2ND REVIEW OF THE STOCK ASSESSMENT OF YELLOWFIN TUNA IN THE EASTERN PACIFIC OCEAN
La Jolla, California (USA) 02-06 December 2019

Japanese longline fishery fishing ground - expansion and shrinkage -

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Outline

1. Define fishing ground
2. Describe history of this fishery development and shrinkage
3. Assess effect of EEZ for CPUE standardization process
4. Future work

1. Define fishing ground

Purpose

Some longline vessels move from Ocean to Ocean. For the convenience to describe vessel strategy, fishing ground is defined using a cluster analysis. Simultaneously, the fishing ground may include information about target species in this area.

Method

- Cluster analysis (K-means) was applied the dataset including location (latitude, longitude), number of active years (years for utilized as fishing ground) and 10 + one combined species catch number (bluefin, southern bluefin, bigeye, yellowfin, albacore, swordfish, striped marlin, black marlin, blue marlin and one combined species (shortbill spearfish + sailfish).
- To avoid missing value for these species catch, the period of analysis is from 1965 to 2018.
- Three different seeds were tested to confirm robustness of the clustering results.
- The number of cluster was referred the results by elbow method and average silhouette method. However it is determined after try and error process looking at species composition, number of catch, geographical distribution and more for each cluster.
- EEZ location is obtained from http://www.marineregions.org/eezsearch.php

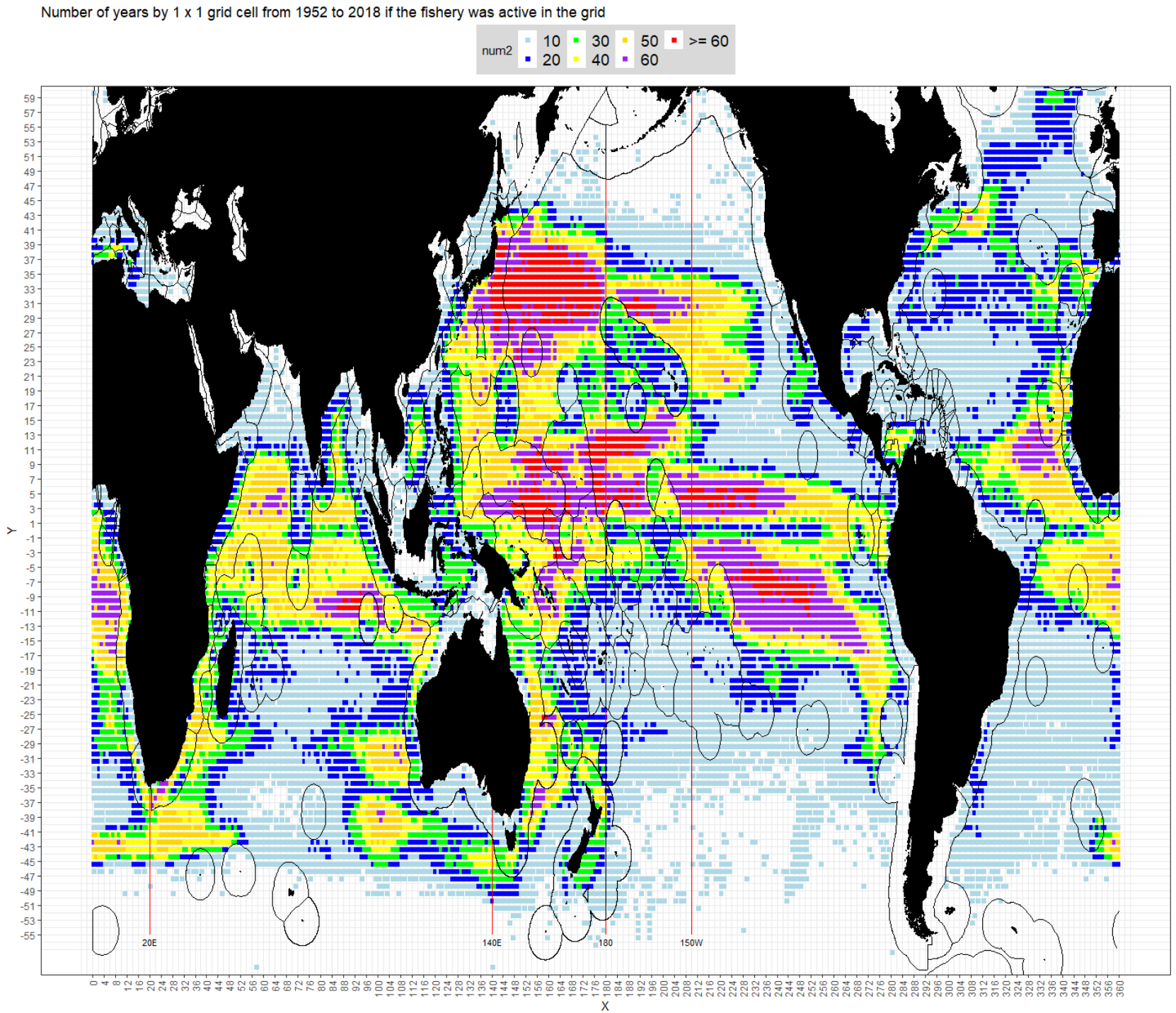
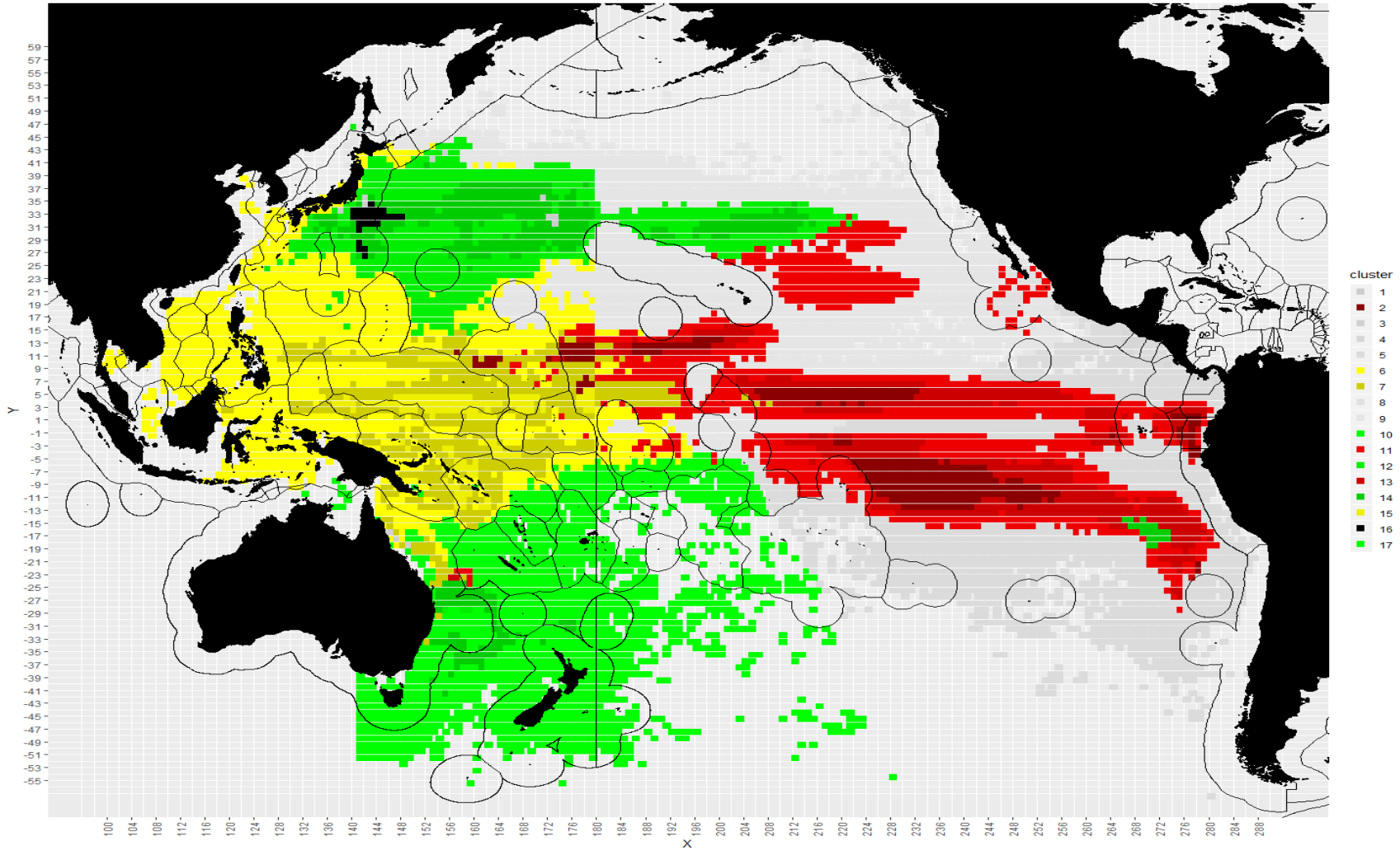
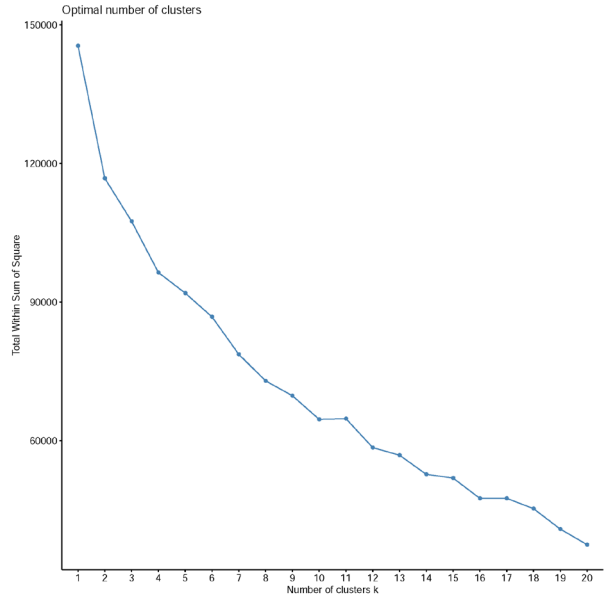


Figure. Number of active years for each 1 x 1 grid cell from 1952 to 2018.

- ✓ If Japanese longline fishery was active at a grid cell in a year, the cell obtain one active year. The cumulative number of year since 1952 was presented as the number of active years on this map.

1. Frequent utilized area by Japanese longline fishery, is surrounded by less utilized fishing area.
2. Also, their fishing grounds were strongly affected by implementation of economic exclusive zone and/or two hundred miles fishing zone (e.g., USA 200NM zone in the Pacific Ocean and the Atlantic Ocean, Maldives in the Indian Ocean, Azores (Portugal) in the Atlantic Ocean etc.).





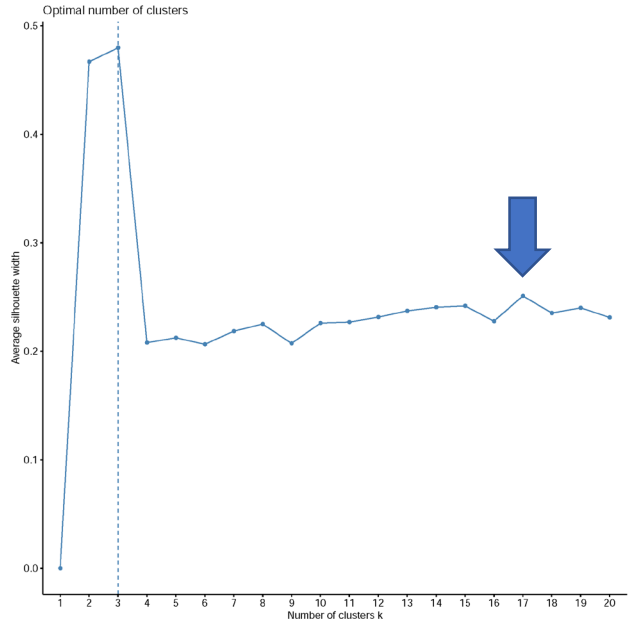


Figure 31. Cluster analysis for detection of fishing ground in the Pacific Ocean using 11 species and number of active year.

