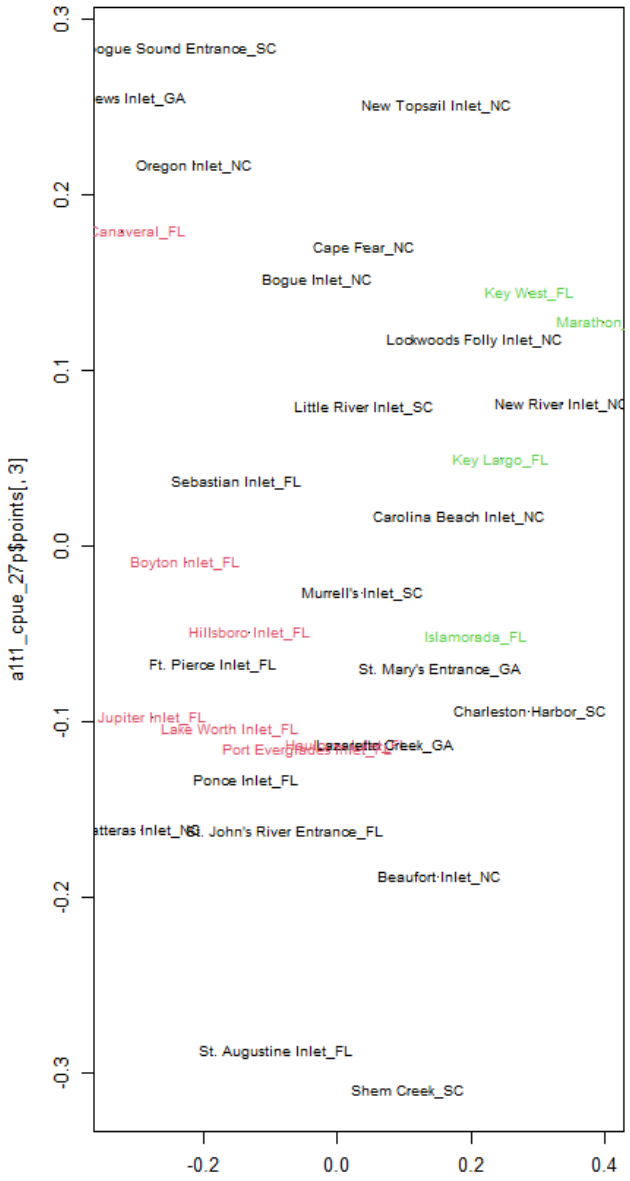
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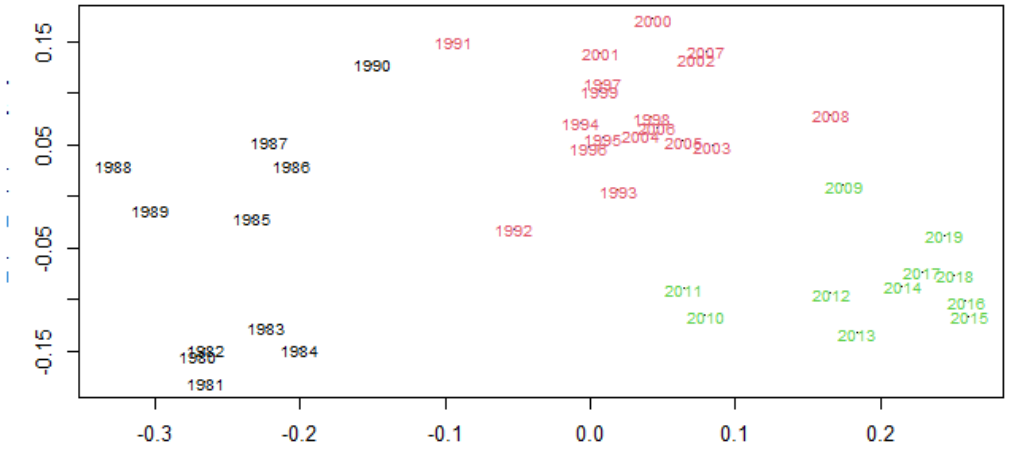

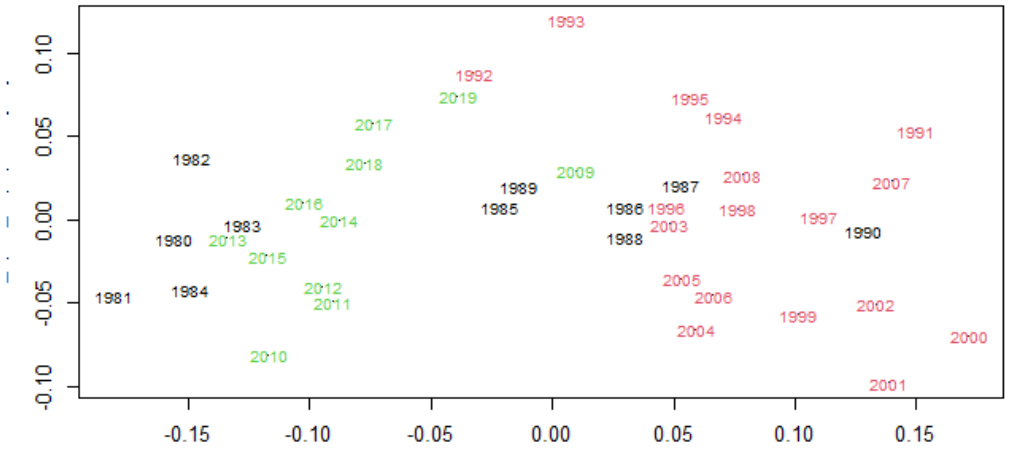

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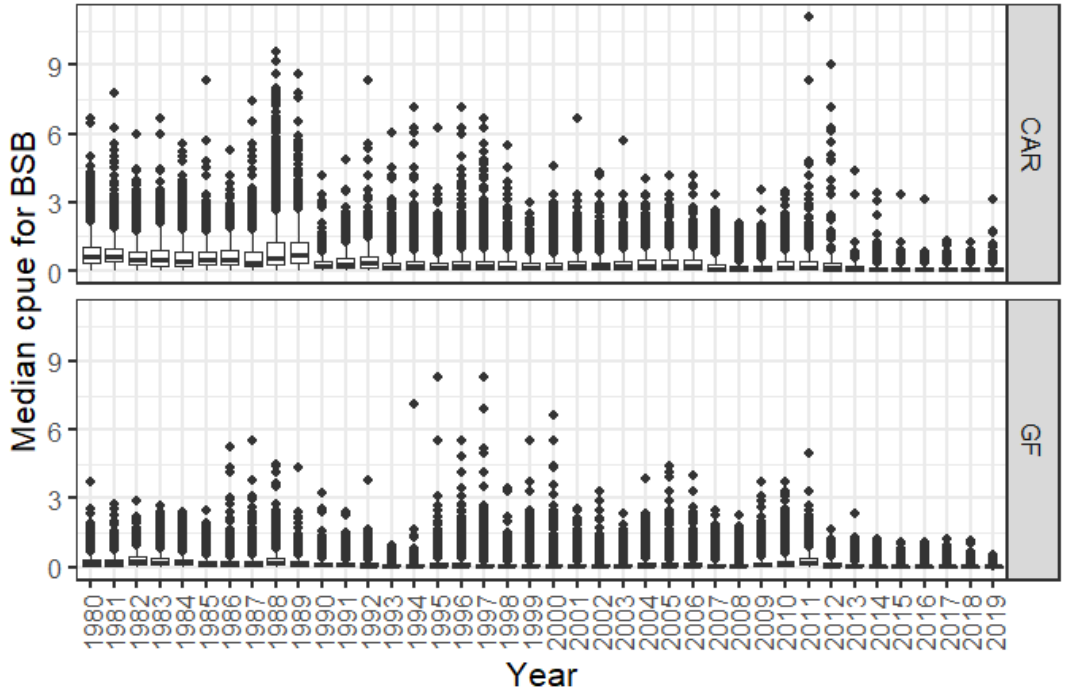
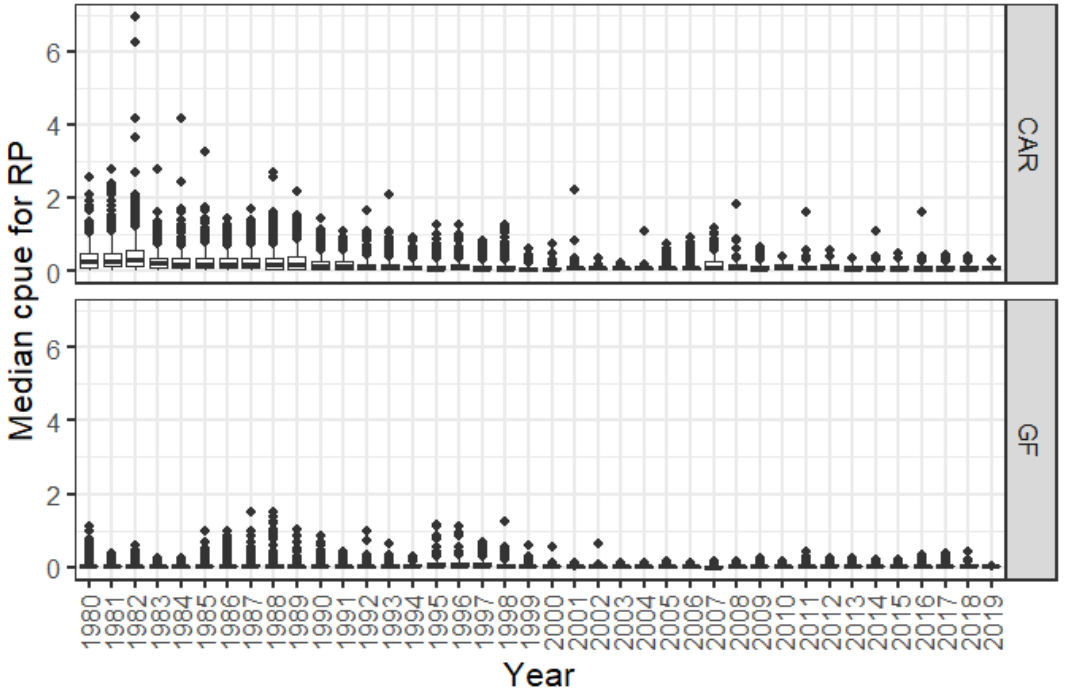
A graphical summary of your random forest

Exploratory data analysis

- Catch rates by year, species and region
- Proportion positive by year, species and region
- Number of vessels with positive trips by year, species and region


Median cpue for BSB
CAR
GF
Year


Median cpue for RP
CAR
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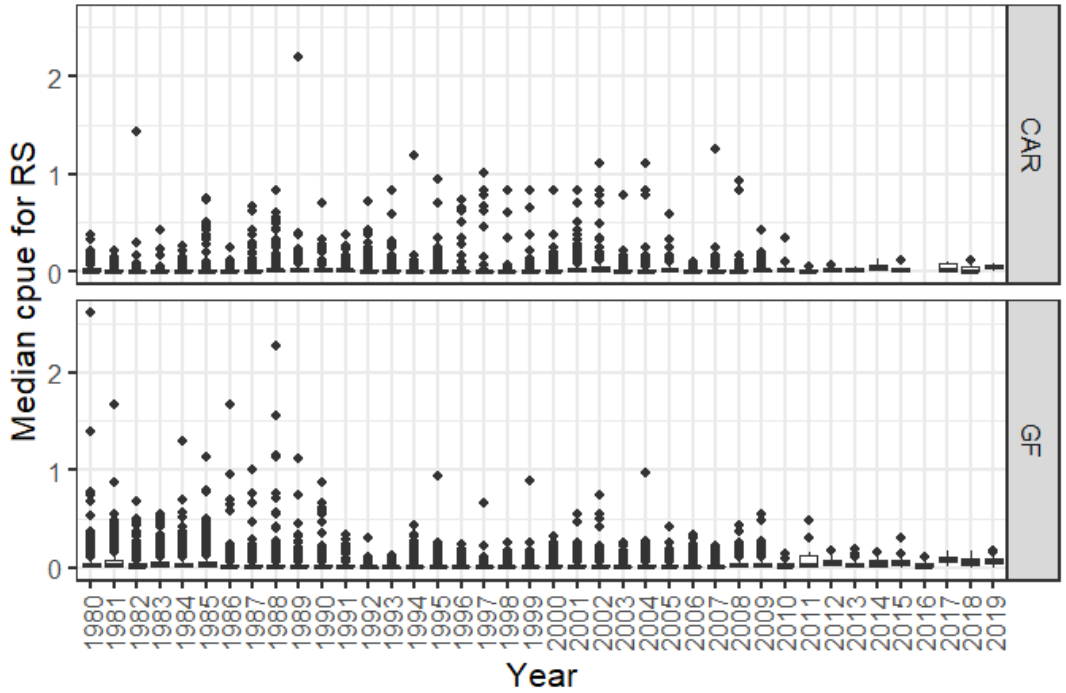
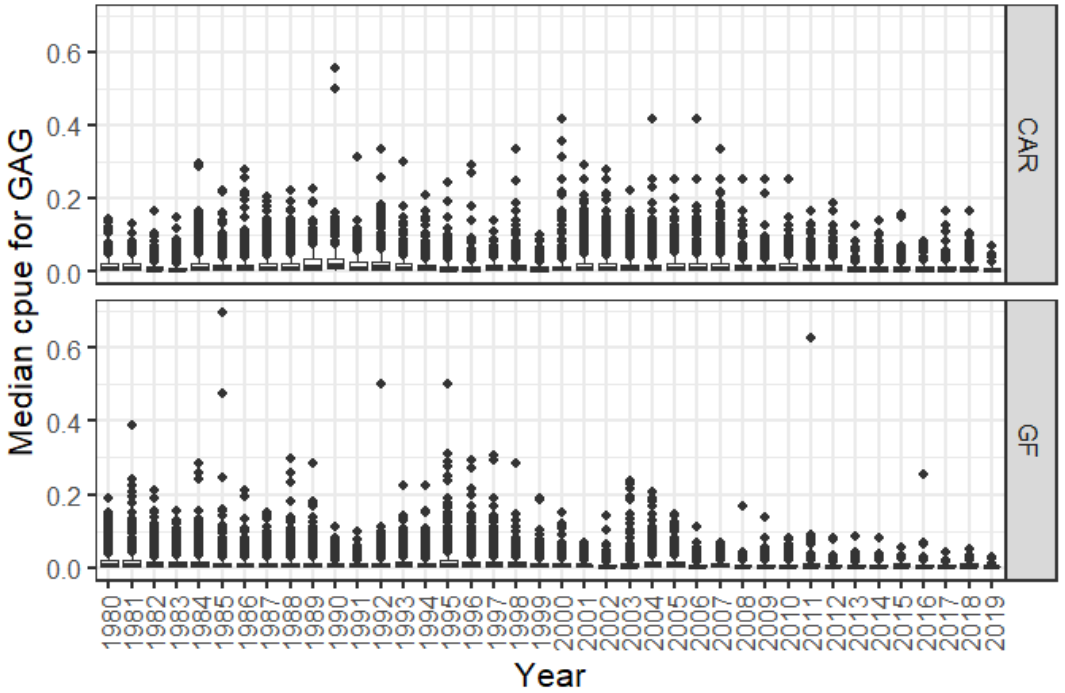
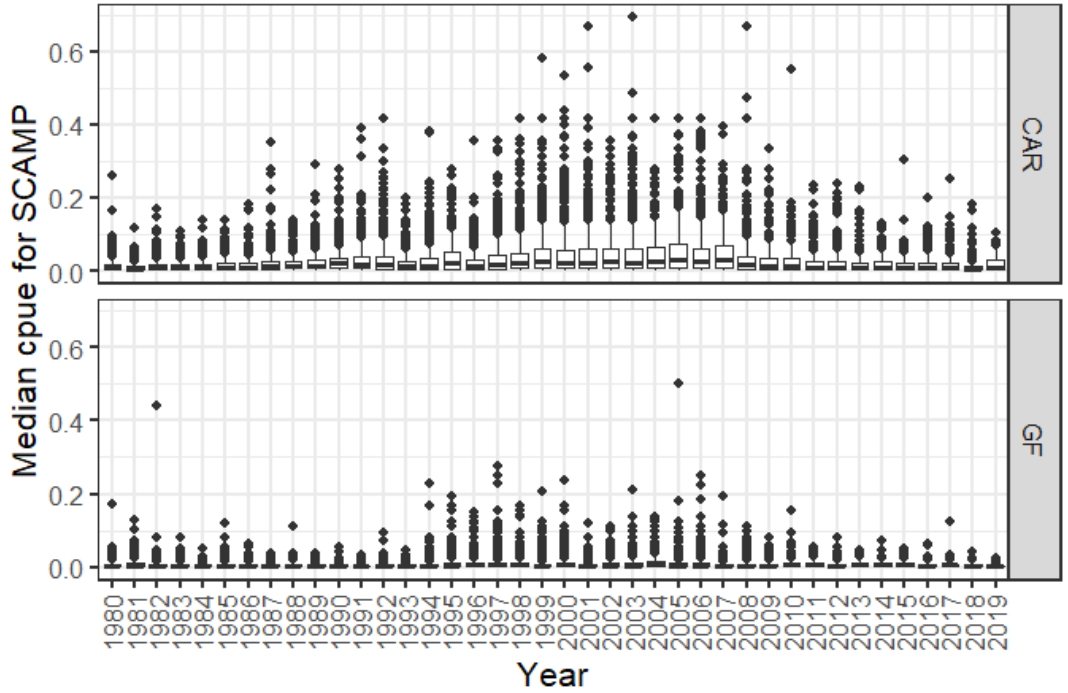
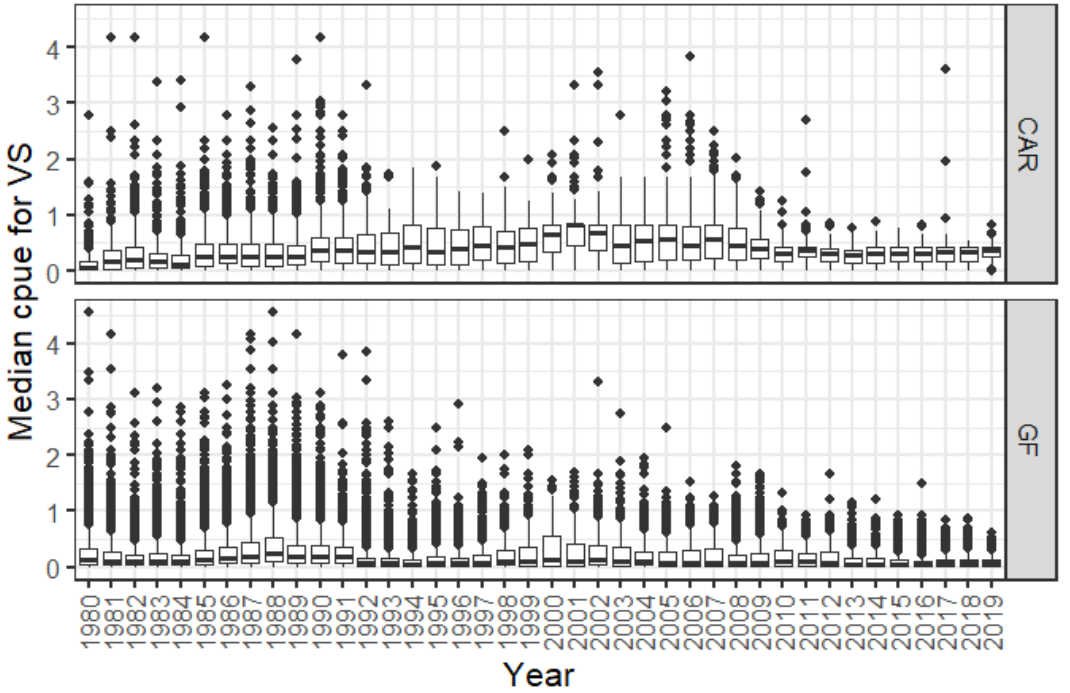
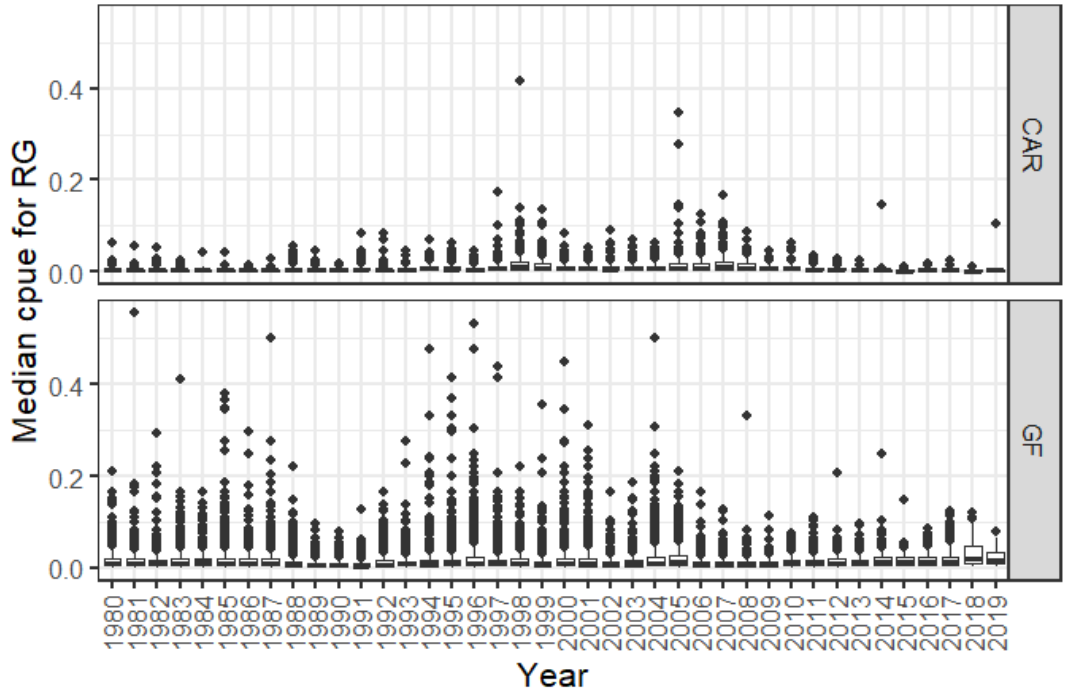
Year

