Annex 8: Working papers presented at the WGBIFS-2017 meeting

Note: Authors are fully responsible for quality of the prepared text and all kind of presented data.

List of working papers:

1. Allocation of BITS hauls from TD;
2. Calibration between new and old the r/v Havfisken.

DTU Aqua
National Institute of Aquatic Resources

WGBIFS 2017 working document

Allocation of BITS hauls from TD

by Henrik Degel (DTU Aqua)

Introduction

Every year during the Baltic International Survey Working Group in March (WGBIFS) a number countries commit themselves to carry out a number of trawl hauls in the Kattegat and Baltic Sea twice a year. The hauls constitute the internationally coordinated "Baltic International Trawl Survey" (BITS).

The survey is designed as a stratified random survey, which distribute the hauls stratified on Sub-division and depth strata. The allocation of hails positions to each country is a several-step procedure (fig. 1) and this document describes in details how hauls are distributed between strata and randomly drawn from a closed list of haul tracks in the Trawl Database. The software used for selecting the hauls has recently been updated using R as the programming language. Previously, the selection was a mixture of several types of software including EXCEL spreadsheets and was not documented except as program codes and a brief description in the WGBIFS report.

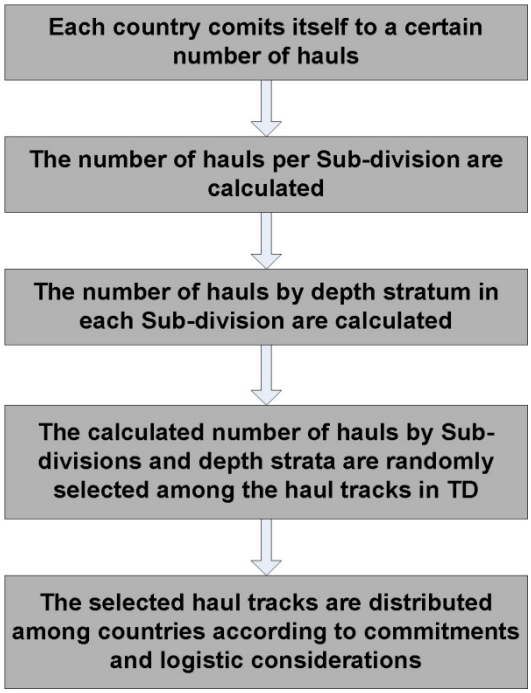

Figure 1. Main steps in allocating BITS haul tracks.

The number of hauls, which each country commits themselves to carry out during the following autumn and the next year spring, is announced during the WGBIFS meeting in March. The total number hauls vary a little but is around 300 in the spring and 270 in the autumn. The total spatial area for the survey falls into two separate sea areas: Sea area 21-24 covering Subdivisions 21, 22, 23 and 24 and sea area 25-28, which covers Sub-divisions 25, 26, 27 and 28.

Description of the Trawl Database

The Trawl Database (TD) consists of a closed list of tracks suitable for demersal trawling. The database covers the Sub-divisions from 22 in the western Baltic Sea to sub-division 28 in the central Baltic Sea. The tracks are sourced from commercial fishing boats as well as from research vessels track libraries. Each haul track is given by start position, end position and a number of waypoints in between. To each position is given the depth and auxiliary information such as origin, recommended gear version to be used, distance of the track and EEZ. Each haul track is identified by a TD Haul number consisting of a combination of the sub-division in which it is situated and a consecutive number. The database is continuously updated based on feed-back from the users concerning change in track statuses due to e.g. new gas and power cables and updated or canceled if serious gear damage is experienced. Errors are of cause also corrected and new haul tracks can be included in the database as well. At present (March 2017) the database holds information about 795 tracks. The format is a plain CSV file, which can be read in e.g. EXCEL.

Allocating the total available hauls to Sub-division and depth interval
(Part 1 in the R-program)

The total numbers of hauls by sea area (SD 21-24 and SD 25-28) are distributed between sub-divisions based on a weighting which consists of a combination of the area (km²) of the sub-divisions and the running mean of the previous 5 years BITS abundance index by Sub-division of cod of age 1+ in 1st quarter. The weighting between area and Cpue is 60% and 40% respectively. The number of hauls in a given Sub-division is given by:

$$N_{SD} = \frac{N_{Total} \times \left[(0.6 \times A_{SD}) + 0.4 \times Cpue_{RM(SDy_{py-6,py-1})}\right]}{\sum_{SD=s}^{t}\left[(0.6 \times A_{SD}) + 0.4 \times Cpue_{RM(SDy_{py-6,py-1})}\right]}$$

where N is the number of hauls, NTotal is the total number of hauls for which the countries has committed itself, SD is the Sub-division, s and t are the start and end of the Sub-division assemble in question. A is the area (km2), Cpue is the Catch per unit effort, RM is the running mean, and the py is the present year. The present year is the year for the autumn survey for which the allocation is made. For the spring survey the present year is the year before for which the allocation is made.

The area of each subdivision can be downloaded from the DATRAS homepage. The abundance index of age 1+ cod in the 1st quarter survey can be downloaded on the same homepage (see annex 1 for details in calculation of the CPUE input values). The Subarea codes in DATRAS output is not the same as used in the haul allocation program. The key between DATRAS and the haul allocation program is given below.

Depth interval	Layer	DATRAS subarea code
0-10	1	8
10-40	2	9
40-60	3	10
60-80	4	11
80-100	5	12
< 100	6	13

Depth interval	Layer	DATRAS subarea code
0-20	1	8
20-40	2	9
40-60	3	10
60-80	4	11
80-100	5	12
< 100	6	13

Remark that the shallow water intervals are different for the two sea areas.

DATRAS subarea (=depth interval) code key for SD 22-24 DATRAS subarea (=depth interval) code key for SD 25-32

Several countries have area restrictions on the distribution of the hauls, which prevent the hauls to be distributed following strict standardized principles. These restrictions can be incorporated in the program and integrated in the outcome.

The allocation by depth interval (Layer) follows the same principles as for the allocation to Sub-division and is given by the equation below.

$$N_{SD,DL} = \frac{N_{SD,Total} \times \left[\left(0.6 \times A_{SD,DL}\right) + 0.4 \times Cpue_{RM(SD,DLy_{py-6,py-1})}\right]}{\sum_{SD,DL=n}^{m}\left[\left(0.6 \times A_{SD,DL}\right) + 0.4 \times Cpue_{RM(SD,DLy_{py-6,py-1})}\right]}$$

where DL is Depth Layer and n and m are the smallest and largest depth layer interval.

If the allocated number of hauls in total does not exactly match the total number of the planed hauls, the numbers can be fine-tuned individually in each stratum to match the total planned hauls.

The allocation of hauls is done by separate runs for each quarter by indicating the quarter in the program.

Random drawing of haul tracks in the Trawl Database
(Part 2 in the R-program)

The next step in the haul allocation process is to decide on which tracks in the Trawl Database (TD) should be realized for the given survey. First, every depth interval area is divided into a number of 10′ N x 20′ E area subunits. If a given subunit covers more than one depth interval, the unit is then used in both subunits. The selection is a two-step process: First are subunits randomly selected among the subunits, which have one or more TD hauls included. This is done in order to assure that the selected hauls are dispersed throughout the whole stratum. Secondly, one haul in each of the selected subunits are selected. Both selections are done without replacements.

For each stratum (Sub-division, depth interval), the number of selected hauls might exceed the number of track available in the TD. Depending on the circumstances, one of three types of haul selection strategies is used:

Type I haul selection strategy is used when the number of hauls selected in a given stratum does not exceeds the number of sub-units for that stratum with one or more tracks included. A number of sub-units, which equal to the selected number of selected hauls, are randomly selected. The selection is made without replacement. For those sub-units where more than one track are identified, one of those tracks is selected randomly.

Type II haul selection strategy is used when the number of hauls selected in a given stratum does exceeds the number of sub-units for that stratum with one or more tracks included, but the number of hauls selected does not exceeds the number of tracks available. In this case, one track is selected in each sub-unit and the rest of the hauls are randomly selected among the remaining tracks available in the given stratum.

Type III haul selection strategy is used when type II does not provide sufficient available tracks to fulfil the number of hauls selected. In this case, the type II selection strategy is used for as many hauls as possible (equals the number of tracks available) and the remaining hauls are selected by use of so called “Strata adjustments”. Strata adjustments are manually reallocation of hauls in the TB from strata where there are tracks available, which have not yet been selected in the haul allocation procedure. The choice of which strata shall be used for the strata adjustment is a subjective

decision based on an idea about the degrees of similarity between the original stratum and the substituted stratum.