- ✓ 17 clusters.
- ✓ Red; bigeye dominated, Yellow; yellowfin, Green; southern bluefin and/or albacore, Black; Swordfish, Grey; Low effort

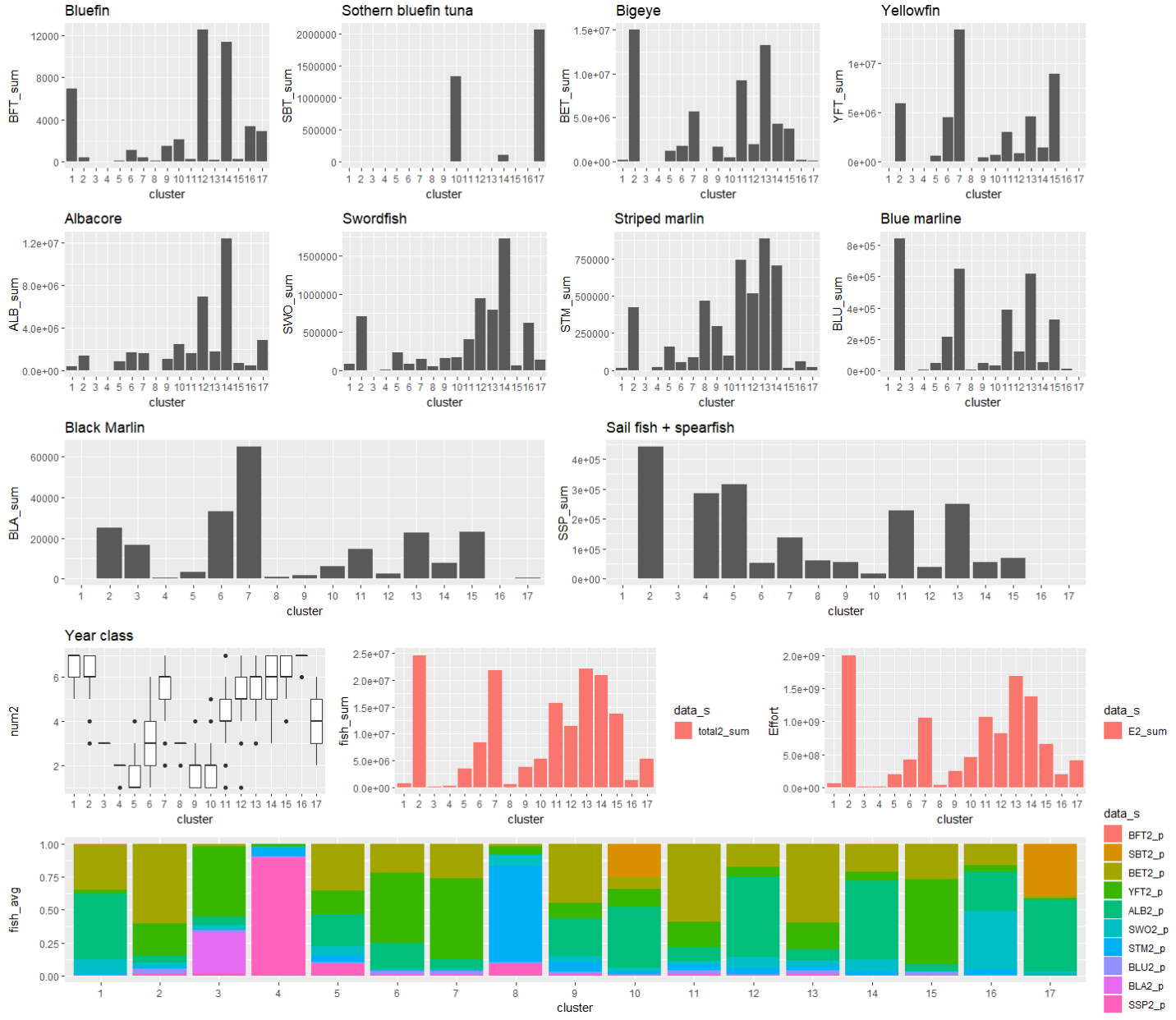


Figure 31. Cluster analysis for detection of fishing ground in the Pacific Ocean using 11 species and number of active year.

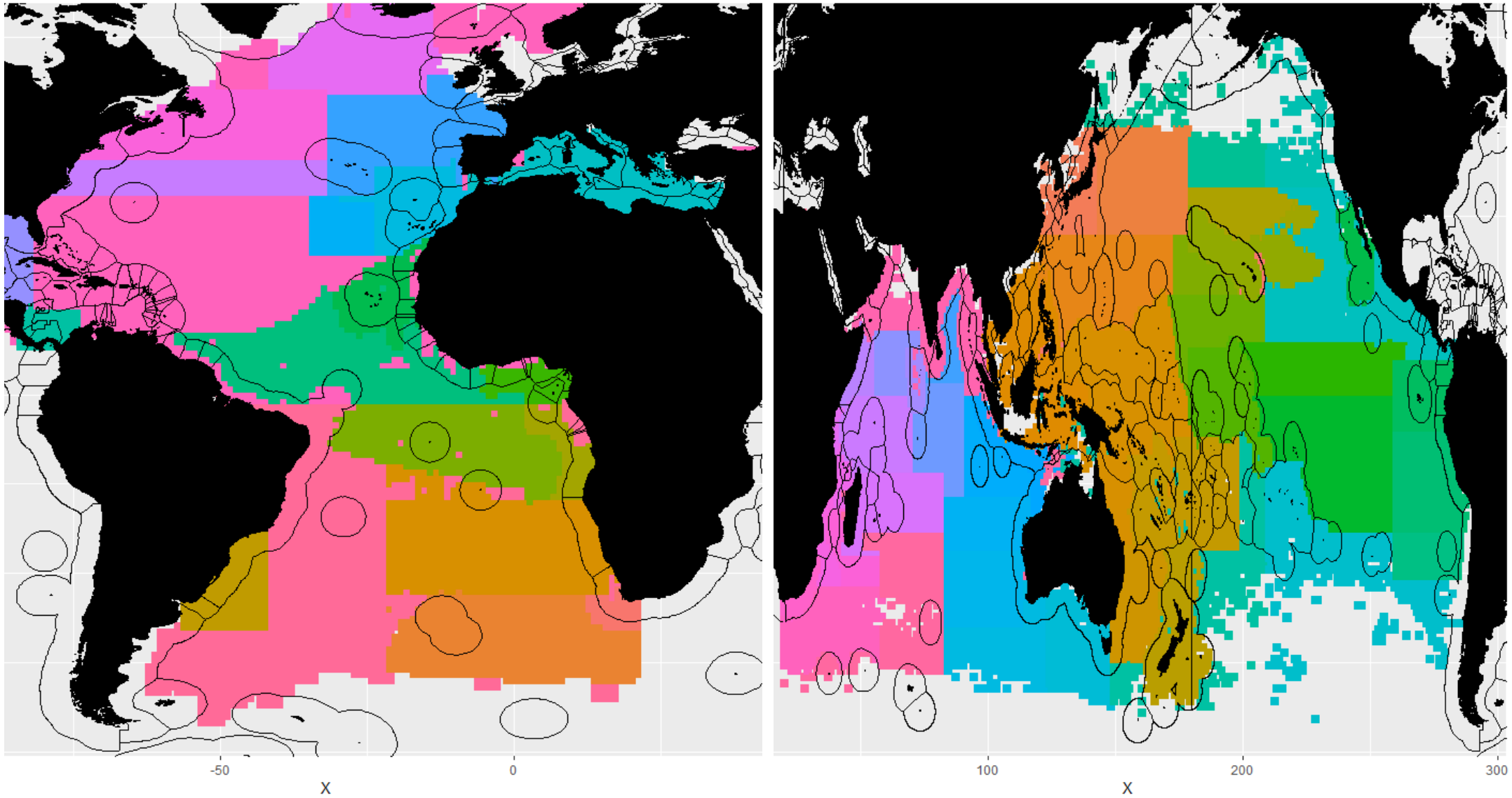
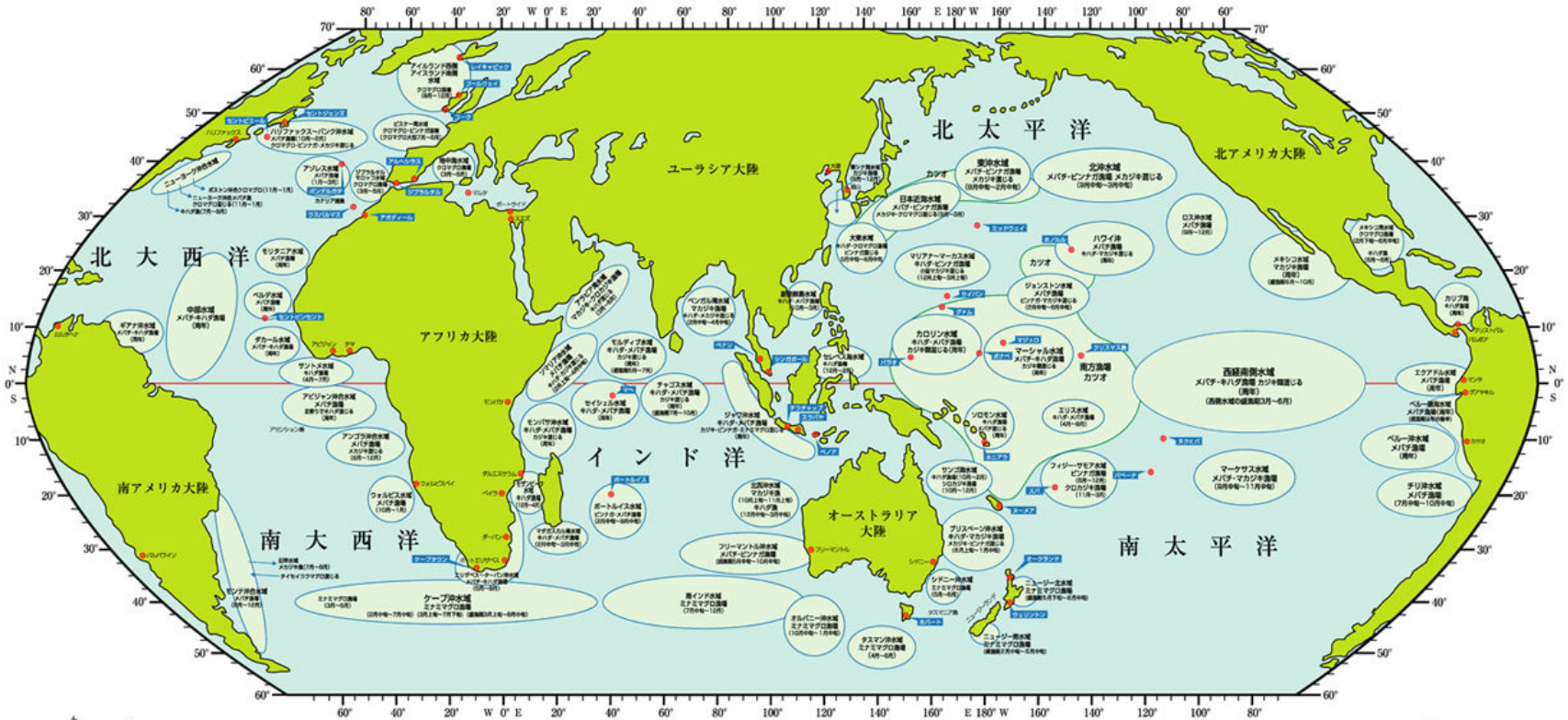


Figure. Fishing ground assignment.

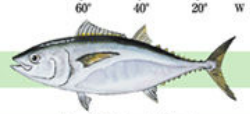
✓ Total of 64 fishing grounds were detected, which is similar to stake holder's perception.

マグロ・カツオの漁場/魚種



クロマグロ

成長すると体長3メートル、重さ400kgにもなる大型のマグロ。大西洋、地中海、日本近海等で獲れます。特に日本近海のものは、昔から親しまれてきたマグロです。また、本マグロとも呼ばれています。

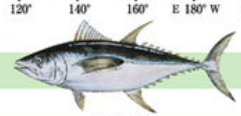


ミナミマグロ

大きいもので体長2メートル、重さ150kg以上になります。オーストラリア、ニュージーランド、南アフリカ（ケープタウン）沖の低水温の海域で獲れます。脂が乗っていることから高級マグロとして寿司屋、料亭で良く使われます。また、インドマグロとも呼ばれています。

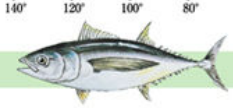
メバチ

体長2メートル、重さ150kg以上にもなり、体型はクロマグロに最も似ていますが、胸ビレが大きいところが異なります。赤道をはさんで南北の緯度約35度にわたる広い範囲で獲れます。漁獲量の一番多いマグロで目玉が大きくぱっちりしていることから目鉢マグロと呼ばれています。



キハダ

大きいもので体長2メートル、重さ100kg以上になります。メバチとほぼ同じ漁場で獲れます。体型がスマートなのが特徴で、赤身のあっさりした味わいが楽しめます。肌が黄色いことから黄肌と呼ばれています。



ビンナガ

マグロ類の中では最も小型で、体長は1メートル前後。世界中の海に広く分布し、大回遊する小型のマグロです。長い刀状の胸びれが特徴で油漬の缶詰の原料になります。またトンボとも呼ばれています。

カツオ

体長90センチメートル。世界中の海に広く分布し、特に南方水域では一年中獲れます。腹側に濃青色のしまが入っているのが特徴です。カツオは用途が広く、刺身、タタキ、節、缶詰等に利用されます。

