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**Assessment of lumpfish (*Cyclopterus lumpus*) in West Greenland based on commercial data 2010-2018**

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**Introduction**

The lumpfish fishery in Greenland is conducted in the spring along the Greenland west coast. The fishery peaks in late May/early June. Prior to year 2000, reported roe landings were below 500 t, but in the last decade landings have steadily increased, reaching the highest level in 2013 with 2 124 t (Fig. 1). Since then, catches have generally decreased, now being around 1 000 t. Before 2015 the fishery was unregulated, but in 2015 a management plan was implemented, that operates with TAC and restricted number of fishing days. The West Coast is divided into seven management areas, with the onset of the fishery being area dependent due to a timely displaced onset of spawning.

The fishery is conducted from small open boats (<6.5m) that operates with gill nets that typically fish for 24 hours. Due to the large mesh size (260mm) the nets are highly selective, and catch predominantly female lumpfish, which are much larger than males (Hedeholm et al. 2013). Upon capture, the roe is removed from the fish, and stored in large barrels before landed at land based facilities. Hence, the number of fish landed is not reported, but only the total amount of roe. Due to the size of the fishing vessels, there is an upper limit to the number of nets each boat can carry. All calculations in this assessment rest on this vital assumption; that each fisherman is assumed to be incapable of increasing fishing effort (nets) as a response to a decline in lumpfish abundance to maintain the same landings. Hence, kg. roe pr. landing is a proxy of landing per unit effort (LPUE) and can be used as a stock status indicator. If the extent of the fishing area is monitored simultaneously, we believe a reasonable indication of stock status can be provided, although no survey is available. The commercial data available have been of varying quality, and data prior to 2010 have not been evaluated valid for assessment purposes as those landings often lack supporting information such as fisherman ID and location.

In this document we describe the assessment procedure, present an LPUE time series from 2010-2017 on lumpfish and estimate the extent of the fishery.

## Data

Since 2010 each landing has reliably been associated with amount of roe (kg.), date, fisherman ID, NAFO division and catch location (field code). Each field code is defined as 1/8 degree latitude \* 1/4 degree longitude, which is roughly 14 km\*8-14 km depending on latitude.

The data has been filtered to avoid bad data and “unserious” fishermen. Hence:

- A fisherman must have been active at least three years from 2008-2018.
- A fisherman must have landed a minimum of 500 kg roe from 2008-2018.

Additionally, a fisherman is considered as a different fisherman if he moves between NAFO areas between years.

Each landing is categorized as “roe”, “whole fish” or “gutted fish”. The roe from the two latter categories is also landed, and the calculations are therefore only based on the “roe” category. Uncategorized landings were sorted based on the value of the catch, with roe having much higher weight specific value. Applying correct conversion factors allows for roe amount to be converted into whole fish weight, which in turn can be used to estimate the number of fish caught. At present the conversion factor from roe to whole fish is 6.7. Based on unpublished data we believe this is too high, and in the present document, only roe landings are reported. Length data from commercial female catches are available from 2011. However, sampling has been sporadic and with insufficient coverage of the fishing area.

## **Analysis**

In this document the procedure is shortly described in words only. All analyses were done in R (R core team, 2014) and the script for calculating LPUE is provided as an appendix to this document, including the data preparations steps. The calculations are derivatives of this script.

Initially, a year and NAFO division specific LPUE (kg pr. landing) for each individual fisherman is calculated. This LPUE is weighted by the share of the total catch in the respective NAFO division taken by the fisherman. All LPUE's from a NAFO area are summarized given a year and NAFO division specific LPUE. To get the LPUE estimate for the entire Greenland west coast, the NAFO division specific LPUE's are weighted by the total west coast landings. This procedure ensures that the fishermen and areas with the highest landings are given the highest weight in the assessment of the stock status.

The field code information is used to get an overview of the extent of the fishery in general, but also to calculate the extent of the fishery in each NAFO division. This is done by simply calculating the number of field codes fished in each year in each NAFO division.

## Results

The 2018 landings were 1002 t which is a decrease of 9% compared to 2017 (Fig. 1).