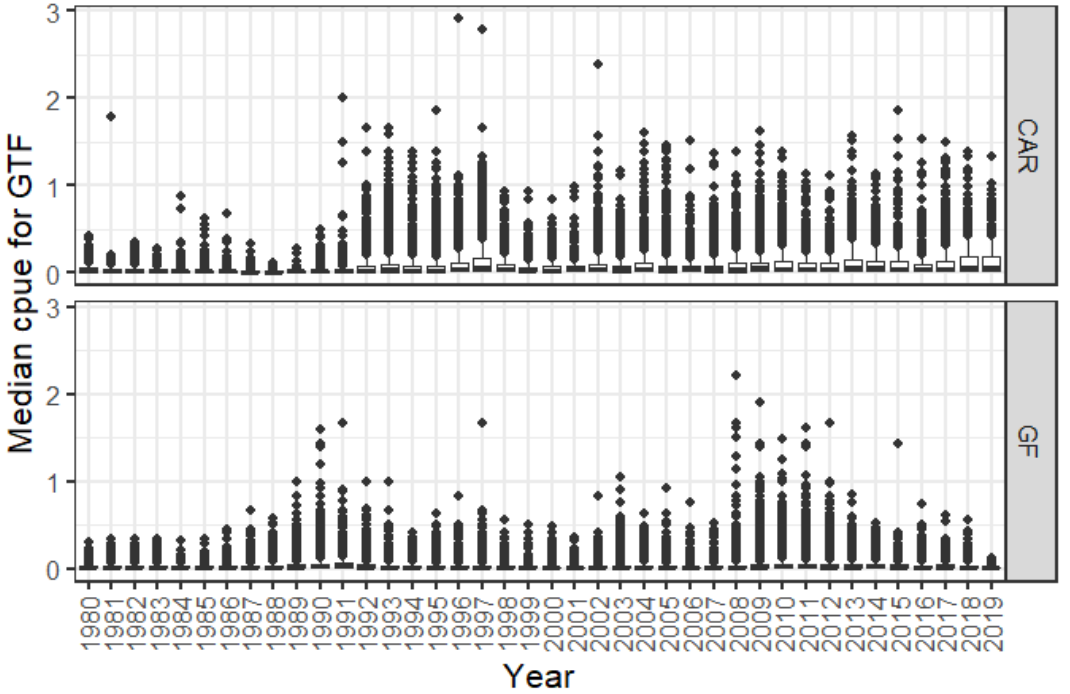

Median cpue for RS
CAR
GF
Year

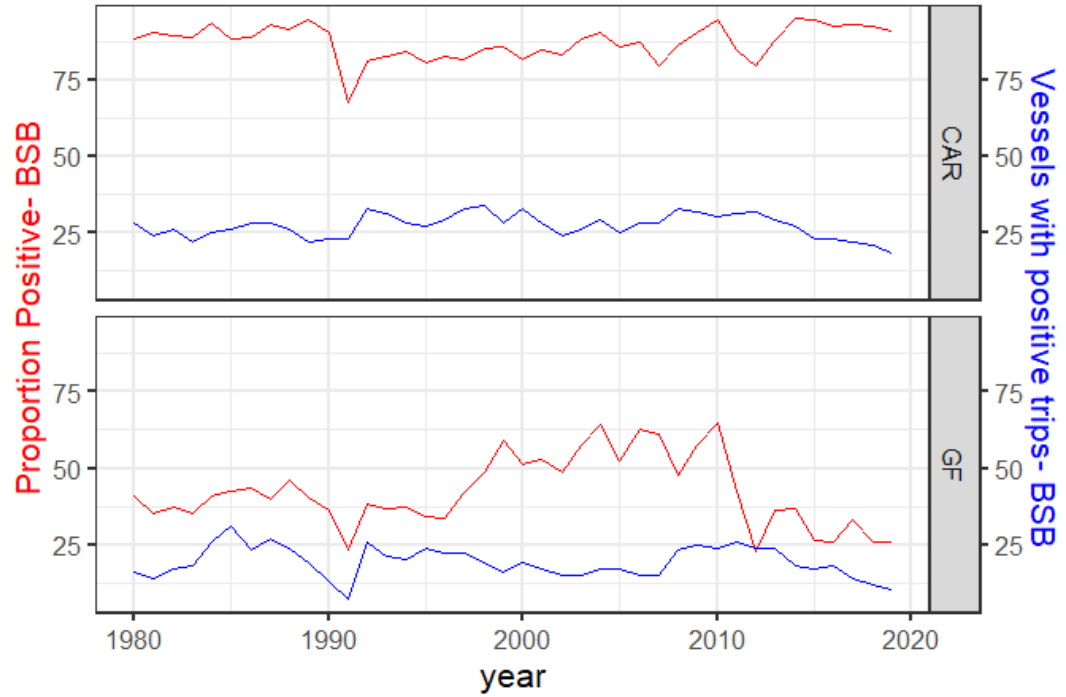

Median cpue for GAG
CAR
GF
Year

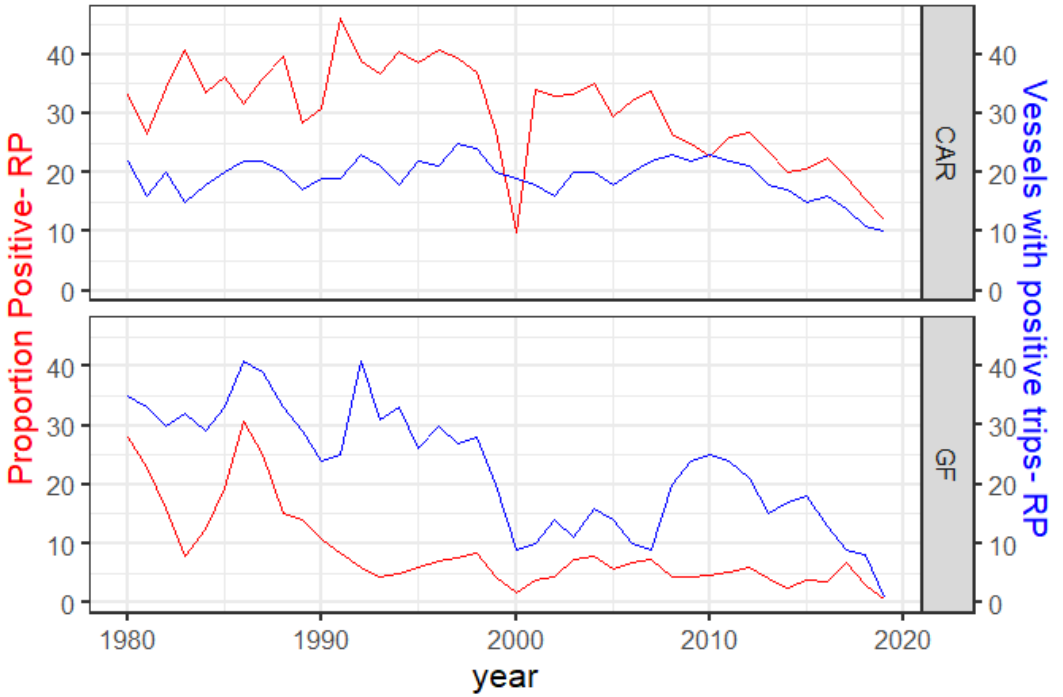

Median cpue for SCAMP
CAR
GF
Year

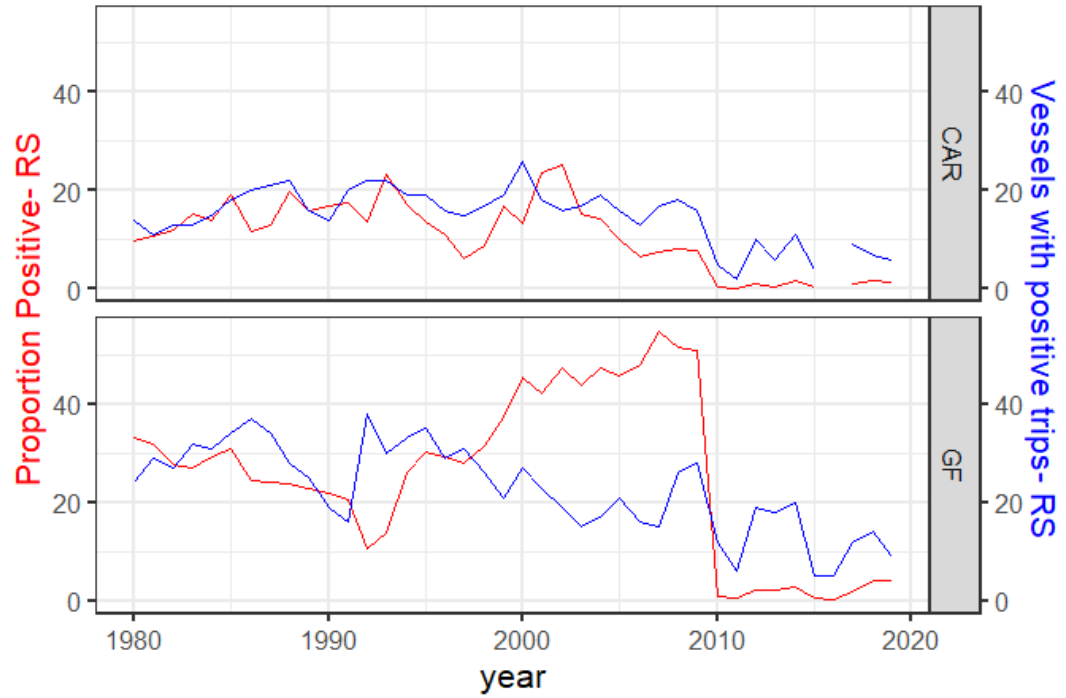

Median cpue for VS
CAR
GF
Year

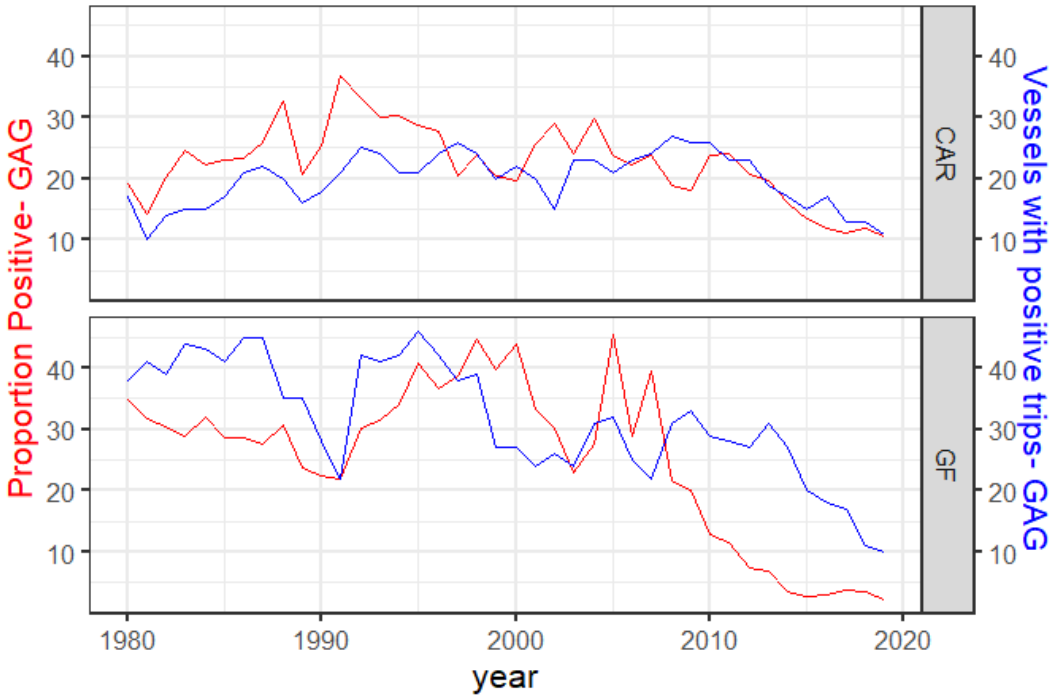

Median cpue for RG
CAR
GF
Year

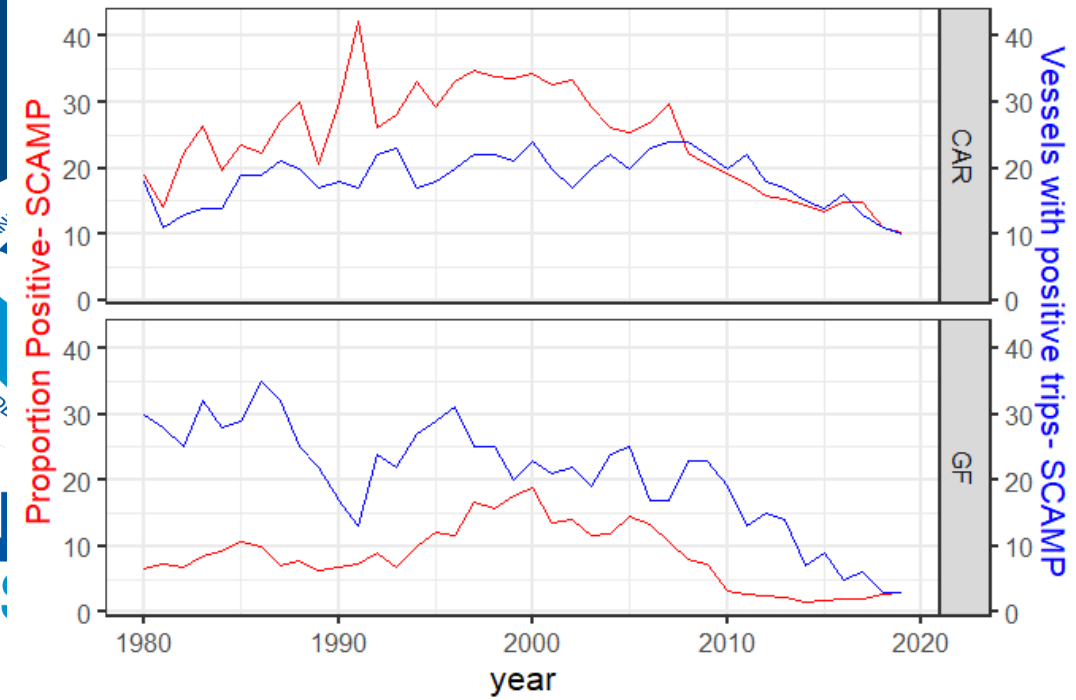

Median cpue for GTF
CAR
GF
Year

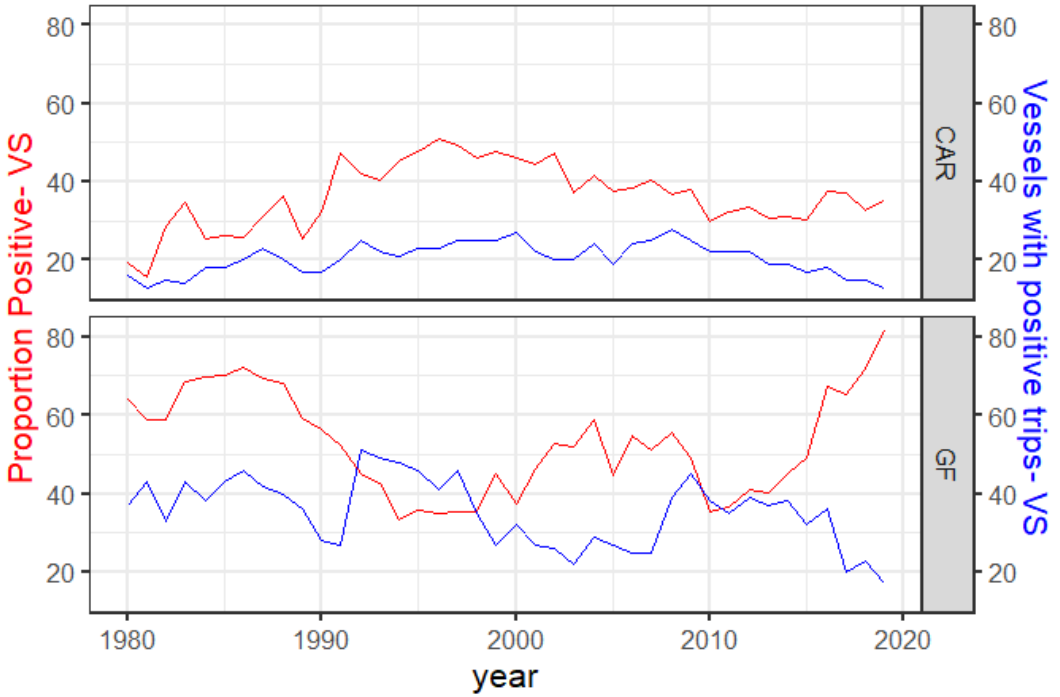

Proportion Positive- BSB
Vessels with positive trips- BSB
CAR
GF
year

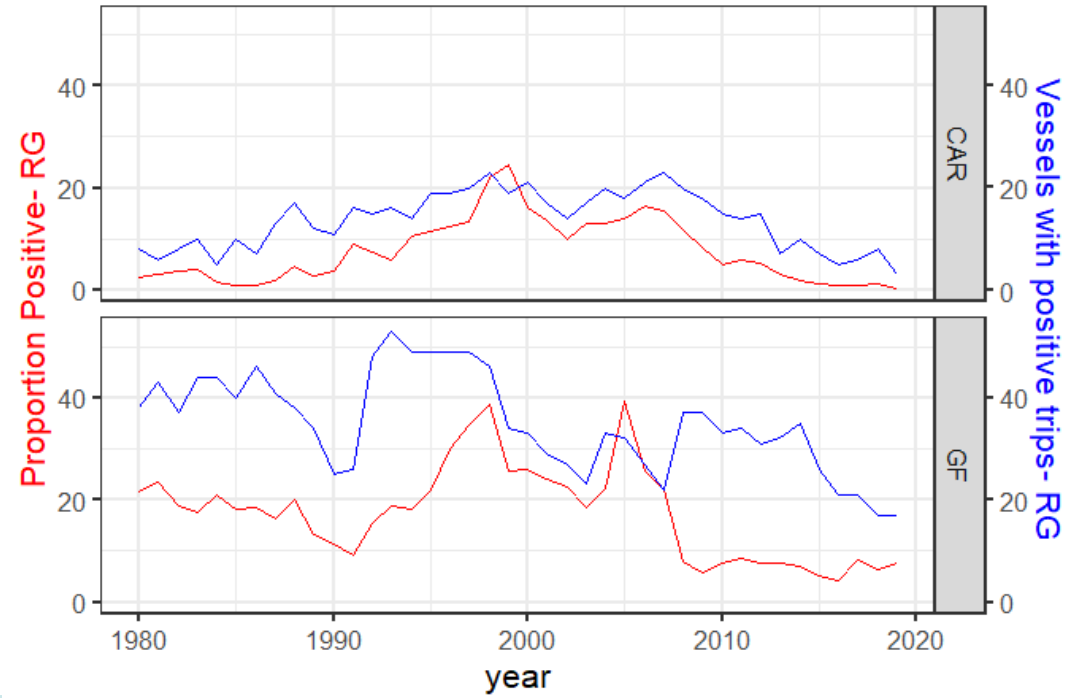

Proportion Positive- RP
Vessels with positive trips- RP
CAR
GF
year

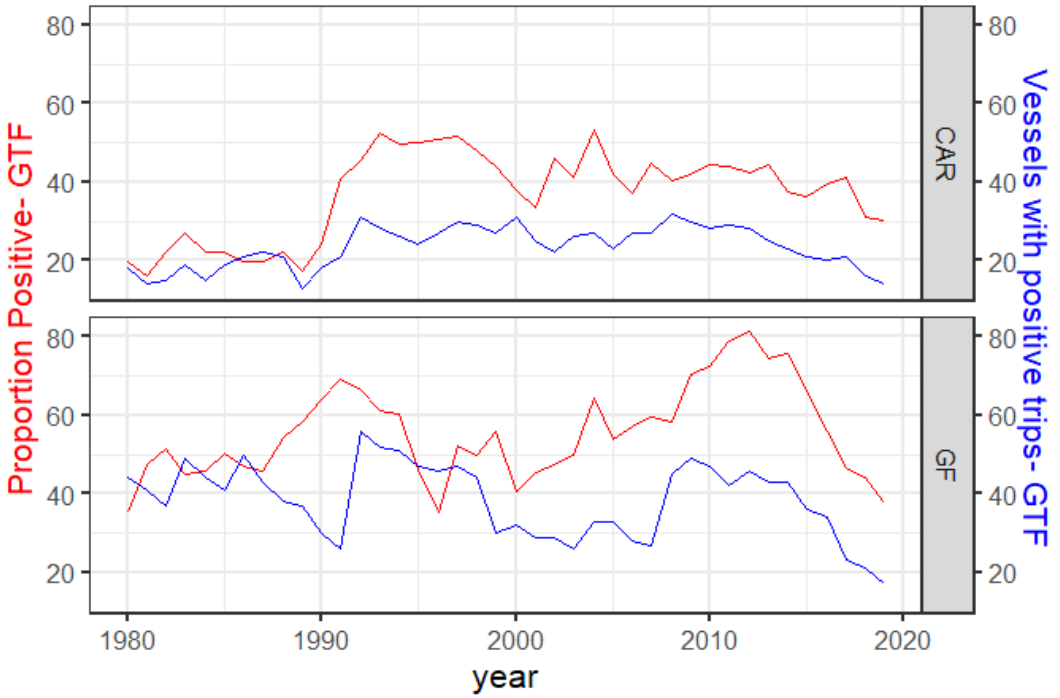