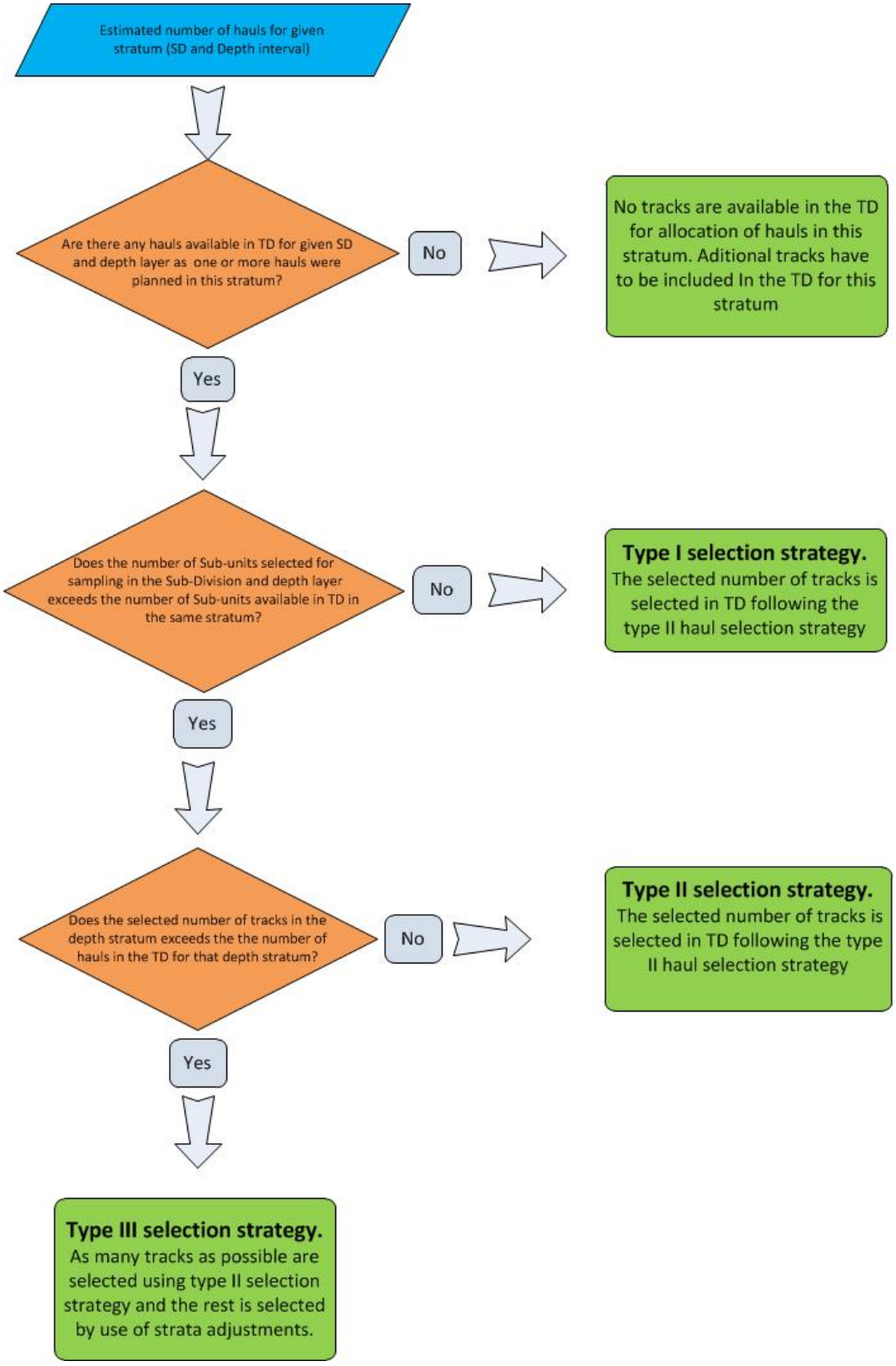

Figure 2. Decision diagram leading to selection of tracks from the Trawl Database (TD). See text for description of Type I, II and III selection strategy.

Distribution of the selected hauls between the countries involved
(Part 3 in the R-program)
When the total agreed tracks are selected in the database, the next step is to distribute these between the countries involved in the BITS according to the numbers of hauls committed by each country.
The distribution is based on logistic considerations about distances between hauls, the necessity for permissions to enter foreign national EEZs and some countries demand of only to operate in own national EEZ. The program considers these issues but do not take into account the numbers of hauls committed by each country. Based on the initial allocation between countries done by the program, the distribution has to be fine-tuned according to the numbers of hauls committed by each country. This is done manually…..
Finally, the program maps the hauls by country and print the list of allocated hauls in various formats specially designed to be used by the cruise leader, the research vessel skipper, the cruise report writer etc.

The possibility to requesting extra hauls during the survey
(Part 4 in the R-program)
This part of the program is a new feature and it has to be discussed and agreed during the WGBIFS meeting in March 2017 before it can be launched.
Many countries include a certain margin when planning the number of days needed for carrying out the number of hauls they have committed themselves for. This is because the experience tells that the weather not always allows fishing in the whole period. This means, that if the weather is fine during the whole cruise and nothing else happens which prevent fishing, one or two days might be in excess at the end of the cruise. In order to fully utilize the ship time allocated to the cruise, a 4th part of the r-program has been developed, which select additionally hauls without violating the random condition of the survey design.
The conditions, which must be obeyed if not to violate the random condition of the survey design is:

- The original hauls allocated must be fished before any extra hauls are fished
- The extra hauls must be requested for a certain Sub-division and Depth interval.
- All the requested extra hauls have to be carried out.
- The fishing of the extra hauls has to follow the instructions in the BITS manual

The extra hauls must be requested by mailing the TD administrator hd@aqua.dtu.dk and XXXXXXXXX as backup.
The extra hauls will be drawn in the TD among the remaining hauls not already used for the initial standard haul allocation and **only hauls within the EEZ of the requesting country will be considered**.

Time wheel for the administration of the BITS haul allocation procedure
The delivery from the Trawl Database is linked to various external events. Therefore, it is necessary to keep some deadlines for input to the TD. The most significant is the Baltic Fish Assessment Working Group in April and the fixed BITS survey in March (1st quarter) and October/November (4th quarter). These events determine the time schedule for the other activities in connection with the database. Previous to a survey the hauls must be assigned to each country and this allocation should be based on the

most resent possible update of the database. Therefore, the feedback from previous survey must be submitted in due time before the survey. Because some countries require up to 6 month to handle the access of foreign vessel into the EZZ and because the exact positions have to be stated in the application, the haul allocation has to be done already soon after the WGBITS meeting in order to be ready for the 4th quarter survey. The haul allocation is normally made at the same time for the following 1st quarter survey because there is not sufficient time between 4th quarter survey and 1st quarter survey to include the TD feedback from the 4th quarter survey in the following years 1st quarter survey. The time schedule wheel for the TD including the haul allocation procedure is given in figure 3.

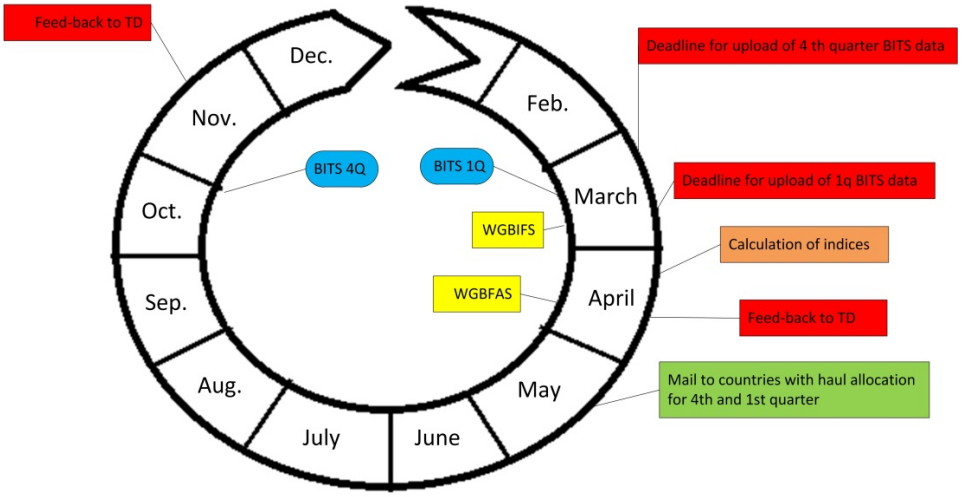

Figure 3. The time schedule wheel for the TD.

Annex 1

Detailed description of calculating of CPUE input values
From the DATRAS homepage:
(https://datras.ices.dk/Data_products/Download/Download_Data_public.aspx)
are the following data tables downloaded:

CPUE per age per area (present year-6 to present year-1, 1st quarter, all subdivisions)

CPUE per age per subarea (present year-6 to present year-1, 1st quarter, all subdivisions)

The CPUE(age1+) is calculated by summing all ages >0 (i.e. Age1 to Age10) for each age and subdivision or for each age, subdivision and depth stratum (=subarea in DATRAS). Finally, the mean of the five years are calculated for all sub-divisions or depth strata by sub-division. The results are saved as csv-files in the formats of the examples below.
Example of the "CpueDepthDist.csv" and "CpueSDDist.csv" input files

SD	DepthInterval	Layer	Cpue
22	10 - 39	2	158.1
22	40 - 59	3	0
22	60 - 79	4	0
22	80 - 99	5	0
22	100 - 119	6	0
24	10 - 39	2	93
24	40 - 59	3	297.4
24	60 - 79	4	1619.5
24	80 - 99	5	0
24	100 - 119	6	0
25	20 - 39	2	252.1
25	40 - 59	3	2144.7
25	60 - 79	4	2134.2
25	80 - 99	5	1083.7
25	100 - 119	6	0
26	20 - 39	2	102.8
26	40 - 59	3	699.3
26	60 - 79	4	1106.1
26	80 - 99	5	846.8
26	100 - 119	6	87
27	10 - 39	2	0
27	40 - 59	3	6.1
27	60 - 79	4	164.8
27	80 - 99	5	101.2
27	100 - 119	6	0
28	10 - 39	2	3.3
28	40 - 59	3	37.6
28	60 - 79	4	82.8
28	80 - 99	5	28.4
28	100 - 119	6	0

SD	AreaSection	Cpue
22	2224	158.1
23	2224	1469.9
24	2224	562.2
25	2528	1424.4
26	2528	608.9
27	2528	90
28	2528	46.7

Headings: "SD"= Sub-division,
"DepthInterval"= Depth interval for the corresponding "Layer","Cpue"= catch per unit effort, "AreaSection"= Sub-division assemble (Kattegat and Western Baltic Sea="2224" and Eastern Baltic Sea= "2528".
BITS depth layer SD 21-24

Annex 2

The R program
The complete program consists of 3 parts:

Part 1 Compilation of the number of hauls in each Sub-division and depth layer
Part 2 Drawing of the identified number of hauls in the Trawl database
Part 3 Allocation of the drawn tracks to the individual countries

The program is attempted to be self-explaining with extended use of comments and guidance both in the log window and in the code.
The following input files have to be prepared before the program can be executed:
AreaDepthLayerDist.csv (Areas of depth layers, no update needed)
AreaSDDist.csv (areas of sub-divisions, no update needed)
CpueDepthDist.csv (CPUE by Sub-division and depth strata of the most resent 5 years)
CpueSDDist.csv (CPUE by depth strata of the most resent 5 years)
PlannedStations.csv (Number of hauls by country as agreed during WGBIFS)
The input and output directories stated has to be changed according to the file structure on the executing PC.