安心！ 安全！ 美味しい！
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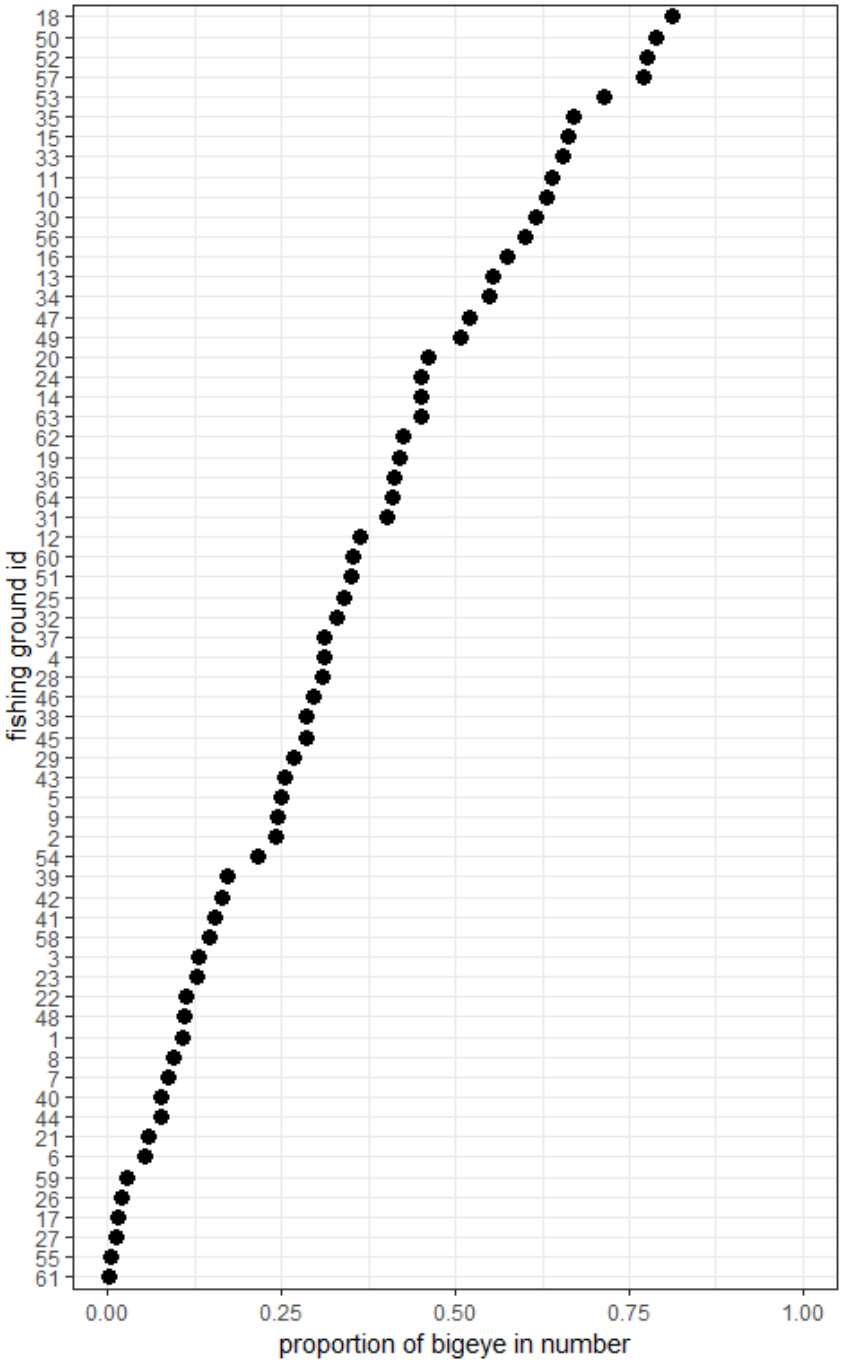
日本かつお・まぐろ漁業協同組合
日本かつお・まぐろ漁業協同株式会社
URL:http://www.japantuna.net/



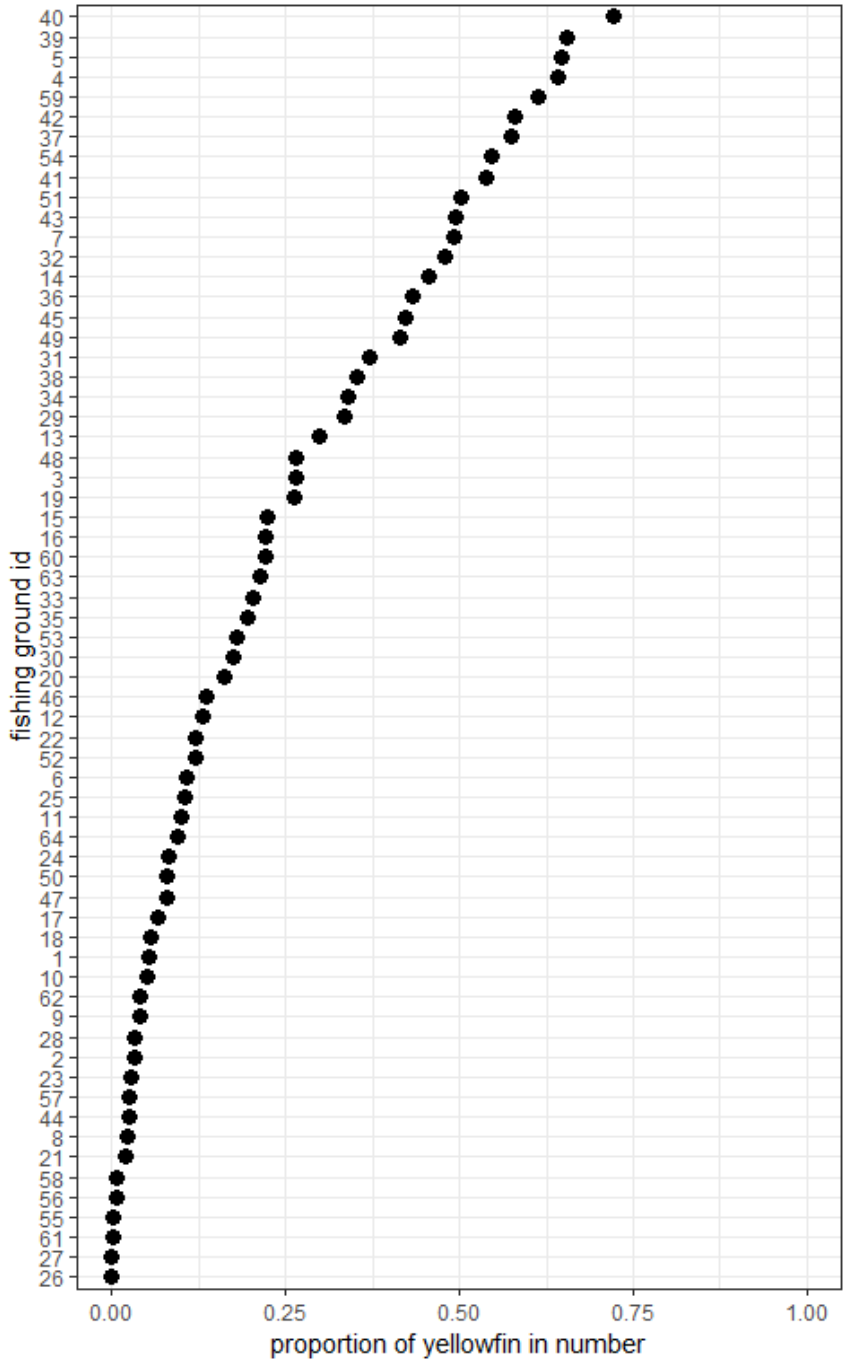
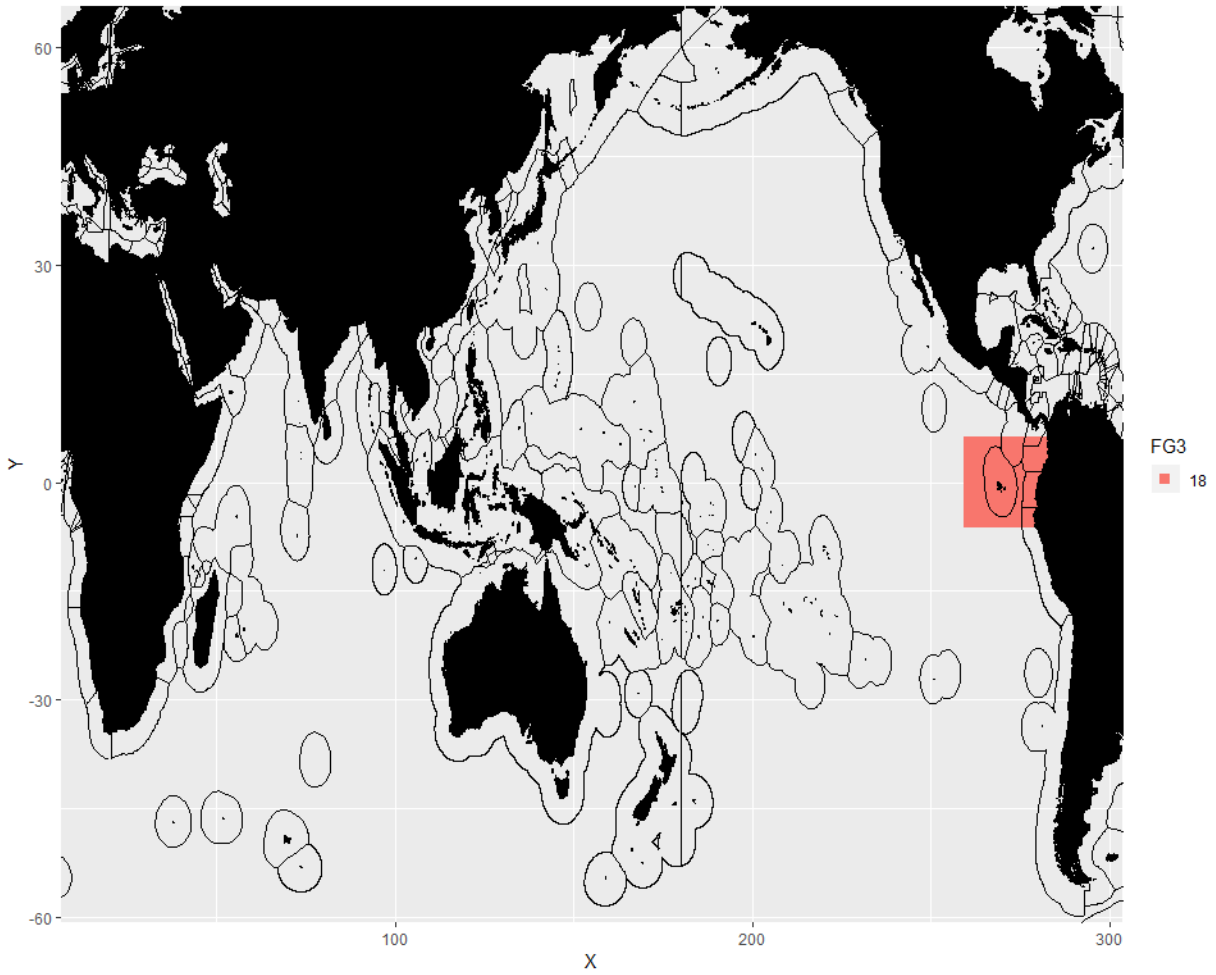


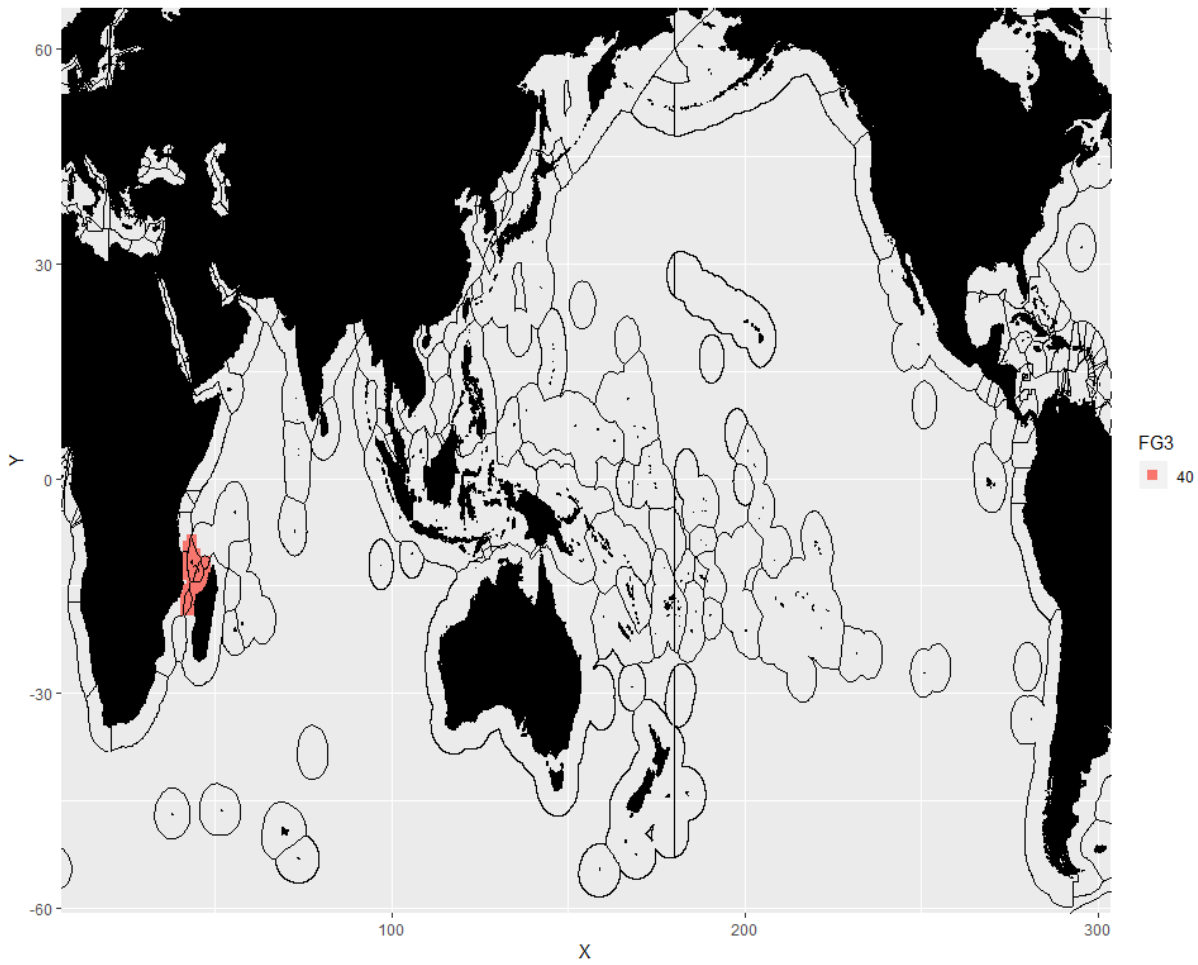
Figure 35. Species proportion in number, total catch number and effort by fishing ground.