Proportion Positive- RS
Vessels with positive trips- RS
CAR
GF
year


Proportion Positive- GAG
Vessels with positive trips- GAG
CAR
GF
year


Proportion Positive- SCAMP
Vessels with positive trips- SCAMP
CAR
GF
year

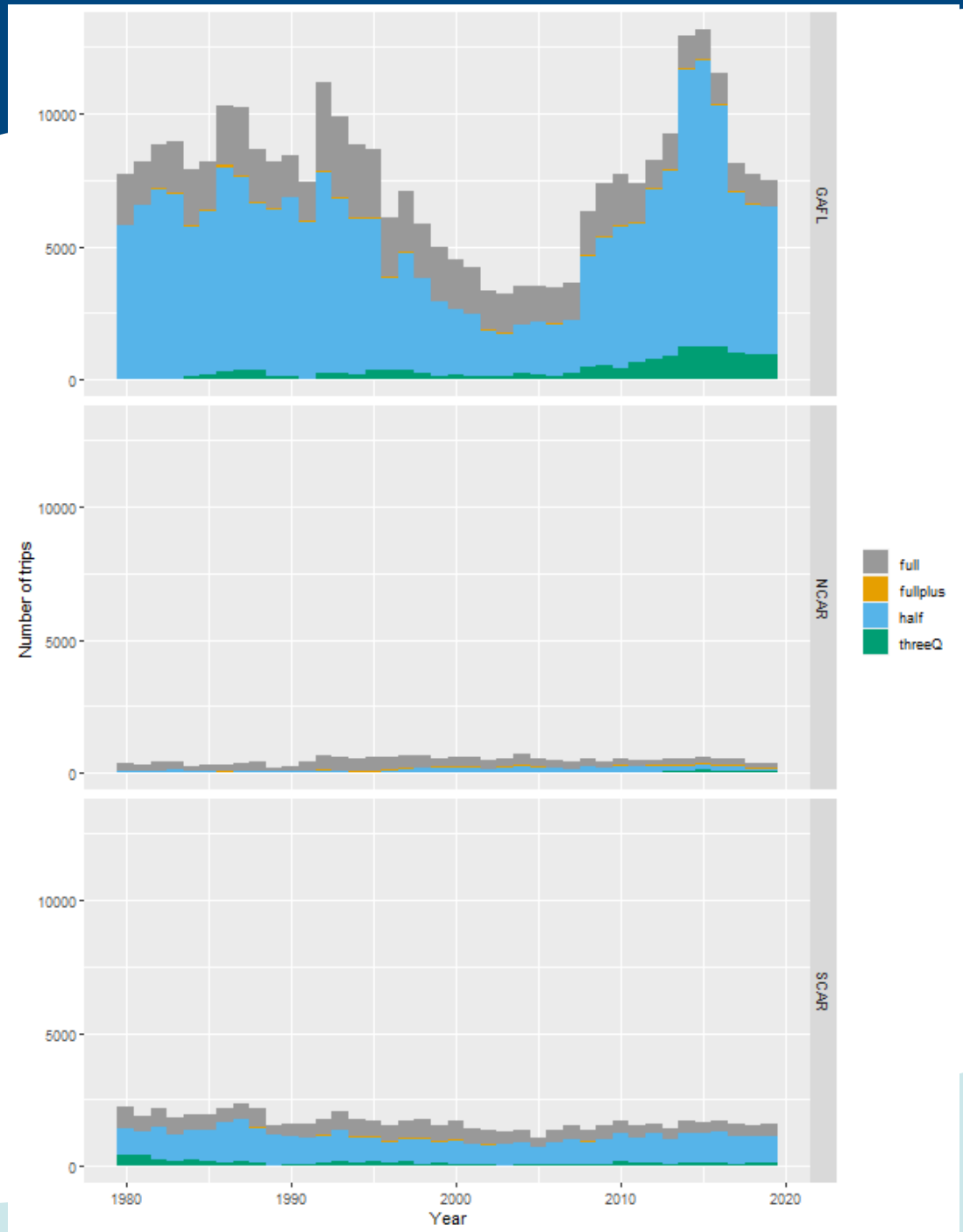

Proportion Positive- VS
Vessels with positive trips- VS
CAR
GF
year


Proportion Positive- RG
Vessels with positive trips- RG
CAR
GF
year


Proportion Positive- GTF
Vessels with positive trips- GTF
CAR
GF
year

GAG EXAMPLE

- Trips by year and region
- Positive gag trips
- Outliers
- Stephens and MacCall by time block
- Trips retained
- Proportion of zero trips retained by year (effective effort)
- Positive only versus S&M input
- dGLM diagnostics
- Index results