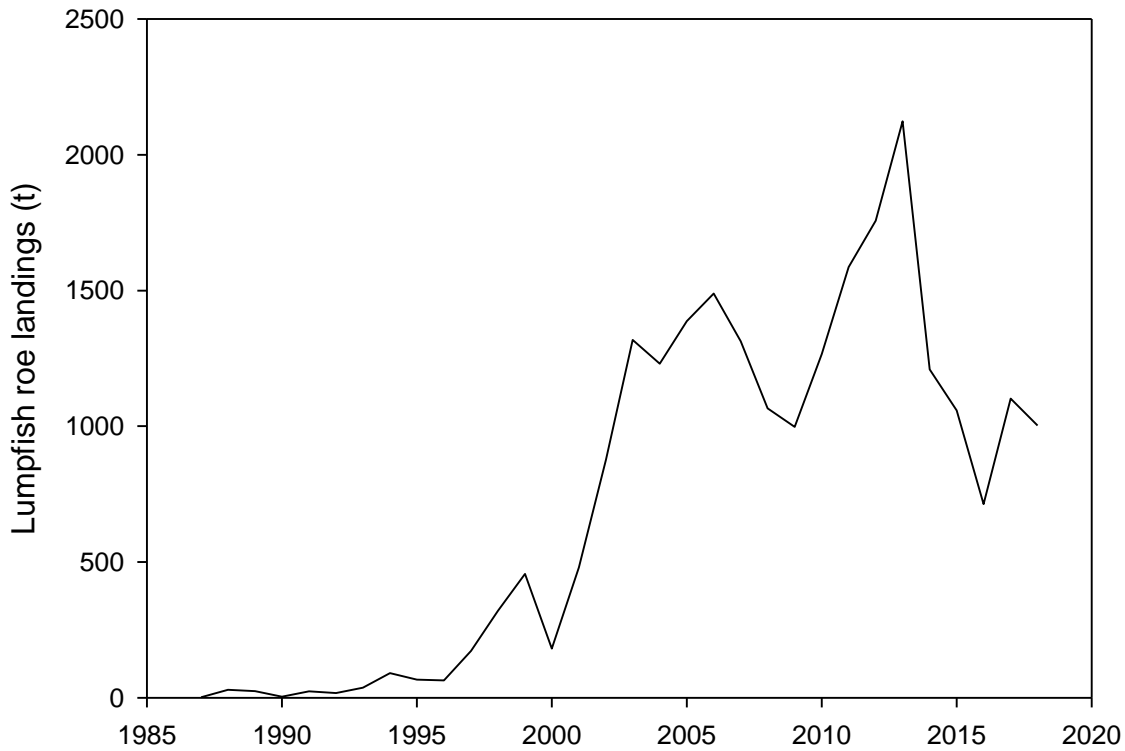


Figure 1: Total lumpfish roe landings (t) from 1987 to 2018.

The LPUE decreased by 40% (Fig. 2, Table I). This was driven by a decrease primarily in NAFO 1D, which decreased to a time series low. The other NAFO areas generally maintained the same LPUE level. In spite of the decrease in LPUE, NAFO 1D is the area with the largest catch (2002 t).

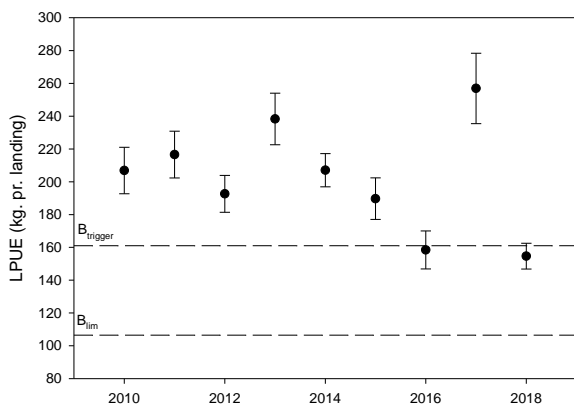


Figure 2: LPUE estimates for the West Greenland area

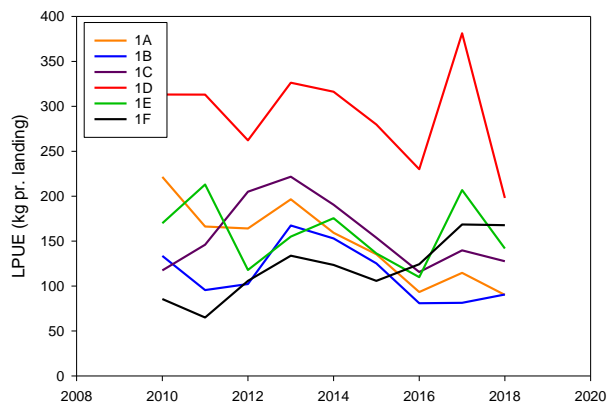


Figure 3: NAFO area specific LPUE estimates.