The fishing ground ground id of 18(off Ecuador) presented highest bigeye proportion, more than 75%, which can consider the vessel selected this fishing ground mainly target on bigeye, while the vessel selected fishing ground id 40 (Mozambique channel west) targeted on yellowfin.

fishing ground id 18(off Ecuador)



fishing ground id 40 (Mozambique channel west)



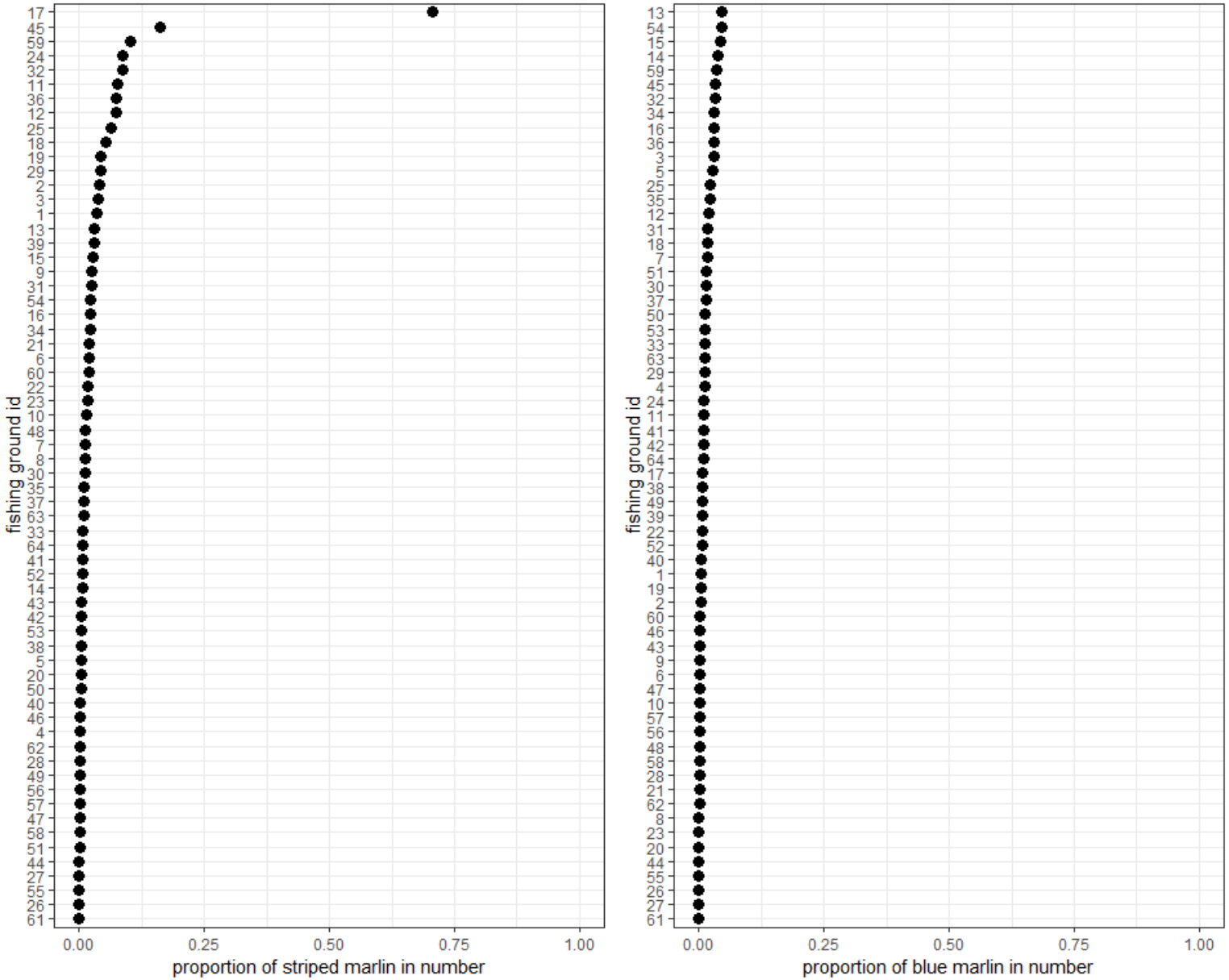
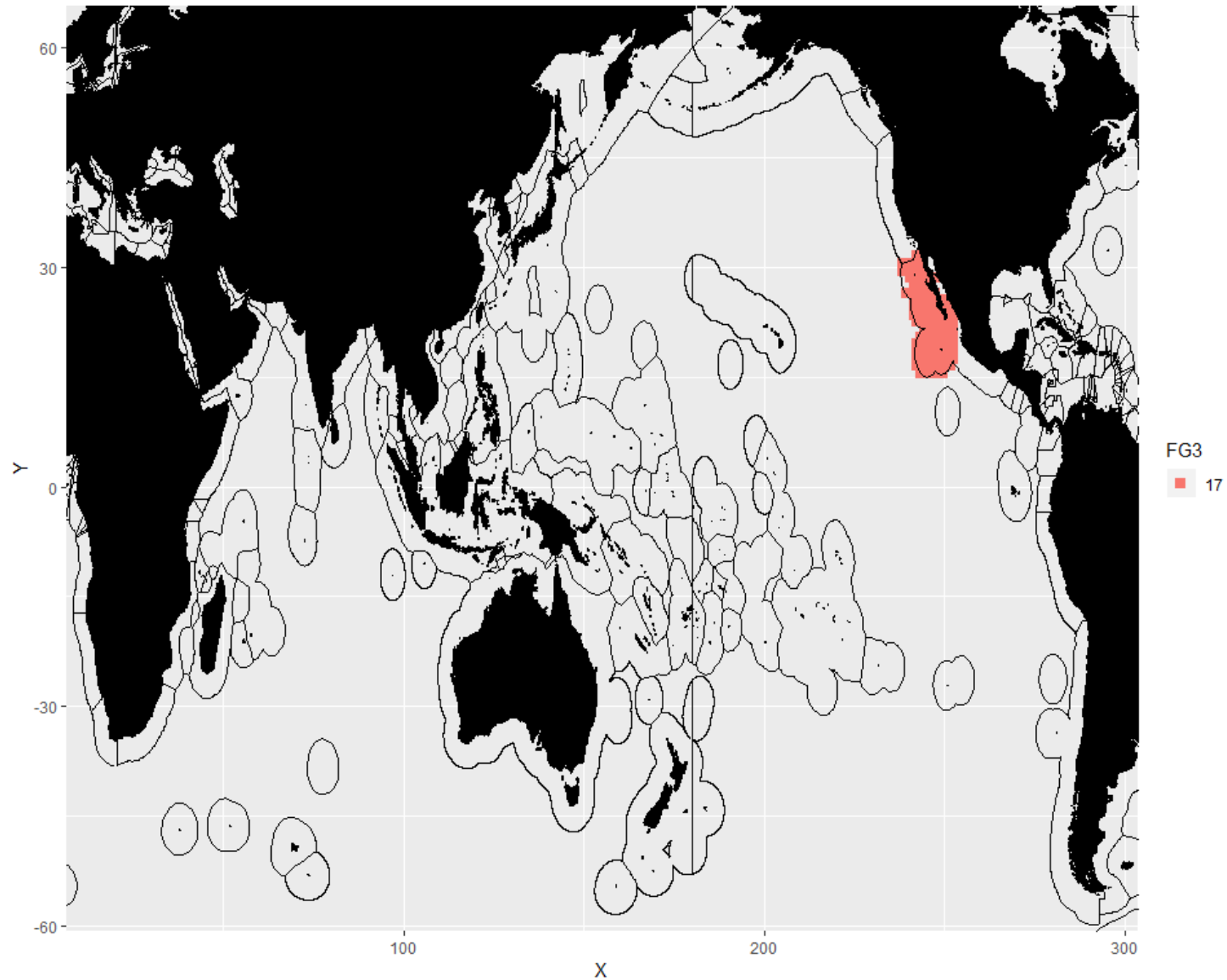


Figure 35. Other species results.

fishing ground id 17 (off Mexico, Pacific side)