GTF EXAMPLE

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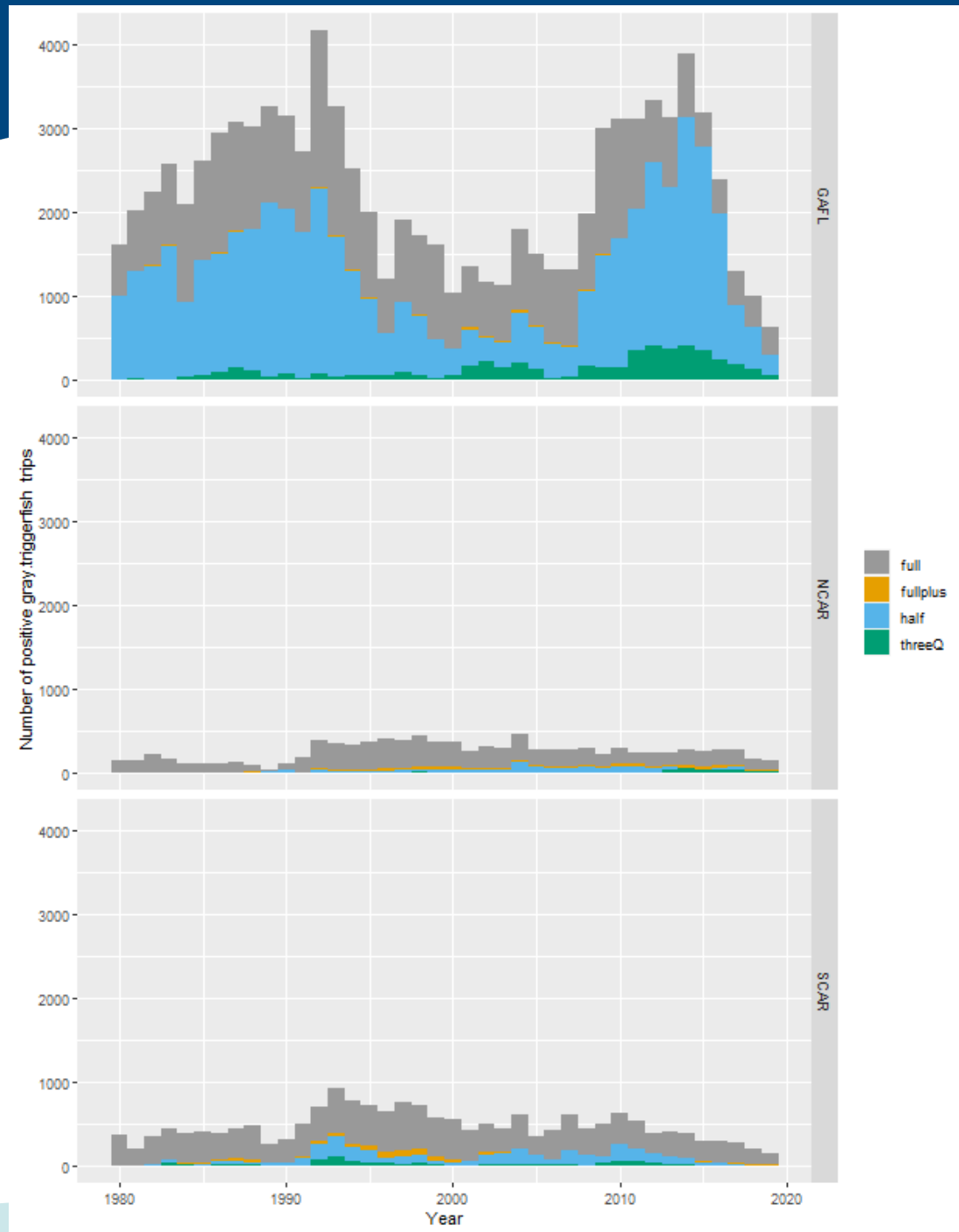

GTF EXAMPLE

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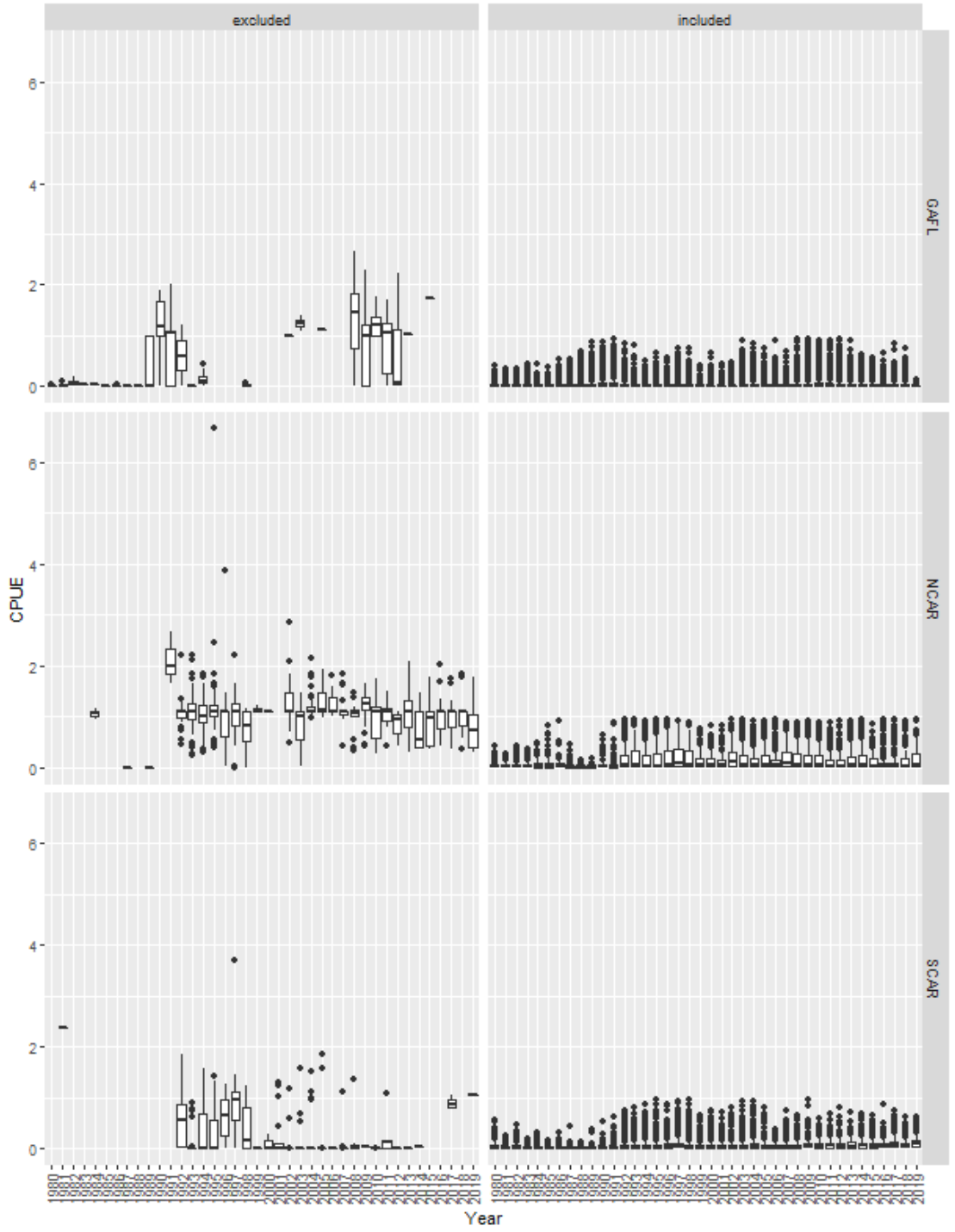
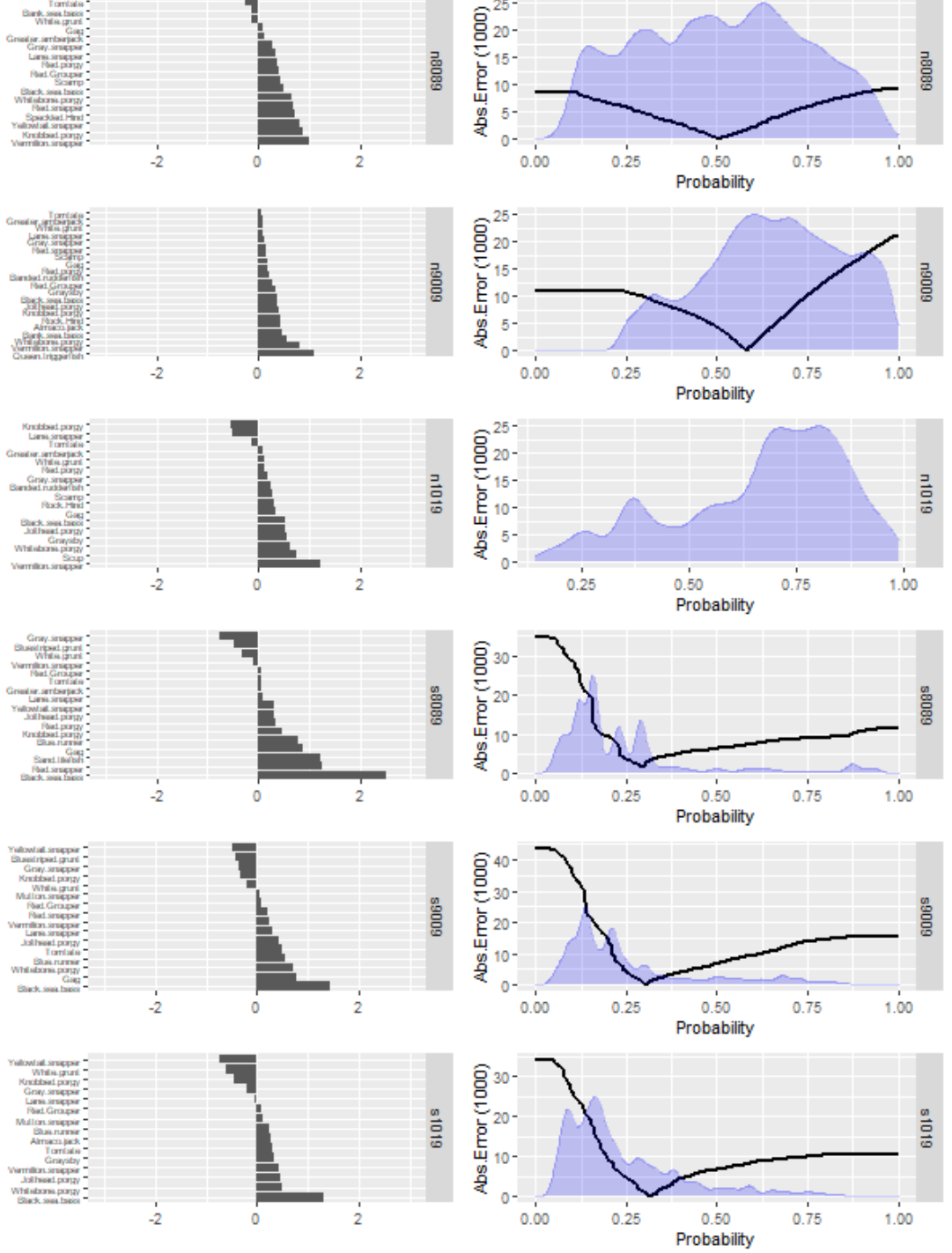


GTF EXAMPLE

- Trips by year and region
- Positive gag trips
- Outliers (top 0.5%)
- Stephens and MacCall by time block
- Trips retained
- Proportion of zero trips retained by year
- Positive only versus S&M input
- dGLM diagnostics
- Index results



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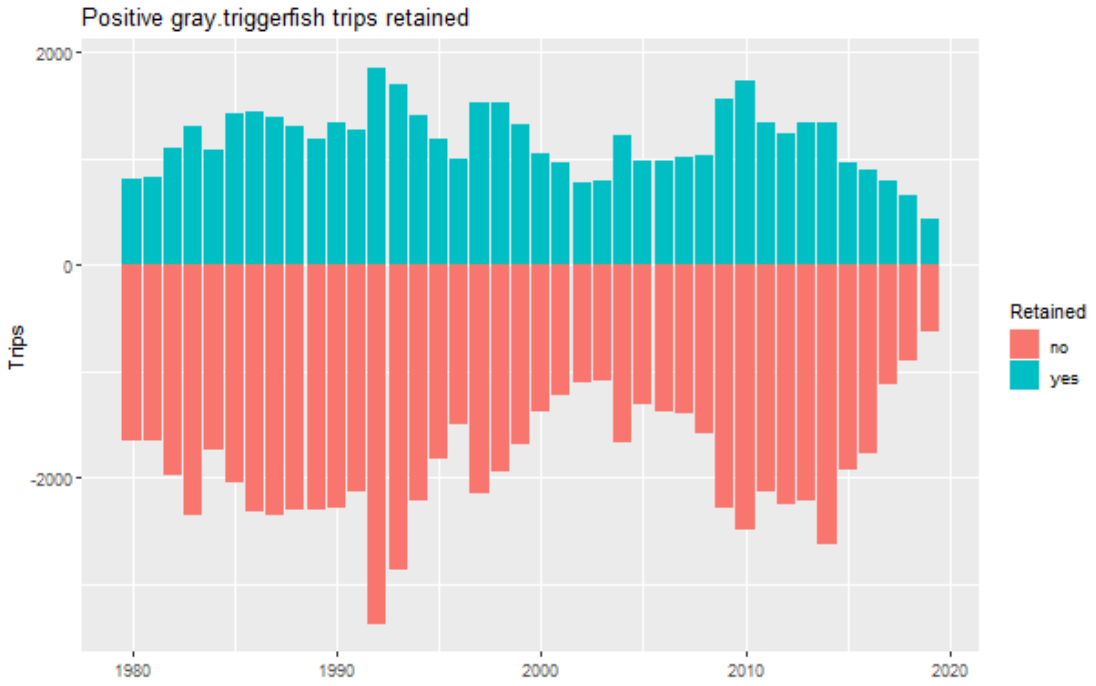

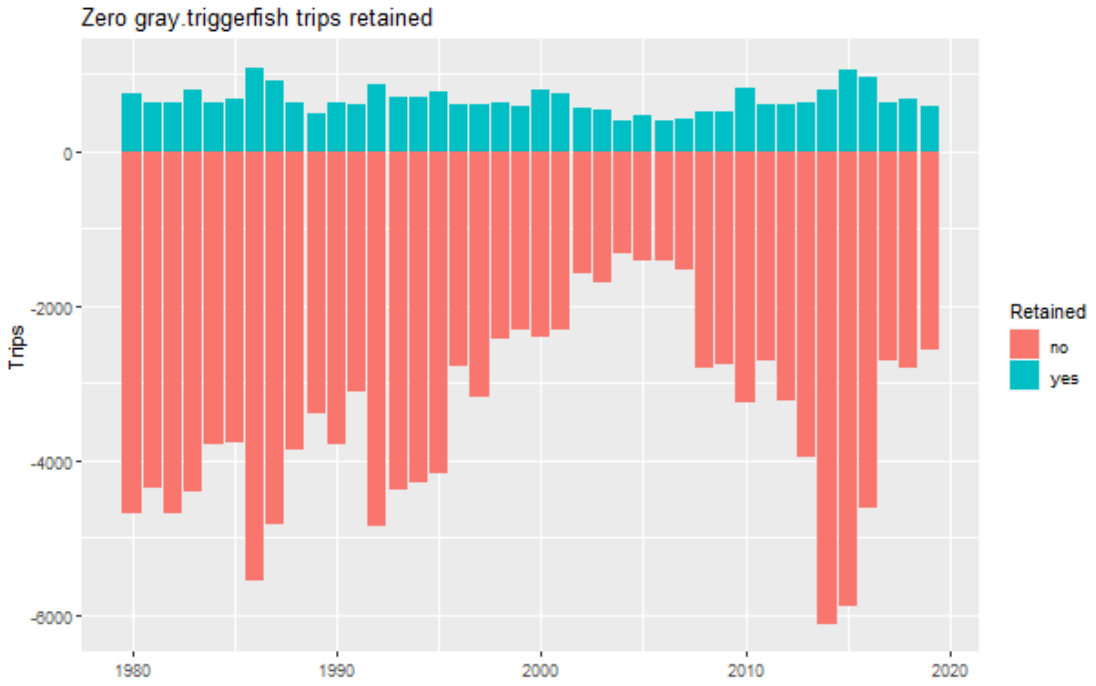

GTF EXAMPLE

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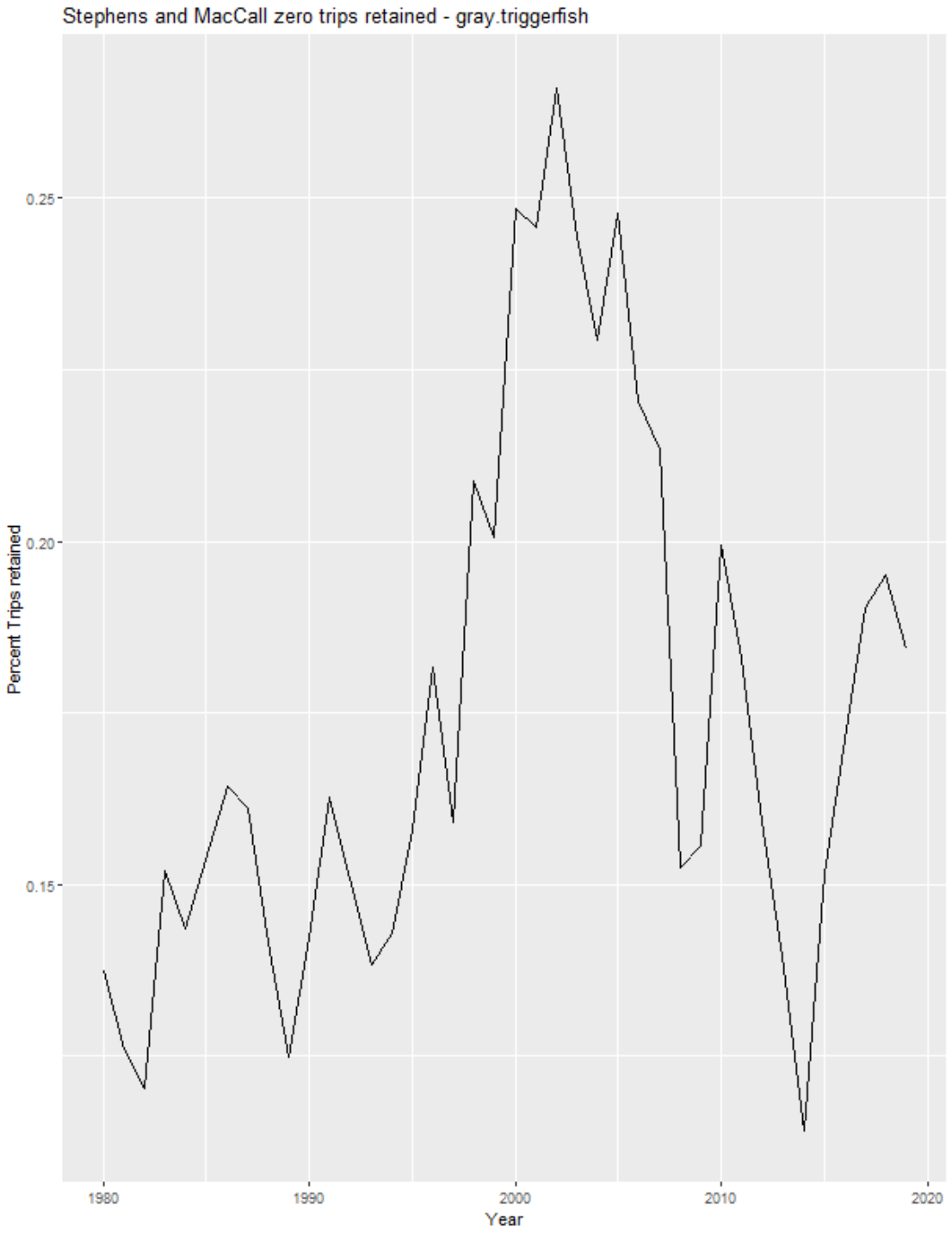