R source codes
Part 1

```
################################################################################################
############################
#Part 1 of Haul allocation program for BITS (stratified random sampling)

#Calculates the number of hauls to be allocated to each depth layer in each Sub-division

# 1.  Update the assigned number of hauls by country by quarter (file:PlannedStations) from the
WGBIFS report
# 2.  Update the running mean of CPUE of 1+ cod (5 resent years) by        1) Subdivision
#                                                                          2) Sub-division, Depth
layer
# 3.  Select the Quarter in line 33
# 4.  Assure that the rounding adjustments (line 128-131) are all "0"
# 4.  Compare total number of planned stations (file:PlannedStations) with the file: NHaulPlanned and
adjust the numbers in lines 128-131 if needed
# 4.  Rerun line 128 and out
# 4.  RUN the PROGRAM "Allocation of BITS stations Part 2" and "Allocation of BITS stations Part 3"

#output: CSV-file stating the number of hauls to be allocated to each depth layer in each Sub-division
################################################################################################
############################
install.packages("plyr")
library(plyr)
#READ INPUT FILES
#Area per SD (Fixed, WGBFAS-report):
AreaSDDist<-read.table("H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of BITS
stations/AreaSDDist.csv",header=TRUE,sep=";")
#Area per SD (Fixed, WGBFAS-report):
AreaDepthLayerDist<-read.table("H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of
BITS stations/AreaDepthLayerDist.csv",header=TRUE,sep=";")
#Runnin mean of 5 previous yers CPUE(cod) per SD (DATRAS):
CpueSDDist<-read.table("H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of BITS
stations/CpueSDDist.csv",header=TRUE,sep=";")
#Runnin mean of 5 previous yers CPUE(cod) per depth strata (DATRAS):
```

```
CpueDepthDist<-read.table("H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of BITS stations/CpueDepthDist.csv",header=TRUE,sep=";")
#Number of planed stations (WGBFAS-report):
PlannedStations<-read.table("H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of BITS stations/PlannedStations.csv",header=TRUE,sep=";")

#####################################################################
#   QUARTER IS SELECTED:
   Quarter<-1
#####################################################################

#         SPECIAL RULES AGREED BY THE WGBIFS
#   Denmark takes always 5 hauls in SD 23:
   FixedNHaulsDK23<-5
   FixedCPUEDK23<-0

#   Sweden takes always 10 hauls in SD 27:
   FixedNHaulsSWE27<-10
   FixedCPUESWE27<-0

#   Germany always takes 45 hauls in SD 24. All other planned hauls in AreaSection 2124 minus hauls of Havfisken in SD 21 are allocated to SD 22
   FixedNhaulsGER24<-45

#   Number of fixed stations taken in Kattegat (sd21) by Denmark:
   FixedNHaulsDK21<-0

#####################################################################
#Abowe adjustments are implemented:
PlannedStations<-PlannedStations[PlannedStations$Quarter==Quarter,]
CpueSDDist$CpueAdj <- CpueSDDist$Cpue
CpueSDDist[CpueSDDist$SD==23,"CpueAdj"] <- FixedCPUEDK23
CpueSDDist[CpueSDDist$SD==27,"CpueAdj"] <- FixedCPUESWE27
PlannedStations[PlannedStations$Vessel=="Havfisken","PlannedNumberOfHauls"] <-
PlannedStations[PlannedStations$Vessel=="Havfisken","PlannedNumberOfHauls"]-
FixedNHaulsDK21


require(stats)

#The number of hauls by Sub-division (including abowe adjustments) is calculated based on the relative distributions calculated
#based on a weighted input of area (0.6) and CPUE (0.4)
#Area per AreaSection is calculated:
temp<-(tapply(AreaSDDist$Area,AreaSDDist$AreaSection, FUN=sum))
temp = data.frame( AreaSection = names(temp), SumArea=temp)
distSDArea<- merge(AreaSDDist, temp, all.x=TRUE)
#Relative area distribution per SD is calculated:
distSDArea$RelArea<-distSDArea$Area/distSDArea$SumArea*100

#CPUE per AreaSection is calculated:
temp<-(tapply(CpueSDDist$CpueAdj,CpueSDDist$AreaSection, FUN=sum))
temp = data.frame( AreaSection = names(temp), SumCpue=temp)
```

```
distSDCpue<- merge(CpueSDDist, temp, all.x=TRUE)

#Relative CPUE distribution per SD is calculated:
distSDCpue$RelCpue<-distSDCpue$CpueAdj/distSDCpue$SumCpue*100
SDHaulDist<-merge(distSDArea,distSDCpue)

temp <- ddply(PlannedStations, c("Quarter","AreaSection"),summarize,
SumPlannedStations=sum(PlannedNumberOfHauls))

SDStationAlocation<- merge(SDHaulDist, temp, all.x=TRUE)
#Fixed number of stations in Kattegat is deducted:



SDStationAlocation$NHaulsRel<-
((0.6*SDStationAlocation$RelArea)+(0.4*SDStationAlocation$RelCpue))/100

SDStationAlocation$SumPlannedStationsAdj<-SDStationAlocation$SumPlannedStations
SDStationAlocation[SDStationAlocation$AreaSection==2224,"SumPlannedStationsAdj"] <-
SDStationAlocation[SDStationAlocation$AreaSection==2224,"SumPlannedStations"]-
FixedNHaulsDK23
SDStationAlocation[SDStationAlocation$AreaSection==2528,"SumPlannedStationsAdj"] <-
SDStationAlocation[SDStationAlocation$AreaSection==2528,"SumPlannedStations"]-
FixedNHaulsSWE27

SDStationAlocation$NHaulsPrim<-
SDStationAlocation$NHaulsRel*SDStationAlocation$SumPlannedStationsAdj
SDStationAlocation$NHaulsSD<-SDStationAlocation$NHaulsPrim

#The number per SD is adjusted with the SPECIAL RULES AGREED BY THE WGBIFS:
SDStationAlocation[SDStationAlocation$SD==24,"NHaulsSD"] <-
PlannedStations[(PlannedStations$Country=="Poland") &
(PlannedStations$AreaSection==2224),"PlannedNumberOfHauls"]+FixedNhaulsGER24
SDStationAlocation[SDStationAlocation$SD==23,"NHaulsSD"] <- FixedNHaulsDK23
SDStationAlocation[SDStationAlocation$SD==22,"NHaulsSD"] <-
SDStationAlocation[SDStationAlocation$SD==22,"SumPlannedStations"] -
SDStationAlocation[SDStationAlocation$SD==23,"NHaulsSD"] -
SDStationAlocation[SDStationAlocation$SD==24,"NHaulsSD"]
SDStationAlocation[SDStationAlocation$SD==27,"NHaulsSD"] <- FixedNHaulsSWE27

SDStationAlocation$NHaulsSD<-round(SDStationAlocation$NHaulsSD,0) #(This file can be used for
check of haul distribution by SD)
SDStatAlocation<-SDStationAlocation [,c("SD", "AreaSection", "Quarter", "NHaulsSD")]

#The number of hauls by Sub-division and depth stratum is calculated based on the number of hauls
by SD calculated above:
temp<-(tapply(AreaDepthLayerDist$Area,AreaDepthLayerDist$SD, FUN=sum))
temp = data.frame( SD = names(temp), SumArea=temp)
distDepth<- merge(AreaDepthLayerDist, temp, all.x=TRUE)
distDepth$RelDepth<-distDepth$Area/distDepth$SumArea

temp<-(tapply(CpueDepthDist$Cpue,CpueDepthDist$SD, FUN=sum))
temp = data.frame( SD = names(temp), SumCpue=temp)
```

```
distCpue<- merge(CpueDepthDist, temp, all.x=TRUE)
distCpue$RelCpue<-distCpue$Cpue/distCpue$SumCpue
DepthStationAlocation<-merge(distDepth,distCpue)

DepthStationAlocation$NHaulsDepthRel<-
((0.6*DepthStationAlocation$RelDepth)+(0.4*DepthStationAlocation$RelCpue)) #(This file can be used
for check of haul distribution by depth strata)
DepthStatAlocation<-DepthStationAlocation [,c("SD", "DepthInterval", "Layer", "NHaulsDepthRel")]

NHaulPlanned<-merge(SDStatAlocation, DepthStatAlocation)
NHaulPlanned$NHauls<-round(NHaulPlanned$NHaulsDepthRel*NHaulPlanned$NHaulsSD,0)
NHaulPlanned<-NHaulPlanned [,c("AreaSection","SD", "Quarter","DepthInterval", "Layer",
"NHauls")]
#####################################################################
#Final adjustment due to rounding errors.
#   Initialy no adjustments should be made (all set to "0")
#####################################################################
NHaulPlanned[NHaulPlanned$SD==25 & NHaulPlanned$Layer==2,"NHauls"] <-
NHaulPlanned[NHaulPlanned$SD==25 & NHaulPlanned$Layer==2,"NHauls"]-0
NHaulPlanned[NHaulPlanned$SD==26 & NHaulPlanned$Layer==4,"NHauls"] <-
NHaulPlanned[NHaulPlanned$SD==26 & NHaulPlanned$Layer==4,"NHauls"]-0

#Add as many strata as needed
#####################################################################

write.table(NHaulPlanned, "H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of BITS
stations/NHaulPlanned.csv", sep=";")

Part 2
#############################################################################################
#####################################
#Part 2 of Haul allocation program for BITS (stratified random sampling)

#The program selects the hauls to be allocated to each depth layer in each Sub-division from the Trawl
Database (TD)

# Part 1 of Haul allocation program for BITS has to be run previous to this

# 1.  RUN FIRST STEP TO LINE 194
# 2.  ADJUST THE STRATA FOR THE ADDITIONAL SELECTION BY USE OF "STRATA
ADJUSTMENTS" (step 2) BASED ON COMMENTS IN LOG
#     AND BY INSPECTION OF "AdditionalSelect" and "MSamplePopulation"
# 3.  RUN SECOND STEP FROM LINE 196 AND OUT.
# 4.  RUN the PROGRAM "Allocation of BITS stations Part 3"

#output: CSV-file listing the haul numbers in TD to be distributed among participating countries
#############################################################################################
#####################################
NHaulPlanned <- read.table("H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of BITS
stations/NHaulPlanned.csv", sep=";")
NHaulPlanned <- NHaulPlanned [NHaulPlanned$NHauls>0,]
#TD data  from all Sub-Division is read
```

```
TD<-read.table("H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of BITS
stations/TD_2016_V1 HD version.csv",header=TRUE,sep=";")

TD <-TD [,c("NrHaul", "RectangleAlpha", "ICES.SD", "Latitude1_deg", "Latitude1_dec_min",
"Longitude1_deg", "Longitude1_dec_min", "Layer", "EEZ")]
#Each haul is allocated to a Rec9 (=sub split of each ICES Statistical Rectangle into 9 sub-rectangles):
TD$latGr<- floor(floor(TD$Latitude1_dec_min)/10)+1
TD$latGr1<- ifelse(TD$latGr>3, TD$latGr -3, TD$latGr)
TD$lonGr<- (floor(floor(TD$Longitude1_dec_min)/20)+1)
TD$Rec9<- ifelse(TD$latGr1>1, TD$lonGr +3, TD$lonGr)
TD$Rec9<- ifelse(TD$latGr1>2, TD$Rec9 +3, TD$Rec9)
TD$Rec9<-paste(TD$RectangleAlpha, TD$Rec9)
TD <-TD [,c("NrHaul", "RectangleAlpha", "ICES.SD", "Latitude1_deg", "Latitude1_dec_min",
"Longitude1_deg", "Longitude1_dec_min", "Layer", "EEZ", "Rec9")]

#...and the list for random selection of SubRec9 is made:
Rec9List<-unique(TD [,c("RectangleAlpha","Rec9", "ICES.SD", "Layer")])

Allocated1<- NULL
Allocated2<- NULL
Allocated3<- NULL
census<-NULL
census1<-NULL
Type2add<-NULL
Type3add<-NULL
Selectedhauls1<-NULL
ManualSelec1<-NULL
ManualSelec2<-NULL
AdditionalSelect1<-NULL
AdditionalSelect2<-NULL
AddHaulsToBeSelected<-NULL

subNHaulPlannedSD<-unique(NHaulPlanned ["SD"])


for (i in subNHaulPlannedSD$SD)  #SubDiv
 {
 subNHaulPlanned<-NHaulPlanned[NHaulPlanned$SD==i,]
 Allocated2<- NULL
 for (j in subNHaulPlanned$Layer) #DepthInterval

  {

  SubRec9TotalList <- Rec9List[Rec9List$ICES.SD==i & Rec9List$Layer==j,]

  if (nrow(SubRec9TotalList)==0)
  {
   SubNHaulspl<-NHaulPlanned[NHaulPlanned$SD==i & NHaulPlanned$Layer==j,]

   p<-SubNHaulspl$NHauls

   tekst1<-paste("...
```

```
Information:No hauls availble in TD for SD ",i," and depth layer",j,"even though",p,"hauls were
planned in this stratum
                ....................................................................")
    cat(tekst1)

    tekst2<-paste("...
GUIDENCE:",p,"hauls have to be selected by use of strata adjustments for SD ",i," and depth
layer",j,"(",p,",0 hauls)
                ....................................................................")
    cat(tekst2)

   ManualSelec1$SD<-i
   ManualSelec1$Layer<-j
   ManualSelec1$N<-p
   remain1 <- data.frame(ManualSelec1)
   AdditionalSelect1<-rbind(AdditionalSelect1, remain1)

   }else{
    SubRec9TotalList <- SubRec9TotalList[,c("RectangleAlpha","Rec9", "ICES.SD", "Layer")]
    SubRec9TotalList$ID <- 1:nrow(SubRec9TotalList)
    SubAntHauls<-NHaulPlanned[NHaulPlanned$SD==i & NHaulPlanned$Layer==j,]    #Number of
hauls to be drawn in SD, Layer
    SubRec9TotalList$Count<-1
    temp1<-(tapply(SubRec9TotalList$Count,SubRec9TotalList$Count, FUN=sum))
    availRec9 = data.frame(TDcheck = names(temp1), SumRec9=temp1)

   if (SubAntHauls$NHauls> availRec9$SumRec9) {
    m<-SubAntHauls$NHauls
    n<-availRec9$SumRec9

    tekst3<-paste("...
Information: (-> Type II or Type III) The number of different Sub-rectangles selected for sampling in
Sub-Div",i,"depth layer",j,"
is larger than the number of Sub-rectangles available in the same stratum in TD. (",m,"hauls,",n,"sub-
rec.)
....................................................................")
    cat(tekst3)

    censusHauls<-TD[TD$ICES.SD==i & TD$Layer==j,]
    censusHauls$Count<-1
    censusHauls$ID <- 1:nrow(censusHauls)
    temp2<-(tapply(censusHauls$Count,censusHauls$Count, FUN=sum))
    availHauls = data.frame(TDcheck1 = names(temp2), SumHauls=temp2)

     if (SubAntHauls$NHauls> availHauls$SumHauls) {
      #Type III. inkluder alle tilgængelige træk (i,j) i selected hauls (resten trækkes manuelt fra andre
strata)
       a<-availHauls$SumHauls
       Nmissing2<-m-a
       tekst4<-paste("...
GUIDENCE: (Type III)" ,Nmissing2,"hauls have to be selected by use of strata adjustments from
another stratum because of insuficient number
of hauls in the TD in Sub-Div",i,"depth layer",j,". (",m,",",a,"hauls.)
```

```
318     ..................................................................")
319             cat(tekst4)
320             censusHauls$Type<-3
321             Type3ad<-censusHauls[,c("NrHaul","Type")]
322             Type3add<-rbind(Type3add, Type3ad)
323             Type3ad<-NULL
324             ManualSelec2$SD<-i
325             ManualSelec2$Layer<-j
326             ManualSelec2$N<-Nmissing2
327             remain2 <- data.frame(ManualSelec2)
328             AdditionalSelect2<-rbind(AdditionalSelect2, remain2)
329
330           } else{
331             #Type II. træk det planlagte antal træk fra tilgængelige træk i stratum (i,j,k)
332             b<-availHauls$SumHauls
333             Nmissing3<-m
334             ID<-sample(1:nrow(censusHauls), SubAntHauls$NHauls, replace=FALSE)
335
336             SubSelectedIDRec9 <- data.frame(ID)                    #Selected hauls in SD, Layer
337             Type2ad<- merge(censusHauls, SubSelectedIDRec9, by="ID", all.selected=FALSE)
338             Type2ad$Type<-2
339             Type2ad<-Type2ad[,c("NrHaul", "Type")]
340             Type2add<-rbind(Type2add, Type2ad)
341             Type2ad<-NULL
342
343             tekst5<-paste("...
344     Information: (Type II.)" ,Nmissing3,"hauls has been selected for sampling in Sub-Div",i,"depth
345     layer",j,"
346     where the number of hauls planned is bigger than the number of Rec9 available
347     but the number of hauls available in TD is sufficient.(",m,",",b,"hauls.)
348     ..................................................................")
349             cat(tekst5)
350             }
351
352         } else  {
353           #Type I. træk det planlagte antal Rec9 fra tilgængelige Rec9 i stratum (i,j)
354           ID<-sample(1:nrow(SubRec9TotalList), SubAntHauls$NHauls, replace=FALSE)
355           SubSelectedIDRec9 <- data.frame(ID)                    #Selected hauls in SD, Layer
356           SubSelecRec9ad<- merge(SubRec9TotalList, SubSelectedIDRec9, by="ID", all.selected=FALSE)
357           SubSelecRec9ad$Count<-1
358           temp<-tapply(SubSelecRec9ad$Count, SubSelecRec9ad$Rec9, FUN=sum)
359           SubNumberRec9 = data.frame(Rec9 = names(temp), SumHauls=temp)
360
361         for (k in SubNumberRec9$Rec9)  #Sub-Rectangle
362           {
363           #Type I. træk det planlagte antal træk fra tilgængelige træk i stratum (i,j,k)
364
365           Type1HaulAvail<-TD[TD$ICES.SD==i & TD$Layer==j & TD$Rec9==k,]
366           Type1HaulAvail$ID <- 1:nrow(Type1HaulAvail)
367           Type1HaulAvail<-Type1HaulAvail[,c("NrHaul", "ID")]
368           Type1HaulAvail <- data.frame(Type1HaulAvail)
369           Type1SubNumberHauls<- SubNumberRec9[SubNumberRec9$Rec9==k,]
370           ID<-sample(1:nrow(Type1HaulAvail), Type1SubNumberHauls$SumHauls, replace=FALSE)
```

```
        Type1add <- data.frame(ID)
        Type1add<- merge(Type1add, Type1HaulAvail, by="ID", all.selected=FALSE)
        Type1add$Type<-1
        Allocated1<-rbind(Allocated1, Type1add)
        }
      Allocated2<-rbind(Allocated2, Allocated1)
      Allocated1<-NULL
       }
      }}
     Allocated3<-rbind(Allocated3, Allocated2)

    }

  Allocated3<-Allocated3[,c("NrHaul","Type")]
  Selectedhauls1<-rbind(Allocated3,Type3add,Type2add)
  Selectedhauls1$sekvens<-order(Selectedhauls1$NrHaul)
  Selectedhauls1<-Selectedhauls1[Selectedhauls1$sekvens,]
  Selectedhauls<- merge(Selectedhauls1, TD, by="NrHaul", all.selected=FALSE)
  NHaulSelected<-nrow(Selectedhauls)
  NHaulPlannedTotal<-sum(NHaulPlanned$NHauls)
  Missing<-NHaulPlannedTotal-NHaulSelected
  tekst6<-paste("...
  Information: In all areas a total of",Missing,"hauls have to be selected by use of strata adjustments.
  .....")
  cat(tekst6)
  write.table(Selectedhauls, "H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of BITS
  stations/list of allocated hauls.csv", sep=";")

  # SECOND STEP:  Selection the remaining planned hauls by use of strata adjustments

  NrHaul<-(TD [,c("NrHaul")])
  TDIndex<-data.frame(NrHaul)
  NrHaul<-(Selectedhauls [,c("NrHaul")])
  IndexSelected <- data.frame(NrHaul)
  IndexSelected$Marker<-1
  MSamplePop<-merge(TDIndex,IndexSelected, by= "NrHaul", all=TRUE)
  MSamplePop$Marker[is.na(MSamplePop$Marker)] <- 0
  MSamplePop<-MSamplePop[MSamplePop$Marker==0,]
  MSamplePopulation<-merge(TD,MSamplePop, by= "NrHaul", all.selected=FALSE)

  #options(error = utils::recover)

  AdditionalSelect<-rbind(AdditionalSelect1, AdditionalSelect2)
  ModAdditionalSelect<-AdditionalSelect
  ModAdditionalSelect$cond<-paste(ModAdditionalSelect$SD, ModAdditionalSelect$Layer, sep="")

  #   implementation of strata adjustment of not succesful haul allocations
  #   Based on inspection of "AdditionalSelect" and "MSamplePopulation" the substituting Layer is
  defined below
  #   ModAdditionalSelect$cond defined as concatenating of "SD" and "Layer"

  ModAdditionalSelect$Layer[ModAdditionalSelect$cond==244] <- 3
  ModAdditionalSelect$Layer[ModAdditionalSelect$cond==252] <- 3
```

```
ModAdditionalSelect$Layer[ModAdditionalSelect$cond==275] <- 6
ModAdditionalSelect$Layer[ModAdditionalSelect$cond==282] <- 3

ModAdditionalSelect$cond<-paste(ModAdditionalSelect$SD, ModAdditionalSelect$Layer, sep="")

for (l in ModAdditionalSelect$cond)  #SubDivLayer
{
  AddHaulsToBeSelectedadd<-NULL
  i<-substr(l,1,2)
  j<-substr(l,3,3)

  SubMSamplePopulation<-MSamplePopulation[MSamplePopulation$ICES.SD==i &
MSamplePopulation$Layer==j,]
  Nrhaul1<- SubMSamplePopulation[,c("NrHaul")]
  SubMSamplePopulation <- data.frame(Nrhaul1)
  SubMSamplePopulation$ID <- 1:nrow(SubMSamplePopulation)
  SubAdditionalSelect<-ModAdditionalSelect[ModAdditionalSelect$SD==i &
ModAdditionalSelect$Layer==j,]
  ID<-sample(1:nrow(SubMSamplePopulation), SubAdditionalSelect$N, replace=FALSE)
  AddHaulsToBeSelectedadd <- data.frame(ID)
  AddHaulsToBeSelectedadd<-merge(AddHaulsToBeSelectedadd, SubMSamplePopulation, by= "ID",
all.selected=FALSE)
  AddHaulsToBeSelectedadd$NrHaul<-AddHaulsToBeSelectedadd$Nrhaul1
  AddHaulsToBeSelectedadd<-merge(AddHaulsToBeSelectedadd, MSamplePopulation, by=
"NrHaul", all.selected=FALSE)
  AddHaulsToBeSelected<-rbind(AddHaulsToBeSelected, AddHaulsToBeSelectedadd)
}
check<-AddHaulsToBeSelected
check$count<-1
z<-(tapply(check$count,check$Marker, FUN=sum))

tekst7<-paste("...
Check: In all areas a total of",z,"hauls have been selected by use of strata adjustments out
of",Missing,"requested.
            .....")


HaulsToBeFished1<-Selectedhauls[,c("NrHaul", "RectangleAlpha", "ICES.SD", "Latitude1_deg",
"Latitude1_dec_min", "Longitude1_deg", "Longitude1_dec_min", "Layer", "EEZ")]
HaulsToBeFished2<-AddHaulsToBeSelected[,c("NrHaul", "RectangleAlpha", "ICES.SD",
"Latitude1_deg", "Latitude1_dec_min", "Longitude1_deg", "Longitude1_dec_min", "Layer", "EEZ")]
TotalHaulsToBeFished<-rbind(HaulsToBeFished1, HaulsToBeFished2)


write.table(TotalHaulsToBeFished, "H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of
BITS stations/list of totalallocated hauls.csv", sep=";")
cat(tekst7)

TD$Latitude1_deg_dec<-(TD$Latitude1_dec_min/60*100/100)+TD$Latitude1_deg
TD$Longitude1_deg_dec<-(TD$Longitude1_dec_min/60*100/100)+TD$Longitude1_deg

write.table(TD, "H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of BITS stations/TD for
plotting.csv", sep=";")
```