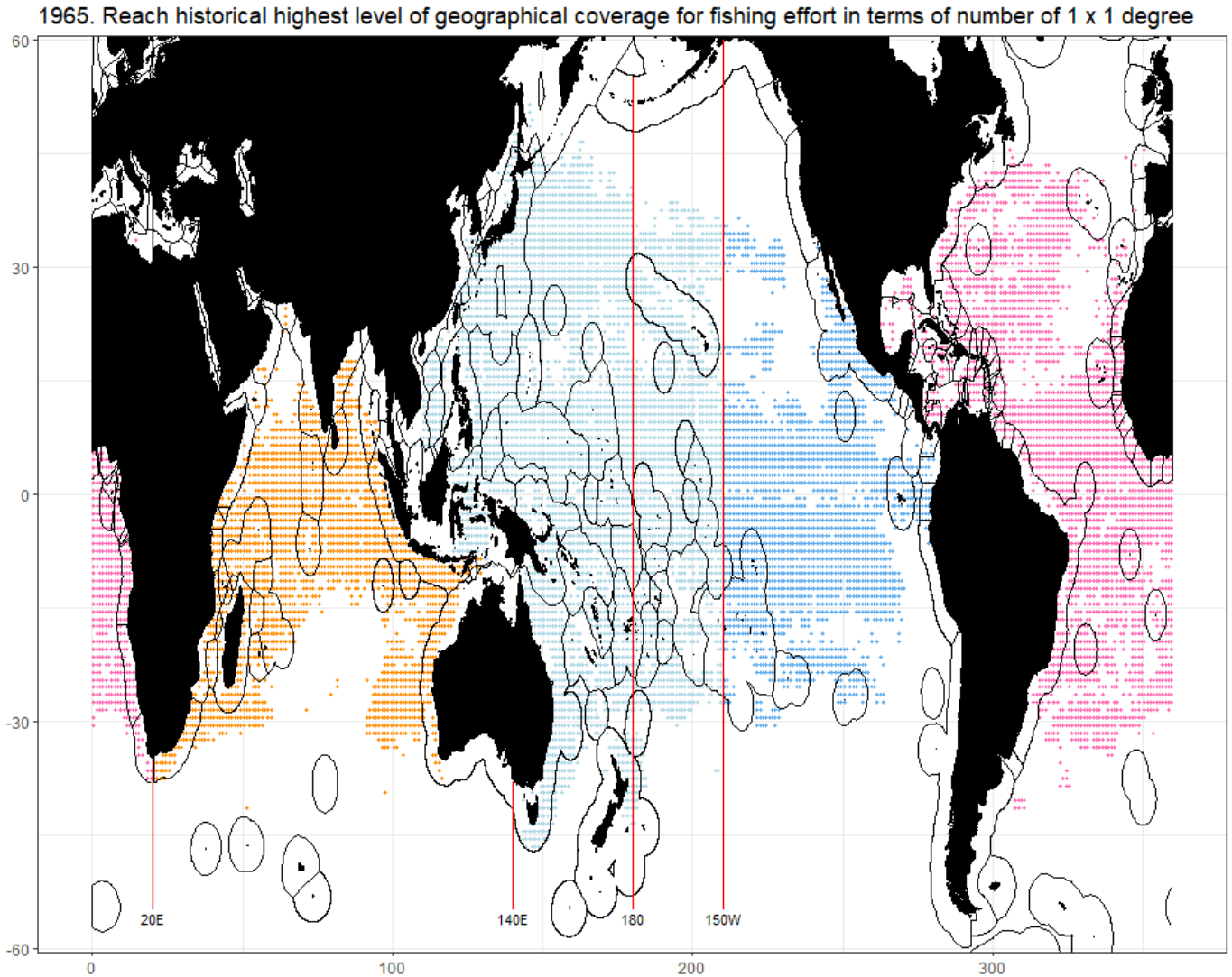


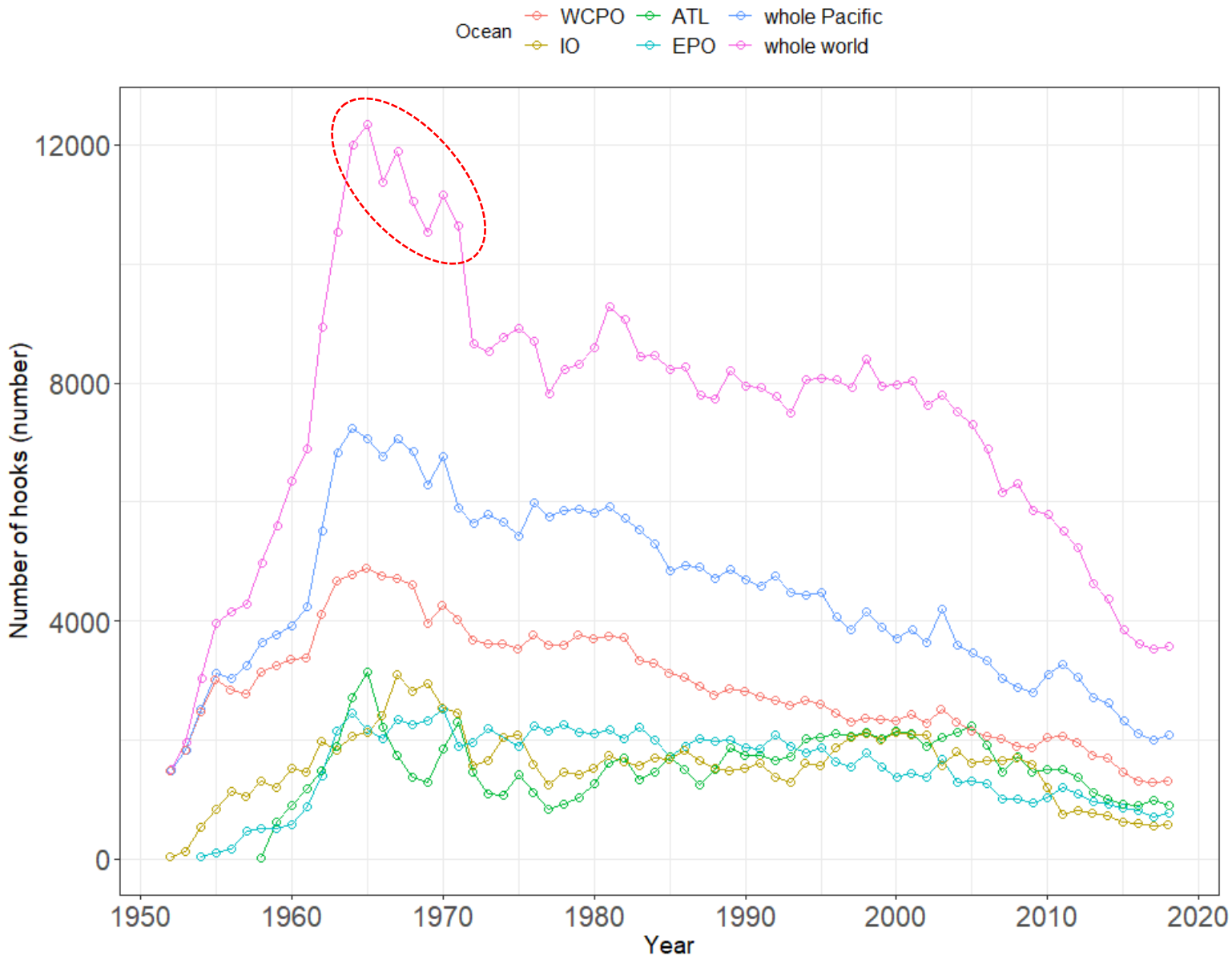
2. Describe history of this fishery development and shrinkage

Purpose
During the fishing ground development, it is recognized that their fishing grounds were strongly affected by implementation of economic exclusive zone and/or two hundred miles fishing zone. The description of history of EEZ implementation is useful to consider sub area definition for CPUE standardization process.

year	event	El Ni?o / La Ni?a *1
1952	Start implementation of logbook data collecting system, and first record in IO	
1953		El Ni?o
1954	First record in EPO	La Ni?a
1955	Reach African continental east coastal area in IO	
1956		
1957		El Ni?o
1958	First record in ATL	
1959	Rapid expansion in ATL, reach American continental west and east coastal areas	
1960		
1961		
1962		
1963		El Ni?o
1964		La Ni?a
1965	Reach historical highest level of geographical coverage for fishing effort in terms of number of 1 x 1 degree in 1965 and showed higher level until 1972, which reflected fishing vessel's searching activity to seek good fishing ground in the state of insufficient information on distribution of tuna species. The "Convention on Fishing and Conservation of the Living Resources of the High Seas" was entered into force at 20 March 1966, which could restrict further expansion of this expansion of #### In addition, in this era main target species was albacore and/or yellowfin. However knowledge for distribution of other tuna and tuna related species were fully gathered untik early 1970. Even though it is limited the upper layer of ocean because of their fishing gear were mainly shallow set.	El Ni?o

1965. Reach historical highest level of geographical coverage for fishing effort in terms of number of 1 x 1 degree



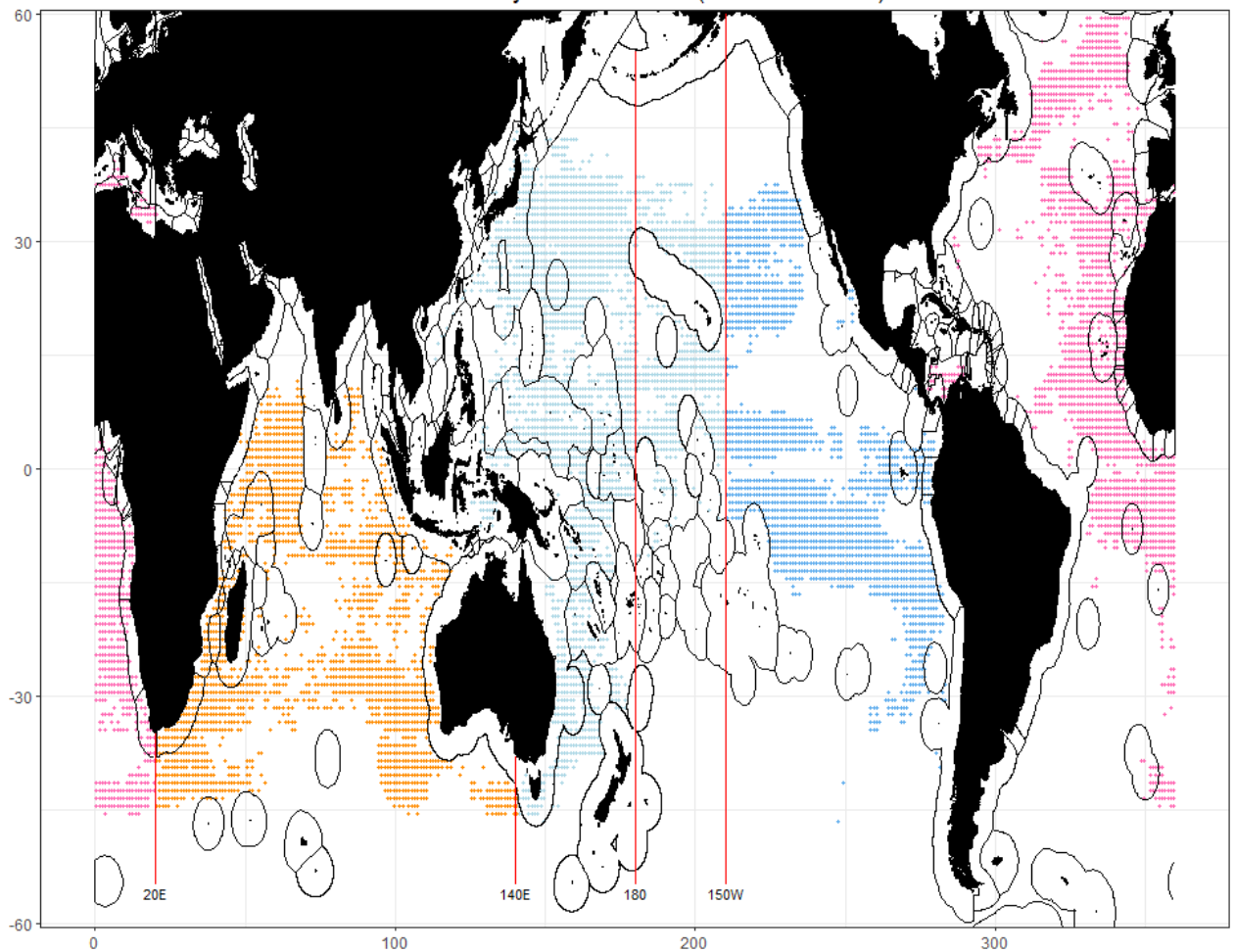

Ocean
WCPO
IO
ATL
EPO
whole Pacific
whole world
Number of hooks (number)
12000
8000
4000
0
1950
1960
1970
1980
1990
2000
2010
2020
Year

year	event
1996	Small and occasinal effort in French Polynesia after 1996 (WCPO and EPO)
1997	Small and occasional effort in New Caledonia (France) 200NM (WCPO) after 1997
1998	No effort in Australia 200 NM after 1998
1999	Domestic measure for reduction of JPN LL vessel by about 20% No effort in Equador (Galapagos) 200 NM after 2000