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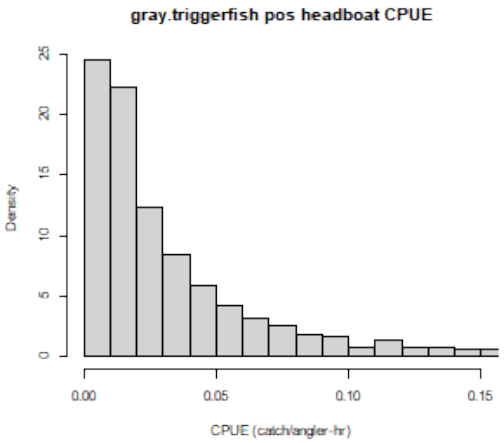

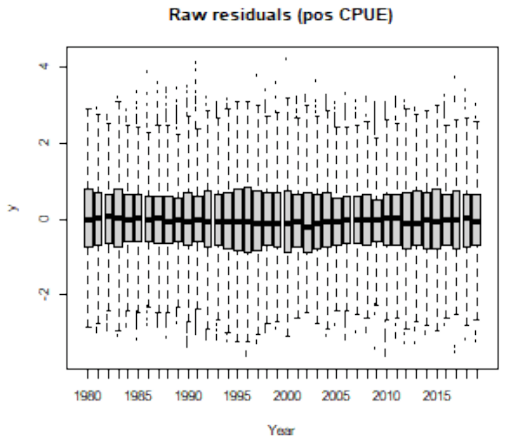

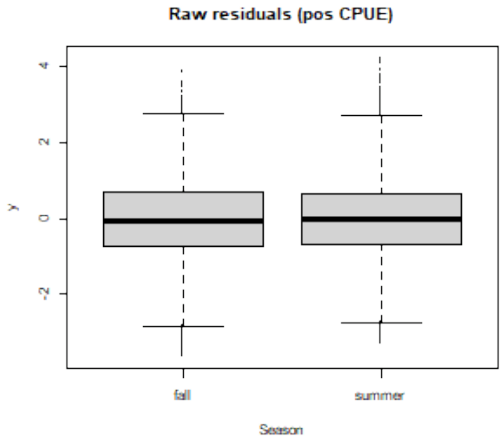

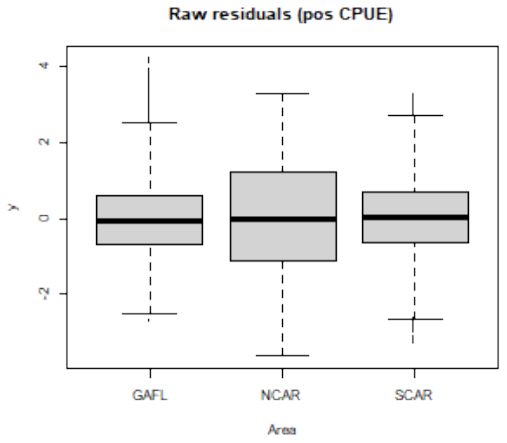

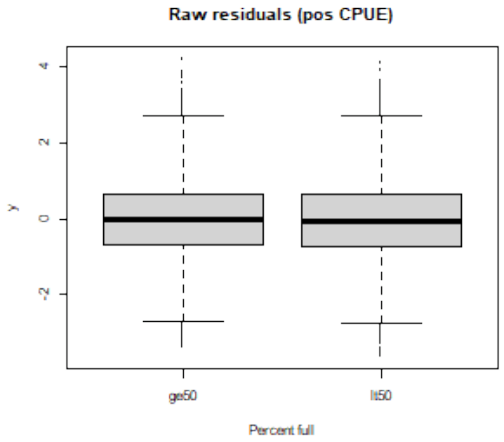

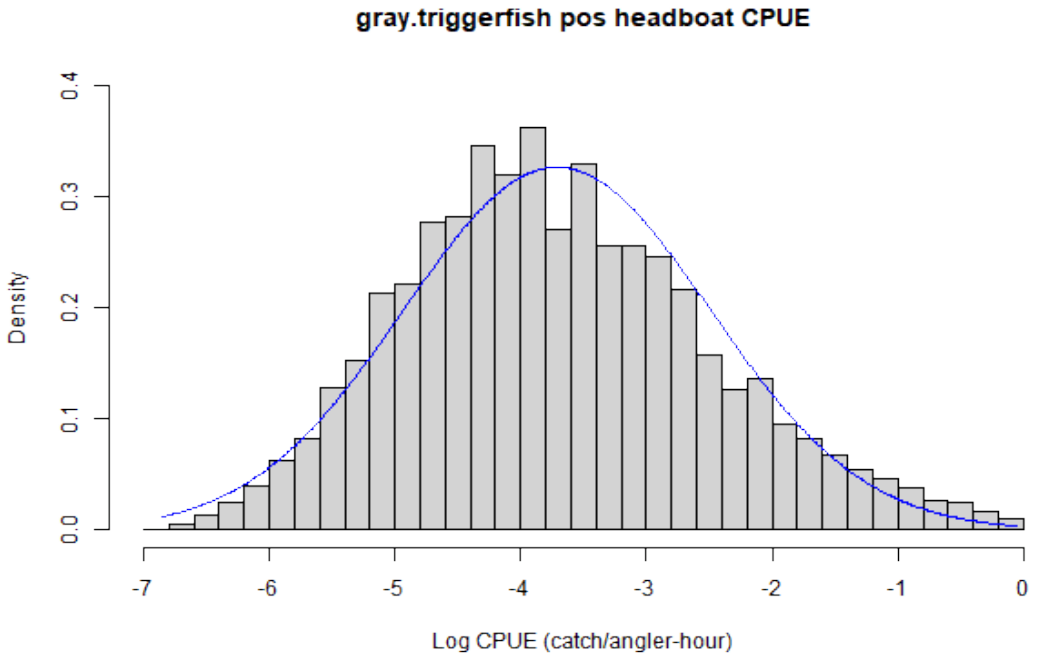

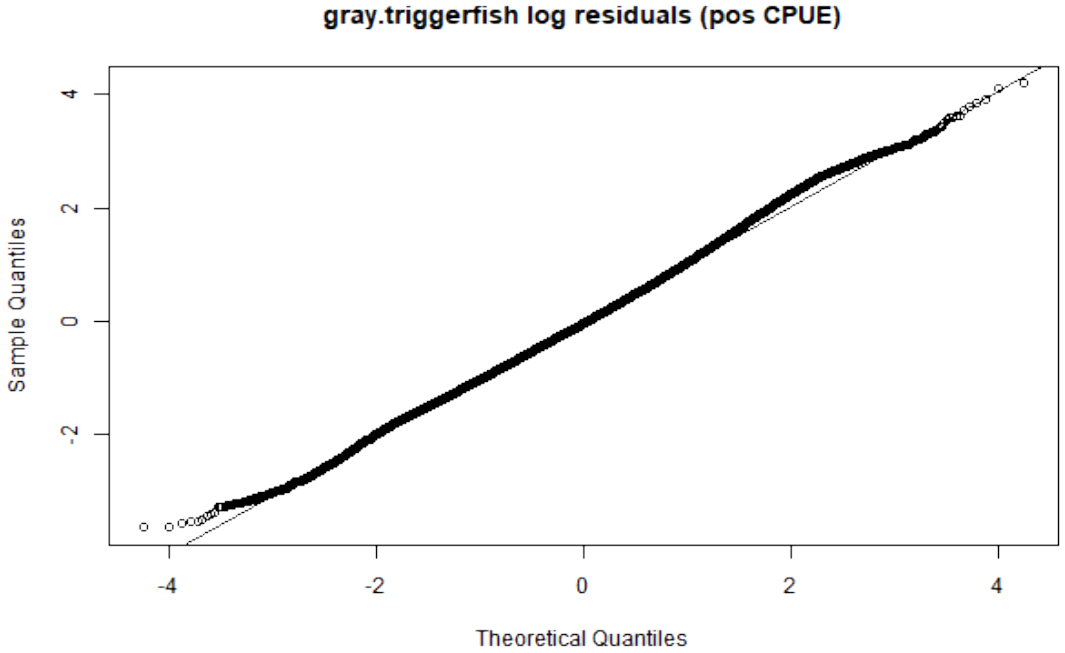

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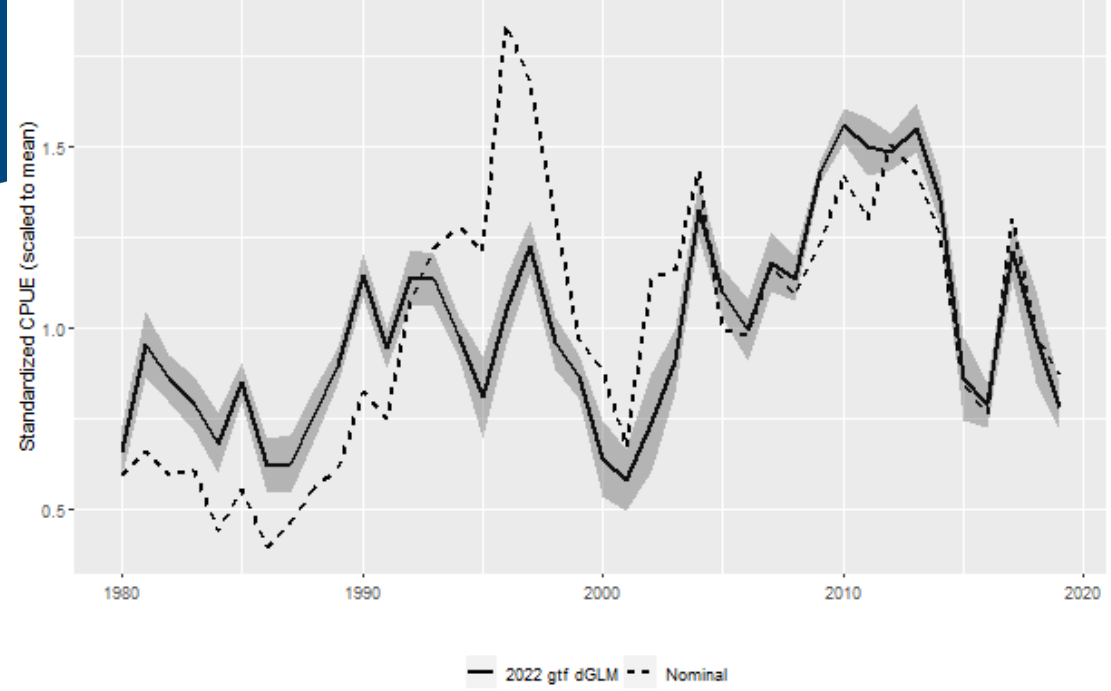
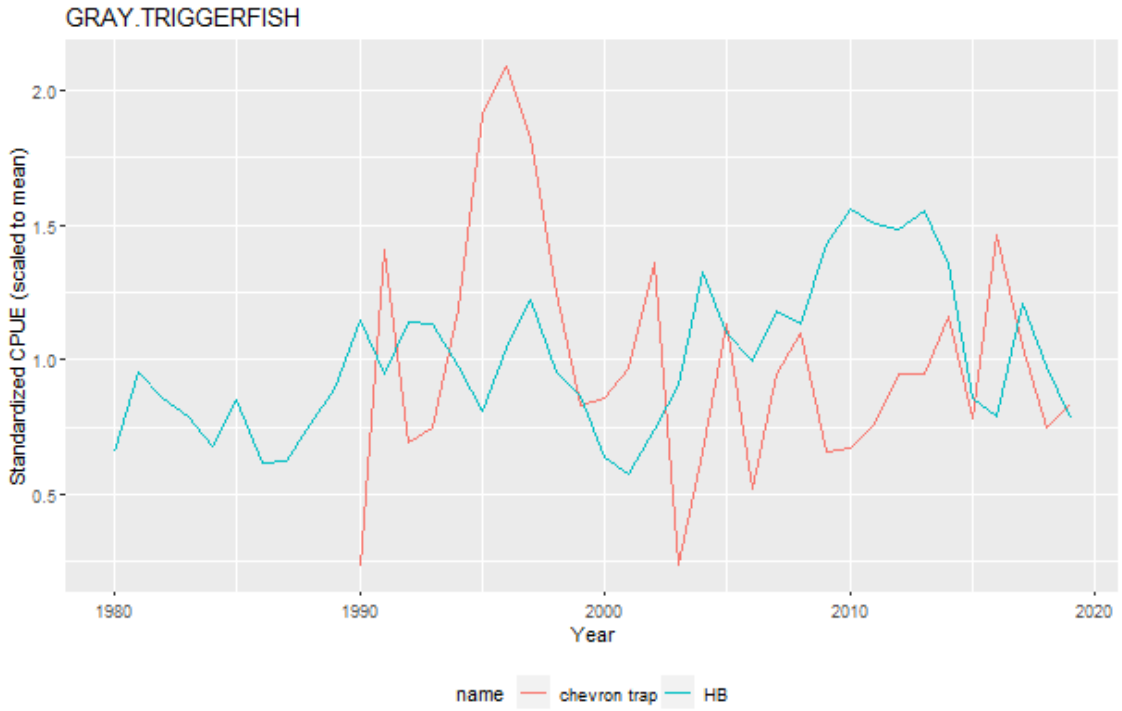
- Stephens and MacCall by time block
- Trips retained
- Proportion of trips retained by year
- Positive only versus S&M input
- dGLM diagnostics
- Index results