Part 3
The final output file is called “list of totalallocated hauls processed.csv” and lists the selected tracks in the Trawl database to be carried out by the participants of the BITS. The file can be imported to EXCEL and the tracks can subsequently be distributed between the countries according to the commitments list (PlannedStations.csv).

```
#Processes the output from Part2
################################################################################
################################################
#Part 3 of Haul allocation program for BITS (stratified random sampling)

#The program allocate a priori the hauls selected by "Haul allocation program for
BITS Part 2".

#Haul allocation program for BITS Part 1 and Haul allocation program for BITS Part 2
have to be run previous to this.

# 1.  RUN FIRST STEP TO LINE 46.
# 2.  MANUALLY SHIFT AROUND AND ADJUST THE DISTRIBUTION BETWEEN
COUNTRIES SO IT FITS THE NATIONAL PLANNED NUMBER OF HAULS
#     BY INSPECTION OF "PlannedStations" and "NHaulPlanned".
# 3.  RUN SECOND STEP FROM LINE 52 AND OUT.


#output: CSV-file listing the haul numbers in TD to be distributed among
participating countries and maps by country of hauls distributed
################################################################################
################################################

#STEP 1
TotalHaulsToBeFished <- read.table("H:/Active nonsystem/ICES
WG/WGBIFS/Surveys/Allocating of BITS stations/list of totalallocated hauls.csv",
sep=";")
TotalHaulsToBeFished$Latitude1_deg_dec<-
(TotalHaulsToBeFished$Latitude1_dec_min/60*100/100)+TotalHaulsToBeFished$Lati
tude1_deg
TotalHaulsToBeFished$Longitude1_deg_dec<-
(TotalHaulsToBeFished$Longitude1_dec_min/60*100/100)+TotalHaulsToBeFished$L
ongitude1_deg
TotalHaulsToBeFished[TotalHaulsToBeFished$ICES.SD<25,"codstock"]<-"21-24"
TotalHaulsToBeFished[TotalHaulsToBeFished$ICES.SD>24,"codstock"]<-"25-32"
TotalHaulsToBeFished$country<-"notassigned"
TotalHaulsToBeFished[TotalHaulsToBeFished$codstock=="21-24" &
TotalHaulsToBeFished$EEZ=="DEN","country"]<-"DEN (SD 21-24)"
TotalHaulsToBeFished[TotalHaulsToBeFished$ICES.SD==27 &
TotalHaulsToBeFished$codstock=="25-32","country"]<-"SWE (SD 25-32)"
TotalHaulsToBeFished[TotalHaulsToBeFished$ICES.SD==24,"country"]<-"GFR (SD
21-24)"
TotalHaulsToBeFished[TotalHaulsToBeFished$EEZ=="grey","country"]<-"DEN (SD
25-32)"
TotalHaulsToBeFished[TotalHaulsToBeFished$codstock=="21-24" &
TotalHaulsToBeFished$EEZ=="POL","country"]<-"POL (SD 21-24)"
```

```
TotalHaulsToBeFished[TotalHaulsToBeFished$codstock=="25-32" &
TotalHaulsToBeFished$EEZ=="POL","country"]<-"POL (SD 25-32)"
TotalHaulsToBeFished[TotalHaulsToBeFished$EEZ=="LTU","country"]<-"LTU (SD
25-32)"
TotalHaulsToBeFished[TotalHaulsToBeFished$EEZ=="RUS","country"]<-"RUS (SD
25-32)"
TotalHaulsToBeFished[TotalHaulsToBeFished$EEZ=="EST" |
TotalHaulsToBeFished$EEZ=="LAT","country"]<-"LAT (SD 25-32)"

TotalHaulsToBeFished[TotalHaulsToBeFished$EEZ=="DEN" &
TotalHaulsToBeFished$ICES.SD>24,"country"]<-"DEN (SD 25-32)"
TotalHaulsToBeFished[TotalHaulsToBeFished$EEZ=="GFR" &
TotalHaulsToBeFished$codstock=="21-24","country"]<-"GFR (SD 21-24)"
TotalHaulsToBeFished[TotalHaulsToBeFished$EEZ=="SWE" &
TotalHaulsToBeFished$codstock=="25-32","country"]<-"SWE (SD 25-32)"
TotalHaulsToBeFished[TotalHaulsToBeFished$RectangleAlpha=="37G0"|TotalHauls
ToBeFished$RectangleAlpha=="37G1"|TotalHaulsToBeFished$RectangleAlpha=="37
G2","country"]<-"GFR (SD 21-24)"
TotalHaulsToBeFished[TotalHaulsToBeFished$RectangleAlpha=="39G5"|TotalHauls
ToBeFished$RectangleAlpha=="40G6"|TotalHaulsToBeFished$RectangleAlpha=="40
G7"|

TotalHaulsToBeFished$RectangleAlpha=="41G8"|TotalHaulsToBeFished$RectangleA
lpha=="41G7","country"]<-"DEN (SD 25-32)"
TotalHaulsToBeFished[TotalHaulsToBeFished$RectangleAlpha=="43G8"|TotalHauls
ToBeFished$RectangleAlpha=="43G9"|TotalHaulsToBeFished$RectangleAlpha=="44
G9"|

TotalHaulsToBeFished$RectangleAlpha=="45G7"|TotalHaulsToBeFished$RectangleA
lpha=="42G8"|

TotalHaulsToBeFished$RectangleAlpha=="45G9"|TotalHaulsToBeFished$RectangleA
lpha=="45G8","country"]<-"SWE (SD 25-32)"

TotalHaulsToBeFished[TotalHaulsToBeFished$RectangleAlpha=="40G5" &
TotalHaulsToBeFished$EEZ=="DEN","country"]<-"DEN (SD 25-32)"
write.table(TotalHaulsToBeFished, "H:/Active nonsystem/ICES
WG/WGBIFS/Surveys/Allocating of BITS stations/list of totalallocated hauls
processed.csv", sep=";")
#library(dismo)
#library(raster)
#library(marmap)
library(rgdal)
library("RODBC")
#library(maptools)
#library(rasterVis)
#library(grid)
library(mapplots)
library(shapefiles)
setwd("H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Allocating of BITS stations")
```

```
coast <-
read.shapefile('Y:/Dynamisk/GEOdata/BasicLayers/CoastLines/Europe/europe')
latlon <- CRS("+proj=longlat +datum=WGS84")
test2 <- TotalHaulsToBeFished
test2<-test2[,c("country")]
test2<-unique(test2)

for (countr in test2)
{
 CountryTotalHaulsToBeFished<-
TotalHaulsToBeFished[TotalHaulsToBeFished$country==countr,]

 test <- CountryTotalHaulsToBeFished
 test1<-test[,c("country")]
 test1<-unique(test1)

 coordinates(test) <- c("Longitude1_deg_dec", "Latitude1_deg_dec")
 proj4string(test) <- latlon

 #Set the limit of the plot to +/- 10% of the extent of the points
 xfactor <- (bbox(test)[1,2]-bbox(test)[1,1])/20
 yfactor <- (bbox(test)[2,2]-bbox(test)[2,1])/20
 xlim <- c(bbox(test)[1,1]-xfactor, bbox(test)[1,2]+xfactor)
 ylim <- c(bbox(test)[2,1]-yfactor, bbox(test)[2,2]+yfactor)

 ########
 #col <- terrain.colors(12)

##############################################################################
#####################
 ##  Draw the maps

##############################################################################
#####################
 basemap(xlim=xlim, ylim=ylim, main = "Haul position map",test1) #, bg="white")
 draw.shape(coast, col="cornsilk", border="transparent", xlim=xlim, ylim=ylim)
 draw.rect()

points(CountryTotalHaulsToBeFished$Longitude1_deg_dec,CountryTotalHaulsToBe
Fished$Latitude1_deg_dec, pch=20, cex=1.0, col="black")
 CountryTotalHaulsToBeFished$NrHaulalpha<-
as.character(CountryTotalHaulsToBeFished$NrHaul)
text(CountryTotalHaulsToBeFished$Longitude1_deg_dec,CountryTotalHaulsToBeFi
shed$Latitude1_deg_dec,CountryTotalHaulsToBeFished$NrHaulalpha,cex=0.5,adj=0,
pos=2,col="black")

 }
```