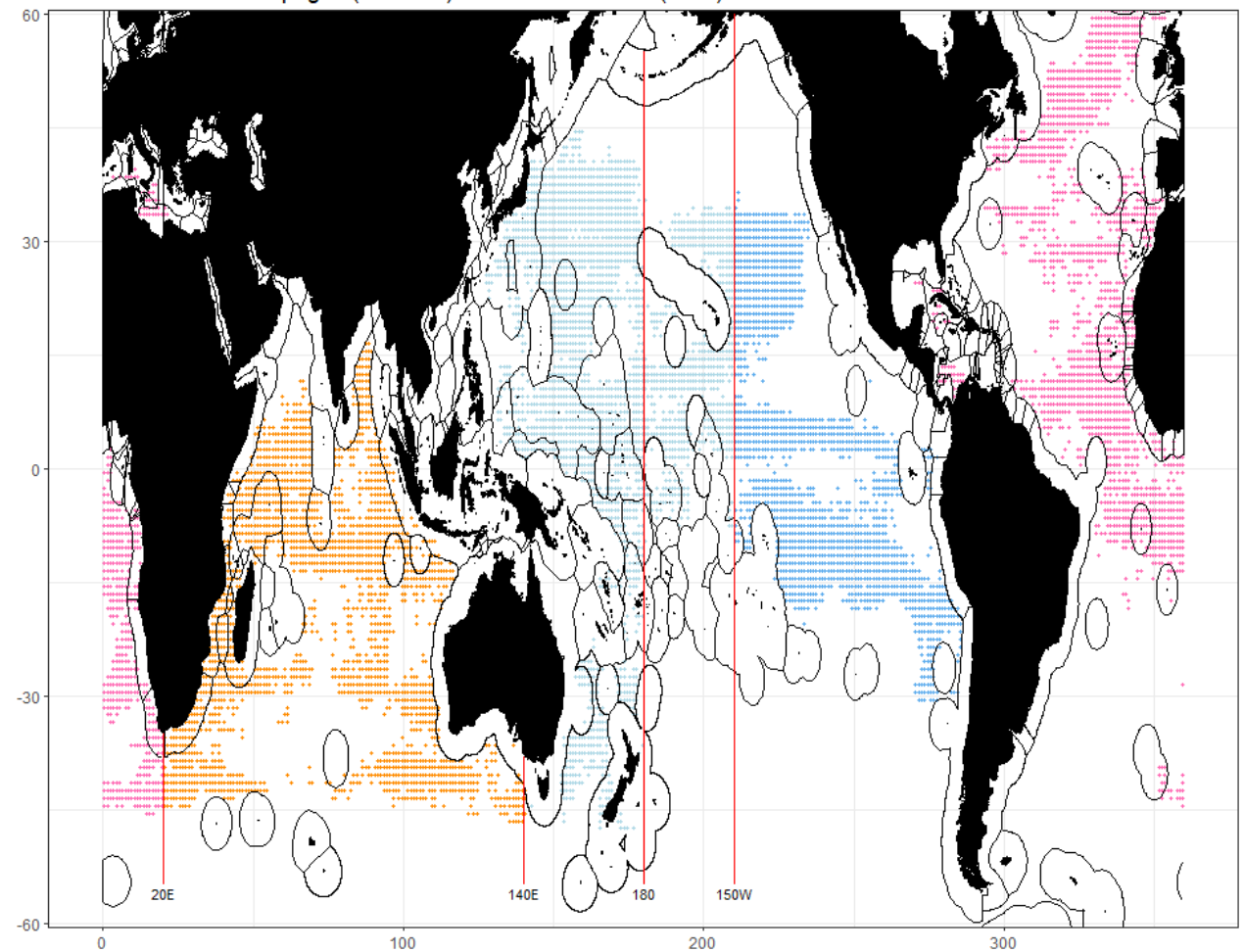
1996

1999

1996. Small and occasinal effort in French Polynesia after 1996 (WCPO and EPO)



1999. No effort in Galapagos (Ecuador) 200 NM after 1999 (EPO)



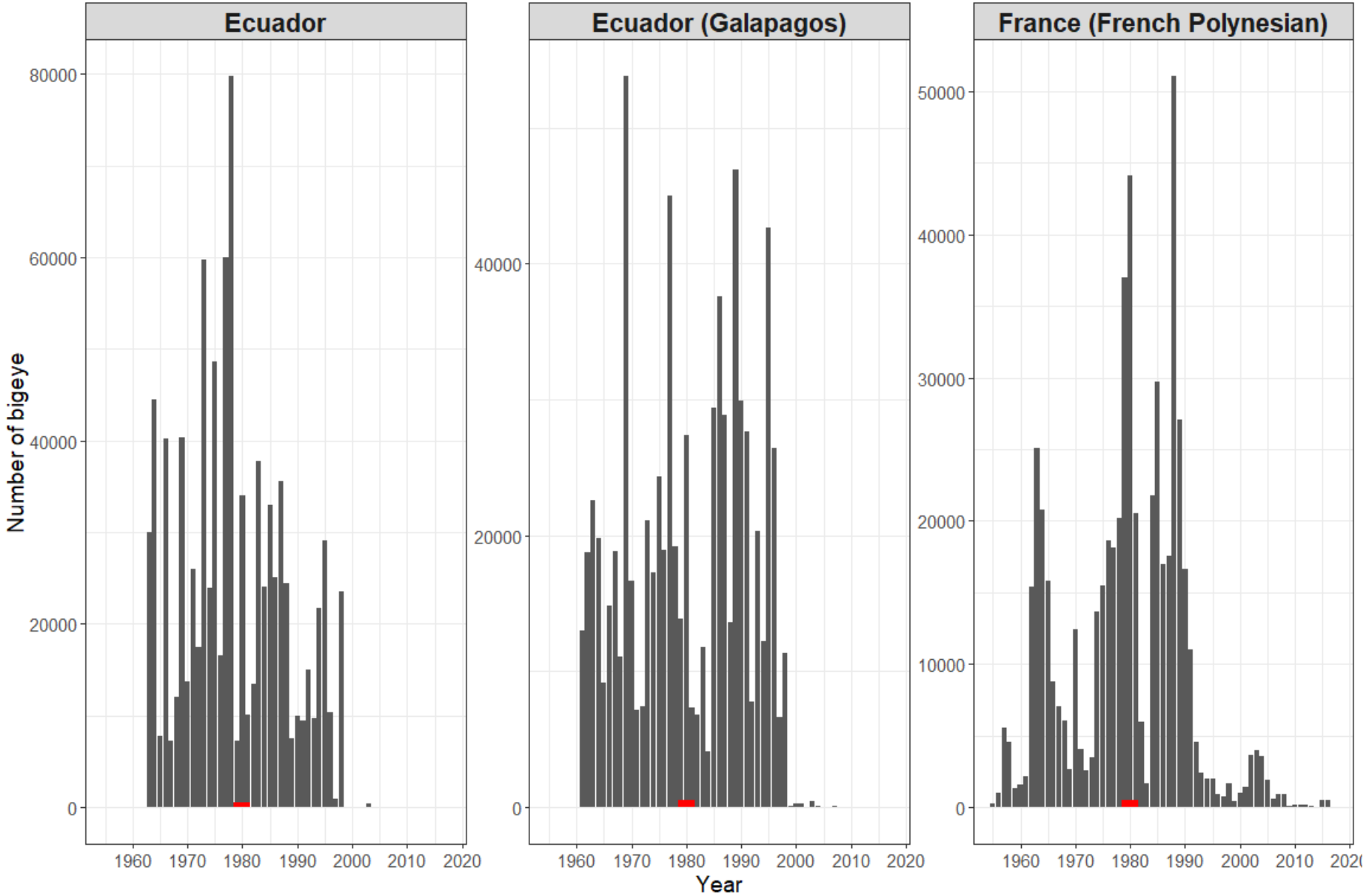


Figure . Catch of bigeye in number in the Galapagos and French Polynesia EEZ.

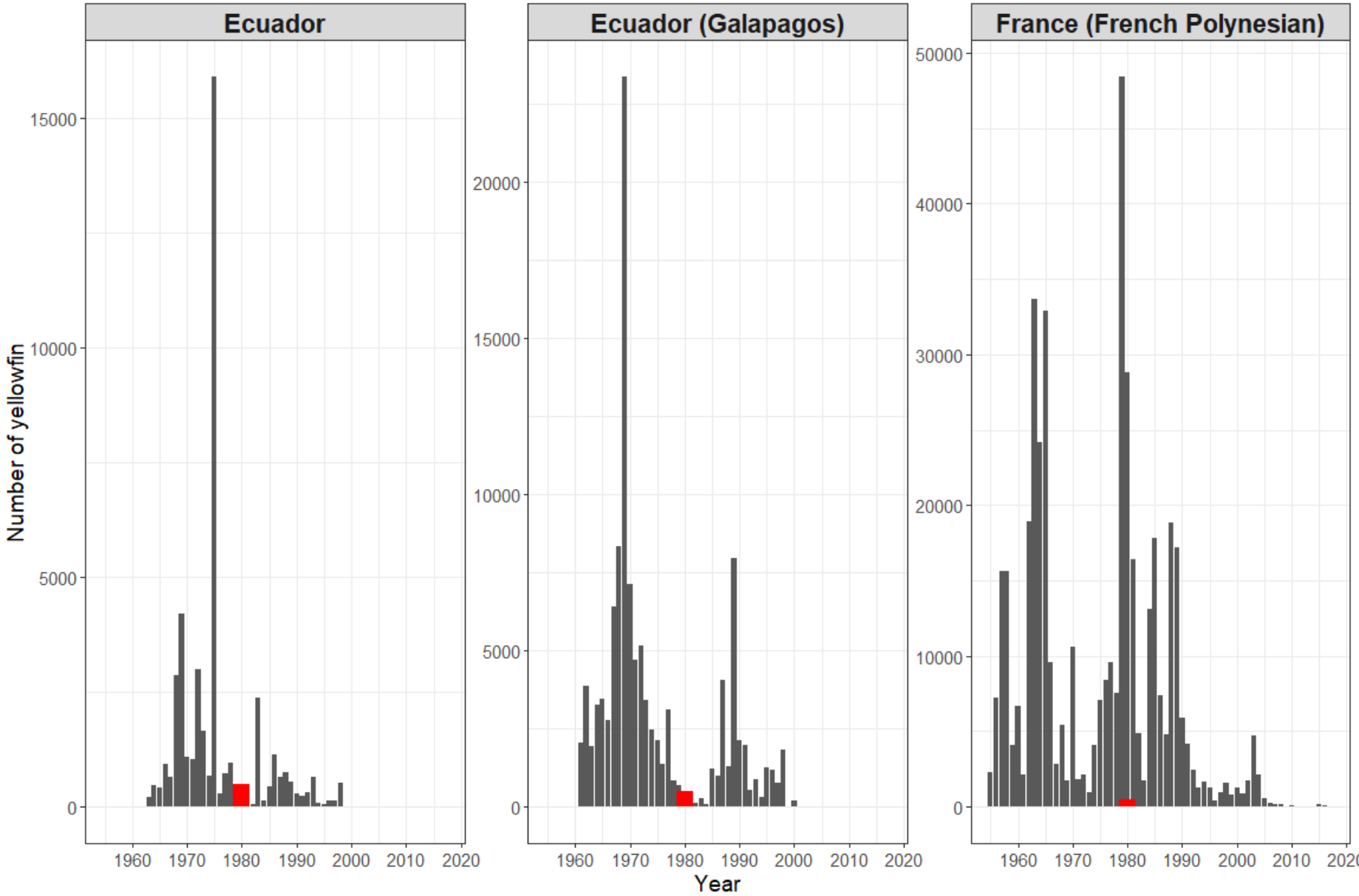
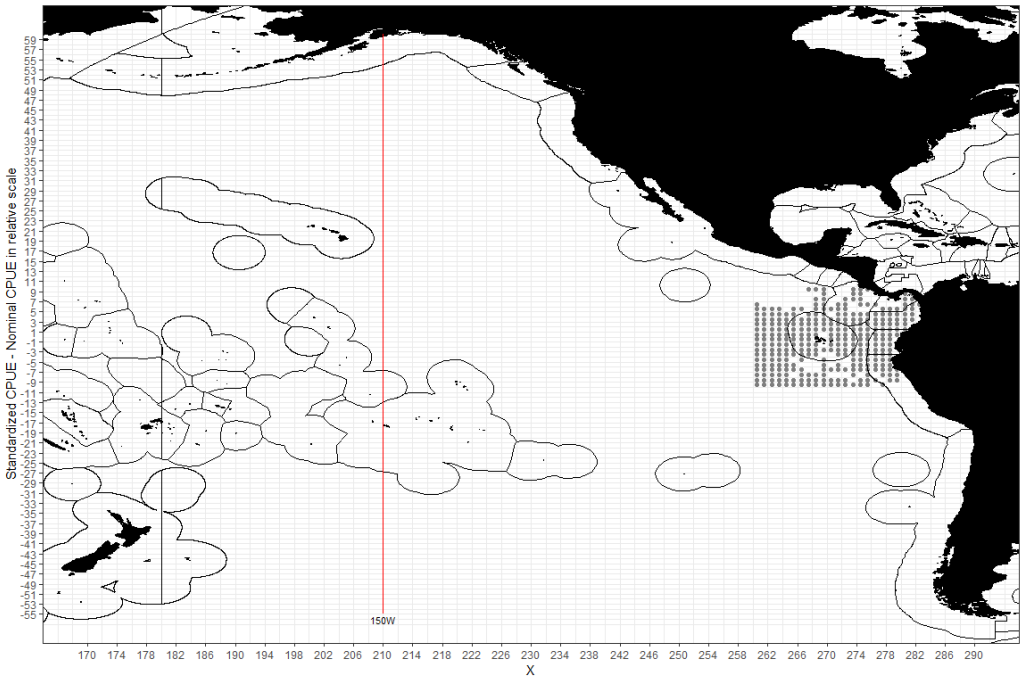


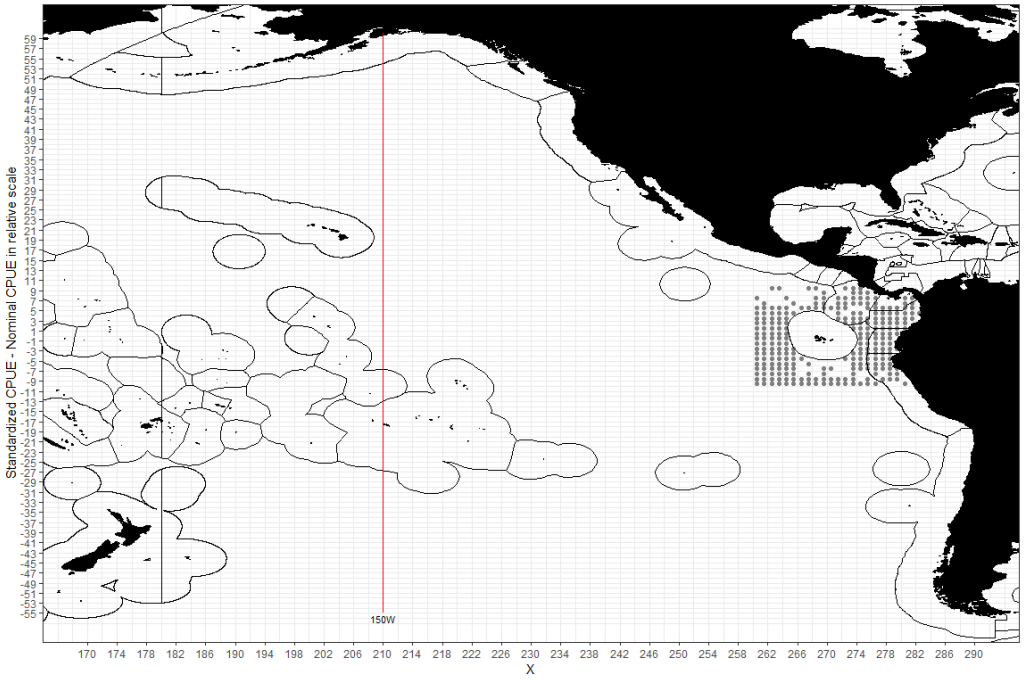
Figure . Catch of yellowfin in number in the Galapagos and French Polynesia EEZ.

