STECF EWG 18 13
Annex 01
Exploring the relationship between fishing mortality and effort using mixed effects models

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October 12, 2018

Contents

1 Model fit and diagnostics

The models suggested to the EWG was of the form

$$F = EFF^{\beta}$$

which was fitted to the fleets and species of the MAP simultaneously using a mixed effects model.

```
df0 <- read.csv('../data/DataGSA9_E_F_rel.csv')

df0 <- transform(df0, logf=log(par_Fbar+0.001), loge=log(KW_days), flt=factor(Fleet),
        spp=factor(Species), beta=(par_Fbar+0.001)/log(KW_days))

fit <- lmer(logf ~ loge + (loge|spp:flt), data = df0)

nd <- expand.grid(flt=factor(levels(df0$flt)), spp=factor(levels(df0$spp)),
        loge=seq(0,16.1,length=1000))
nd$pred <- predict(fit, newdata=nd)
nd <- transform(nd, eff=exp(loge), fpred=exp(pred))
```

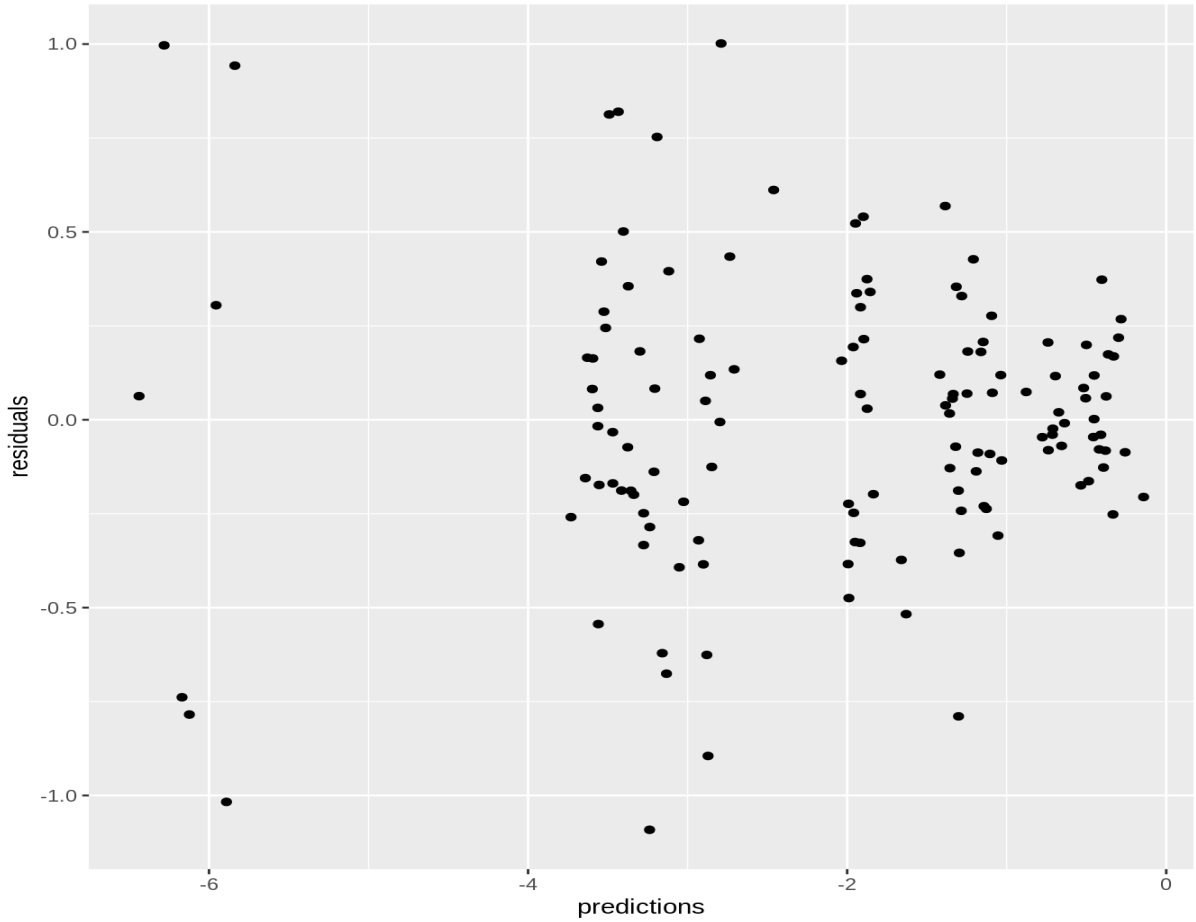

Figure 1: homogeneity of variance

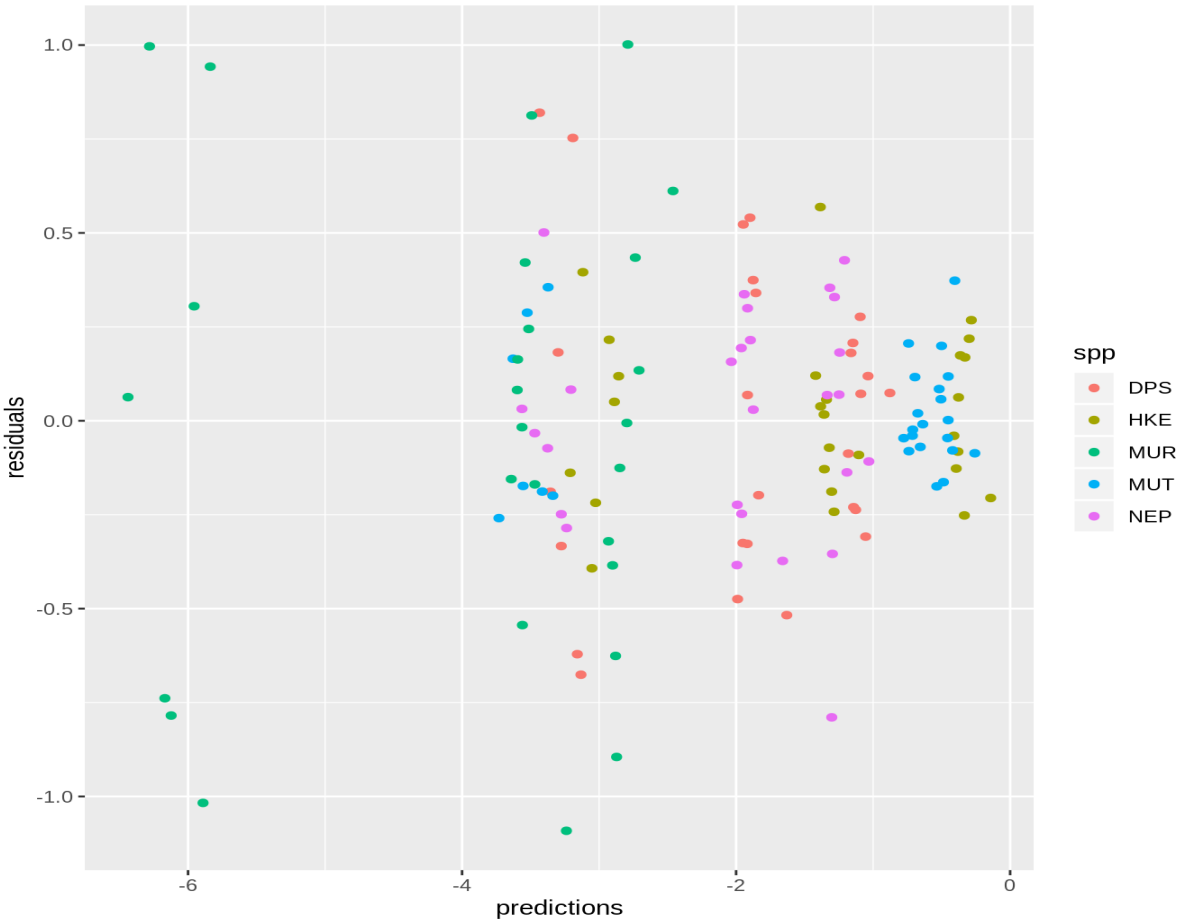

Figure 2: homogeneity of variance by species

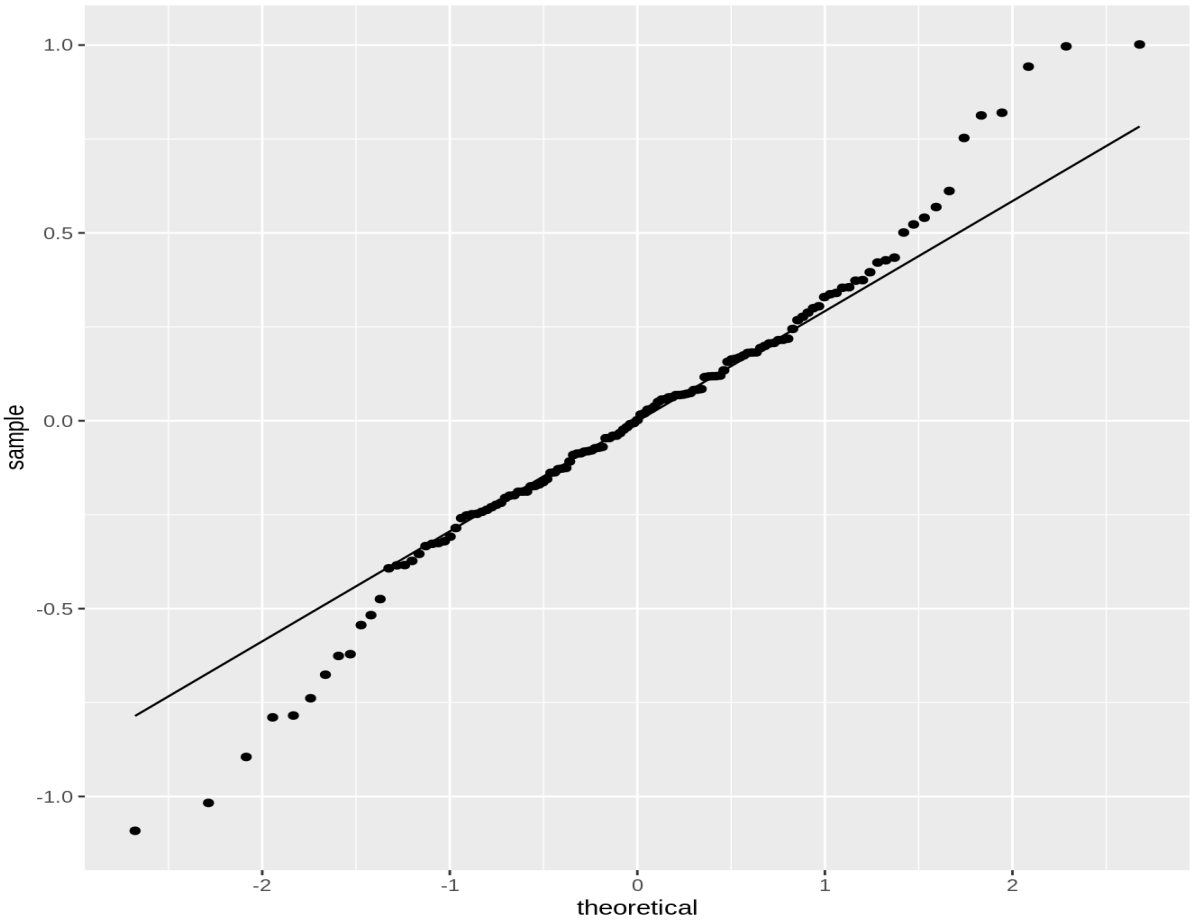

Figure 3: Residuals distribution

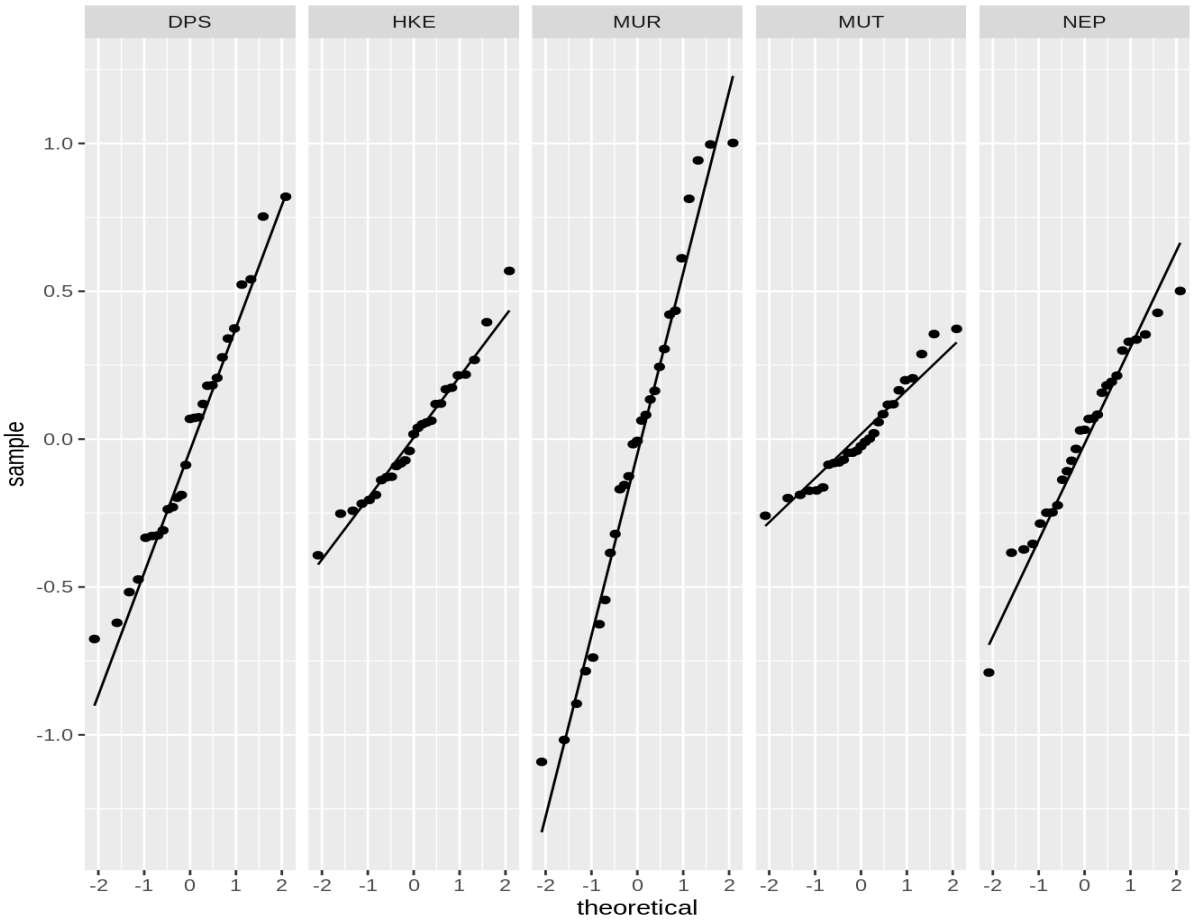

Figure 4: Residuals distribution by species

```
## $`spp:flt`
```

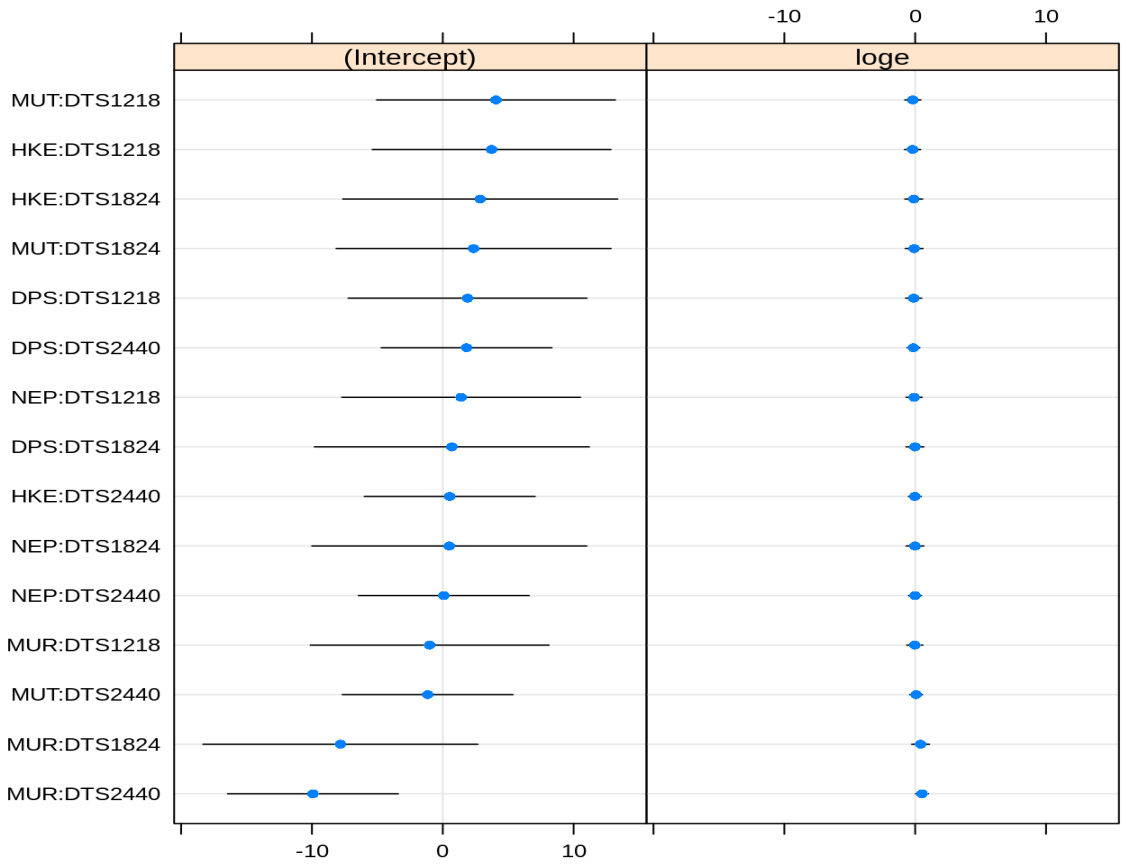

Figure 5: Random effects

2 Model predictions and obsevations

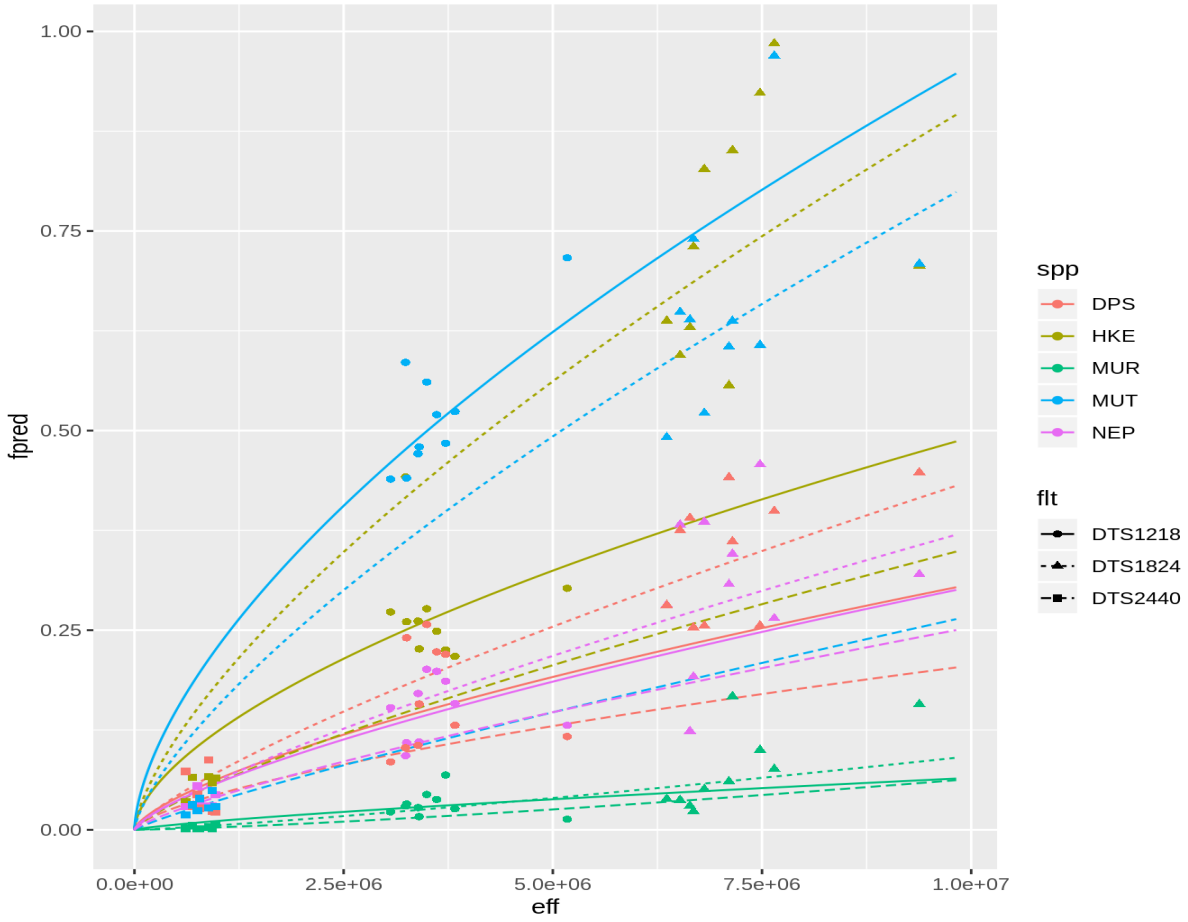

Figure 6: Model predictions and obsevations

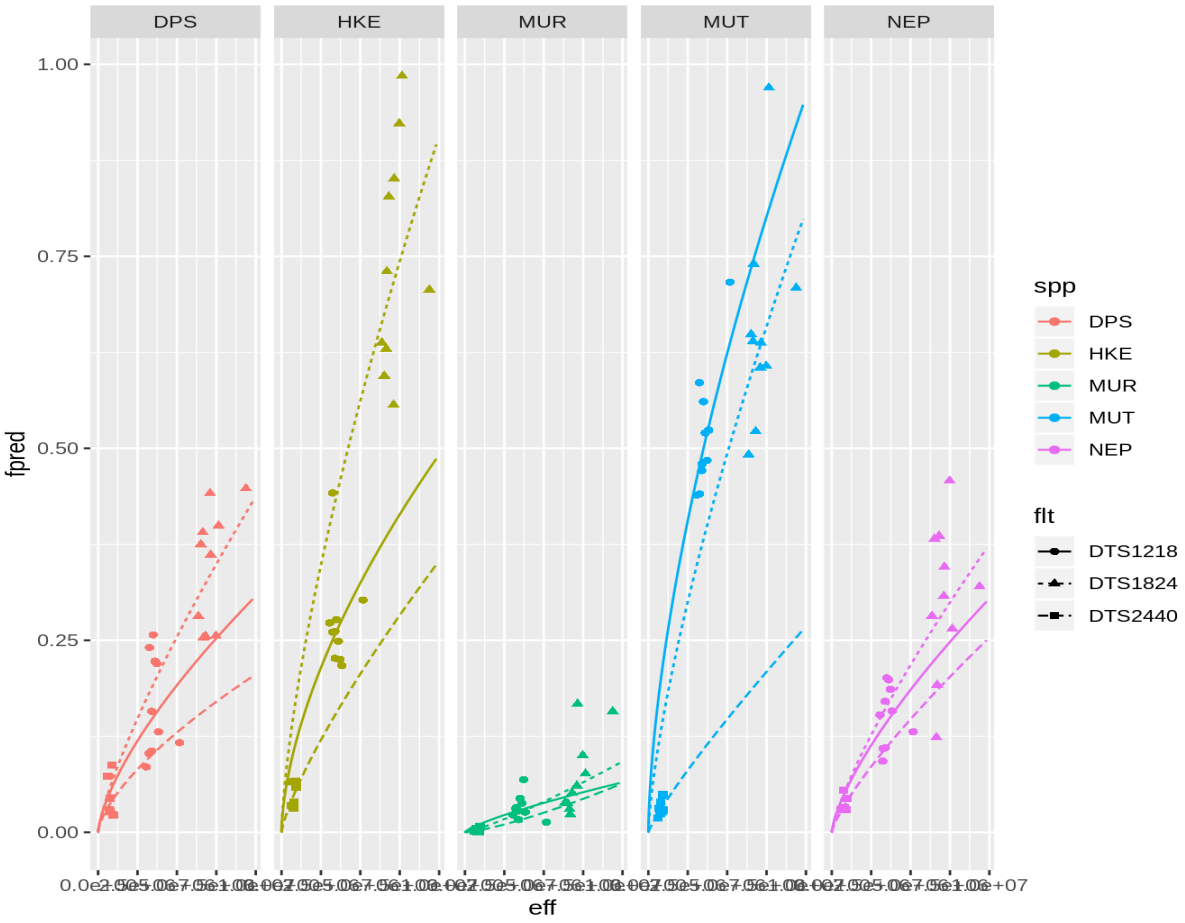

Figure 7: Model predictions and obsevations by species

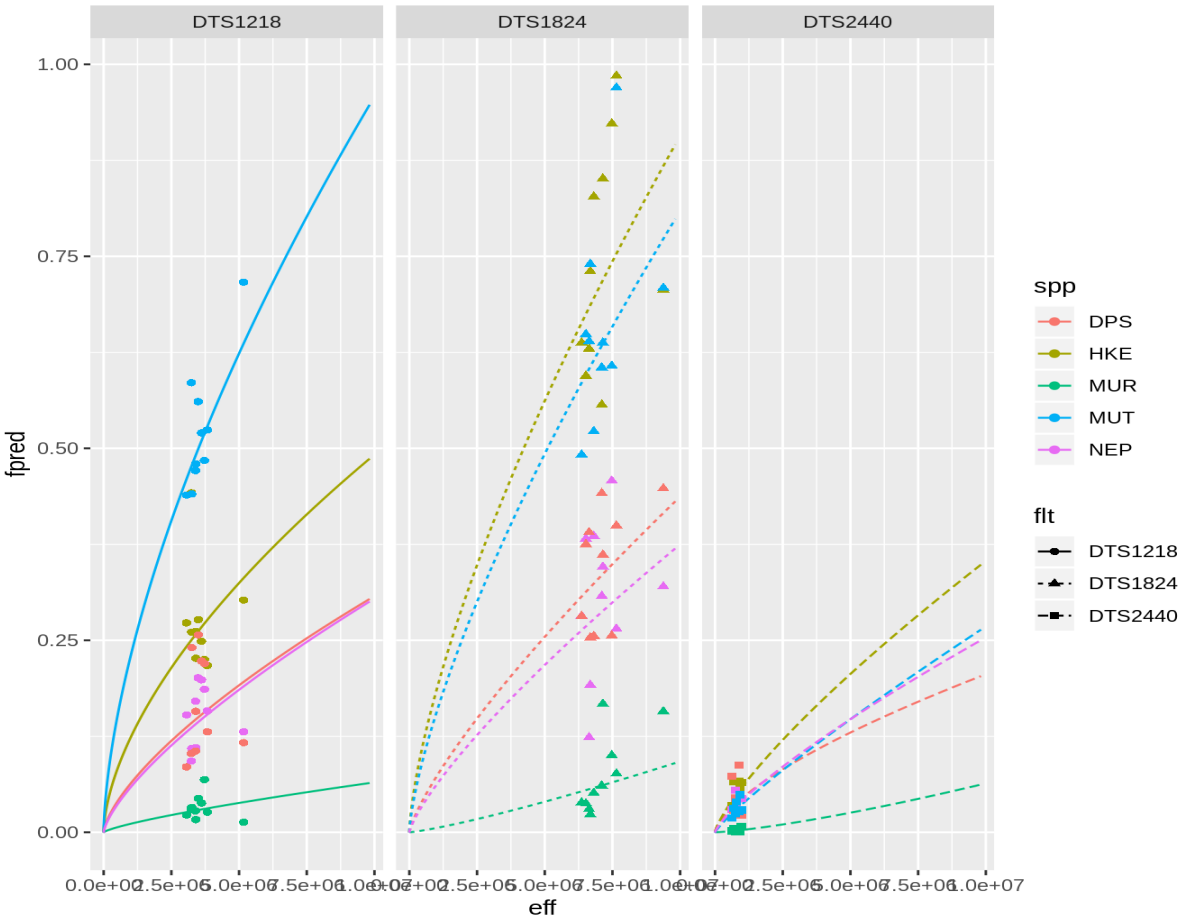

Figure 8: Model predictions and obsevations by fleet

STECF EWG 18 13 Annex 02a: Mixfisheries analysis and data screaning (French haul by haul data)

09-10-2018

1) Introduction

This document presents the data screaning and mixed fisheries analysis carried out by EWG1813 to French trawl fleets operating in the Northwest Mediterranean.

2) Read and pre-process data

```
# Set species and gears for the MAP
SelSpecies <- c('HKE', 'DPS', 'MUT', 'ARS', 'ARA', 'NEP')
SelGears <- c('OTT', 'OTM', 'OTB')
trgref <- 0.75

# read data file
catOrig <- read.csv2('../../data/datarequest/fr/dataset1_FRA_2012-2017_v2.csv',
stringsAsFactors=FALSE)

catOrig[,c('gearlen', 'effort', 'lonIni', 'latIni', 'lonFin', 'latFin', 'LAN', 'DIS', 'price', 'i