Part 4
This part is used when participants in the BITS are requesting extra hauls to the hauls already allocated by the normal standard haul allocation procedure.

```
#############################################################################
#################################################
#Part 5 of Haul allocation program for BITS (stratified random sampling)

#The program select extra hauls for given Sub-dicision and depth interval.

#Haul allocation program for BITS Part 1 and Haul allocation program for BITS Part 2
have to be run previous to this.

# 1.  Chose the Sub-division, depth interval and EZZ to allocate more hauls.
# 2.  Chose the number of extra hauls to be selected.
# 3.  Run the rest of the program.
############################
# Depth interval            Layer    #
#   0-10/20         1      #
#   10/20-40            2      #
#   40-60                  3      #
#   60-80                  4      #
#   80-100               5      #
#   < 100        6      #
############################
# Country            Code #
# Poland             POL #
# Denmark (incl. grey)  DEN #
# Germany              GFR #
# Sweden             SWE #
# Latvia             LAT #
# Lithuania           LTU #
# Estonia            EST #
# Finland            FIN #
# Rusia              RUS #
############################

#output: CSV-file listing the extra haul numbers in TD to and maps the positions
#############################################################################
#################################################
library(plyr)
library(mapplots)
library(shapefiles)
library(rgdal)
#############################################################################
#############################################################################
Sub_div<-25
DepthInterval<-4
NHaulstoDraw<-6
NationalZone<-"DEN"
#############################################################################
#############################################################################
```

```
TD<-read.table("C:/Arbejdsting der skal tilbage på H-drev/BITS 2017
spring/Allocating of BITS stations/TD_2016_V1 HD
version.csv",header=TRUE,sep=";")
#TotalHaulsToBeFished <- read.table("H:/Active nonsystem/ICES
WG/WGBIFS/Surveys/Allocating of BITS stations/list of totalallocated hauls.csv",
sep=";")
TotalHaulsToBeFished <- read.table("C:/Arbejdsting der skal tilbage på H-drev/BITS
2017 spring/2017/2017 spring/Planned hauls for Q1 2017.csv", header=TRUE,sep=";")
TotalHaulsToBeFished <-TotalHaulsToBeFished [,c("NrHaul", "SD")]
TotalHaulsToBeFished$id<-1
haulRemaining<- merge(TotalHaulsToBeFished,TD, all=TRUE)
haulRemaining$id[is.na(haulRemaining$id)] <- 2
haulRemaining<-haulRemaining[haulRemaining$id==2,]
haulRemaining$EEZ1<-haulRemaining$EEZ
haulRemaining$EEZ1[haulRemaining$EEZ=="grey"]<-"DEN"
haulRemaining<-haulRemaining[haulRemaining$ICES.SD==Sub_div &
haulRemaining$Layer==DepthInterval & haulRemaining$EEZ1==NationalZone,]
haulRemaining$ID <- 1:nrow(haulRemaining)
haulRemaining1<-haulRemaining[,c("NrHaul", "ID")]
haulRemaining1 <- data.frame(haulRemaining)
ID<-sample(1:nrow(haulRemaining1), NHaulstoDraw, replace=FALSE)
addtionalHauls <- data.frame(ID)
extrahauls<- merge(addtionalHauls, haulRemaining, by="ID", all.selected=FALSE)
extrahauls <-extrahauls [,c("NrHaul", "ICES.SD", "RectangleAlpha", "Layer",
"Latitude1_deg", "Latitude1_dec_min", "Longitude1_deg", "Longitude1_dec_min",
"Mean_Depth", "Distance", "EEZ", "Source")]
#write.table(extrahauls, "H:/Active nonsystem/ICES WG/WGBIFS/Surveys/Extra
hauls.csv", sep=";")
write.table(extrahauls, "C:/Arbejdsting der skal tilbage på H-drev/BITS 2017
spring/Allocating of BITS stations/Extra hauls.csv", sep=";")

extrahauls$Latitude1_deg_dec<-
(extrahauls$Latitude1_dec_min/60*100/100)+extrahauls$Latitude1_deg
extrahauls$Longitude1_deg_dec<-
(extrahauls$Longitude1_dec_min/60*100/100)+extrahauls$Longitude1_deg

coast <- read.shapefile('C:/Arbejdsting der skal tilbage på H-drev/BITS 2017
spring/Allocating of BITS stations/Shapefiles/europe')
latlon <- CRS("+proj=longlat +datum=WGS84")

 coordinates(extrahauls) <- c("Longitude1_deg_dec", "Latitude1_deg_dec")
 proj4string(extrahauls) <- latlon

 #Set the limit of the plot to +/- 10% of the extent of the points
 xfactor <- (bbox(extrahauls)[1,2]-bbox(extrahauls)[1,1])/20
 yfactor <- (bbox(extrahauls)[2,2]-bbox(extrahauls)[2,1])/20
 xlim <- c(bbox(extrahauls)[1,1]-xfactor, bbox(extrahauls)[1,2]+xfactor)
 ylim <- c(bbox(extrahauls)[2,1]-yfactor, bbox(extrahauls)[2,2]+yfactor)
 ########
 #col <- terrain.colors(12)
```

```
##############################################################################
#####################
 ##
 ##  Draw the maps
 #
 ##

##############################################################################
#####################

 basemap(xlim=xlim, ylim=ylim, main = "Haul position map","Extra hauls") #,
bg="white")
 draw.shape(coast, col="cornsilk", border="transparent", xlim=xlim, ylim=ylim)
 draw.rect()
 points(extrahauls$Longitude1_deg_dec,extrahauls$Latitude1_deg_dec, pch=20,
cex=1.0, col="black")
 extrahauls$NrHaulalpha<- as.character(extrahauls$NrHaul)

text(extrahauls$Longitude1_deg_dec,extrahauls$Latitude1_deg_dec,extrahauls$NrH
aulalpha,cex=0.5,adj=0,pos=2,col="black")
```