Assess effect of EEZ for CPUE standardization process (case study off Galapagos)

```
# log-normal
    ln.model <- log(CPUE) ~ yrqtr + latlong + nhbf + hooks
# log-normal
    const <- 0.1 * mean(df$CPUE)
    df.cons <- df
    df.cons$CPUE <- df.cons$CPUE + const
    ln.fit <- glm(ln.model, family=gaussian(identity), data=df.cons)
```

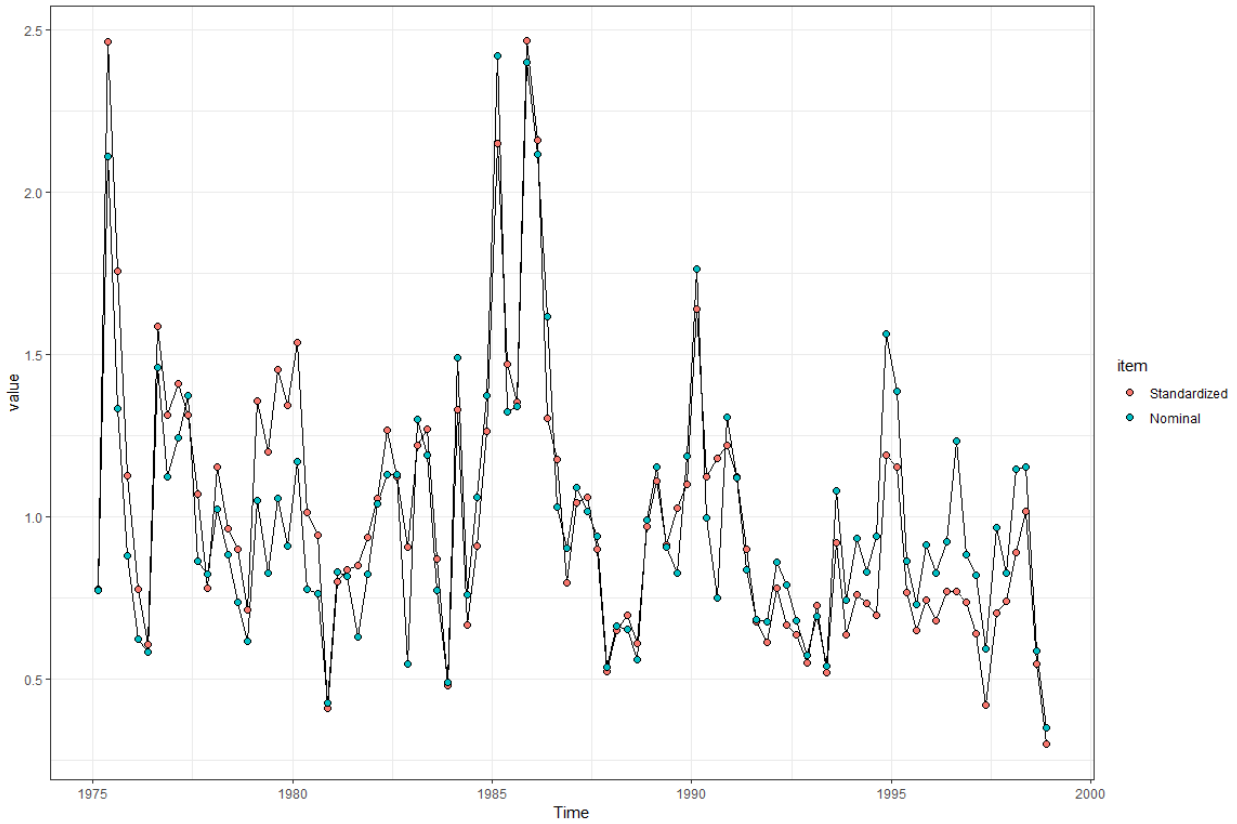
Period; 1975 – 1995, Area; 100E – 70E, 10S-10N (include and exclude Galapagos EEZ)

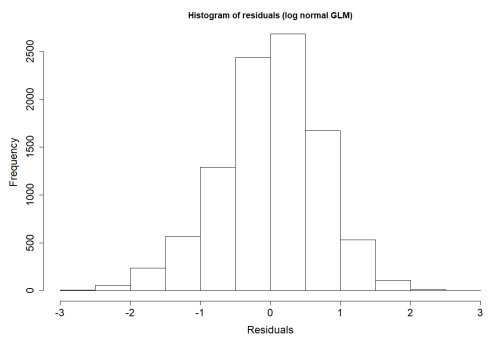


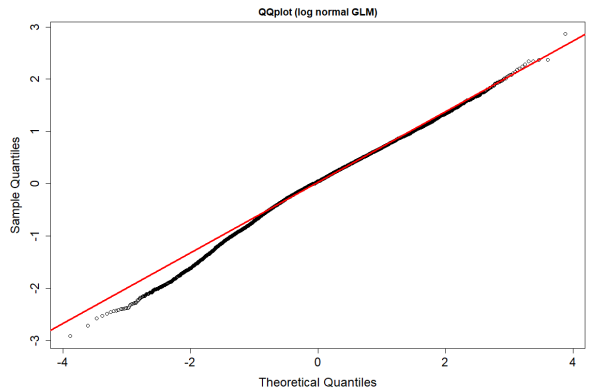


Assess effect of EEZ for CPUE standardization process (case study off Galapagos)

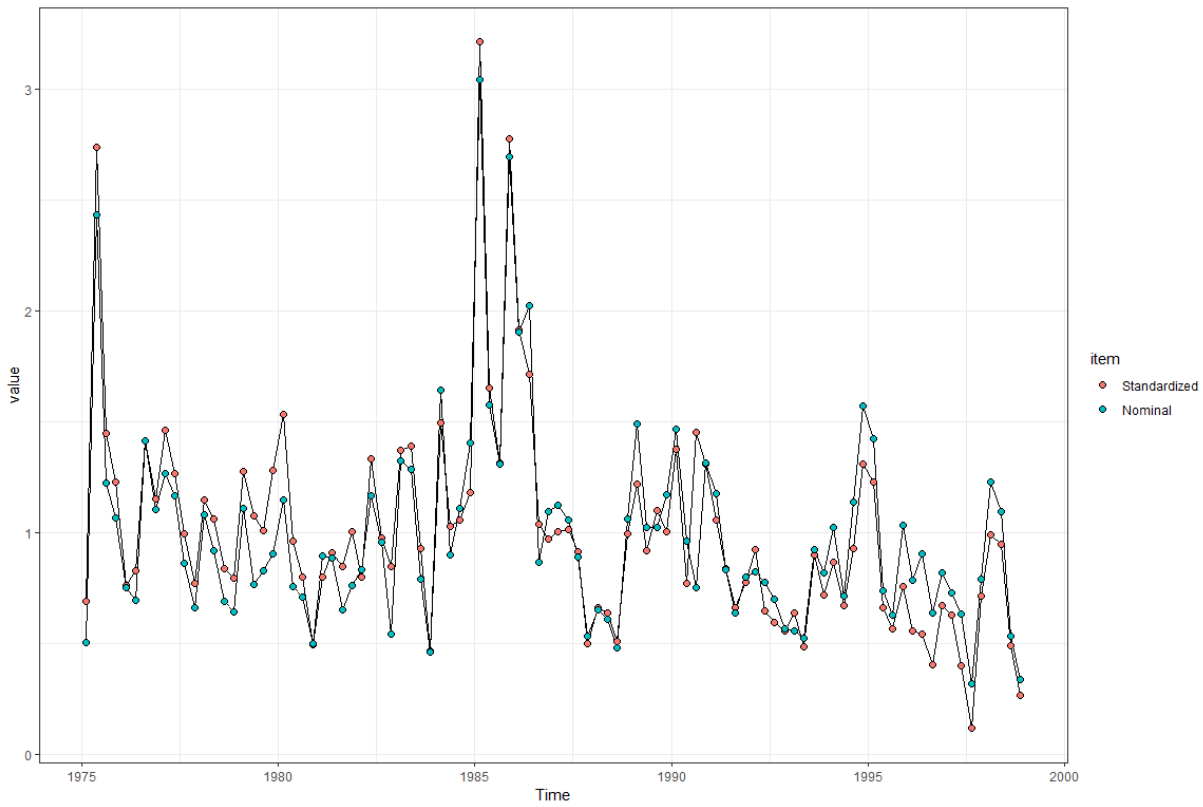
include

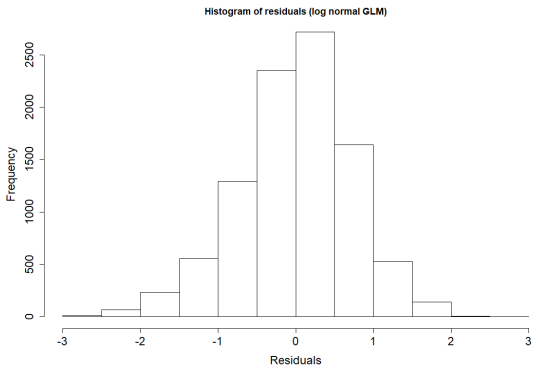


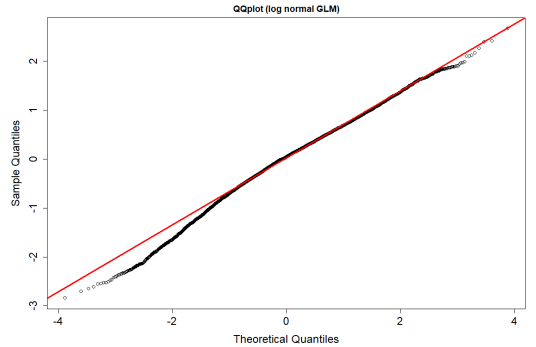




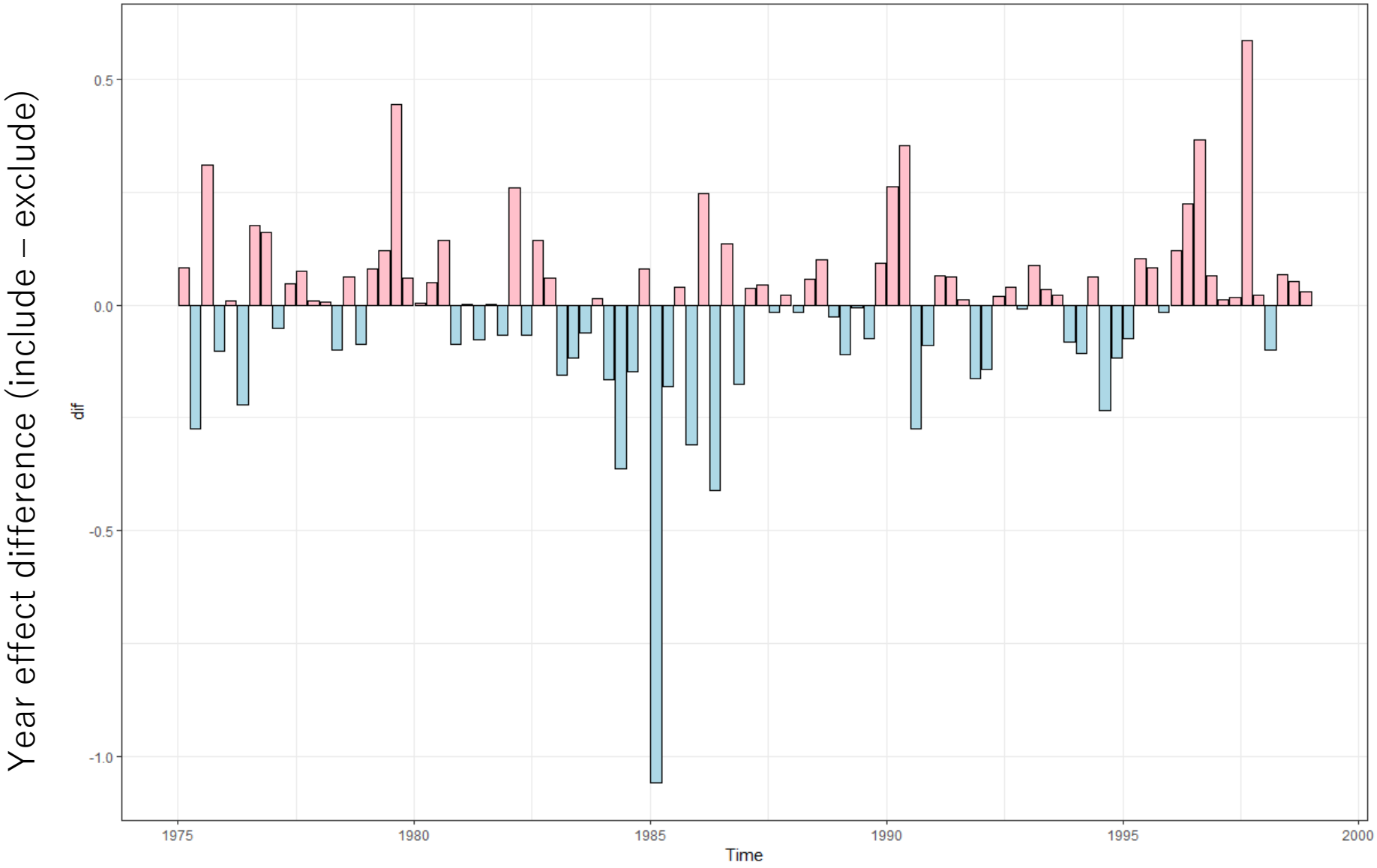
exclude



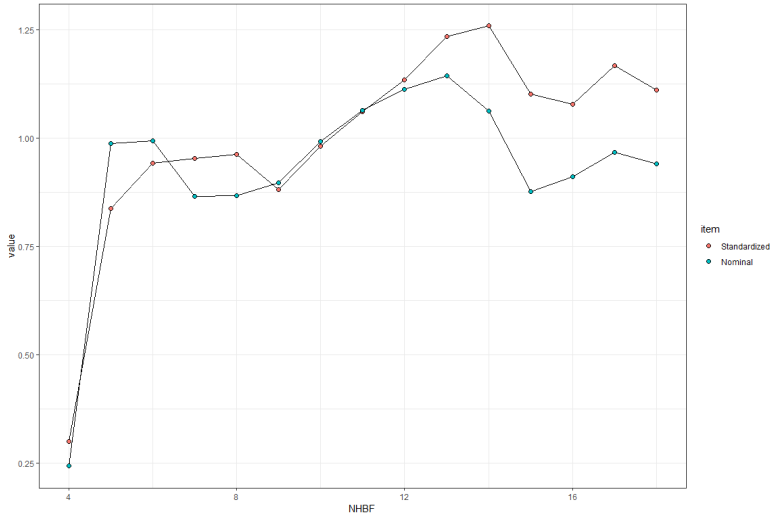




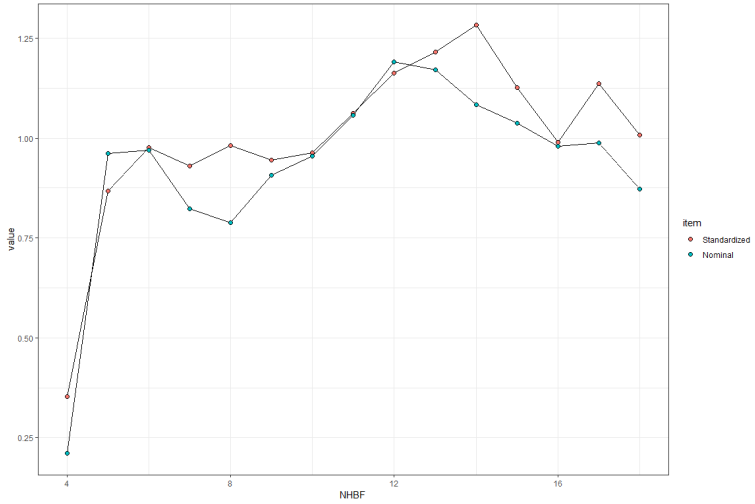
BET


Year effect difference (include – exclude)
dif
0.5
0.0
-0.5
-1.0
1975
1980
1985
1990
1995
2000
Time