# process some variables
cat <- transform(catOrig, id=paste(vslId, date, haulno, sep=':'),
    LOAMP1=cut(vslLen, breaks=c(0,12,18,24,40)),
    LOAMP2=cut(vslLen, breaks=c(0,15,26,40)),
    taxon=toupper(taxon),
    mon=as.numeric(unlist(lapply(strsplit(date, "-"),'[',2))),
    year=as.numeric(unlist(lapply(strsplit(as.character(date), "-"),'[',1))),
#   Depth=-depth,
    slope=as.factor(c(">=100m", "<100m")[(1*(depth > 100)+1)]),
    lpue = LAN/effort,
    catch = ifelse(is.na(LAN), 0, LAN) + ifelse(is.na(DIS), 0, DIS)
)

# build new variables
```

```r
# season
Season <- numeric(nrow(cat))
Season[which(cat$mon %in% c(12,1,2))] = 1
Season[which(cat$mon %in% c(3:5))] = 2
Season[which(cat$mon %in% c(6:8))] = 3
Season[which(cat$mon %in% c(9:11))] = 4
cat$season <- Season

# target species and spp fraction

cat$target <- cat$sppfrac <- NA
lst0 <- lapply(split(cat, cat$id), function(x) {
    x$sppfrac <- x$LAN/sum(x$LAN, na.rm=TRUE)
    x$target <- as.factor(c("No","Yes")[(max(x$sppfrac, na.rm=TRUE)>trgref)+1])
    x
})
cat <- do.call('rbind', lst0)

# allocate GSA
GSAs <- readOGR("../../R Scripts/gsas.shp")
```

```
## OGR data source with driver: ESRI Shapefile
## Source: "/home/gamitjo/Work/EWG1813-NWMedDemersals2/R Scripts/gsas.shp", layer: "gsas"
## with 31 features
## It has 12 fields
```

```r
GSAP <- SpatialPolygons2PolySet(GSAs)
fp <- findPolys(events=data.frame(EID=1:nrow(cat), X=cat$lonIni, Y=cat$latIni), polys=GSAP)
cat$GSA <- NA
cat[fp$EID,'GSA'] <- factor(as.numeric(substr(unique(GSAs$SMU_CODE)[fp$PID],1,2)))

# build dataset by haul with species aggregated
byhaul <- unique(cat[,c('id','LOAMP1','gear', 'year','season','slope', 'effort', 'target')])
byhaul$lan <- tapply(cat$LAN, cat$id, sum, na.rm=TRUE)
byhaul$dis <- tapply(cat$DIS, cat$id, sum, na.rm=TRUE)
byhaul$catch <- tapply(cat$catch, cat$id, sum, na.rm=TRUE)
byhaul$mixfish <- tapply(cat$sppfrac, cat$id, max, na.rm=TRUE)
byhaul <- transform(byhaul, lpue = lan/effort, cpue = catch/byhaul$effort)
```

3) Data screening

The data were provided by the French autorities and constitutes haul by haul observations specifically for this EWG.

The data screening was focused on showing the number of hauls and LPUE, broken down by length-over-all (LOA) classes, depth classes, season and year.