Vertical bars are standard errors.  $B_{trigger}$  and  $B_{lim}$  values are indicated

Table I: LPUE by year.

year	lpue
2010	206.9
2011	216.6
2012	192.7
2013	238.3
2014	207.1
2015	189.7
2016	158.4
2017	256.9
2018	154.6

The number of fished field codes increased from 217 in 2017 to 265 in 2018 (Table II) but is still distributed from 60°N to 71.5°N (Fig. 4). This increase was seen in most areas (except 1F and 1C). The number of active fishermen increased substantially in all areas except 1F.

The average fish length has been surprisingly stable between years, considering the low sample size, with 2011 (N=109), 2012 (N=561) and 2013 (N=69) length means being within 1.1% of each other (2011-2013 average=37.62 cm) whereas the 2014 (N=273) and 2015 fish (N=244) were slightly larger (39.18 cm and 38.3, respectively). There was no sampling from the commercial fishery in 2016-2018.

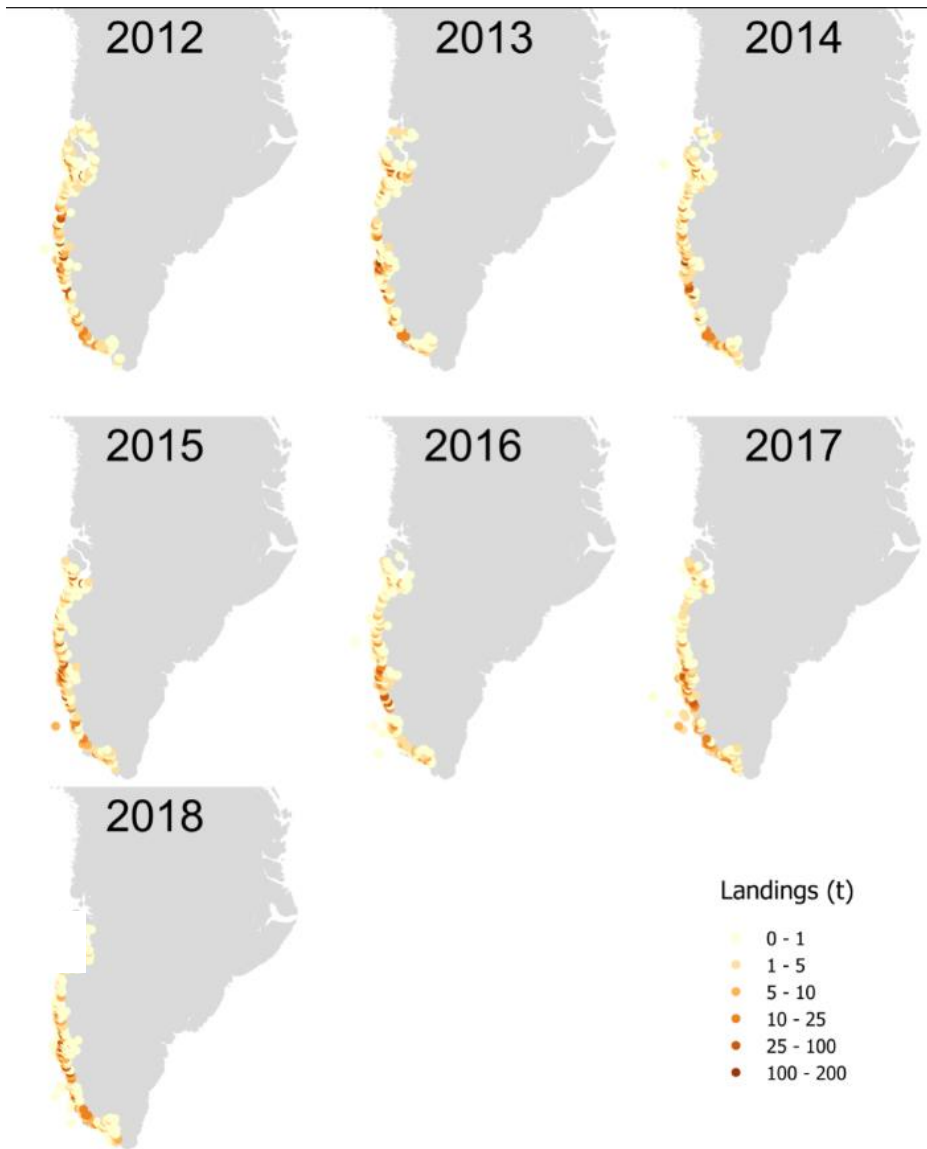


Figure 4: Distribution of lumpfish roe catches (t) summarized by field code.