Results of calibration between the Danish old R/S Havfisken and new R/S Havfisken II

by Henrik Degel, DTU Aqua

Introduction

The Danish research vessel "Havfisken" (code in DATRAS: HAF) has for more than 50 years been used for research. It was built in wood in 1962 as a side trawler weighting 20 BRT and is outdated. Among many other tasks, the vessel has carried out the BITS survey in Kattegat and western Baltic. Therefore, it has been replaced by the newly built "Havfisken II" (code in DATRAS: 26HF). It was decided to establish a calibration exercise between the old Havfisken and the new Havfisken II in order to be able to continue already established BITS survey time series

Trawling procedure and material

The exercise was carried out in the period from 13-19/3 – 2016 in the area of Skagerrak and the north-western part of Kattegat. The method used was parallel hauling between the two vessels. Figure 1 shows the sets of parallel hauls.

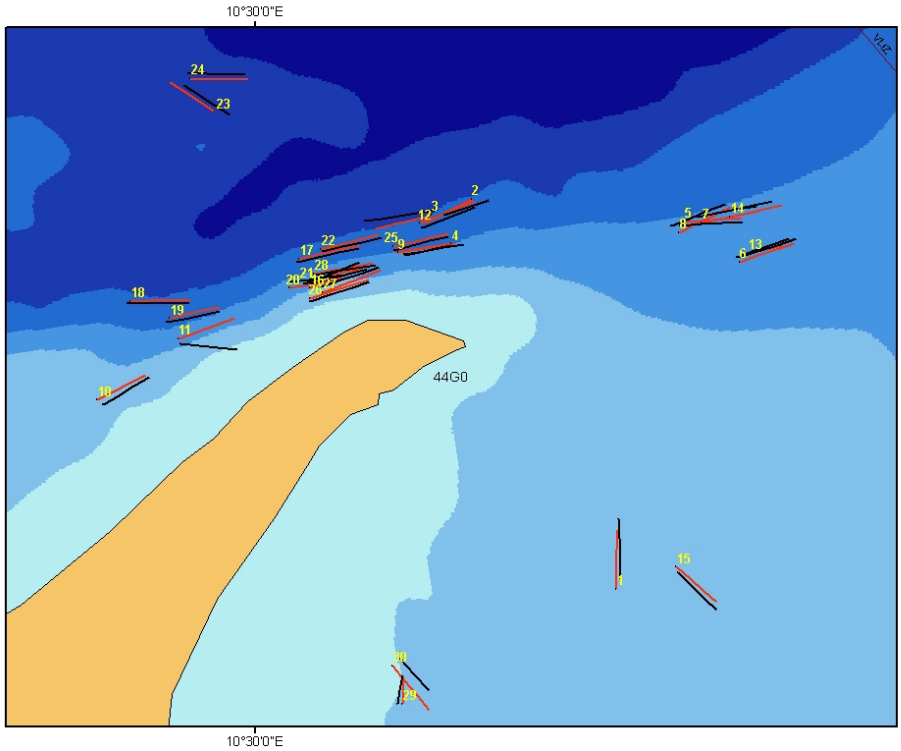

Figure 1. Map showing the parallel hauls with indication of pair haul number (red lines indicate tracks of the new Havfisken. Black lines indicate tracks of the old Havfisken.