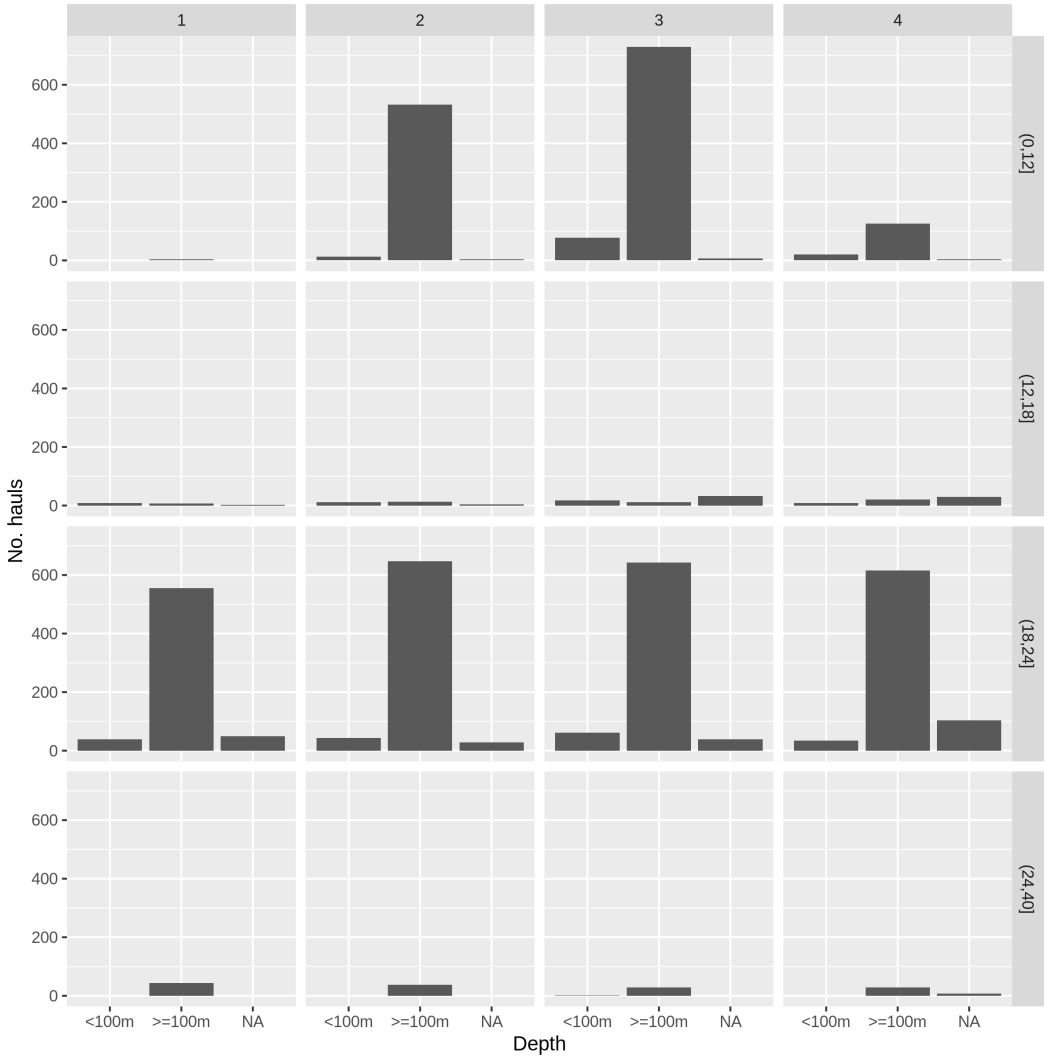

Figure 1: Hals at depth ranges (<100m or >=100m) by LOA and Season

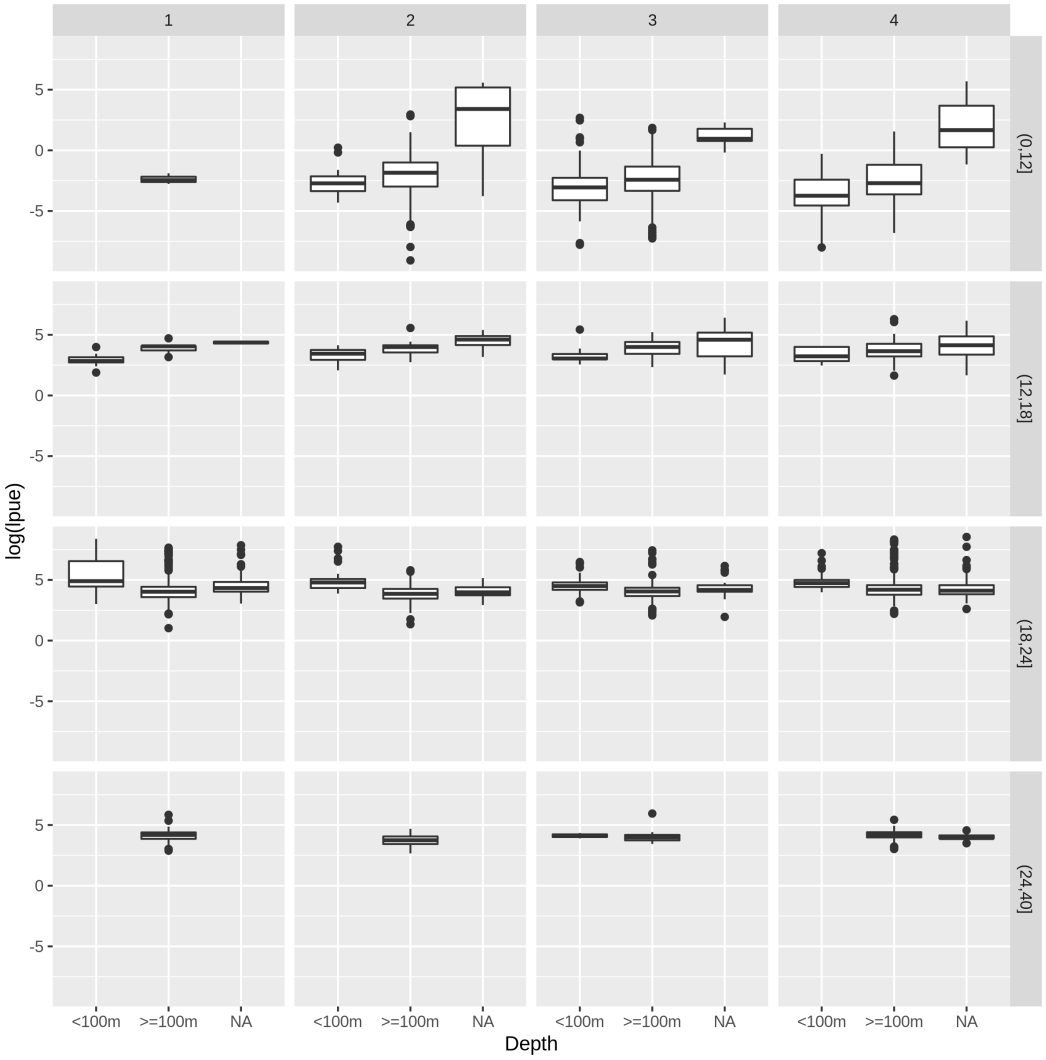

Figure 2: log(LPUE) operating at depth ranges (<100m or >=100m) by LOA and Season

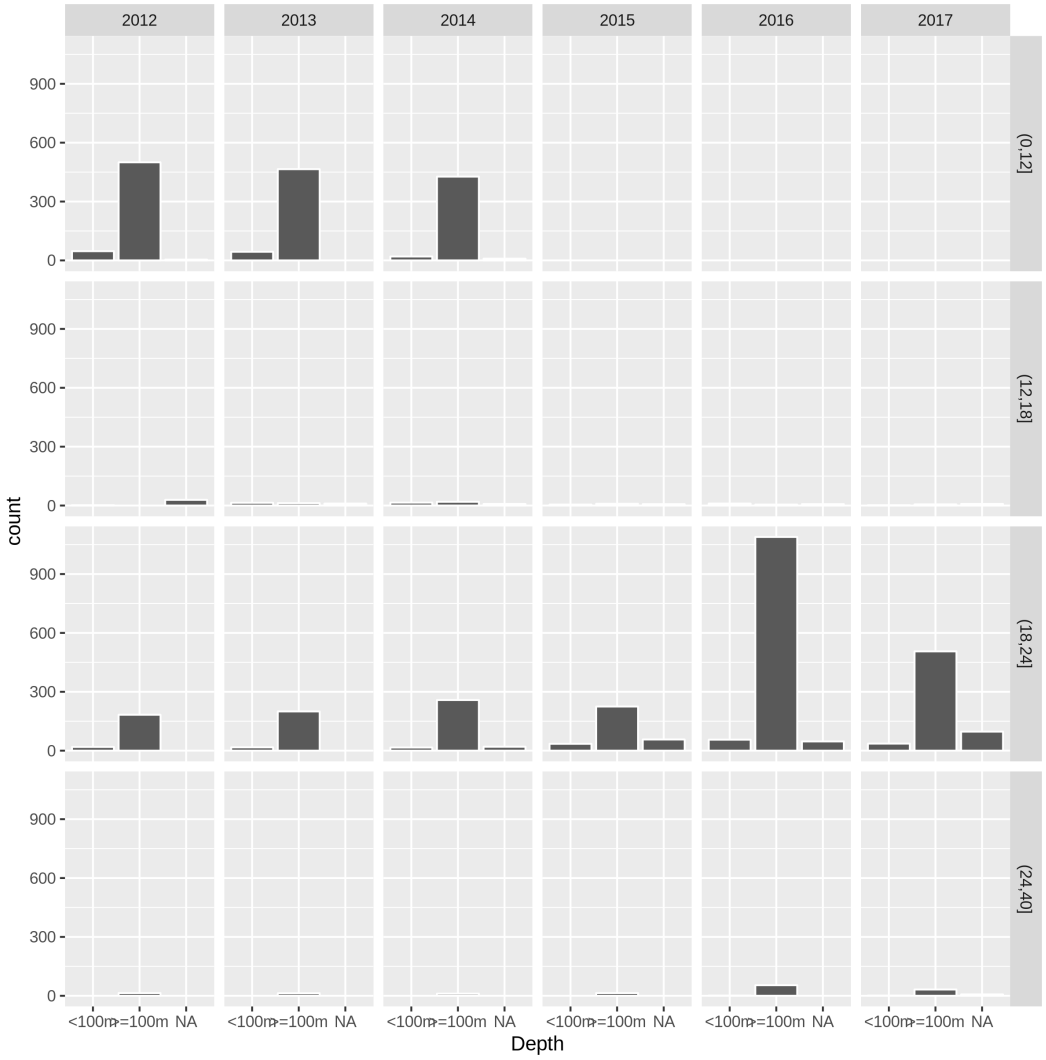

Figure 3: Hauls at depth ranges (<100m or >=100m) by LOA and Year

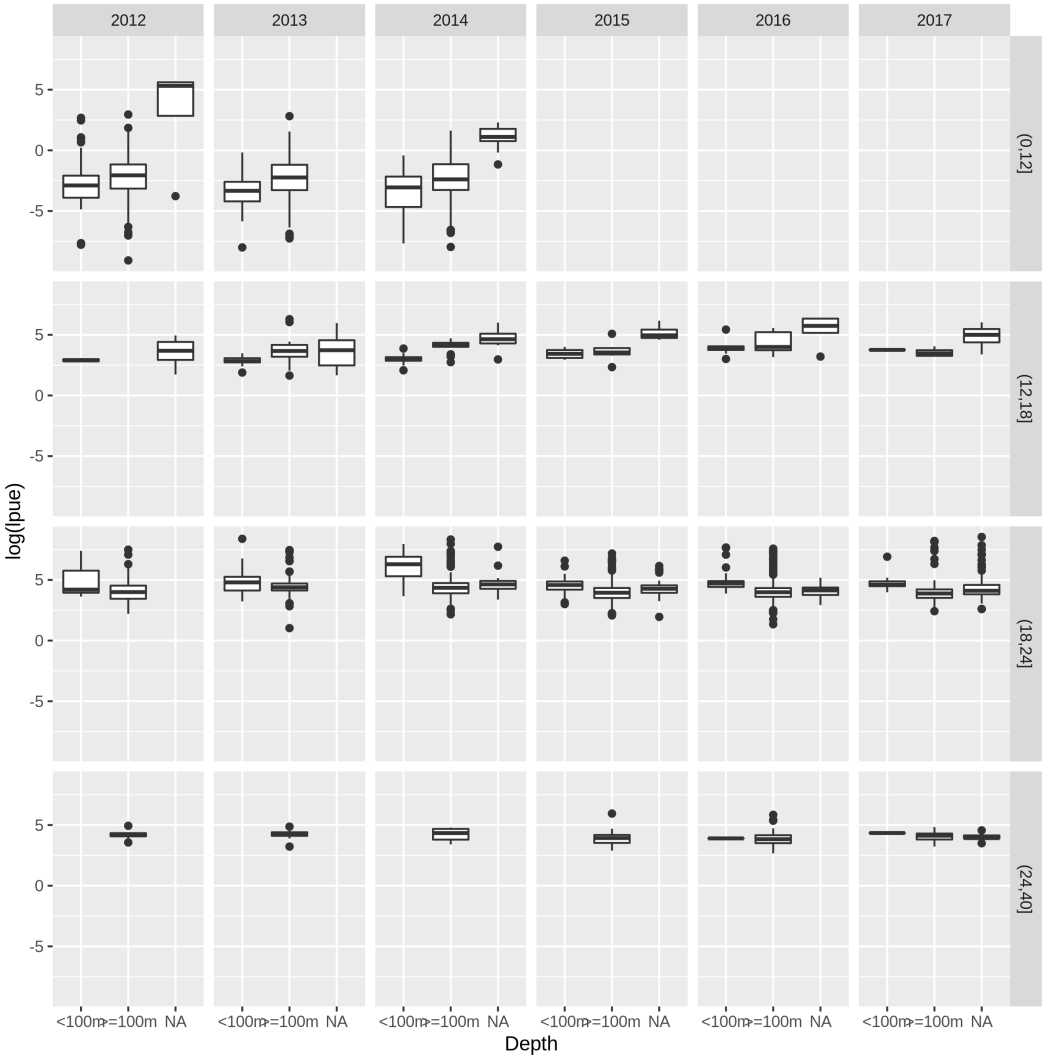

Figure 4: log(LPUE) operating at at depth ranges (<100m or >=100m) by LOA and Year

4) Mixfisheries

The mix-fisheries analysis was performed to evaluate the level of "non-mix" in the fisheries and potential impact of choke species. The rationale is that if a number of hauls are "clean", it means a certain level of specialization exists. Fleet's specialization should be explored/fostered to increase the probabilitty of the MAP's success, since the species targeted by the MAP are not all in the same level of over-exploitation. On the other hand if a haul is mostly made of one species, limiting effects by other species are less important and can be avoided.

The analysis presented here is based on haul-by-haul data provided by the French authorities.

	2012	2013	2014	2015	2016	2017
(0,12]	2	0	0	0	0	0
(12,18]	7	18	31	11	11	8
(18,24]	202	217	294	317	1192	639
(24,40]	14	13	11	14	55	40

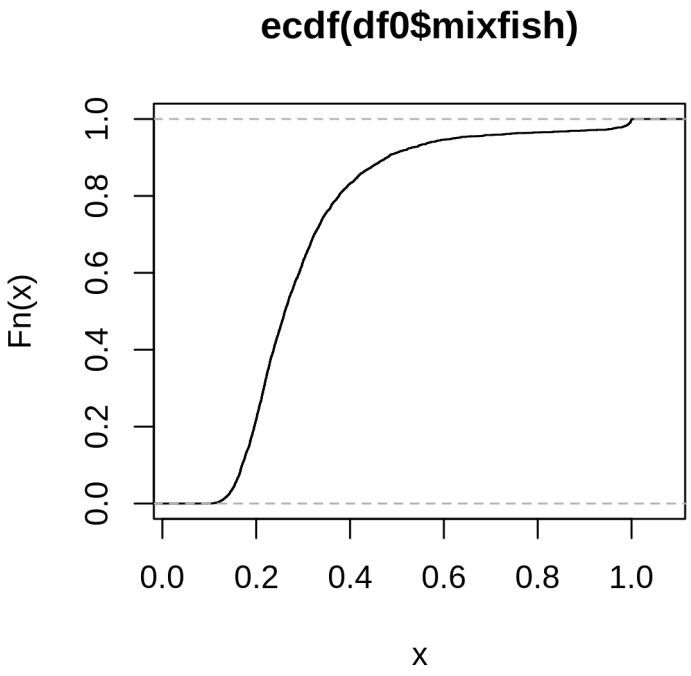

Figure 5: Cumulative distribution the maximum fraction of the landings belonging to a single species by haul for the trawl fleets

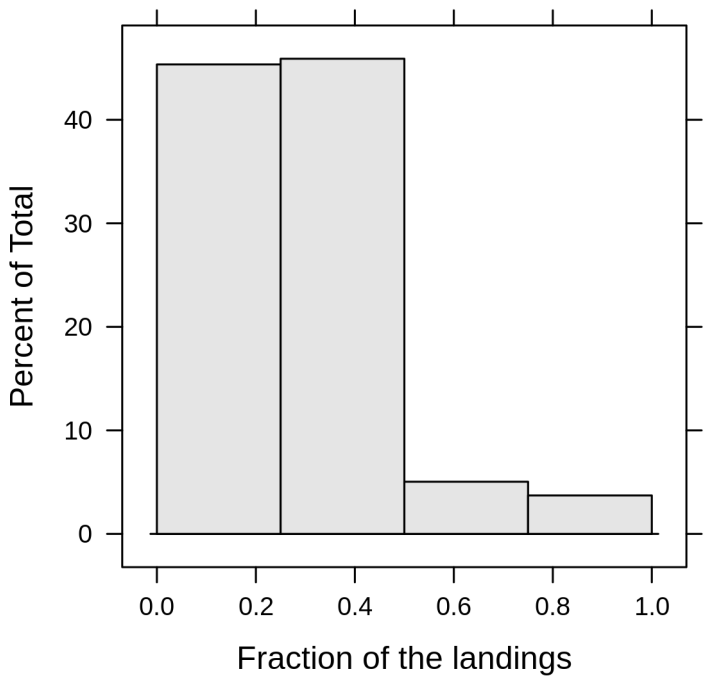

Figure 6: Hauls by maximum fraction of the landings belonging to a single species for the trawl fleets

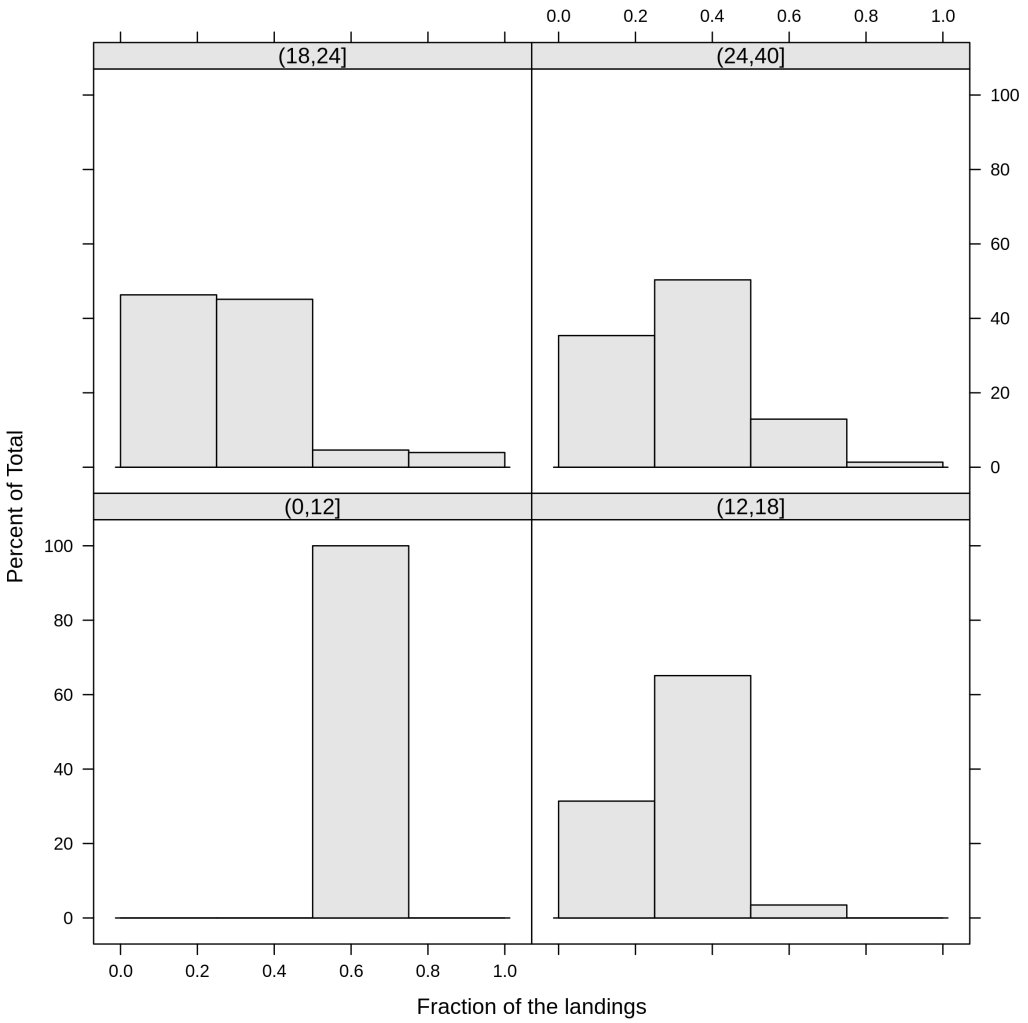

Figure 7: Hauls by fraction of the landings belonging to a single species and LOA