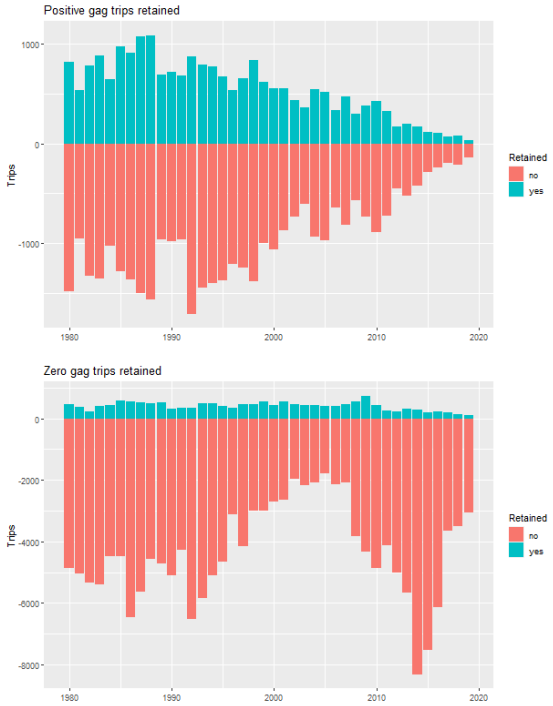


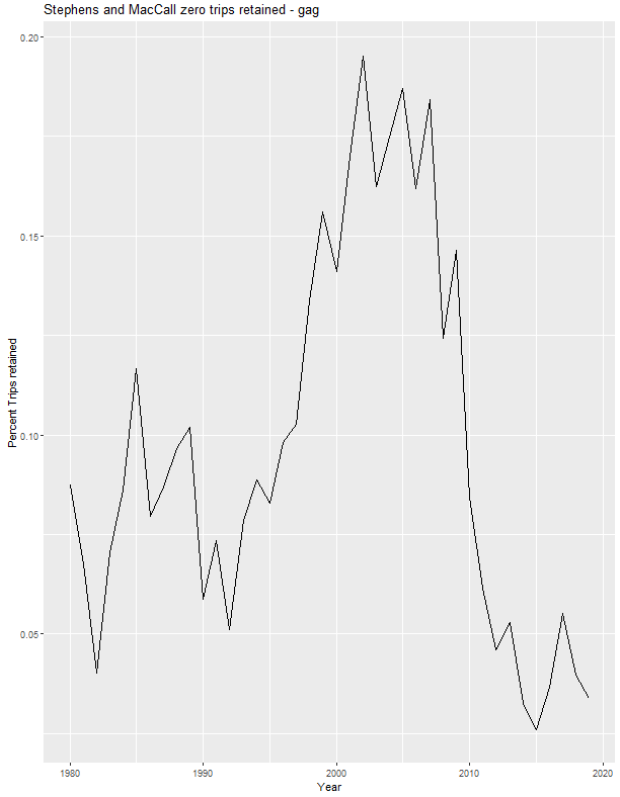


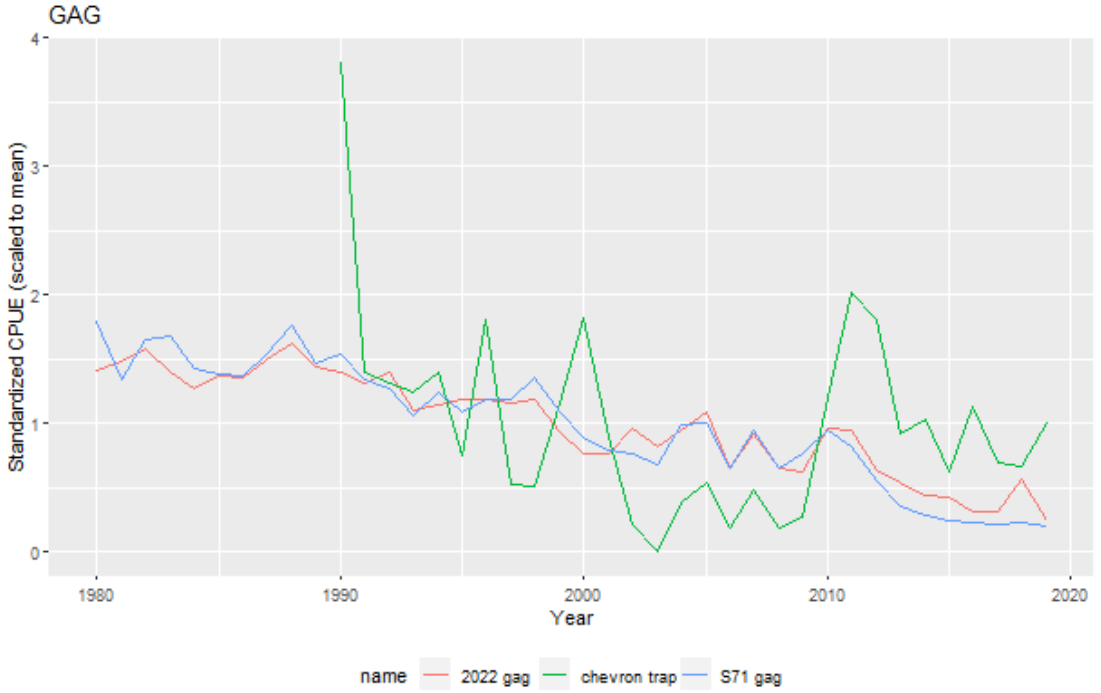
GTF EXAMPLE

- Trips by year and region
- Positive gag trips
- Outliers
- Stephens and MacCall by time block
- Trips retained
- Proportion of trips retained by year
- Positive only versus S&M input
- dGLM diagnostics
- Index results

GAG

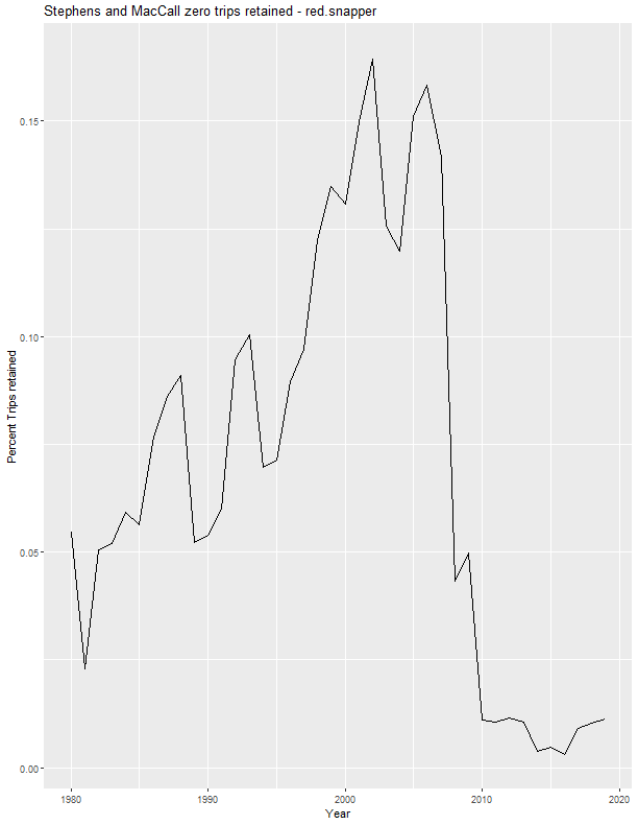

Positive gag trips retained
Trips
1000
0
-1000
1980
1990
2000
2010
2020
Retained
no
yes
Zero gag trips retained
Trips
0
-2000
-4000
-6000
-8000
1980
1990
2000
2010
2020
Retained
no
yes

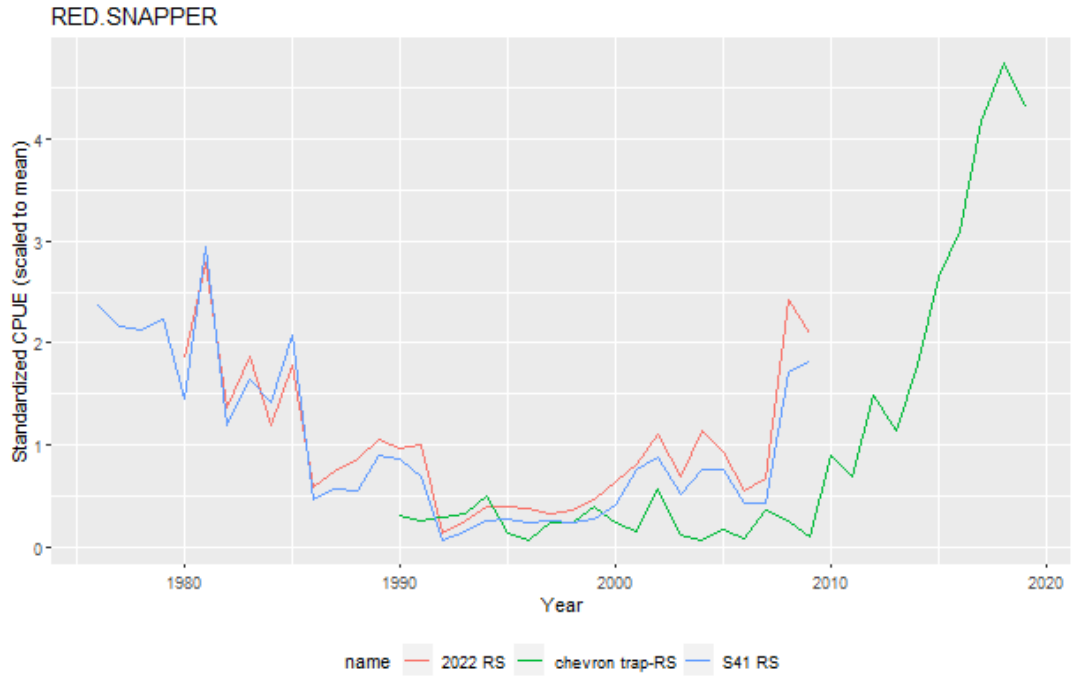

Stephens and MacCall zero trips retained - gag
Percent Trips retained
0.20
0.15
0.10
0.05
1980
1990
2000
2010
2020
Year


GAG
Standardized CPUE (scaled to mean)
4
3
2
1
0
1980
1990
2000
2010
2020
Year
name
2022 gag
chevron trap
S71 gag

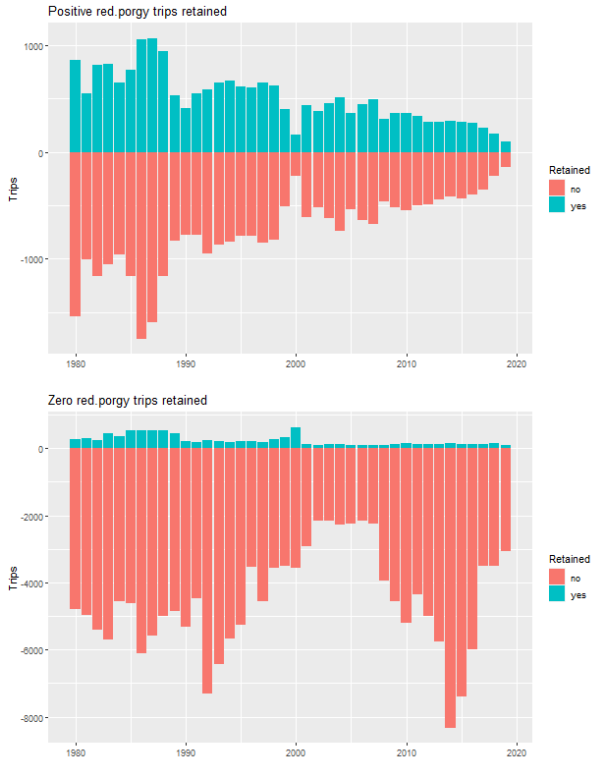
Red Snapper

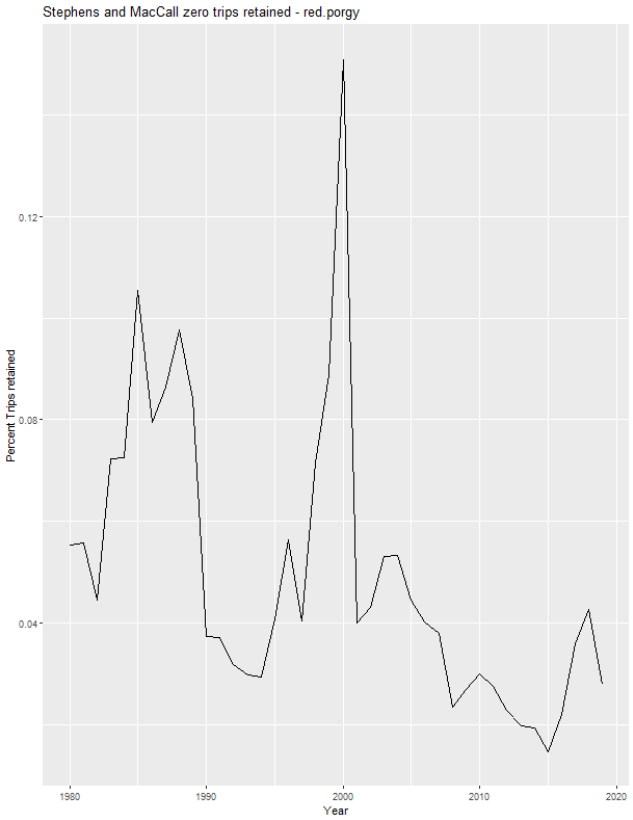
Positive red.snapper trips retained
Trips
Retained
no
yes
Zero red.snapper trips retained
Trips
Retained
no
yes

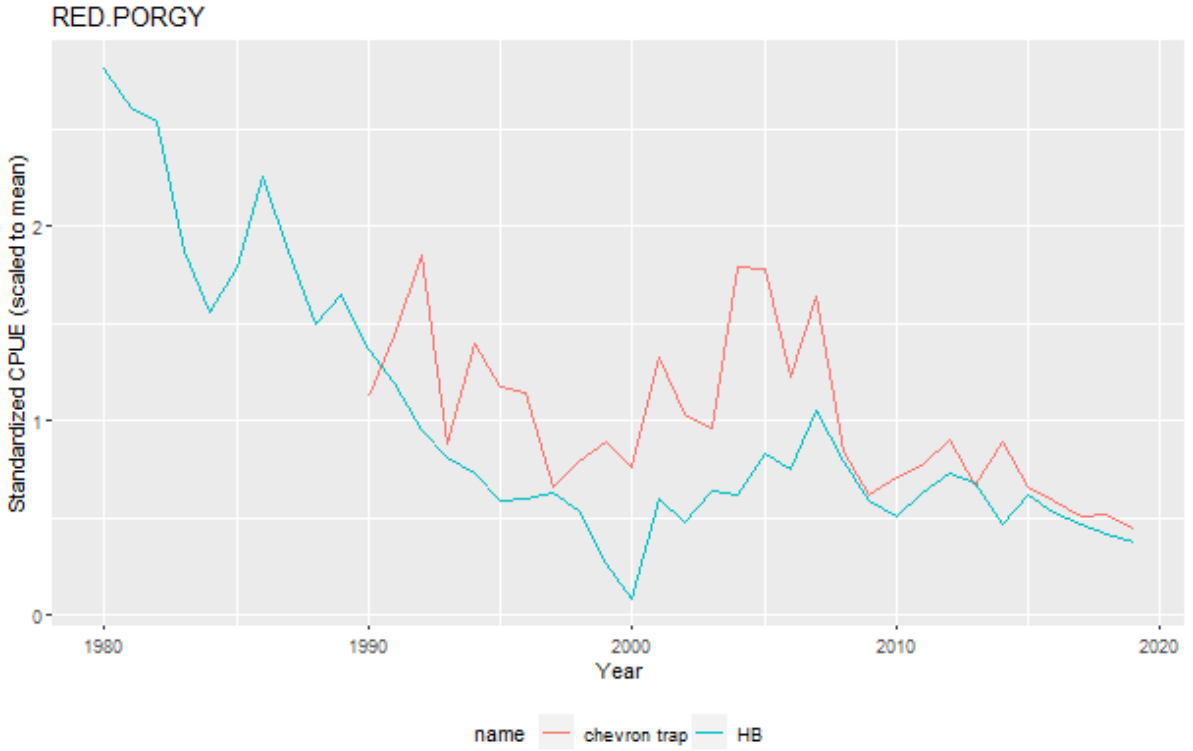

Stephens and MacCall zero trips retained - red.snapper
Percent Trips retained
Year


RED.SNAPPER
Standardized CPUE (scaled to mean)
Year
name
2022 RS
chevron trap-RS
S41 RS