The criteria for selecting this area were that it could be expected to exhibit reasonable abundance of cod and flatfish and that each species could be expected to exist in length span comparable to the length span observed during BITS and finally that trawling could be carried out on depth comparable to the depth observed during the BITS. In addition the selected area was in a convenient distance from the home port of the vessels, Strandby, on the east coast of Jutland.
The trawl used was the small standard BITS trawl (TV3 #520) with standard ground gear. Because the old Havfisken is a side trawler, it has not been possible to use the normal standard trawl doors. Instead a set of "Munkebo" trawl doors have been used for the whole time series and during this calibration exercise. The new Havfisken uses "Thyborøn" trawl doors (1.78 m² (63 inch), Weight 205 kg), which is the BITS standard trawl doors for TV3 #520.
The trawling procedure follows the standard BITS trawling procedure, which dictates 30 minutes of haul duration, trawling speed of 3 knots and trawling only during day-time. Parallel trawling was used where the two vessels conduct to parallel tracks simultaneous few hundred meters from each other. The engine power of the old Havfisken is not always sufficient to keep up this speed if the current is strong and against the trawling direction. This has the consequence that the trawling distance in these cases differs between the two vessels.
30 haul pairs were conducted, but only 28 hauls can be included in the analysis because two hauls of the old Havfisken were invalid (Haul pair 9 and haul pair 28) due to significant catches of peat, which completely blocked the cod end. The trawl and haul parameters of the 30 haul pairs are shown in table 1 together with the catches of the most important flatfish species and cod.

Haul pair	Validity	Vessel	Fishing duration	Mean depth	OtterBoard Distance	Wire Length	Distance (Bottom)	Catch of most important species				
								Dab	Turbot	Plaice	Flounder	Cod
			Minutes	Meters	Meters	Meters	Nautic miles	Kg	Kg	Kg	Kg	Kg
1	V	New	30	22	65.3	136	1.5	37.7	0.72	49	0.7	3.37
	V	Old	30				1.45	33.6	0.7	37.1	1.0	0.2
2	V	New	30	78	74.3	250	1.5	0.89	0.0	6.88	0.0	69.2
	V	Old	30				1.25	1.7	0.0	5.4	0.3	21.1
3	V	New	30	77	69	225	1.5	0.0	0.0	19.4	0.0	118.5
	V	Old	30	80.3		232	1.15	0.5	0.0	12.5	0.0	27
4	V	New	30	54		188	1.5	6.07	1.53	31.3	1.2	94.4
	V	Old	30	53.2		186	1.2	10.9	0.0	54.5	0.9	32.8
5	V	New	30	52	69.3		1.5	33.8	0.0	24.9	0.0	222
	V	Old	30	51.1		186	1.5	10.4	0.0	16	0.0	41.6
6	V	New	30	42	73.3	168	1.5	4.25	0.36	16.8	1.1	28.1
	V	Old	30	44.5	43.7	186	1.5	6.6	0.0	9.3	0.6	5.9
7	V	New	30	51	72.6	188	1.5	0.12	0.0	27.6	2.0	133
	V	Old	30	52.9	39	186	1.5	3.6	0.0	16	0.6	43.4
8	V	New	30	50	71.6	188	1.5	8.42	0.0	20.4	0.0	19.45
	V	Old	30	53.6	36	232	1.5	12.4	0.0	10.6	0.0	144.5
9	V	New	30	75.8	78	232	1.5	0.0	0.0	0.0	0.0	0.0
	I	Old	30	52		232	1.5	0.0	0.0	0.0	0.0	0.0
10	V	New	30	55	70.4	182	1.5	10.2	0.49	36.5	0.9	2.51
	V	Old	30	27		186	1.45	9.2	0.0	24.2	0.4	0.1
11	V	New	30	32	66.6	136	1.5	75.7	0.0	164	2.4	112
	V	Old	30	50		232	1.5	73.3	0.0	379	0.7	3.1
12	V	New	30	54.8	72.8	182	1.5	2.8	0.0	31.6	0.5	83
	V	Old	30	71		277	1.5	7.5	0.0	21.4	0.3	40.8
13	V	New	30	44.9	74.5	182	1.5	2.79	0.0	14.6	2.1	40.4
	V	Old	30	44		232	1.5	2.12	0.0	7.4	1.0	36.9
14	V	New	30	69	75.3	235	1.5	4.97	0.0	16.4	1.4	130.6
	V	Old	30	53		277	1.5	13.5	0.0	11.5	0.2	74.4

15	V	New	30	50.8	73.1	182	1.5	3.24	0.0	72.3	1.0	8.9296
	V	Old	30	25		186	1.4	20.4	0.0	43.1	0.4	1.6
16	V	New	30	23	68	136	1.5	48.8	2.2	50.9	1.2	105.9
	V	Old	30	57		232	1.5	0.0	0.0	27.6	0.0	40.8
17	V	New	30	53	72.3	200	1.5	1.68	0.0	42.8	0.0	136.5
	V	Old	30	74		277	1.5	10.1	0.0	29.6	0.0	71.7
18	V	New	30	75	76	240	1.5	1.49	0.0	39.5	0.3	260.01
	V	Old	30	78		277	1.5	1.7	0.0	22.7	0.2	93.1
19	V	New	30	80	75.5	250	1.5	4.79	0.0	52.6	0.4	16.24
	V	Old	30	67		277	1.45	1.95	0.0	24.8	1.0	2
20	V	New	30	56	74.3	235	1.5	43.5	1.7	67.4	0.7	63.3
	V	Old	30	58.5	28	277	1.4	22.4	0.0	47.8	0.7	22.6
21	V	New	30	56	73.6	216	1.5	5.18	1.53	15.2	0.7	42.1
	V	Old	30	52.5	31	236	1.5	7.5	0.0	10.2	0.3	11.9
22	V	New	30	77	73.3	240	1.5	5.35	0.0	61.5	0.7	32.2
	V	Old	30	75	23.5	277	1.5	15.4	0.0	51	0.0	7.3
23	V	New	30	93	74.6	312	1.5	0.0	0.0	0.0	0.0	3.9
	V	Old	30	95	25	315	1.35	0.1	0.0	0.6	0.0	0.2
24	V	New	30	98	77	312	1.5	0.43	0.0	0.41	0.0	7.2
	V	Old	30	100.5	34	315	1.45	0.2	0.0	0.0	0.0	0.0
25	V	New	30	62	71	215	1.5	26.5	0.0	76.4	0.4	47.7
	V	Old	30	59.9	37	236	1.35	10.7	0.7	71.7	0.0	16.2
26	V	New	30	36	64.6	150	1.5	33.6	1.63	146	0.6	14.3
	V	Old	30	31.2	37	136	1.5	46.1	0.4	195	1.5	2.3
27	V	New	30	46	72.7	200	1.5	45	1.31	98.2	2.1	4.1
	V	Old	30	48.4	35	186	1.5	14.5	0.5	59.7	0.0	6.5
28	V	New	30	60	69.7	215	1.5	0.0	0.0	0.0	0.6	0.0
	I	Old	30	56.9		186	1.5	0.0	0.0	0.0	0.3	0.0
29	V	New	15	17	62.5	136	0.75	23.9	0.0	74.6	0.0	8.5
	V	Old	15	17.6	37	136	0.75	19	0.0	42.8	0.0	4.8
30	V	New	30	17	63.3	136	1.5	39.4	0.0	86.3	1.8	18.5
	V	Old	30	17.8	43	136	1.4	27.3	0.0	43	0.4	13.5

Analyzing method

The comparison of the species specific catches of the new Havfisken versus the old Havfisken were done based on a statistical method for inter-calibration of surveys, i.e. determining the relative selectivity of two gear types or two vessels described in the draft paper "Intercalibration of survey trawl gear using paired hauls" prepared by Thygesen et al. 2015. The method relies on data from paired trawl hauls performed with the two gear types.

The relative selectivity for each gear is modelled by use of the length distribution of the catches of the actual species and includes the swept area and three sets of random size dependent variables expressing:

1) The local background size distribution (The true length distribution at the bottom at the spot for the haul. This will not be estimated but is only linking the relative selectivity of the two gears);
2) The haul specific fluctuations in the length distribution in the catch (This express the fact that the catch in one haul is different than the catch in another haul due to local variations of the abundance of the fish);
3) The relative selectivity of the two gears by length group (This is the component we are looking for in order to identify the any significant differences, which prevent us from directly comparing the catches of one gear with the catches of another gear and to convert the result from one gear to the other.

The catches are assumed to be Poisson distributed. Poisson distributions is used when it is assumed that the observations are independent (the catch in one haul is independent of the catch in another haul).

Trawling results

The total number of the potential relevant species in relation to index calculation in Kattegat and the Baltic Sea are given in table 2.

Vessel	**Species**									
	Long rough dab	Dab	Turbot	Plaice	Lemon sole	Wich flounder	Flounder	Brill	Sole	Cod
New Havfisken	7119	**7597**	17	8195	2608	7	68	19	11	1561
Old Havfisken	4053	5656	4	8831	1444	9	37	14	32	796
Total	11172	13253	21	17027	4052	16	105	33	43	2357

Table 2. Total number of flatfish species and cod caught by the two vessels.

The amount of the catches by haul are given in table 1 for the most index-relevant and frequently caught flatfish (dab, turbot, plaice, flounder) and cod. The catch of other species are too sparse to allow the establishment of conversion factors.

The length distributions of the four index-relevant and sufficient frequently caught species are shown in figure 2.

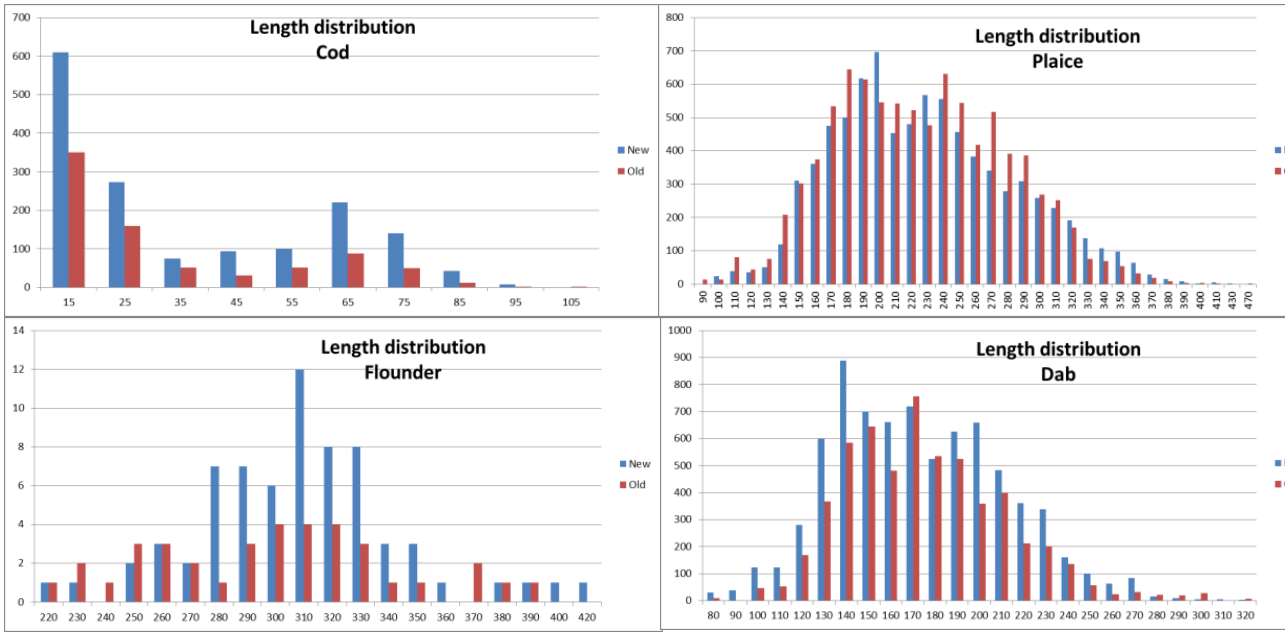

Figure 2. Compare of length distribution for the two vessels for the four most frequently caught species.