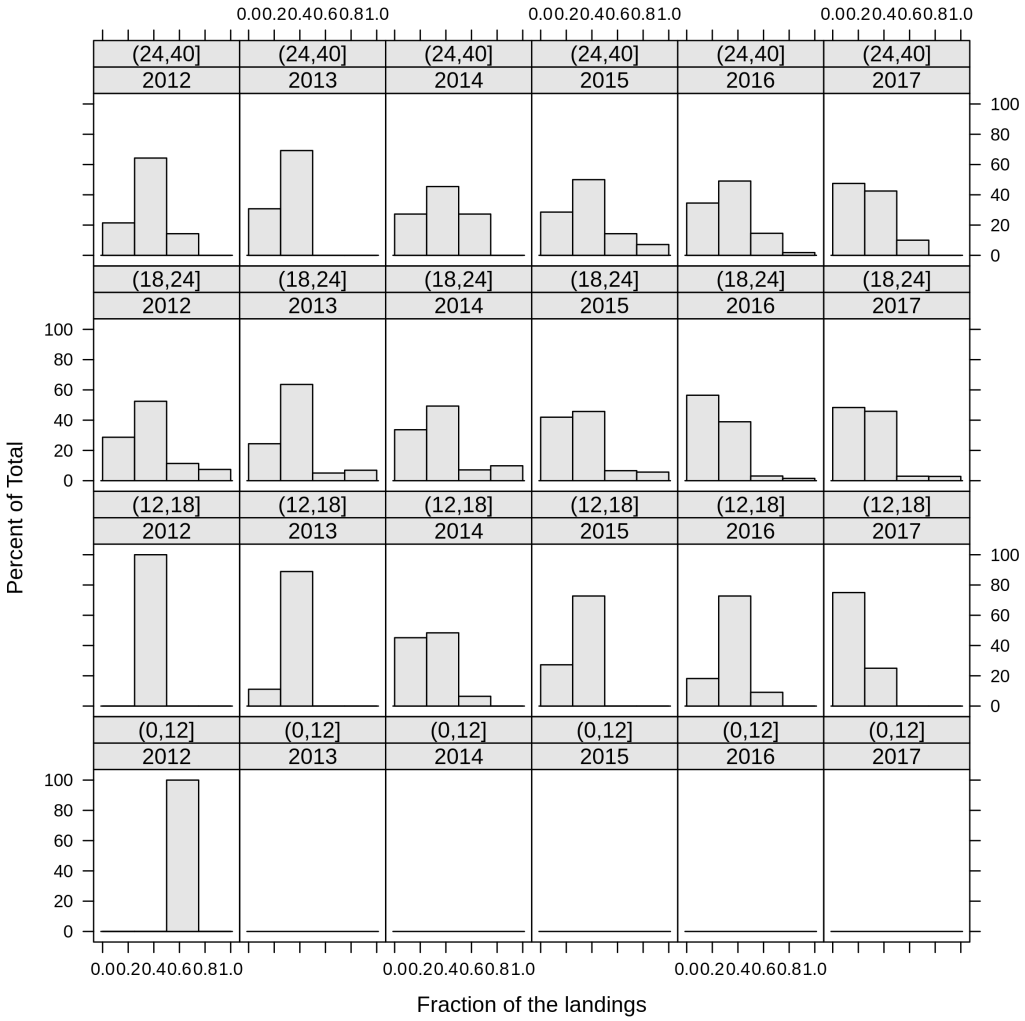

Figure 8: Hauls by fraction of the landings belonging to a single species, LOA and year

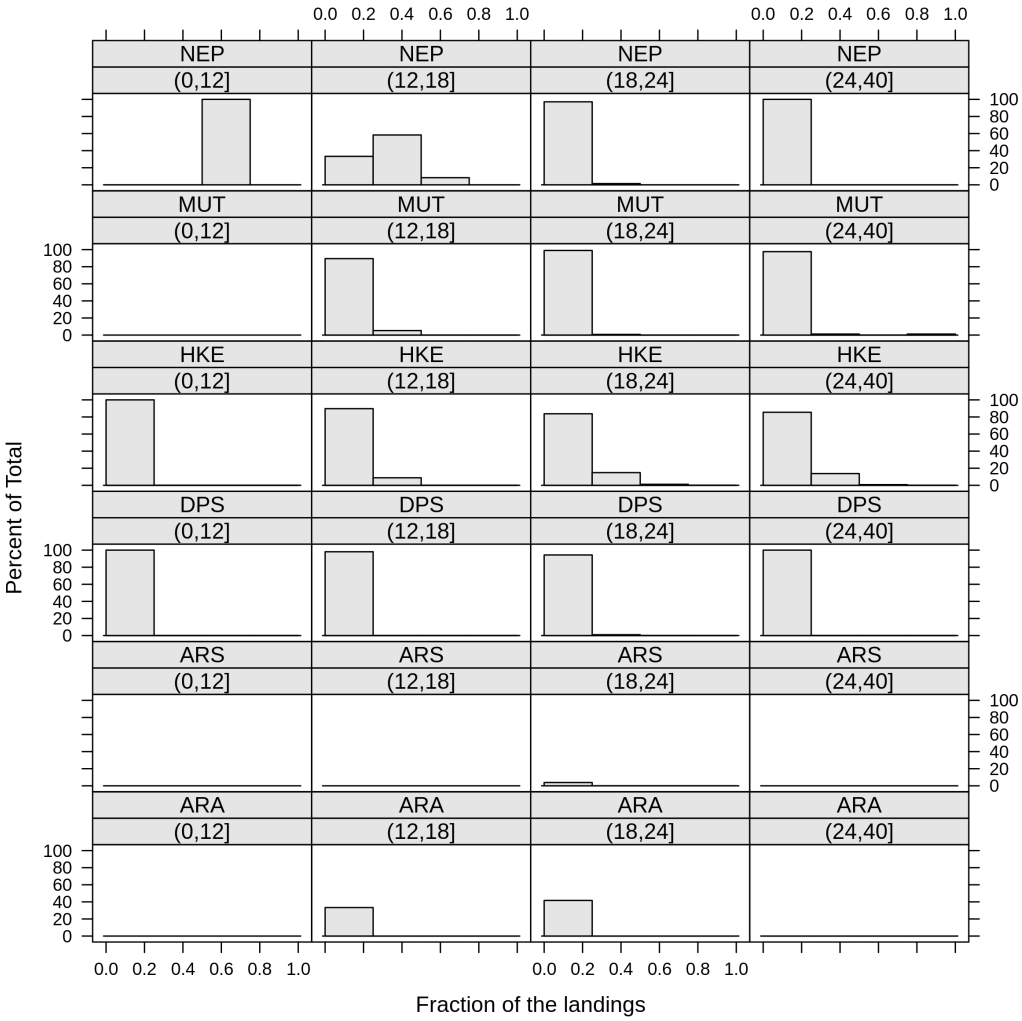

Figure 9: Hauls by fraction of the landings belonging to the species in the MAP by LOA

STECF EWG 18 13: Mixfisheries analysis and data screaning (French trip by trip data)

11-10-2018

1) Introduction

This document presents the data used by EWG1813 to identify factors affecting vessels's efficiency and mix-fisheries levels of the French trawl fleets operating in the Northwest Mediterranean.

2) Read and pre-process data

```
# Set species and gears for the MAP
SelSpecies <- c("HKE", "DPS", "MUT", "ARS", "ARA", "NEP")
SelGears <- c("OTT", "OTM", "OTB")
trgref <- 0.75

df0 <- read.csv("../../data/datarequest/LB-Like/df0_LB_FRA_AREA.csv", sep = ";")

df0$Date <- as.integer(df0$Date)
df0$id <- paste0(df0$CFR, df0$Date, df0$AREA, df0$Gear)
df0$id2 <- paste0(df0$CFR, df0$Date)

# build dataset by haul with species aggregated
byhaul <- unique(df0[, c("id", "LOAMP1", "Gear", "Year", "Season", "Depth",
    "tot")])
byhaul$mixfish <- tapply(df0$sppfrac, df0$id, max, na.rm = TRUE)
```

3) Data screening

The data were provided by the French authorities specifically for this EWG.

The data screening was focused on showing the number of vessels and the CPUE, broken down by length-over-all (LOA) classes, depth classes, season and year.

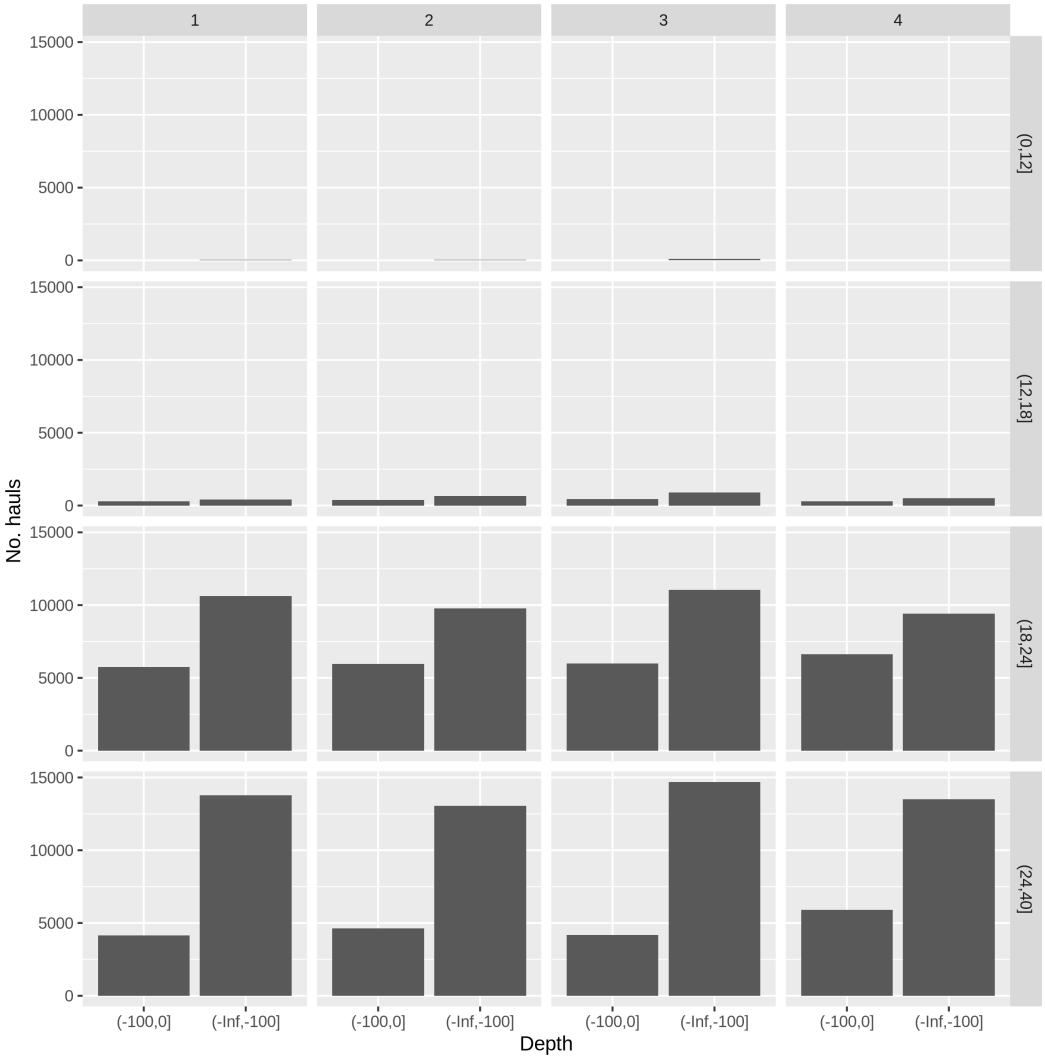

Figure 1: Hals at depth ranges (<100m or >=100m) by LOA and Season

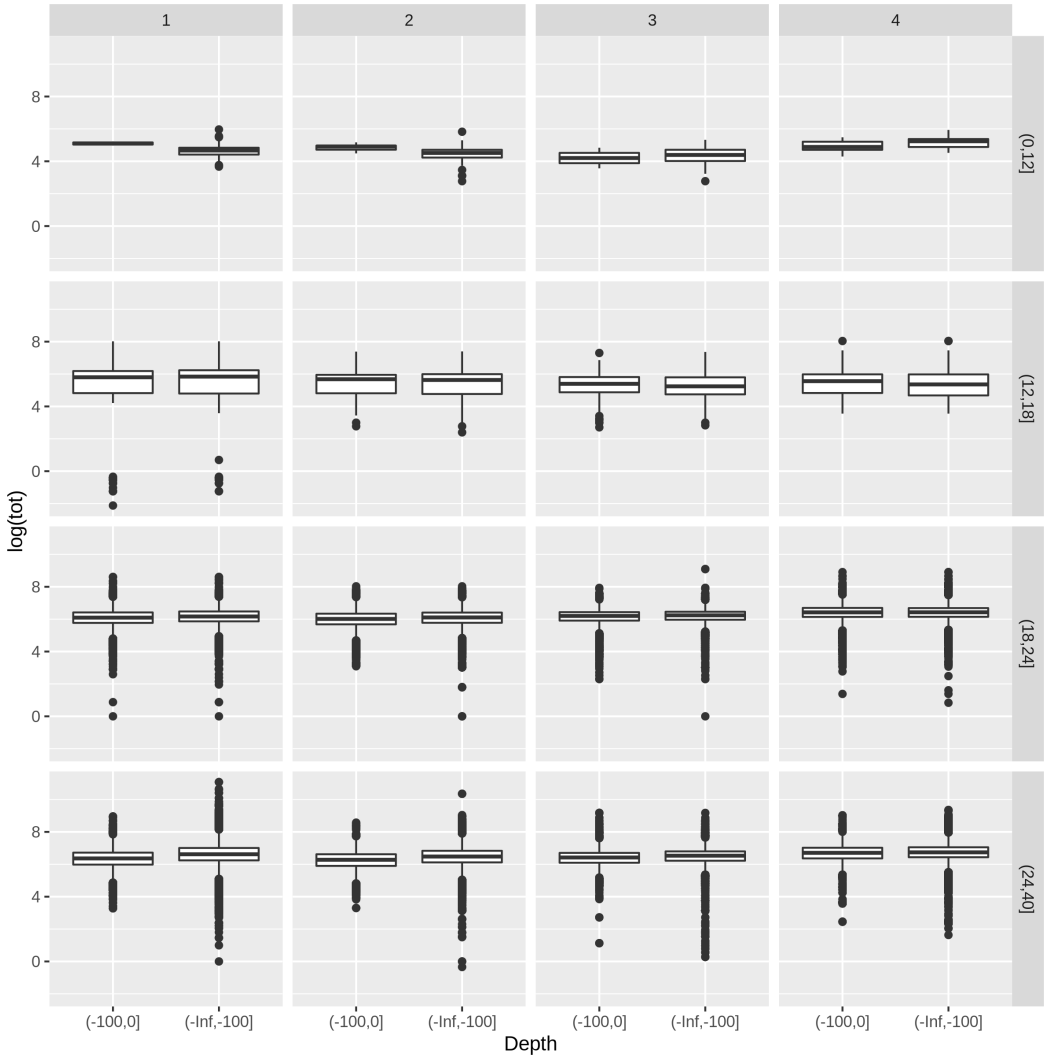

Figure 2: log(LPUE) operating at depth ranges (<100m or >=100m) by LOA and Season