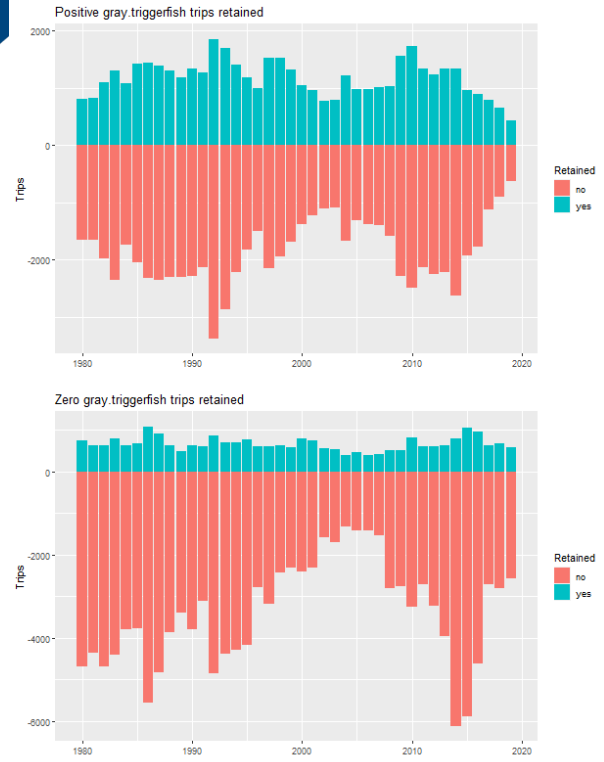
Red Porgy

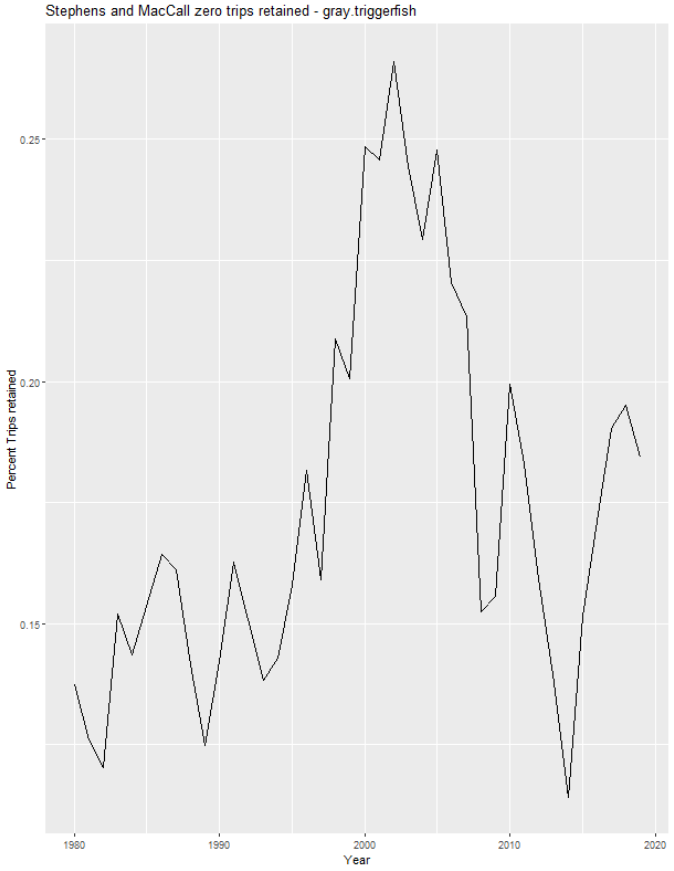

Positive red.porgy trips retained
Trips
1000
0
-1000
1980
1990
2000
2010
2020
Retained
no
yes
Zero red.porgy trips retained
Trips
0
-2000
-4000
-6000
-8000
1980
1990
2000
2010
2020
Retained
no
yes


Stephens and MacCall zero trips retained - red.porgy
Percent Trips retained
0.12
0.08
0.04
1980
1990
2000
2010
2020
Year

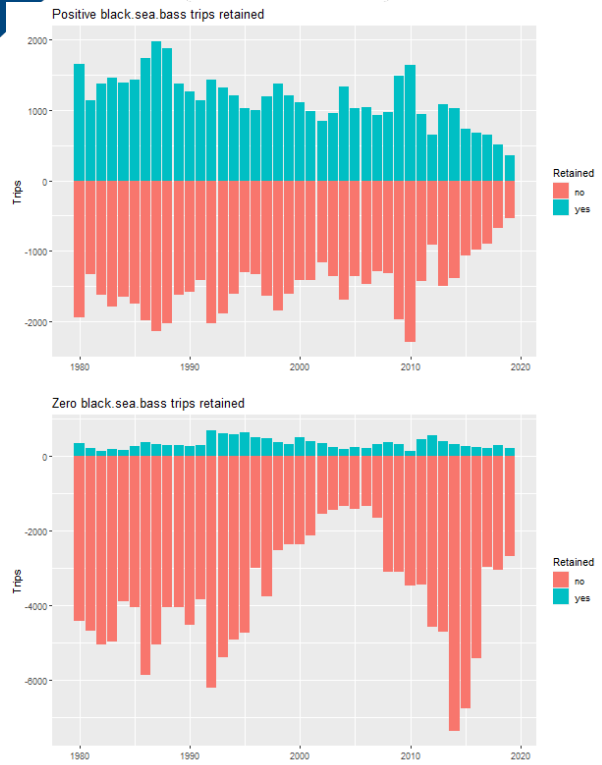

RED.PORGY
Standardized CPUE (scaled to mean)
2
1
0
1980
1990
2000
2010
2020
Year
name
chevron trap
HB

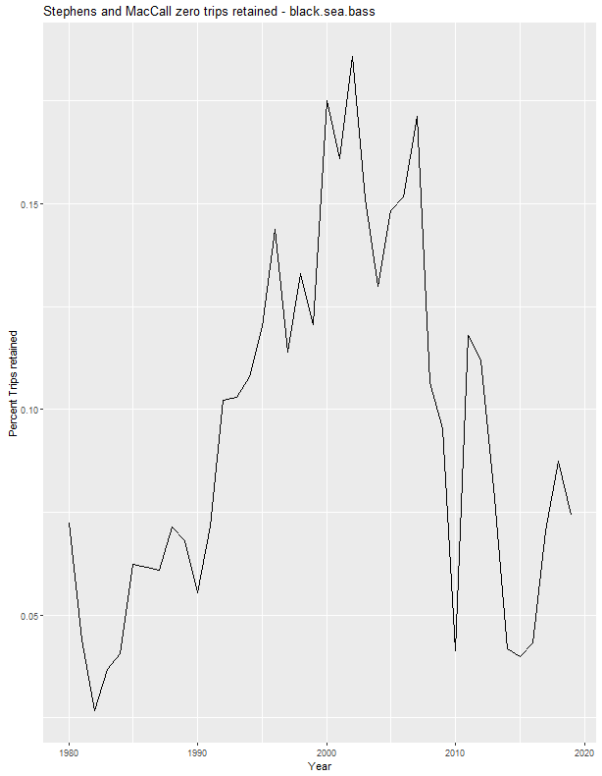
Gray triggerfish

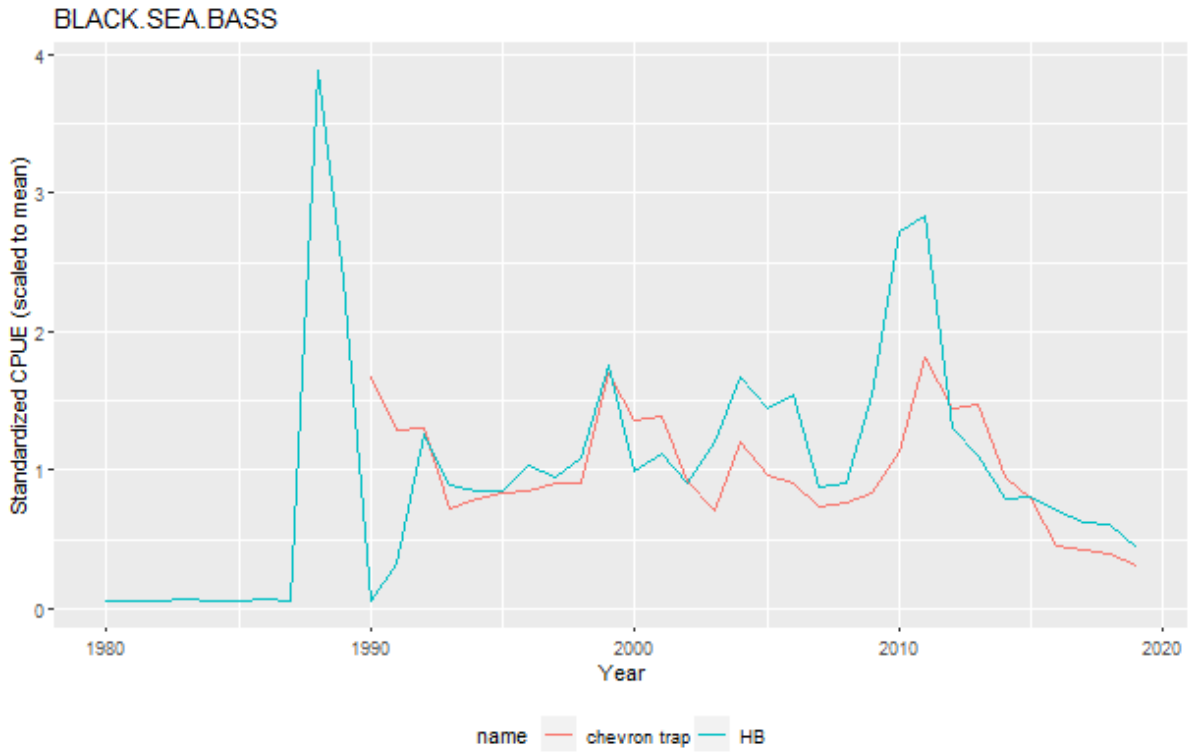




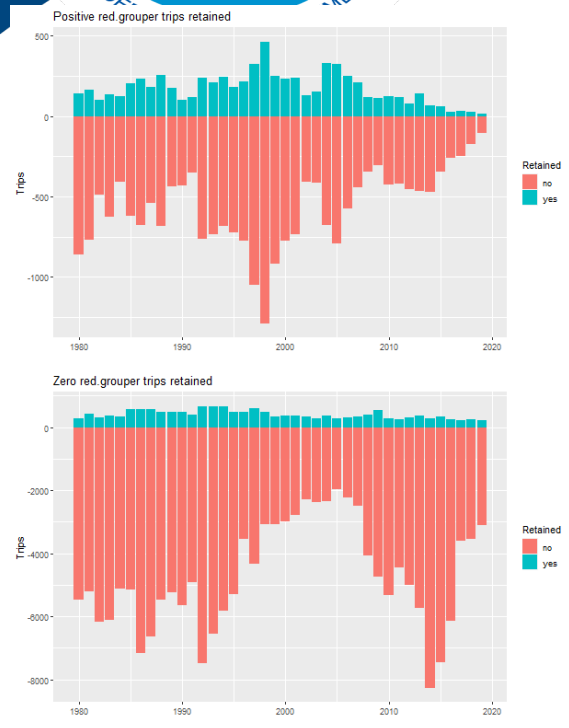
Black sea bass

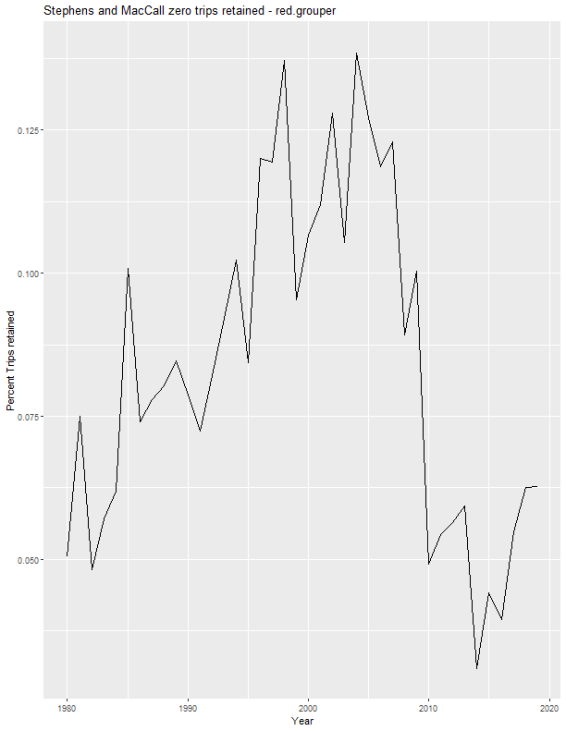


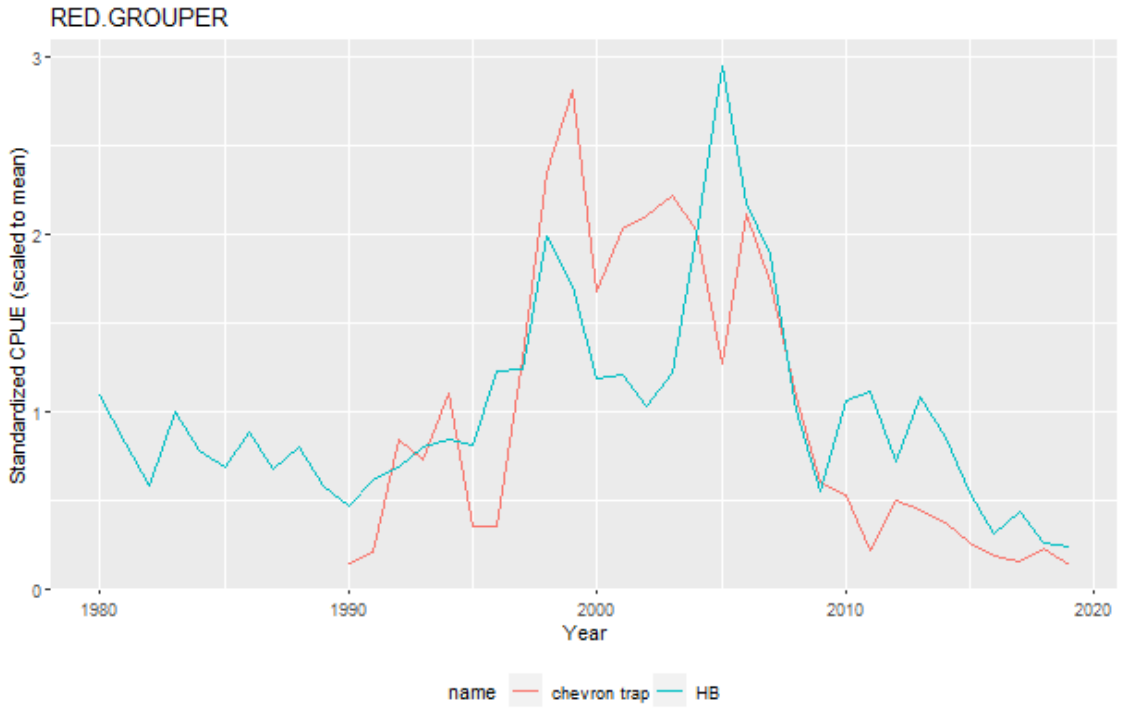




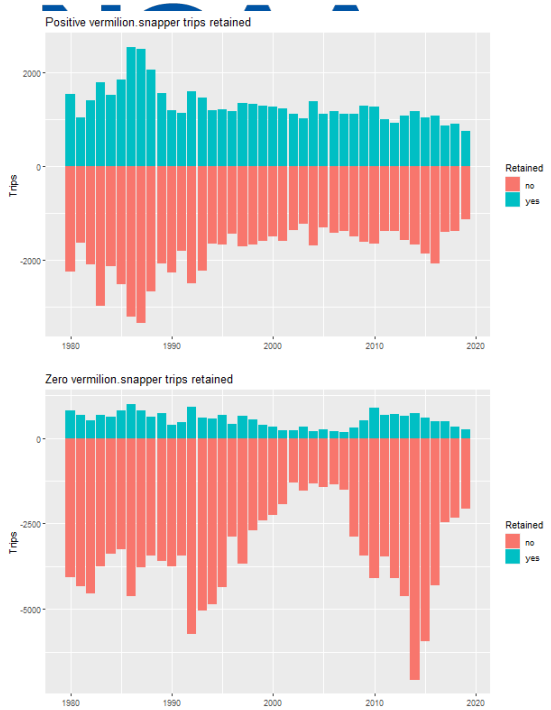
Red grouper

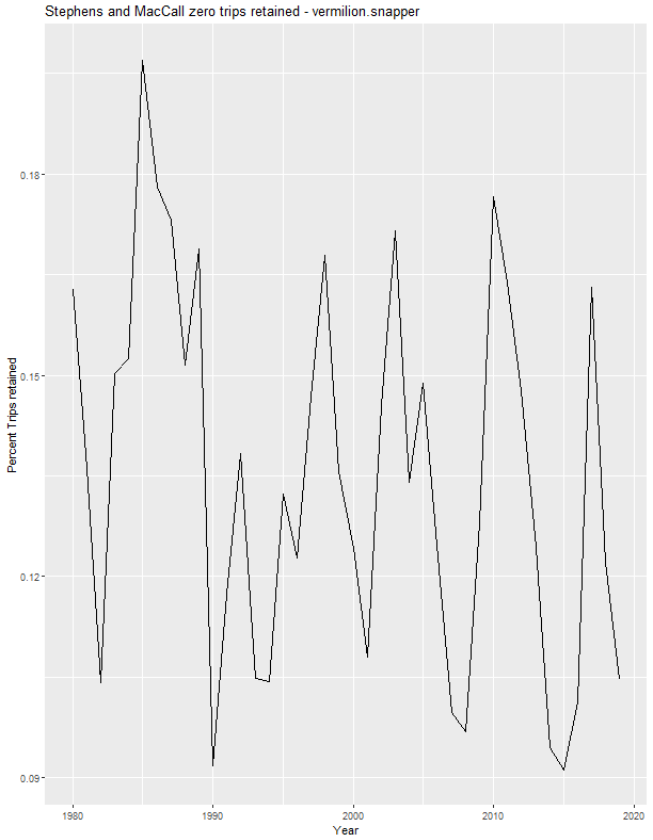

Positive red.grouper trips retained
Trips
Retained
no
yes
Zero red.grouper trips retained
Trips
Retained
no
yes