Results of calibration factors modelling

Figure 3 shows the relative selectivity for the new Havfisken compared with the old Havfisken for each of the most frequent caught species. The circles indicate the individual observations (hauls) and the solid lines indicate the estimated conversion factor. The grey area indicates the 95% significant intervals. The conversion factor (y-axis) expresses the factor which the catches of the new Havfisken must be multiplied with in order to be comparable to the time series of the old Havfisken. The exact calibration factors by length group are given in table 3.

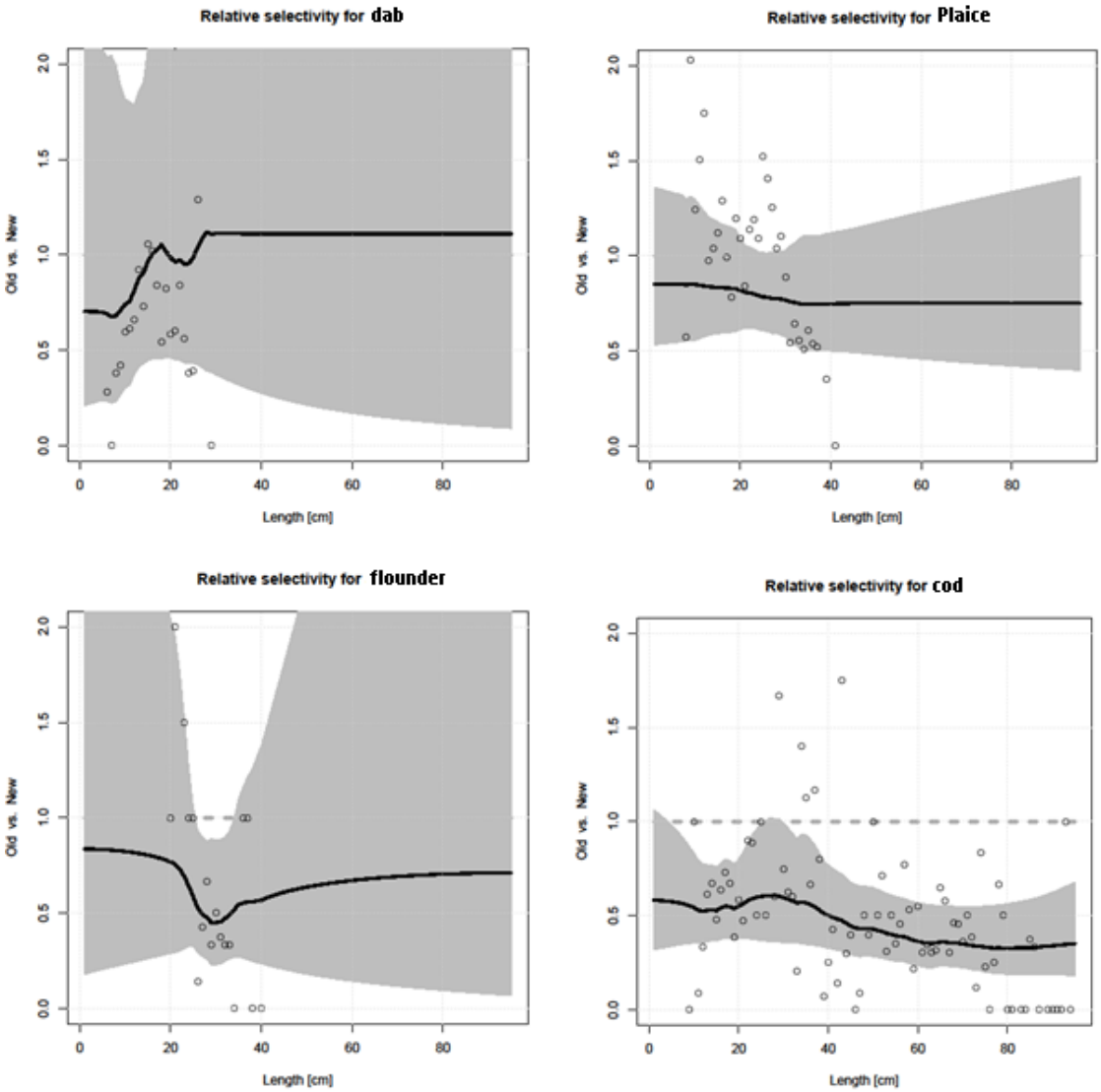

Figure 3. Graphs showing the estimated calibration factors (solid line) for dab plaice, flounder and cod by cm length group for converting CPUE values from new Havfisken to old Havfisken time series. Grey area indicates significant intervals for the estimate. Open circles indicate observations. The conversion factor expresses the conversion from the new Havfisken to the old Havfisken

Discussion

Because the vessels use different rigging due to different trawl doors, the distance between the doors is more than double as large for the new Havfisken that for the old Havfisken (mean distance for new and old Havfisken is 71.5 meters and 34.6 meters respectively). Looking at the compare of length distribution (figure 1) there seems to be a difference in the selection of all length groups between the flatfish and the cod. The difference in the number in all length groups of cod is significant larger (largest for the new Havfisken) than is the case for the flatfish species. This might be explained by the difference in response to herding effect by the doors where cod is likely to respond by aggregating close to the median line of the trawl and then after a while to fall back into the belly of the trawl while flatfish is less likely to seek towards

the median of the trawl and will be able to escape under the bridles. As a consequence the catch of cod represents individuals from the water mass defined by the opening of the net and the distance between the doors while the catch of flatfish represent the water mass defined by the opening and the distance between the wings. The difference in trawling distance might influence on the catch as well. In 12 cases out of the 30 hauls the old Havfisken was not capable of keeping up the 3 knots and consequently has a shorter trawl distance than the new Havfisken. The difference was in average for the 12 hauls 0.14 knots and 0.06 knots including all hauls.
The difference in hauling procedure of the trawls might influence the catch of round fish as large individuals might escape when the wire are coiled up and the net is floating in the surface before it is pulled onboard the side trawler. The hauling process onboard the aft trawler is a more continuous movement, which does not allow the fish to escape.
The number of long rough dab and lemon sole (table 2) is probably sufficient to calculate if the catches of these two species are significantly different and would justify if conversion factors should be established for these two species as well.

Conclusions
The estimated conversion factors for cod and flounder are at a level, which means that they are significantly different from 1 for all size groups found and it is recommended to converting BITS CPUE estimates obtained with the new Havfisken to the BITS CPUE estimates obtained with the old Havfisken. This means that BITS surveys results acquired with the new Havfisken can be included in the existing time series for cod and flounder if the species specific conversion factors are applied.

The conversion factors estimated for plaice and dab are not significant different from 1, which indicates that no conversion factors should be applied and that the estimated obtained by the new Havfisken can be directly compared with the estimate obtained with the old Havfisken. It should be noted that the conversion factor estimates particularly for dab are very uncertain and not very well estimated. This has to do with high variability and **not** due to small catches of dab during the exercise.
The conversion factors which should be used are given in table 3.

It is suggested that the corrected indices are introduces already this for this year assessment for cod and flounder by converting the new Havfisken input to old Havfisken standard followed by a conversion of the complete time series for the old Havfisken to new Havfisken standard. As the change is relatively large for especially cod but also for flounders, it is recommended that the new time series is implemented in connection with a future benchmark process.

References
Thygesen et al. Intercalibration of survey trawl gear using paired hauls. Draft prepared by Uffe Høgsbro Thygesen, Kasper Kristensen, Teunis Jansen, Jan E. Beyer. Additional authors to be included. DTU-Aqua, Danish Technical University. Compiled September 1, 2015.

Table 3. The estimated conversion factors by 1 cm length group for cod and flounder.

Cod	
Length gr. Cm	**Conversion factor**
<13	0.54
14	0.53
15	0.52
16	0.53
17	0.53
18	0.53
19	0.54
20	0.55
21	0.55
22	0.54
23	0.55
24	0.56
25	0.58
26	0.59
27	0.60
28	0.60
29	0.61
30	0.61
31	0.61
32	0.60
33	0.60
34	0.59
35	0.58
36	0.57
37	0.57
38	0.57
39	0.56
40	0.55
41	0.53
42	0.51
43	0.50
44	0.49
45	0.48
46	0.48
47	0.46
48	0.45
49	0.44
50	0.43
51	0.43
52	0.43
53	0.43
54	0.42
55	0.42
56	0.41
57	0.40
58	0.40
59	0.39
60	0.39
61	0.38
62	0.37
63	0.37
64	0.36
65	0.36
66	0.35
67	0.36
68	0.36
69	0.36

70	0.36
71	0.36
72	0.35
73	0.35
74	0.35
75	0.34
76	0.34
77	0.34
78	0.33
79	0.33
80	0.33
81	0.33
82	0.33
83	0.33
84	0.33
85	0.33
86	0.33
87	0.33
88	0.33
89	0.33
90	0.33
91	0.34
92	0.34
>93	0.34

Flounder	
Length gr. (Cm)	Conversion factor
<=20	0.77
21	0.76
22	0.73
23	0.69
24	0.64
25	0.59
26	0.53
27	0.50
28	0.48
29	0.45
30	0.45
31	0.46
32	0.47
33	0.49
34	0.52
35	0.55
36	0.56
37	0.56
38	0.56
39	0.57
>=40	0.57