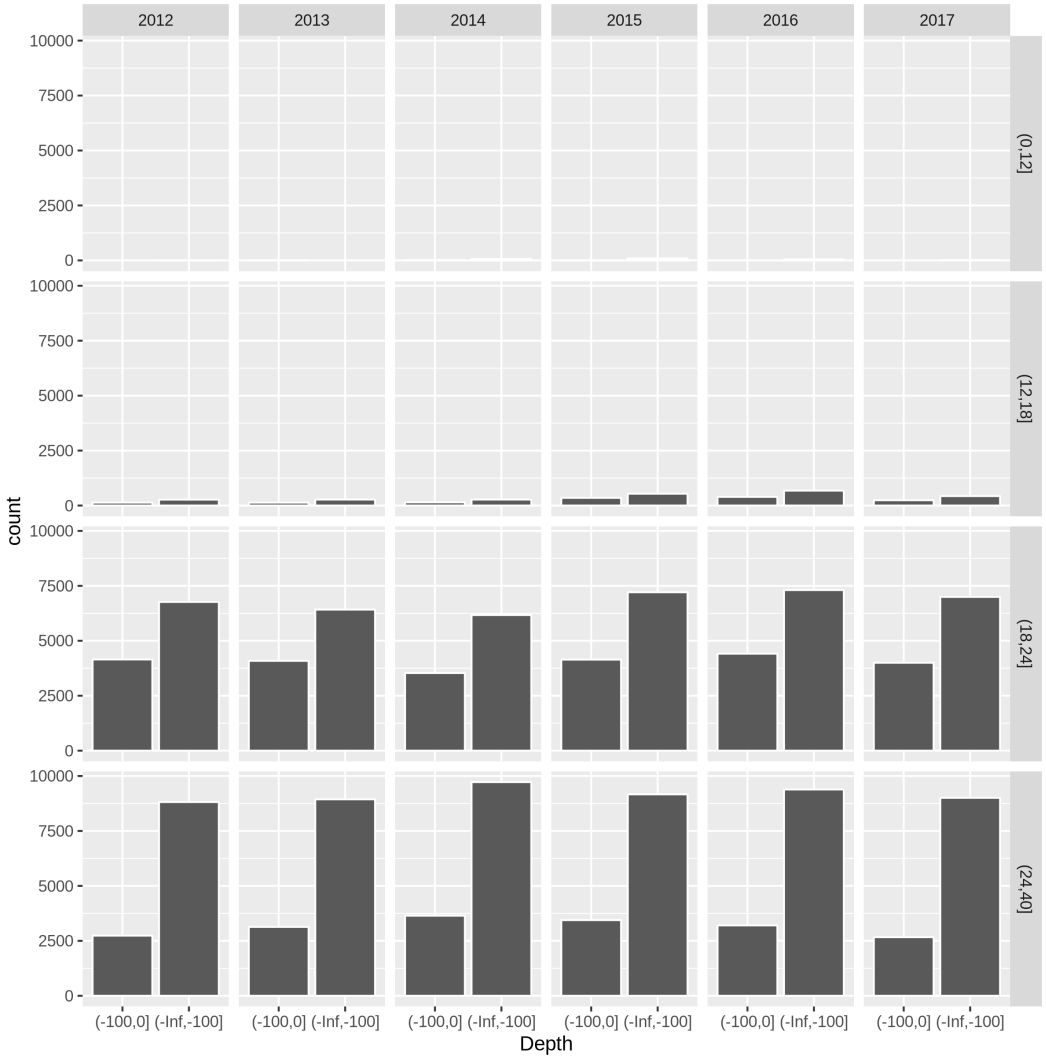

Figure 3: Hauls at depth ranges (<100m or >=100m) by LOA and Year

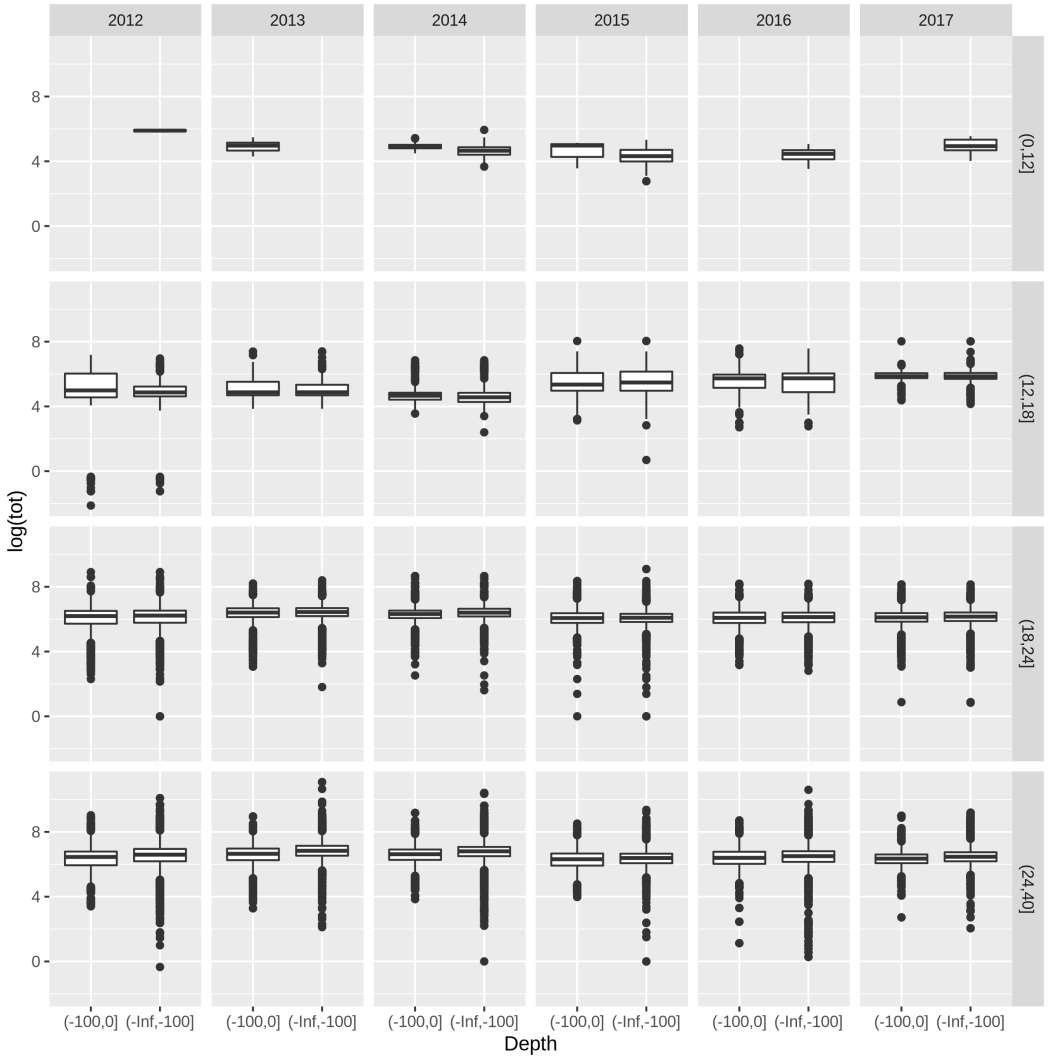

Figure 4: log(LPUE) operating at at depth ranges (<100m or >=100m) by LOA and Year

4) Mixfisheries

The mix-fisheries analysis was performed to evaluate the level of "non-mix" in the fisheries and potential impact of choke species. The rationale is that if a number of hauls are "clean", it means a certain level of specialization exists. Fleet's specialization should be explored/fostered to increase the probabilitty of the MAP's success, since the species targeted by the MAP are not all in the same level of over-exploitation. On the other hand if a haul is mostly made of one species, limiting effects by other species are less important and can be avoided.

The analysis presented here is based on data aggregated by fishing day. Ideally, this analysis should be done on a haul-by-haul basis to allow a proper evaluation of the mixed-fisheries nature of the fishery.

	2012	2013	2014	2015	2016	2017
(0,12]	2	11	86	92	48	14
(12,18]	405	405	418	889	1073	672
(18,24]	10917	10506	9703	11350	11721	10996
(24,40]	11552	12074	13369	12610	12591	11675

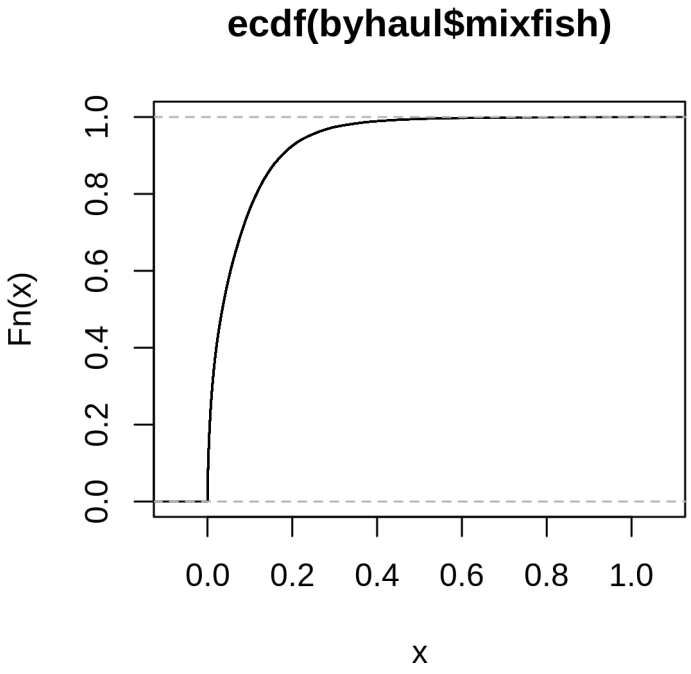

Figure 5: Cumulative distribution the maximum fraction of the landings belonging to a single species by haul for the trawl fleets

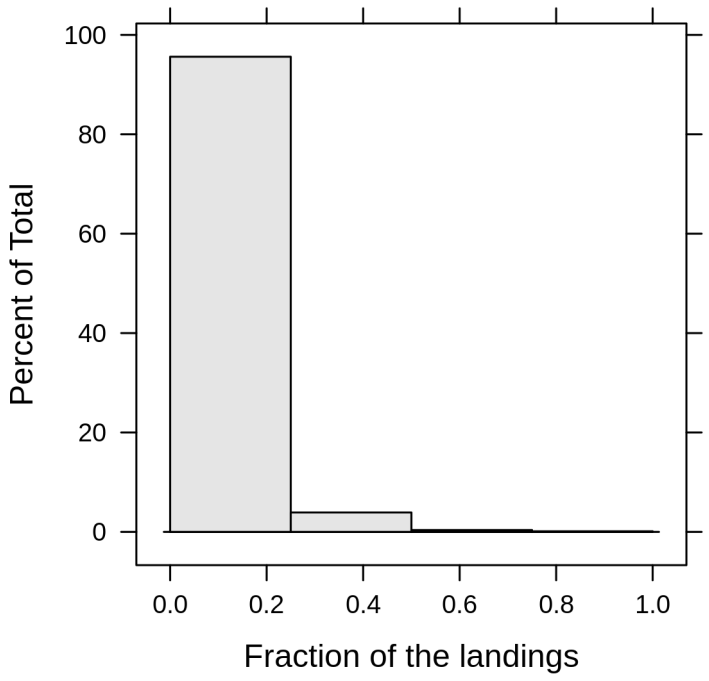

Figure 6: Hauls by maximum fraction of the landings belonging to a single species for the trawl fleets

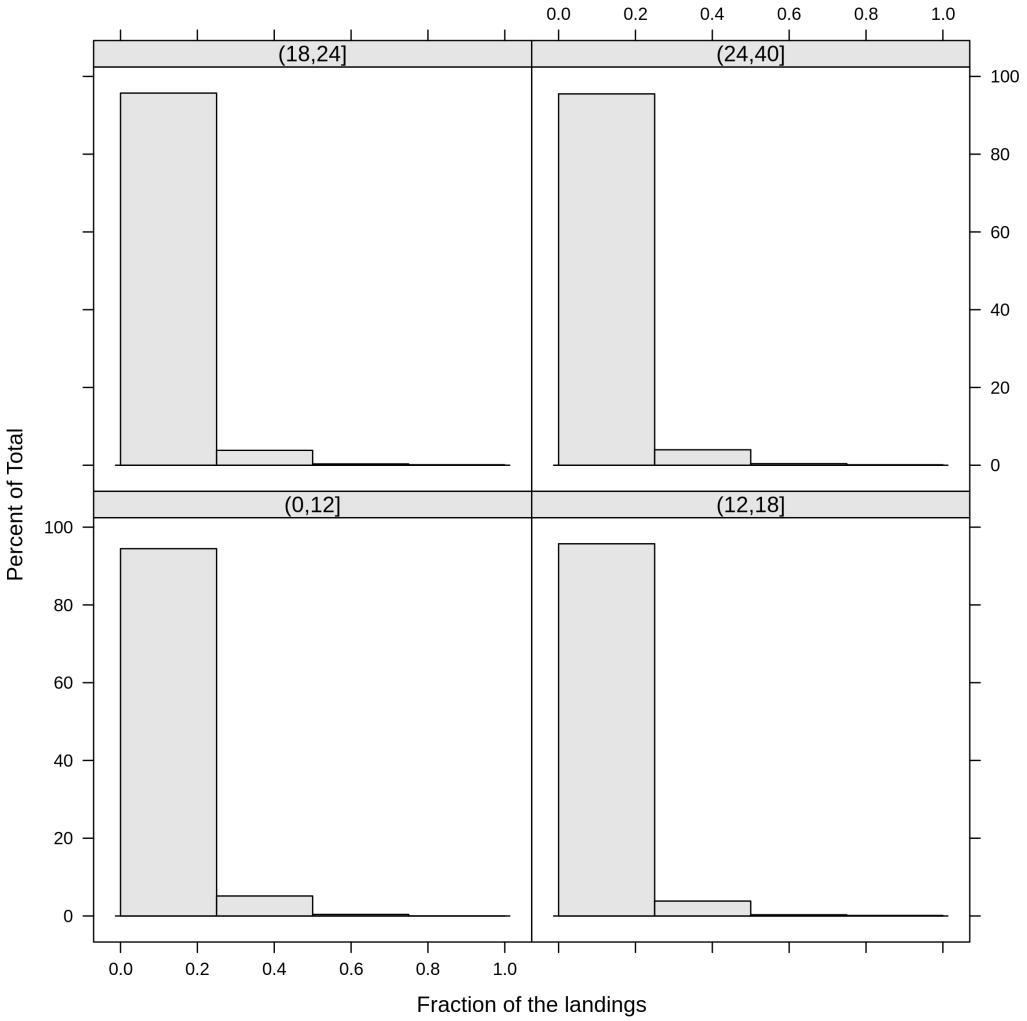

Figure 7: Hauls by fraction of the landings belonging to a single species and LOA

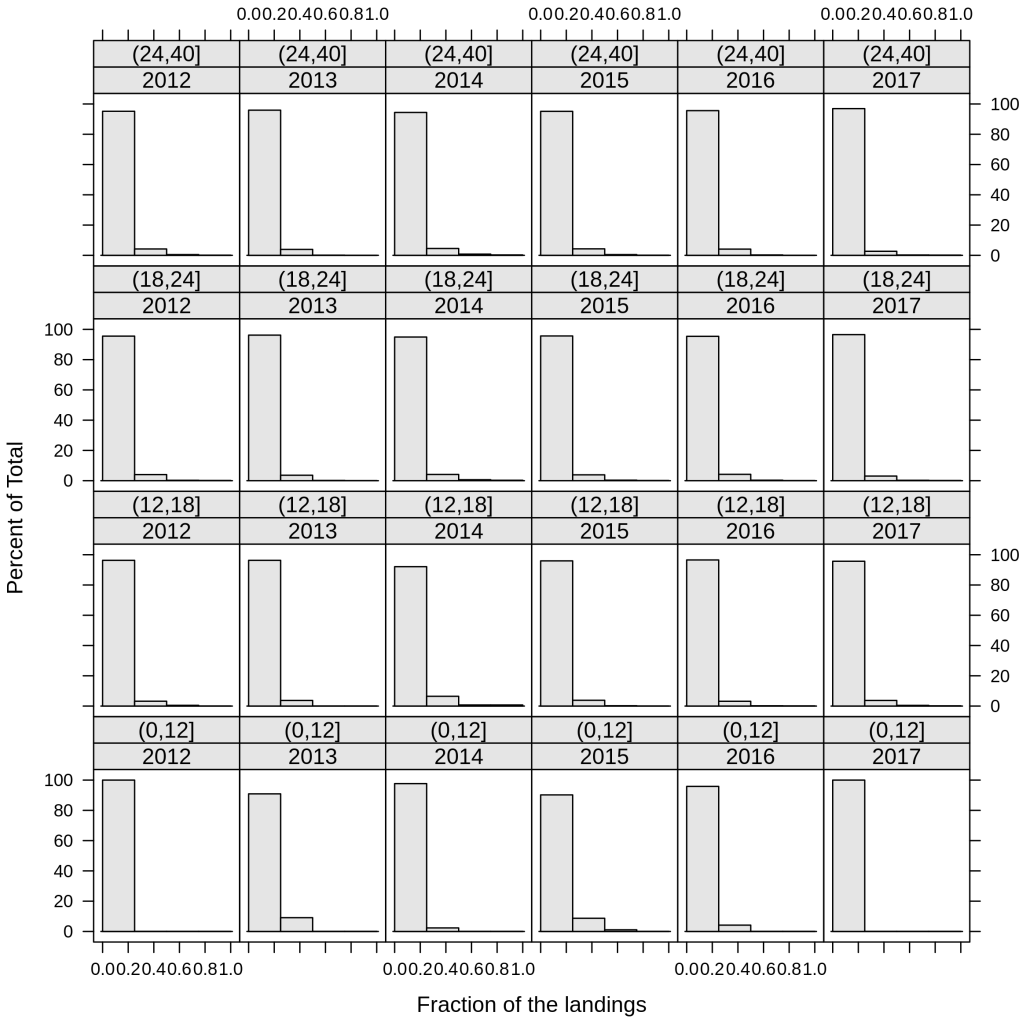

Figure 8: Hauls by fraction of the landings belonging to a single species, LOA and year

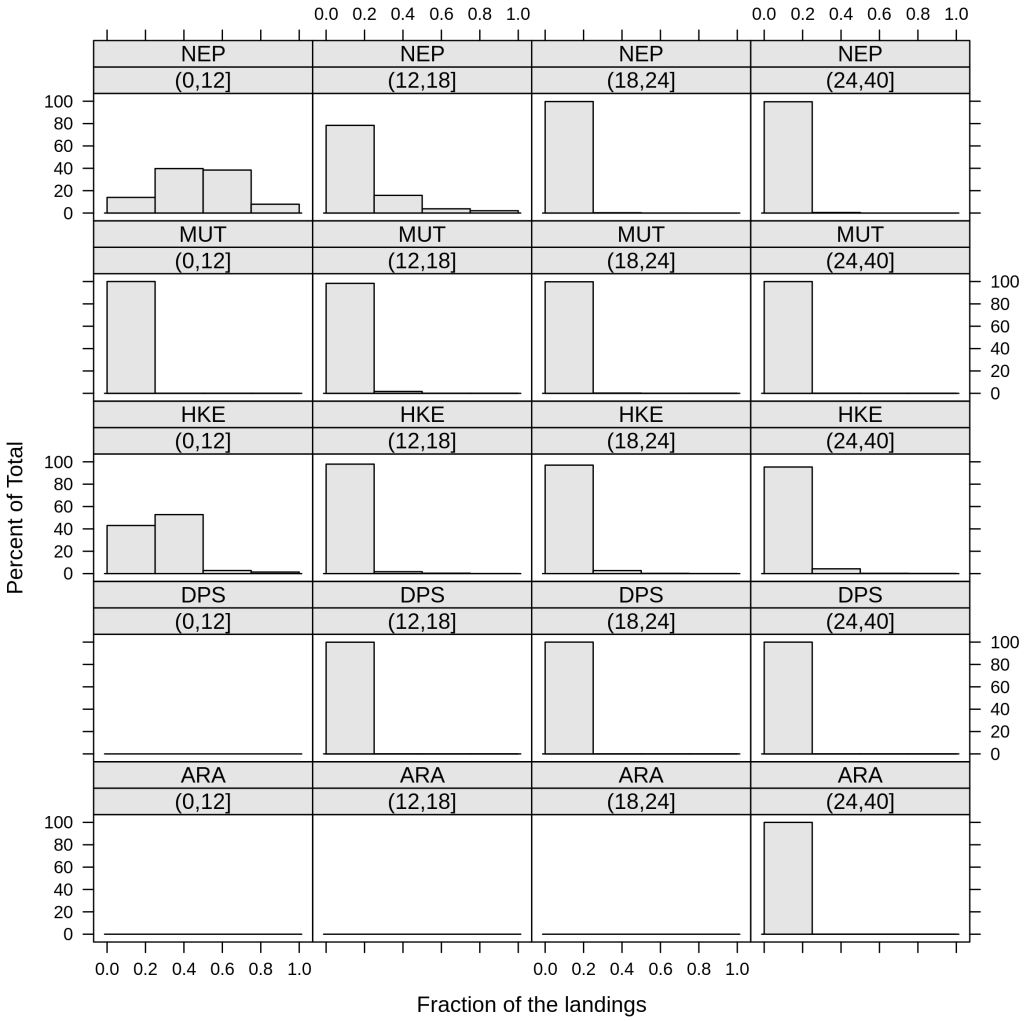

Figure 9: Hauls by fraction of the landings belonging to the species in the MAP by LOA

STECF EWG 18 13: Mixfisheries analysis and data screaning (Spanish-Catalonian trip by trip data)

09-10-2018

1) Introduction

This document presents the data used by EWG1813 to identify factors affecting vessels's efficiency and mix-fisheries levels of the Spanish-Catalonian fleets operating in the Northwest Mediterranean.