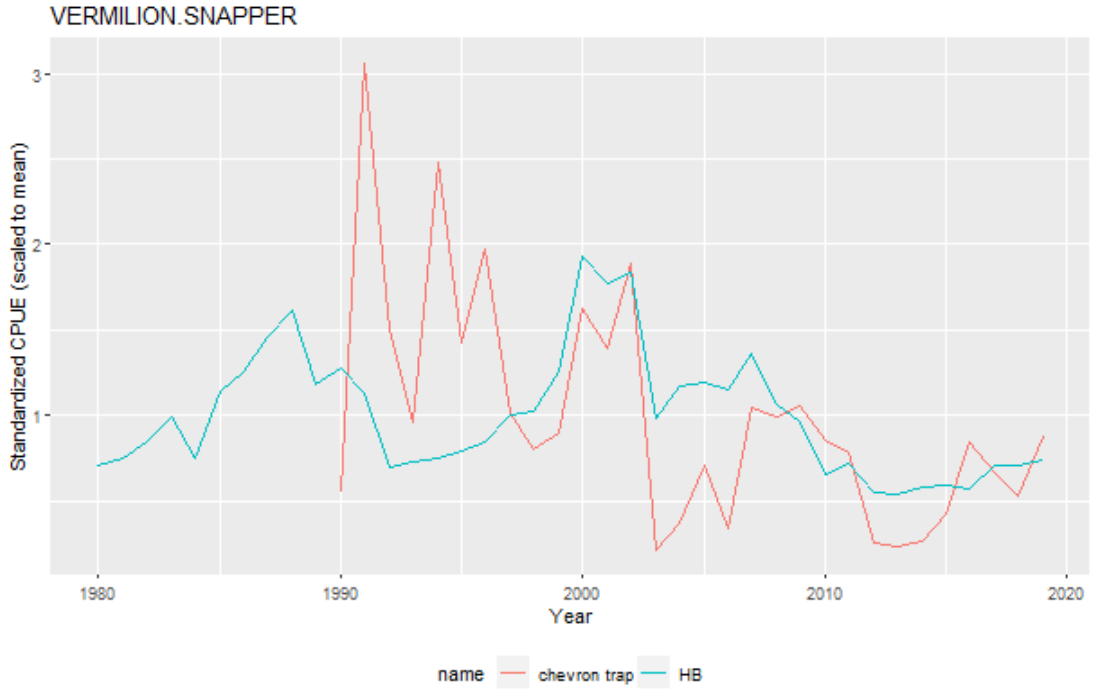

Stephens and MacCall zero trips retained - red.grouper
Percent Trips retained
Year


RED.GROUPER
Standardized CPUE (scaled to mean)
Year
name
chevron trap
HB

Vermilion snapper

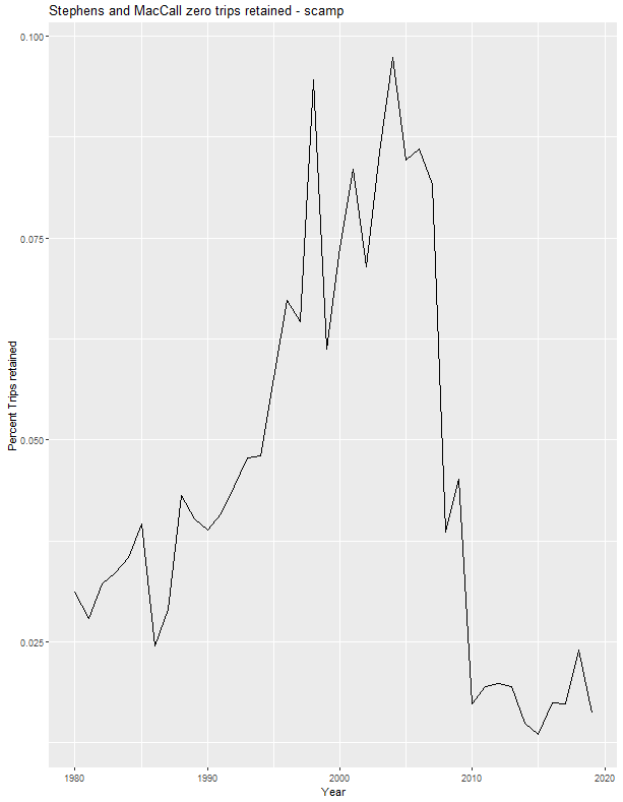


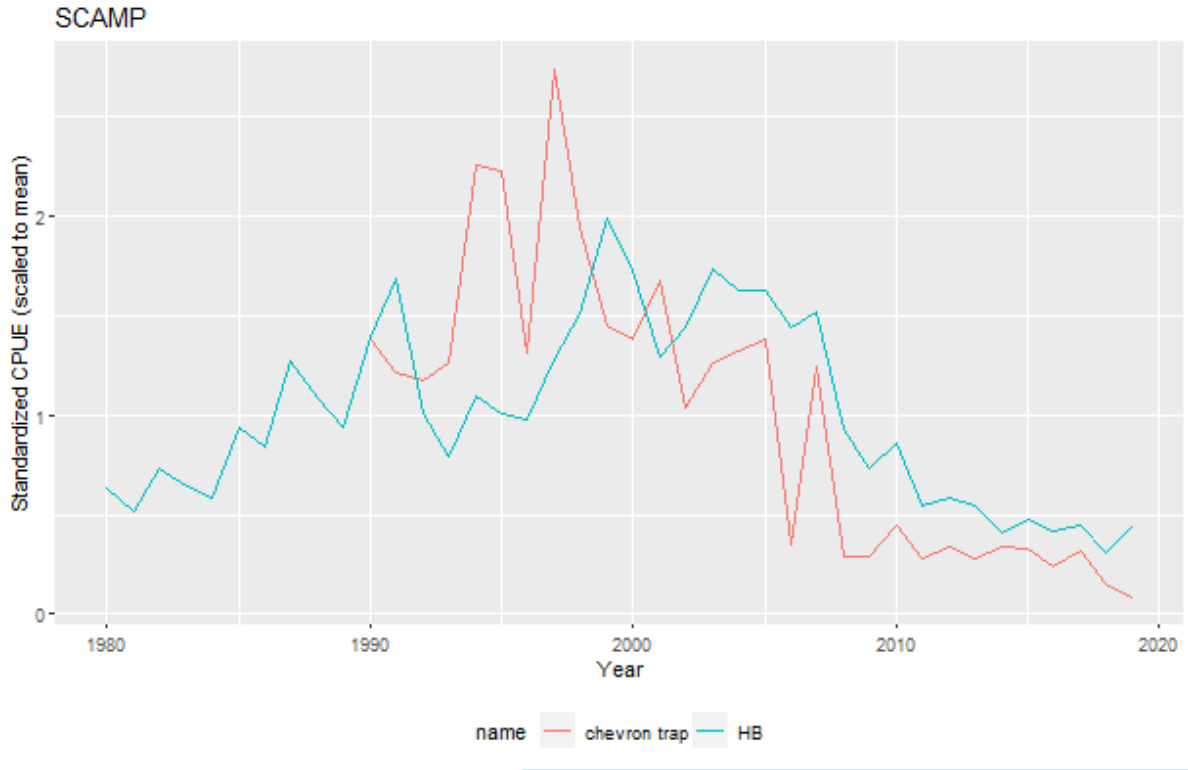


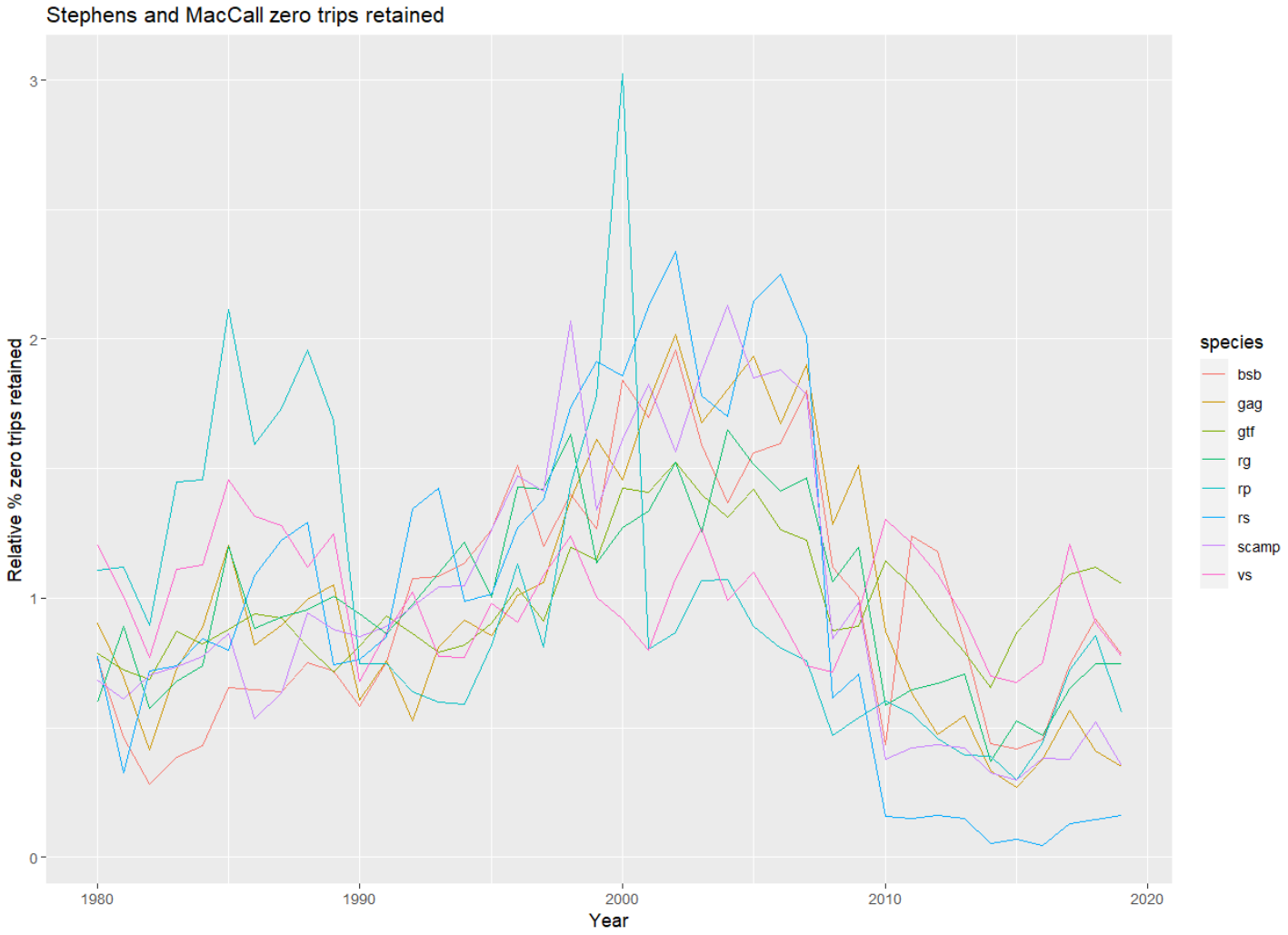


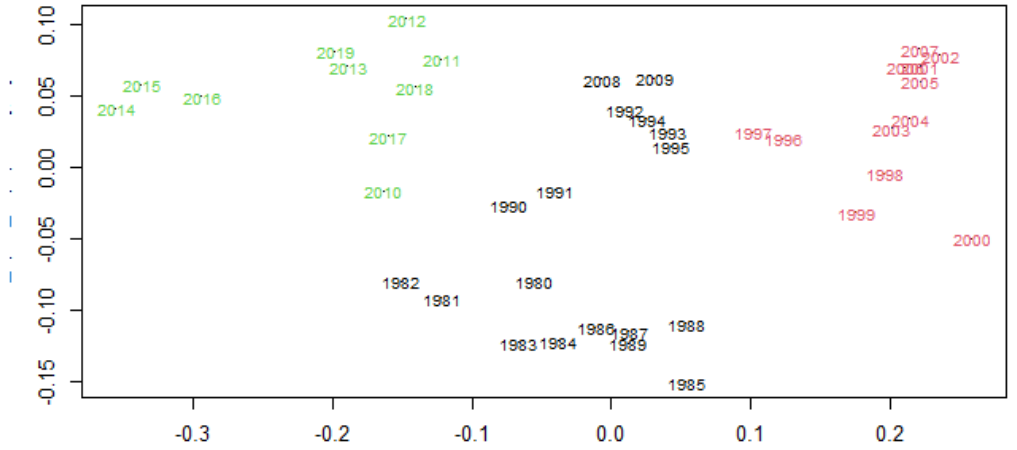
Scamp

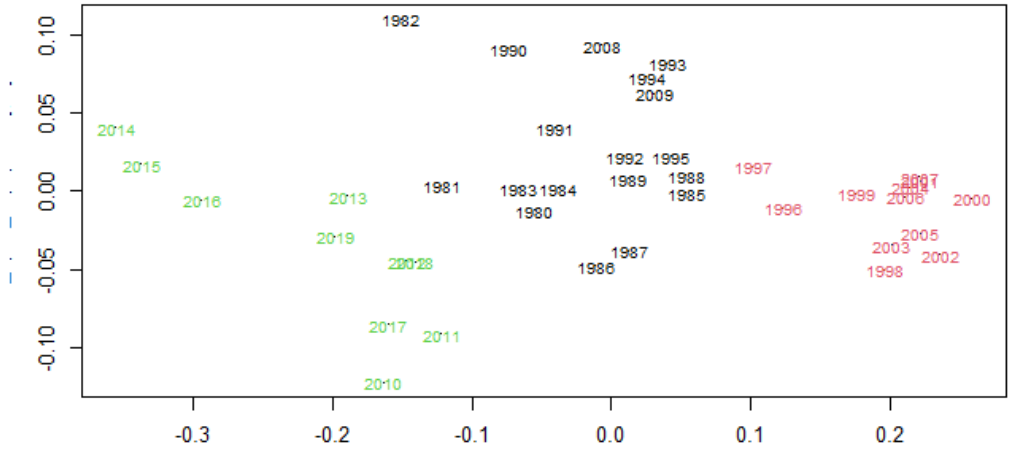
Positive scamp trips retained
Trips
Retained
no
yes
Zero scamp trips retained
Trips
Retained
no
yes


Stephens and MacCall zero trips retained - scamp
Percent Trips retained
Year


SCAMP
Standardized CPUE (scaled to mean)
Year
name
chevron trap
HB


Stephens and MacCall zero trips retained
Relative % zero trips retained
Year
0
1
2
3
1980
1990
2000
2010
2020
species
bsb
gag
gtf
rg
rp
rs
scamp
vs


0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.3
-0.2
-0.1
0.0
0.1
0.2


0.10
0.05
0.00
-0.05
-0.10
-0.3
-0.2
-0.1
0.0
0.1
0.2

0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.10
-0.05
0.00
0.05
0.10

NOAA FISHERIES

SUMMARY

- Pattern suggesting decrease in proportion positive by species and region
- Pattern suggesting decrease in number of vessels with positive trips by species and region
- Consistent decline starting in approximately 2010 in how Stephens and MacCall is identifying effective effort (retaining zero trips)
- Species specific targeting in the headboat fishery due to management regulations

Recommendation:

- A cautionary approach should be taken when developing fishery dependent indices for use in the stock assessment process.
- The burden of proof should be providing additional evidence that these fishery dependent indices are reflecting trends in abundance (i.e., compared to fishery independent indices, presence of strong year class in age comps corresponding to the say year in the index, etc.).
- It should now be assumed 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.).