include

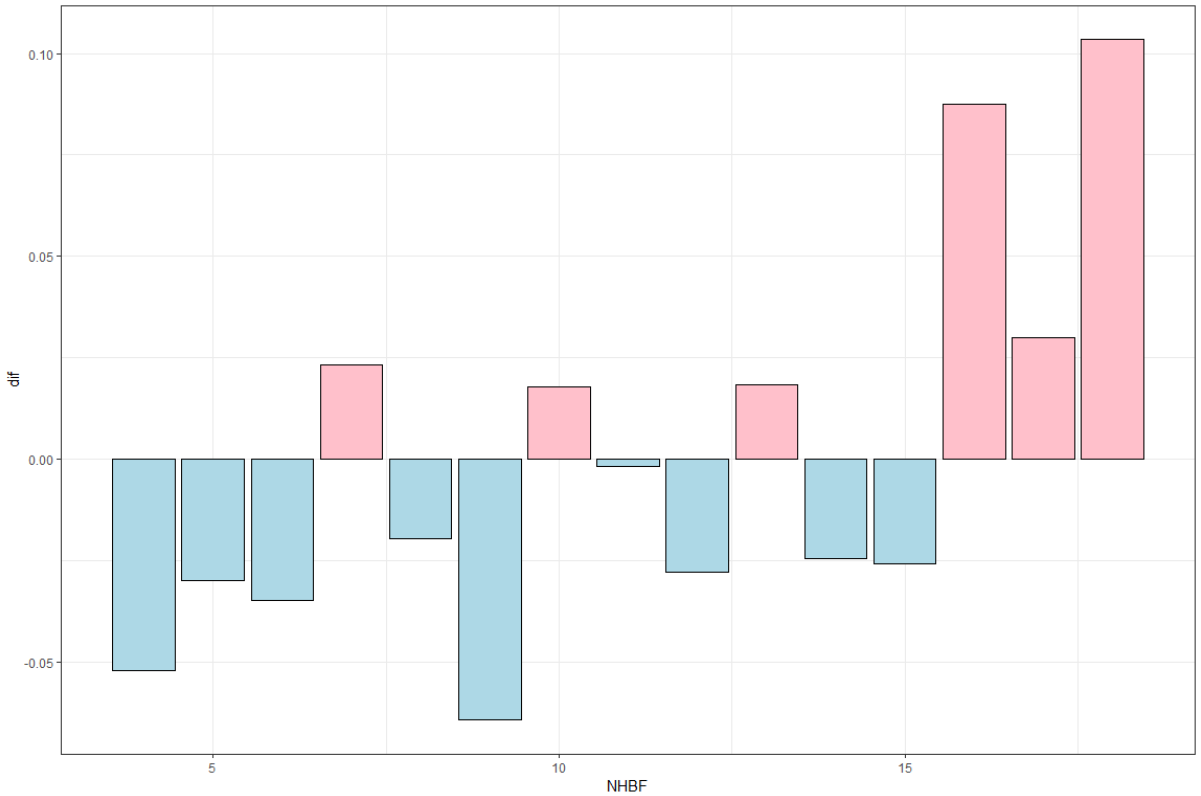


exclude



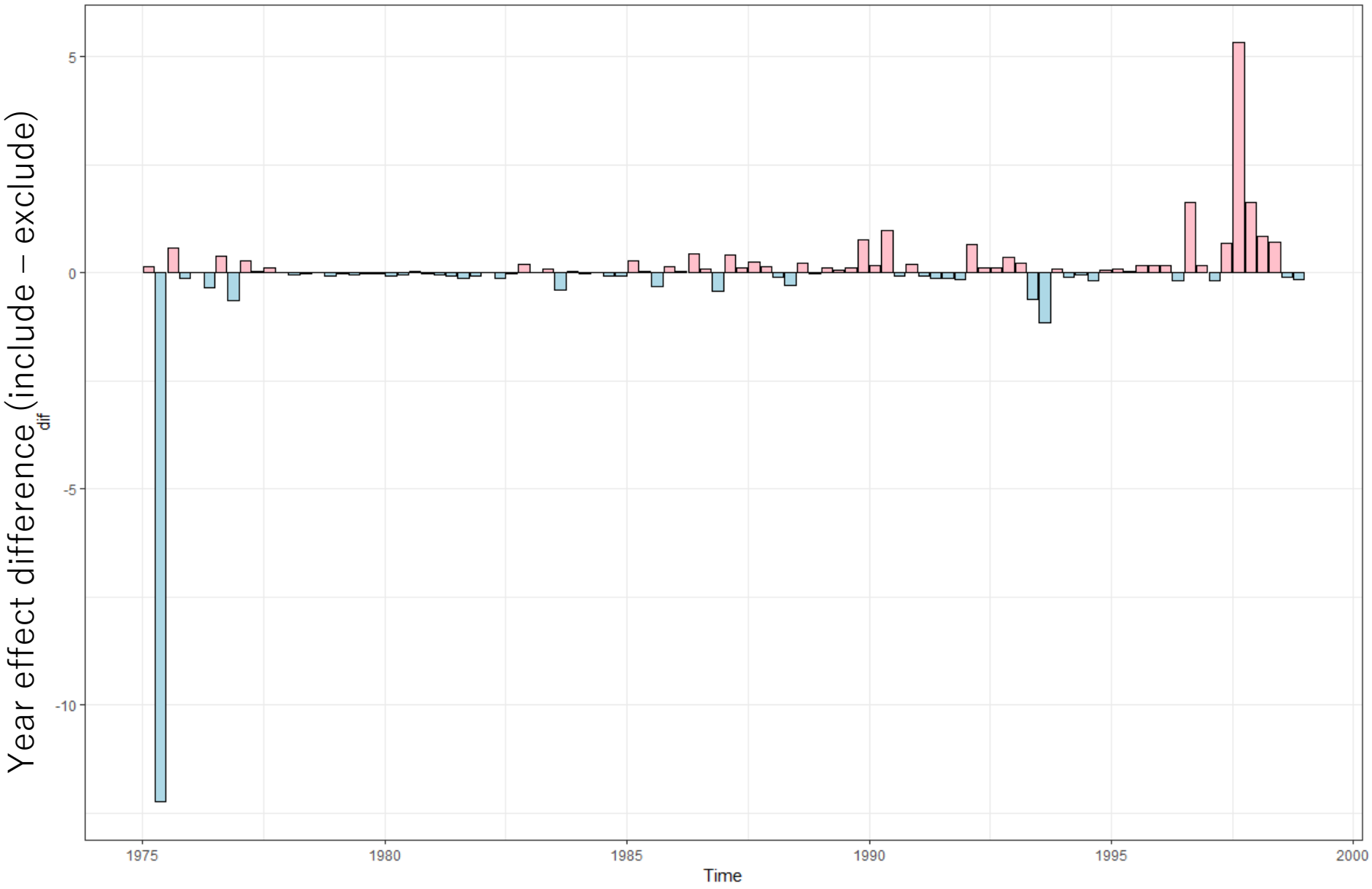
BET

NHBF effect difference
(include – exclude)

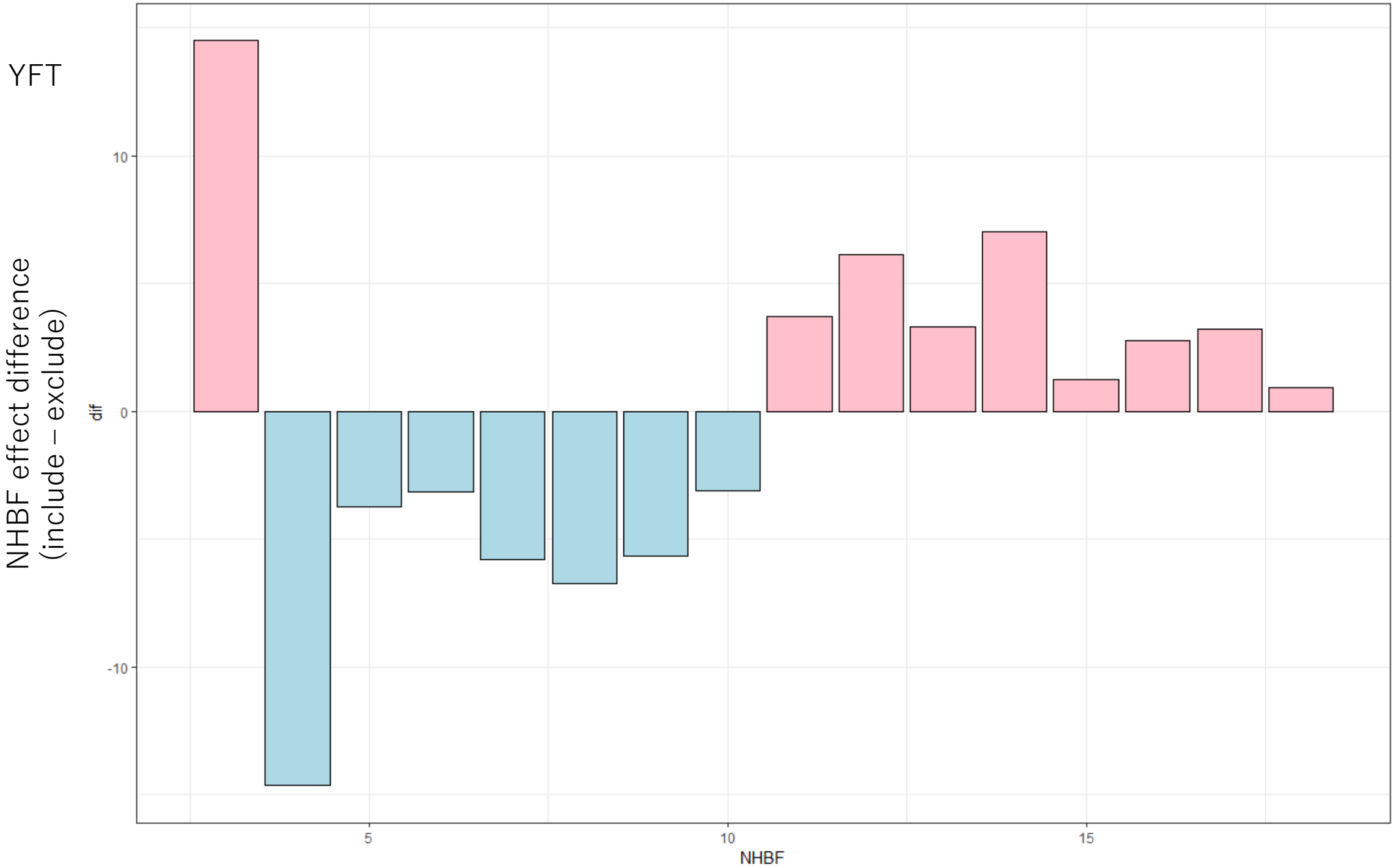


NHBF

YFT


Year effect difference$_{dif}$ (include – exclude)
5
0
-5
-10
1975
1980
1985
1990
1995
2000
Time

YFT


NHBF effect difference
(include – exclude)
dif
10
0
-10
5
10
15
NHBF

4. Future work

1. To describe characteristics of each fishing ground and then find vessel strategy
2. To find more general characteristic for effect of EEZ on CPUE standardization process
   - ✓ Test other variables including Oceanographic conditions
   - ✓ Test other model including VAST and more (which model does have good performance)
   - ✓ Test other EEZ including USA, French Polynesia and more