2) Read and pre-process data

```
# Set species and gears for the MAP
SelSpecies <- c("HKE", "DPS", "MUT", "ARS", "ARA", "NEP")
SelGears <- c("OTT", "OTM", "OTB")
trgref <- 0.75

df0 <- read.csv("../../data/datarequest/LB-Like/df0_LB_ESP.csv", sep = ";")

df0$Date <- as.integer(df0$Date)
df0$id <- paste0(df0$CFR, df0$Date)

# build dataset by haul with species aggregated
byhaul <- unique(df0[, c("id", "LOAMP1", "Gear", "Year", "Season", "Depth")])
byhaul$mixfish <- tapply(df0$sppfrac, df0$id, max, na.rm = TRUE)
```

3) Data screening

The data were provided by the Spanish/Catalonian authorities specifically for this EWG.

The data screening was focused on showing the number of vessels and the CPUE, broken down by length-over-all (LOA) classes, depth classes, season and year.

```
## Error in FUN(X[[i]], ...): object 'tot' not found
```

```
## Error in FUN(X[[i]], ...): object 'tot' not found
```

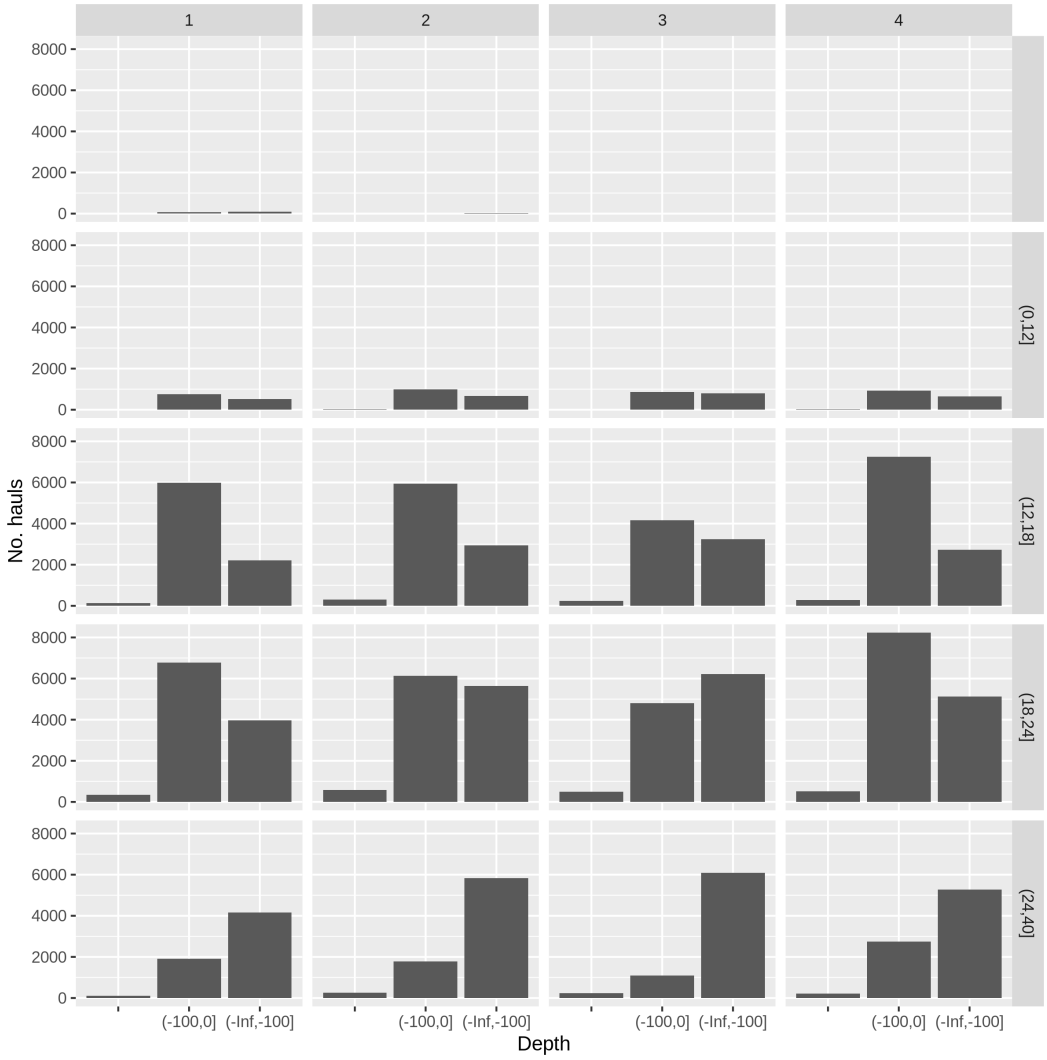

Figure 1: Hals at depth ranges (<100m or >=100m) by LOA and Season

Figure 2: log(LPUE) operating at depth ranges (<100m or >=100m) by LOA and Season

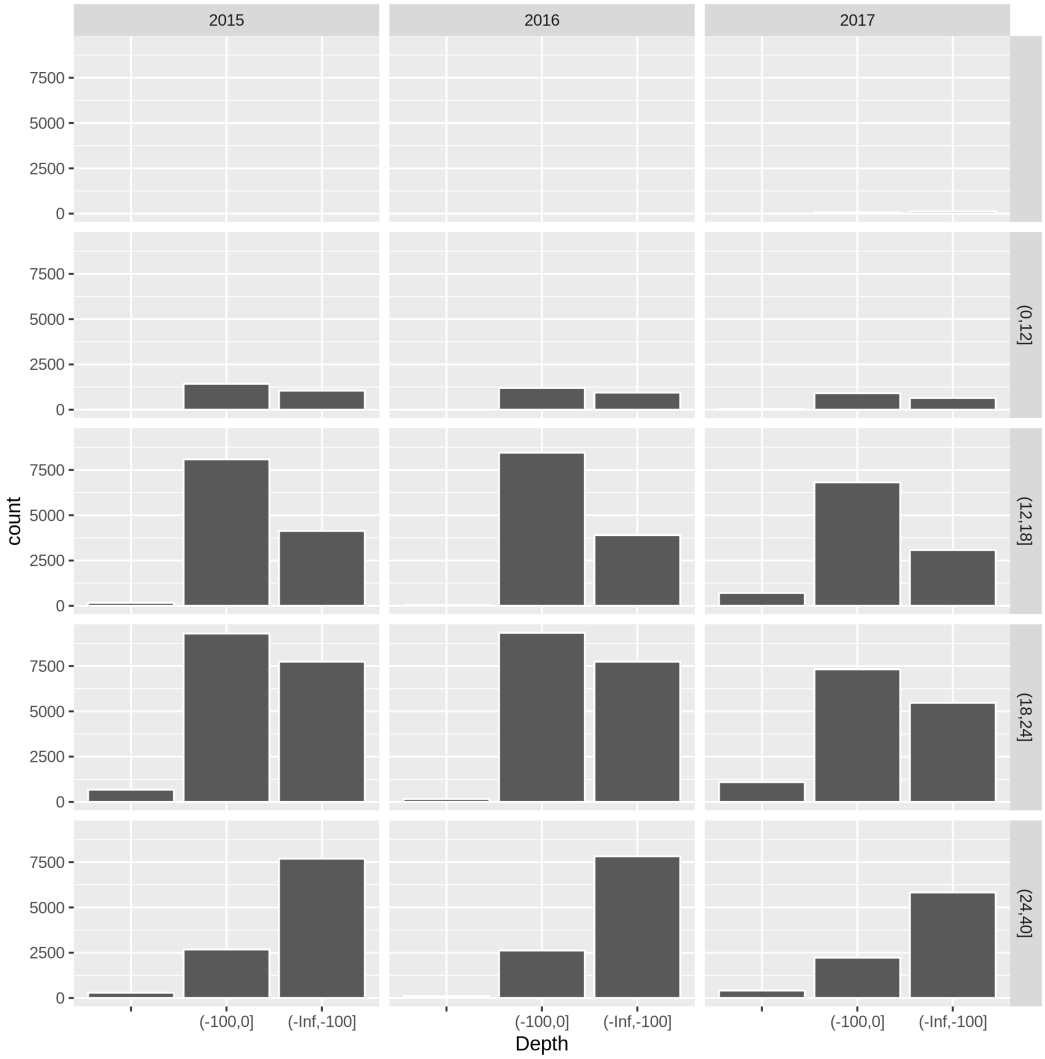

Figure 3: Hauls at depth ranges (<100m or >=100m) by LOA and Year

Figure 4: log(LPUE) operating at at depth ranges (<100m or >=100m) by LOA and Year

4) Mixfisheries

The mix-fisheries analysis was performed to evaluate the level of "non-mix" in the fisheries and potential impact of choke species. The rationale is that if a number of hauls are "clean", it means a certain level of specialization exists. Fleet's specialization should be explored/fostered to increase the probabilitty of the MAP's success, since the species targeted by the MAP are not all in the same level of over-exploitation. On the other hand if a haul is mostly made of one species, limiting effects by other species are less important and can be avoided.

The analysis presented here is based on data aggregated by fishing day. Ideally, this analysis should be done on a haul-by-haul basis to allow a proper evaluation of the mixed-fisheries nature of the fishery.

	2015	2016	2017
	0	0	187
(0,12]	2492	2151	1614
(12,18]	12391	12402	10609
(18,24]	17714	17238	13881
(24,40]	10666	10554	8473

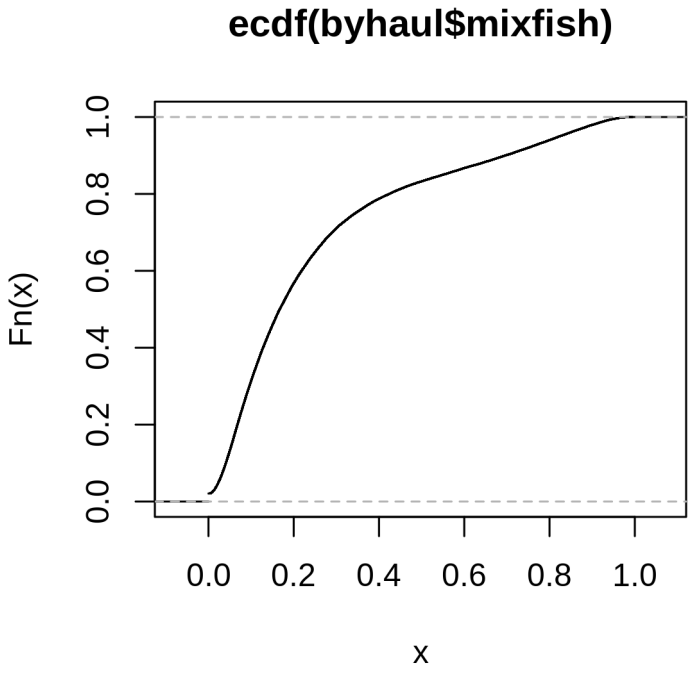

Figure 5: Cumulative distribution the maximum fraction of the landings belonging to a single species by haul for the trawl fleets

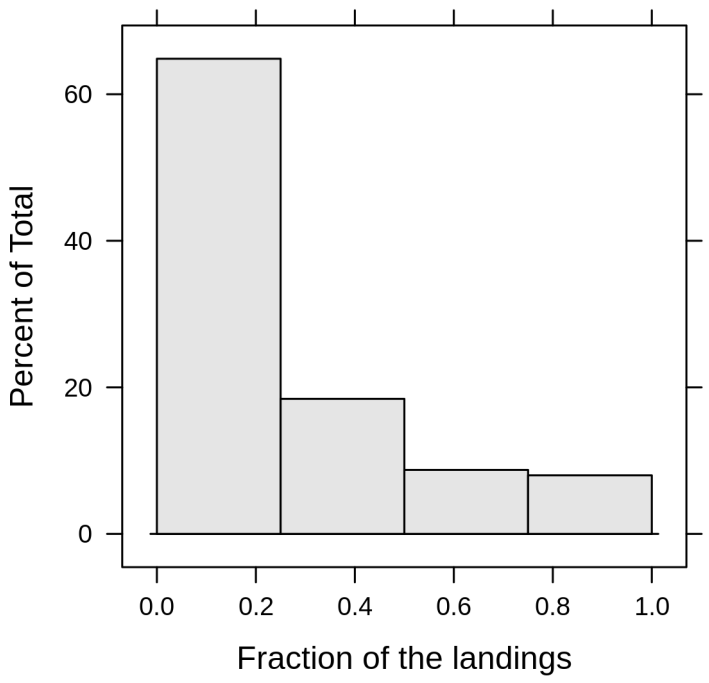

Figure 6: Hauls by maximum fraction of the landings belonging to a single species for the trawl fleets

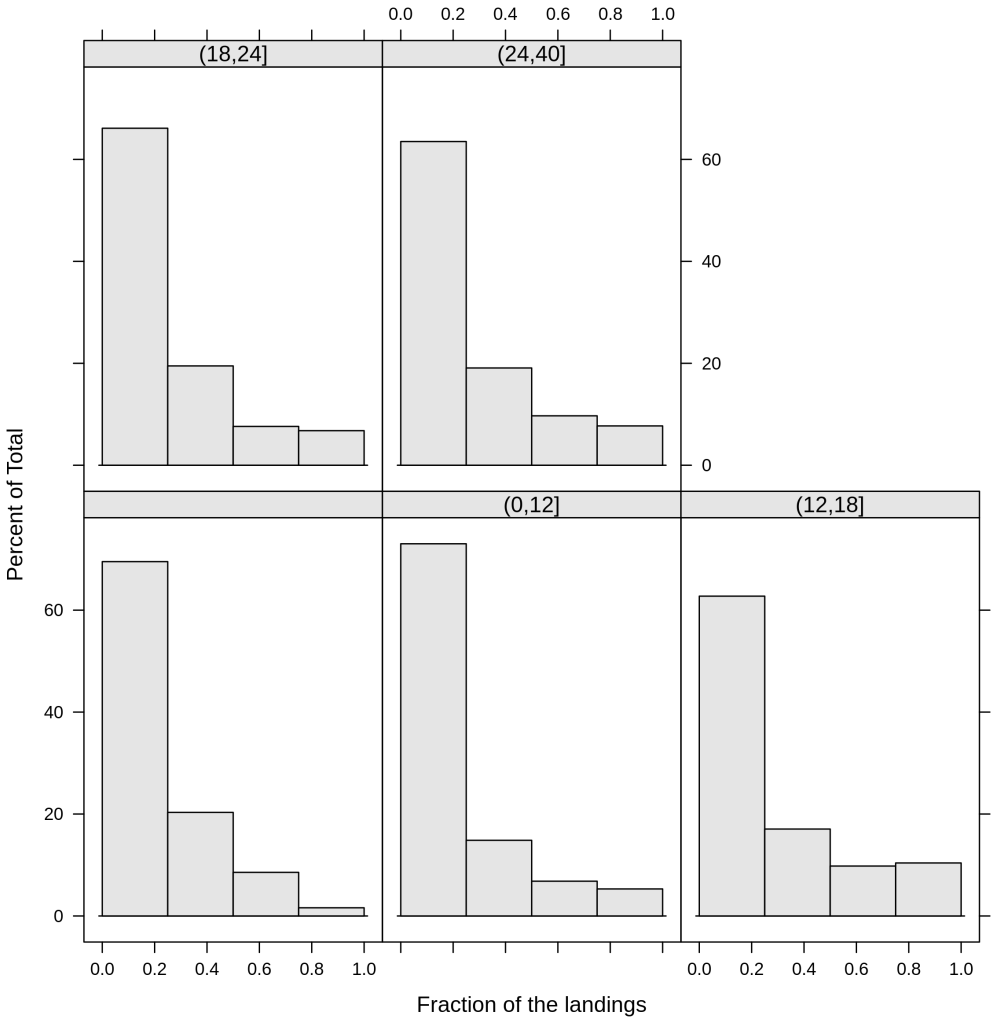

Figure 7: Hauls by fraction of the landings belonging to a single species and LOA

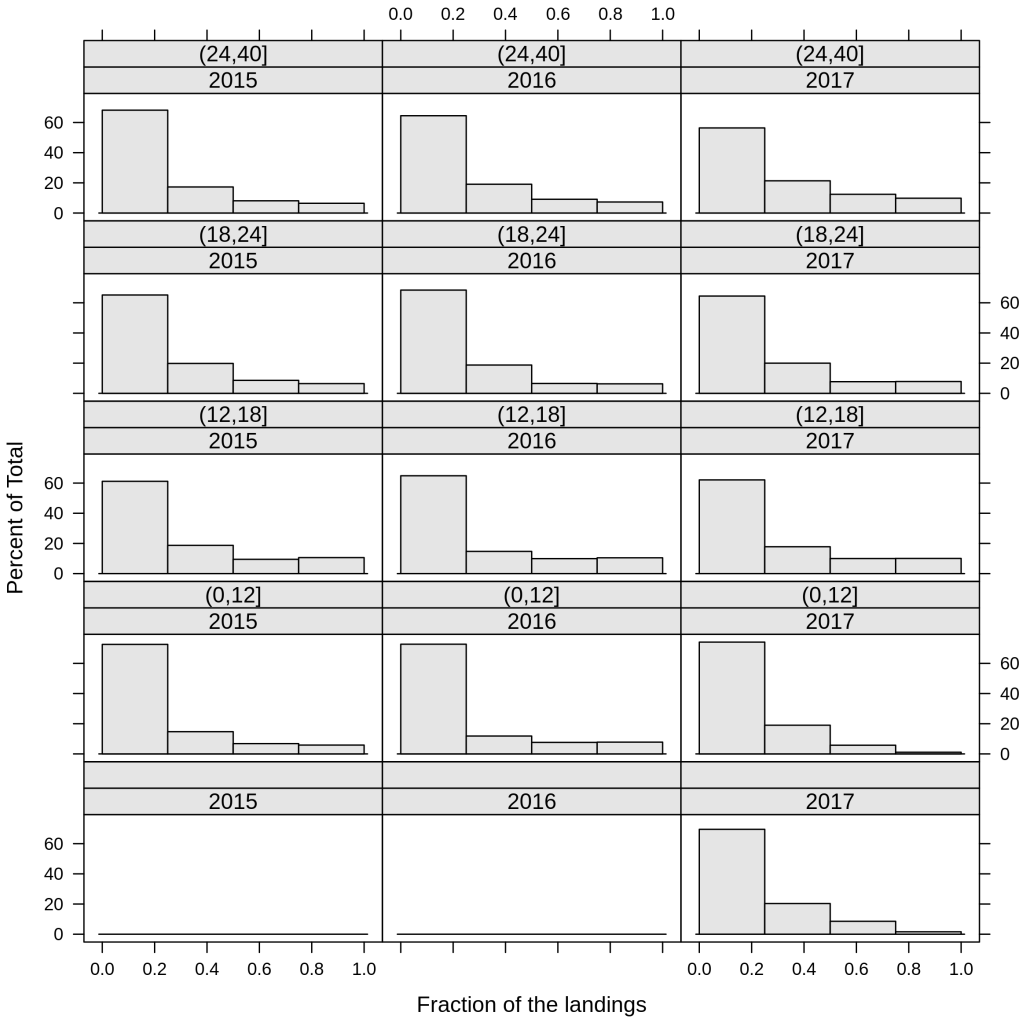

Figure 8: Hauls by fraction of the landings belonging to a single species, LOA and year

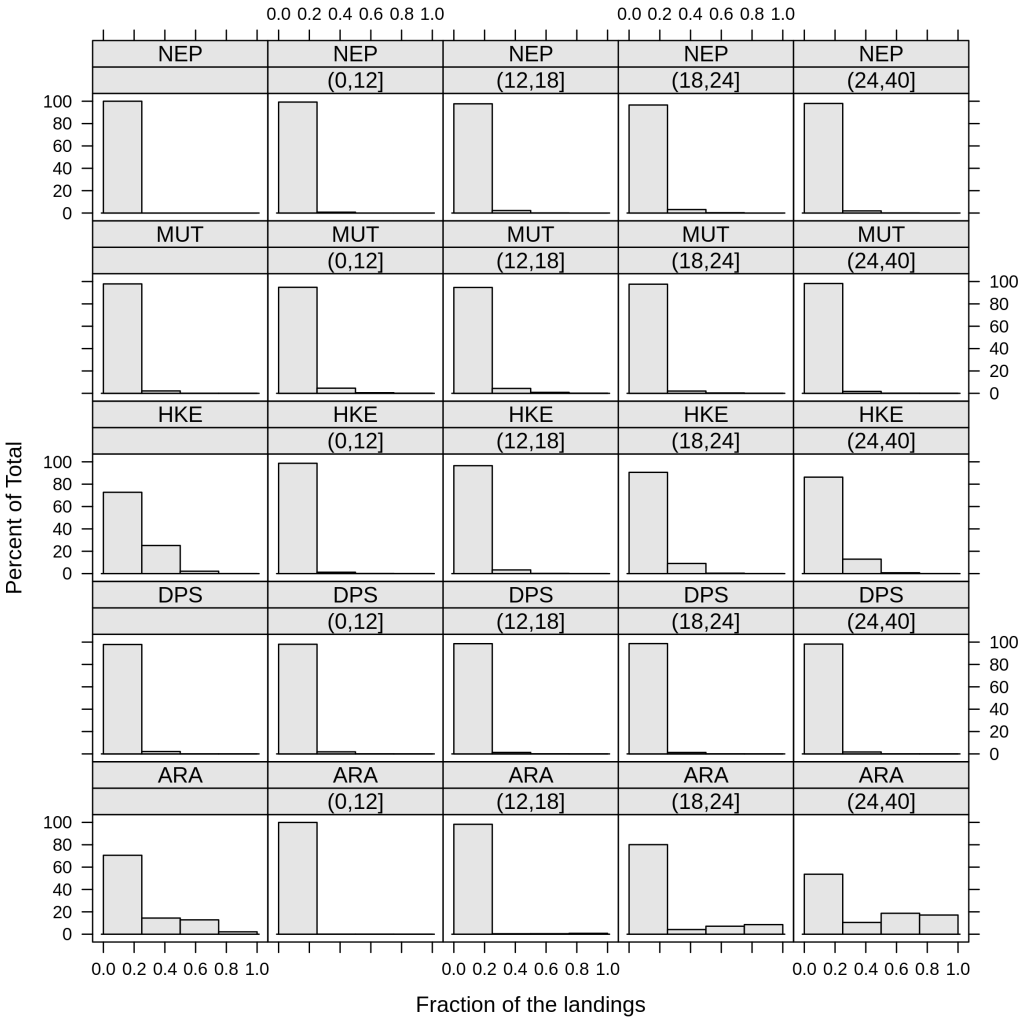

Figure 9: Hauls by fraction of the landings belonging to the species in the MAP by LOA

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ANNEX 03

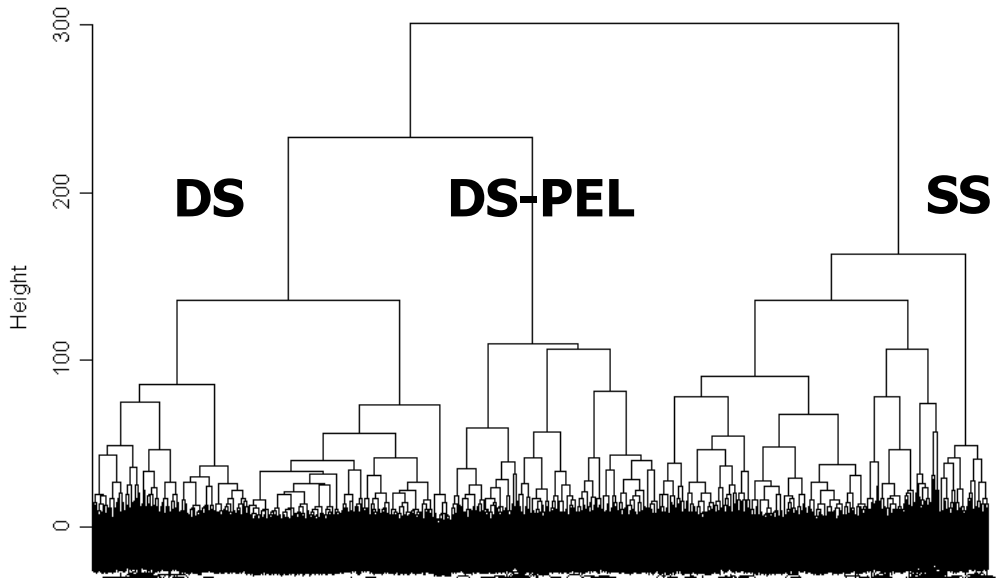
ALTERNATIVE METIERS DEFINITIONS FOR SPAIN AND ITALY

1 - SPAIN

1.1 - GSA 6

Sant Carles de la Ràpita:

This is one of the most important harbours in terms of number of trawlers in GSA6. The boats basically exploit the Ebro delta platform. In this port the dendrogram resulting from the cluster analysis showed that the bottom trawl fleet operated following three main fishing strategies or métiers that target the shallow shelf (SS), the deep shelf (DS), and another one targeting the DS but using a bottom trawl gear with a high vertical opening allowing larger catches of small pelagics (DS-PEL) (Figure 1). The percentages in landed biomass, incomes and fishing days dedicated to each of the métiers is also shown. The most important métier in terms of economic income and fishing days (very similar to those dedicated to DS) was SS, although DS-PEL was the most important métier in landed biomass. The most important species landed from SS were, among a high variety, the stomatopod crustacean *Squilla mantis* and *M. barbatus*. In DS, the main landings included the decapods crustacean *Liocarcinus depurator*, the cephalopod mollusk *Eledone cirrhosa*, *S. mantis* and *M. merluccius*. The main landings from the DS-PEL métier were also highly diverse, with *Engraulis encrasicolus*, *M. merluccius*, *Trachurus* spp. and *Scomber scombrus* among the most important ones (Table 1).



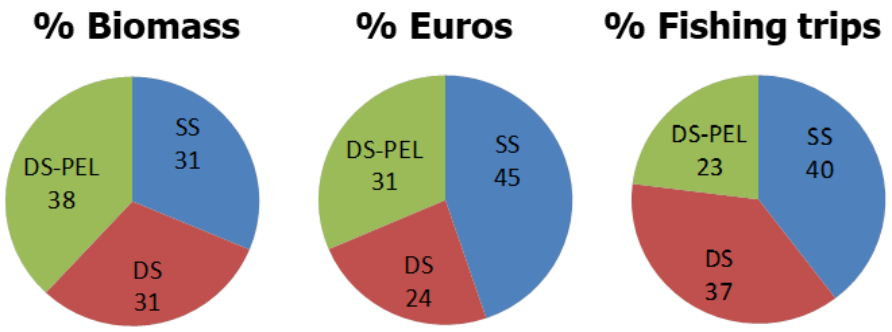


Figure 1. Top panel: dendrogram resulting of the cluster analysis of daily landings per boat from daily sales bills in 2006-2007 from Sant Carles (GSA6). Lower panel: percentages represented by each of the métiers detected in terms of biomass, income and fishing days. SS: Shallow shelf; DS: deep shelf; DS-PEL: deep shelf exploited with a high vertical opening bottom trawl gear.

Table 1. Most important species (kg/day) in each of the fishing strategy detected in Sant Carles port. Abbreviations as in Figure x.

SS		**DS**		**DS-PEL**	
S. mantis	43.0	*L. depurator*	25.4	*E. encrasicolus*	79.7
M. barbatus	38.5	*E. cirrhosa*	22.6	*M. merluccius*	55.1
S. aurata	27.2	*S. mantis*	19.8	*Trachurus* spp	44.9
O. vulgaris	12.2	*M. merluccius*	19.0	*S. scombrus*	44.4
Trachurus spp	10.6	*T. minutus*	17.8	*T. minutus*	42.8
S. officinalis	7.4	*Trachurus* spp	15.8	*E. cirrhosa*	37.7
P. erythrinus	6.5	*C. linguatula*	13.1	*L. piscatorius*	34.2
M. merluccius	6.3	Actinopterigios	12.7	*M. barbatus*	26.8
C. conger	6.3	*L. piscatorius*	12.7	Actinopterigios	18.0
M. kerathurus	6.1	*C. macrophthalma*	9.5	*C. macrophthalma*	14.0

Llançà:

Placed at the northern side of GSA 6. The boats exploit both the continental shelf and the slope. In this port the dendrogram resulting from the cluster analysis showed that the bottom trawl fleet operated following three main fishing strategies or métiers that target the continental shallow and deep shelf (SS-DS), the upper slope (US), and the middle slope (MS) (Figure 2). The most important métier in terms of economic income and fishing days was SS-DS, although in terms of landed biomass US as the most important métier. The most important landings for the SS-DS corresponded, among a high variety, to a mixed fish category (that gathered small fish species and/or small individuals of lager species) followed by the cephalopod mollusk *Octopus vulgaris* and *M. merluccius* among a high variety of landings. The landings from the US were clearly dominated by *Micromessistius poutassou*, followed by hake, whereas *A. antennatus* clearly dominated in the MS (Table 2).

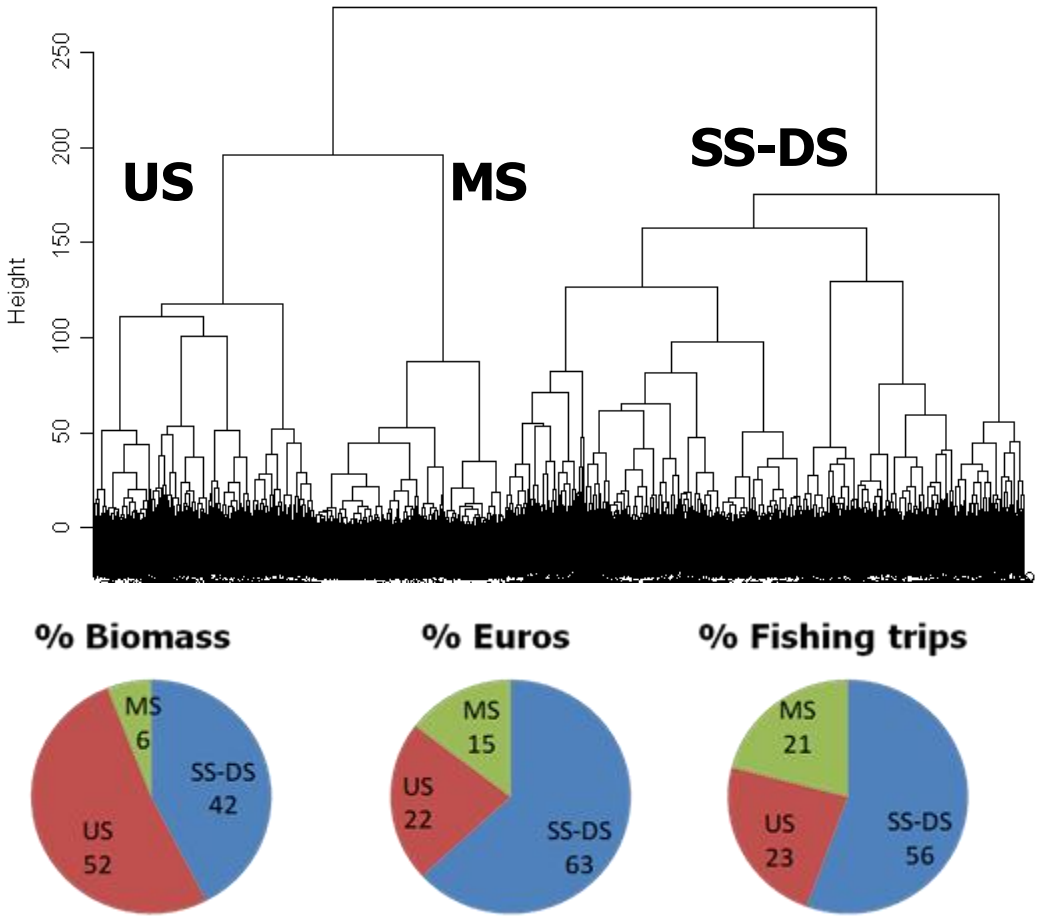


Figure 2. Top panel: dendrogram resulting of the cluster analysis of daily landings per boat from daily sales bills in 2006-2007 from Llançà (GSA6). Lower panel: percentages represented by each of the métiers detected in terms of biomass, income and fishing days. SS-DS: Shallow shelf-deep shelf; US: upper slope; MS: middle slope.

Table 2. Most important species (kg/day) in each of the fishing strategy detected in Llancà port. Abbreviations as in Figure x.

SS-DS		**US**		**MS**	
Actinopterigios	42.9	*M. poutassou*	690.7	*A. antennatus*	38.3
O. vulgaris	40.5	*M. merluccius*	31.8	*M. poutassou*	16.9
M. merluccius	40.5	*P. blennoides*	19.0	*M. merluccius*	10.7
T. trachurus	31.7	Actinopterigios	15.8	*P. blennoides*	9.4
M. barbatus	18.8	*Lophius* spp	8.2	*Plesionika* spp	7.8
Perciformes	11.7	*E. cirrhosa*	7.5	Actinopterigios	6.0
L. vulgaris	11.7	*L. caudatus*	7.4	*G. longipes*	4.7
S. officinalis	10.7	*Plesionika* spp	6.8	*T. sagittatus*	4.2
E. cirrhosa	9.3	*T. sagittatus*	6.2	*P. narval*	1.7
T. minutus	8.4	*A. boyeri*	5.6	Crustacea	1.4

1.2 - GSA1

Vélez-Málaga:

Located in Málaga at the middle of GSA 1 in the Alboran Sea. The boats exploit both the continental shelf and the upper slope. In this port the dendrogram resulting from the cluster analysis showed that the bottom trawl fleet operated following two main fishing strategies targeting the continental shallow shelf (SS) and the deep shelf and upper slope (DS-US) (Figure 3). The most important métier in terms of landed biomass and economic income was DS-US, although most fishing days were dedicated to the SS. Landings from SS were dominated by *O. vulgaris*, although a variety of other species were also important. In the DS-US landings were clearly dominated by *M. poutassou*, although as for SS a high variety of other species were also important (Table 3).

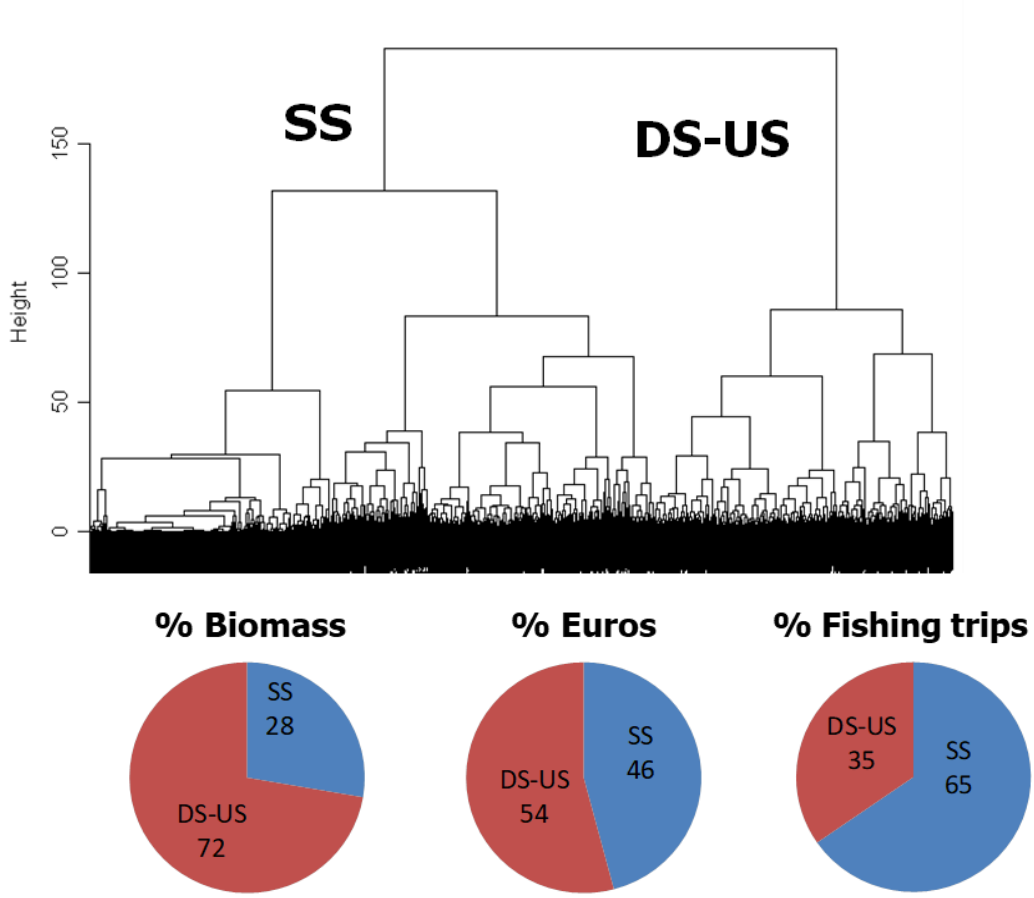


Figure 3. Top panel: dendrogram resulting of the cluster analysis of daily landings per boat from daily sales bills in 2006-2007 from Vélez-Málaga (GSA1). Lower panel: percentages represented by each of the métiers detected in terms of biomass, income and fishing days. SS: Shallow shelf; DS-US: Deep shelf and upper slope.

Table 3 Most important species (kg/day) in each of the fishing strategy detected in Vélez-Málaga port. Abbreviations as in Figure x.

SS		DS-US	
O. vulgaris	63.5	*M. poutassou*	746.4
M. poutassou	30.0	*Trachurus* spp	51.9
Trachurus spp	22.9	*S. canicula*	16.4
P. acarne	16.4	*Lophius* spp	15.6
Mullus spp	10.3	*Phycis* spp	10.0
S. officinalis	9.0	*G. galeus*	7.5
Rajidae	5.4	*M. merluccius*	7.3
Diplodus spp	4.9	*N. norvegicus*	6.5
Lophius spp	3.8	*P. longirostris*	6.2
A. tuberculata	3.3	*L. vulgaris*	5.3

1.3 - GSA 5

Mallorca:

The ports based in the Mallorca Island centralize all their landings in Palma. In this case the segmentation included all ports in this Island, where most of the bottom trawl fleet of the Balearic Islands is based. The fleet is characterized by exploiting the four main bathymetric strata, the shallow shelf (SS), deep-shelf (DS), upper slope (US) and middle slope (MS) targeting different species (Figure 4). Moreover, the fleet is highly versatile and it is frequent that boats combine different fishing strategies in the same fishing trip (Palmer et al. 2009, Quetglas et al. 2012). The most important metiers in terms of fishing days are the SS and MS (Figure 5). In terms of biomass, shelf metiers dominate over slope metiers, whereas in terms of economic income the inverse applies (Ordines 2016). The most important category in both biomass and economic income from the SS is a mixed fish category, in which species mainly of the families Triglidae, Serranidae, Trachinidae and Scorpaenidae are gathered together (Ordines et al. 2014), followed by *M. surmuletus* and *O. vulgaris*, among a high variety of other species. *M. Merluccius* dominates landings from DS and is also important in US after *M. Poutassou*, although again the mixed fish category is an important landing from the DS, and for both DS and US there is a high variety of other species also important in the landings. *A. antennatus* clearly dominates landings from the MS.

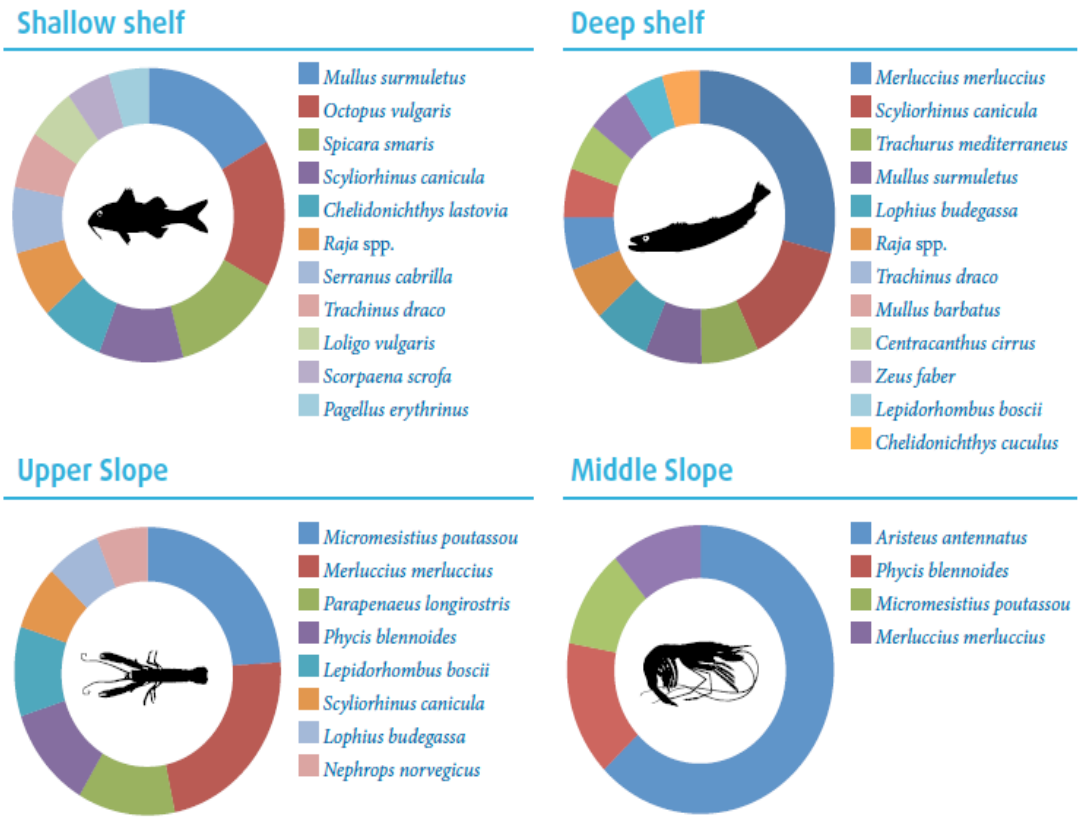


Figure 4. Species composition (% of landed biomass) in the four basic fishing strategies followed by the bottom trawl fleet in the Mallorca Island. Source: Quetglas et al 2016

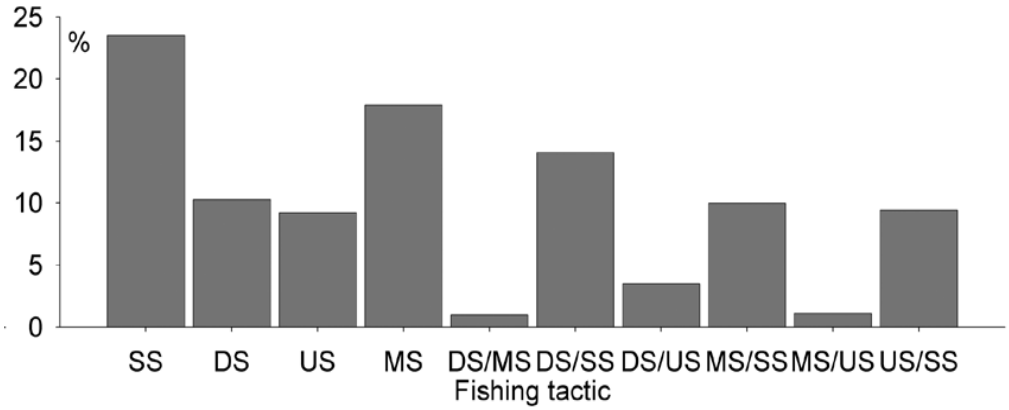


Figure 5: Percentage of fishing days dedicated by the bottom trawl fleet in Mallorca Islands to the four basic fishing strategies and their combinations. Source: Quetglas et al 2012

2 - ITALY

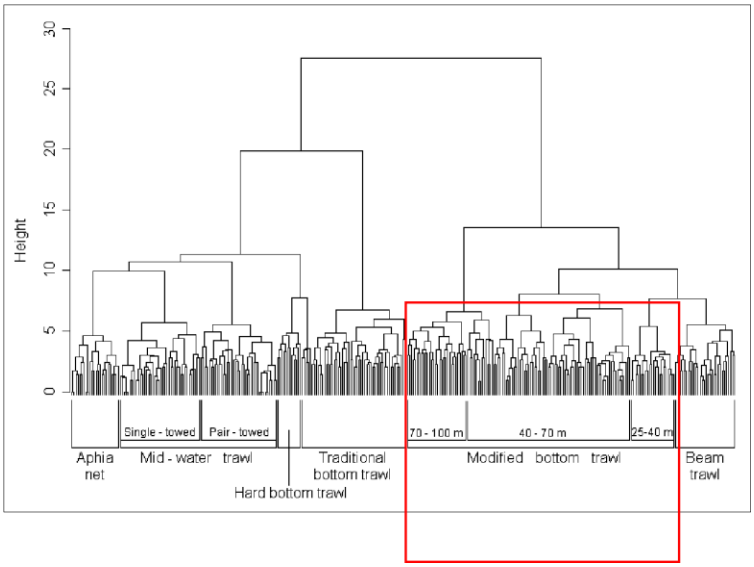
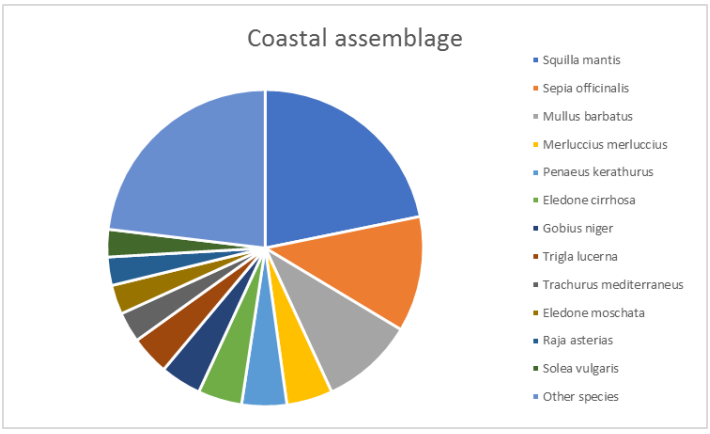


Figure 6. Example of assemblages defined for the Viareggio port in GSA9. The rectangle includes the trips of trawlers operating close to the coast up to 100m. The cluster immediately in the left includes trips targeting Nephrops. On the right vessels using beam trawls targeting flat fishes. Other métiers can be identified as those targeting small pelagics and the already disappeared fisheries targeting Aphia minuta with small meshed trawls and for sparids using heavy groundropes.

The bulk of the Viateggio fishery target coastal species (Figure 7) mixes as the shelf is large in this area, while towards the north and to the south, the shelf is narrower and most of the vessels target species living at deeper waters, and in particular pink shrimps on the shelf border and red shrimps on the slope.

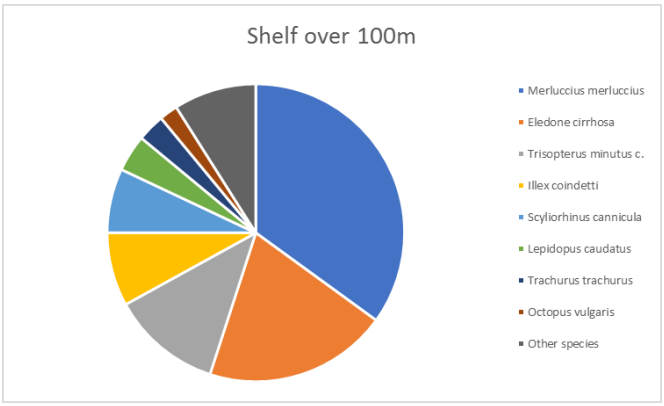


COASTAL ASSEMBLAGE	
Squilla mantis	21.8
Sepia officinalis	11.8
Mullus barbatus	9.5
Merluccius merluccius	4.7
Penaeus kerathurus	4.6
Eledone cirrhosa	4.5
Gobius niger	4.2
Trigla lucerna	4
Trachurus mediterraneus	3.1
Eledone moschata	3
Raja asterias	2.9
Solea vulgaris	2.8

Other species	23.1

Figure 7. Species composition of the coastal assemblage

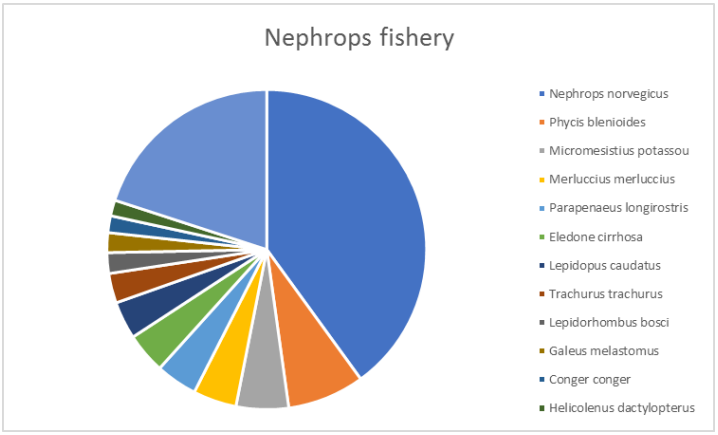
Example of mix fishery of vessels operating on the shelf at depths over 100m is shown in Figure 8.



SHELF FISHERY OVER 100M	
Merluccius merluccius	35
Eledone cirrhosa	20
Trisopterus minutus c.	12
Illex coindetti	8
Scyliorhinus cannicula	7
Lepidopus caudatus	4
Trachurus trachurus	3
Octopus vulgaris	2
Other species	9

Figure 8. Species composition of the shelf assemblage

Examples of catch composition of vessels operating between 300 and 600m targeting Nephrops norvegicus. The species represents a variable fraction of the total catch (Figure 9).

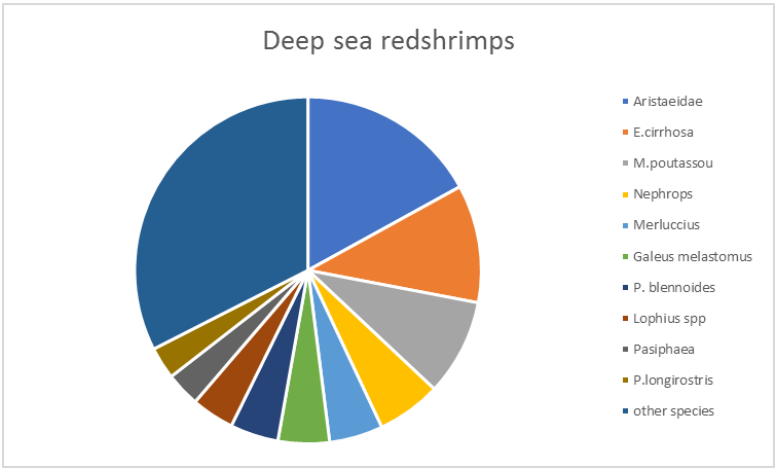


NEPHROPS FISHERY	
Nephrops norvegicus	40
Phycis blenioides	7.8
Micromesistius potassou	5.3
Merluccius merluccius	4.4
Parapenaeus longirostris	4.2
Eledone cirrhosa	4.1
Lepidopus caudatus	3.8
Trachurus trachurus	3
Lepidorhombus bosci	2.1
Galeus melastomus	2
Conger conger	1.7
Helicolenus dactylopterus	1.6

Other species	20

Figure 9. Species composition of nephrops fishery

Example of landings composition of deep sea shrimps fishery in GSA9 (Figure 10). Aristaeidae shrimps include the two species: Aristaeus antennatus and Aristaeomorpha foliacea which may be caught in different proportions by area and with high fluctuations among years.



DEEP SEA SHRIMPS	
Aristaeidae	17.1
E.cirrhosa	10.9
M.poutassou	9.2
Nephrops	6.0
Merluccius	5.1
Galeus melastomus	4.8
P. blennoides	4.5
Lophius spp	4.1
Pasiphaea	3.2
P.longirostris	3.1
other species	32.0

Figure 10. Species composition of the deep sea red shrimp fishery.

In Figure 11 it is shown the pattern of bathymetric displacements of the Viareggio fleet along the year. The height represents the percentage of vessels exploiting the different grounds in the different months. During summer, part of the fleet that in general operates close to the coast moves towards deeper waters (>100m) targeting especially horned octopus Eledone cirrhosa and Merluccius merluccius, with by-catch mainly composed by Scyliorhinus canicula, Zeus faber, Raja clavata. Small-sized individuals of horned octopus have a very high commercial value.

The number of vessels that exploit Nephrops at depths between 300 and 600m increase in summer due to better weather conditions and another peak is observed in december before the Christmas and New Year holidays.

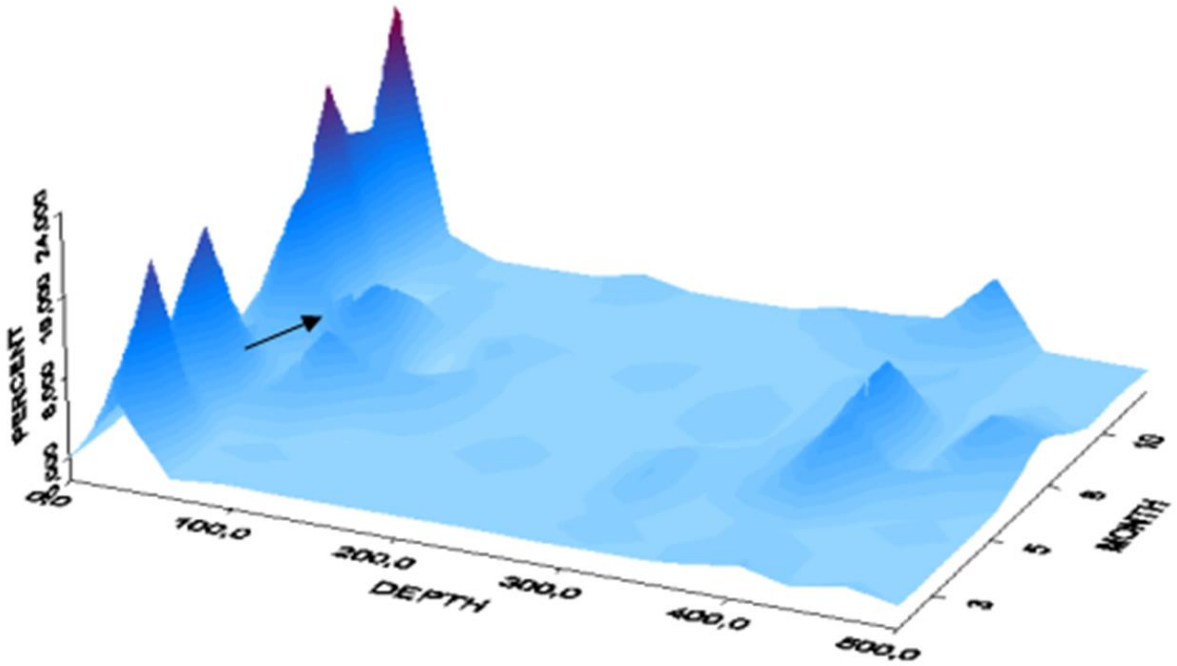


Figure 11. Depth distribution of the Viareggio fleet by month. The arrow underlines a shift of the distribution of part of the fleet that moves to deeper waters in summer targeting horned octopus.

3 – Bibliography

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