Table II: Number of field codes fished and active fishermen in each NAFO division and year.

Year	Field codes fished						To- tal	Number of fishermen						Total
	1A	1B	1C	1D	1E	1F		1A	1B	1C	1D	1E	1F	
2012	22	113	38	43	17	32	265	109	164	158	141	33	61	666
2013	11	106	23	57	19	33	249	100	154	85	171	33	69	612
2014	5	109	37	33	13	36	233	57	131	115	88	36	68	495
2015	21	79	34	59	15	31	239	43	126	105	102	34	60	470
2016	18	69	38	44	25	32	226	41	103	101	96	32	47	420
2017	17	51	40	62	14	44	217	43	97	118	119	30	71	456
2018	28	72	39	77	26	44	265	57	152	151	154	39	67	582

The cumulative catches shows that a large share of the catches were taken early in the season compared to the last couple of years (Fig 5). However, the last part of the catch was taken later in the season than normally probably as a result of the lower than expected catches.

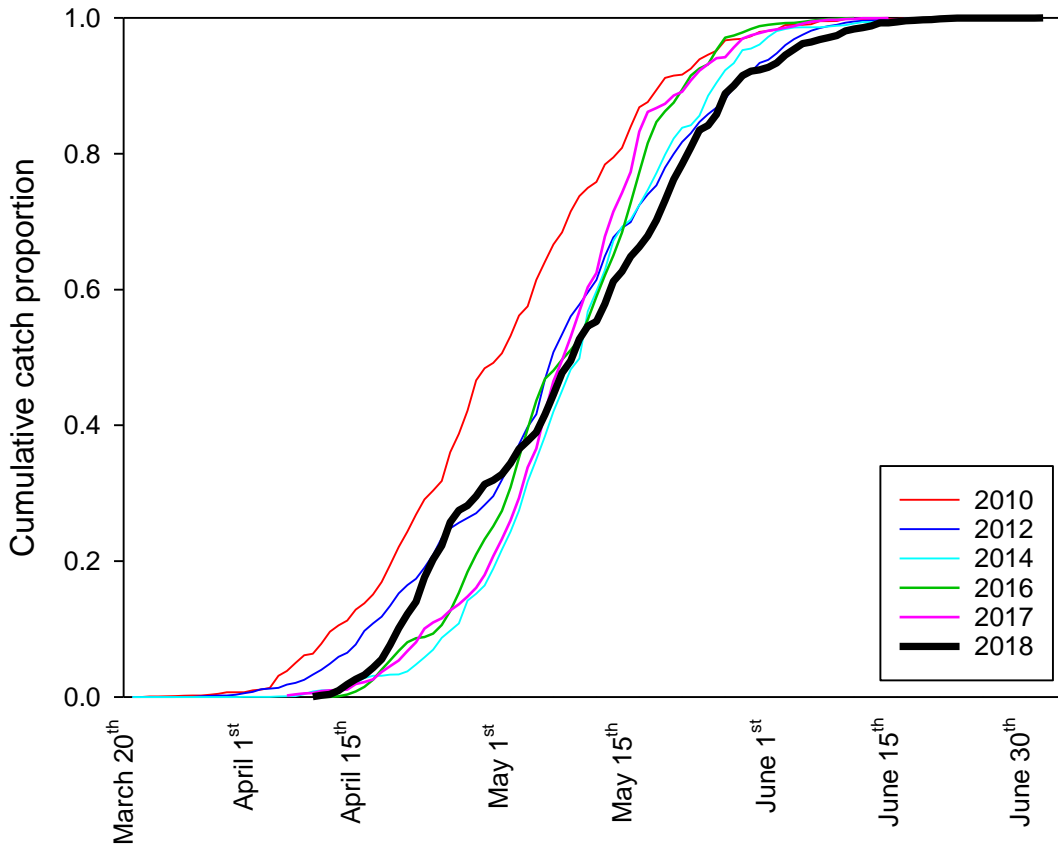


Figure 5: Cumulative catches in proportions

### Discussion

The data used in this assessment seem consistent, and provides a useful tool in assessing the state of the lumpfish stock (given correct assumptions). Landings remains at a similar level in 2018 compared to 2017. This catch required a much larger effort, and LPUE decreased to a time series low (155) which is also below the limit reference point  $B_{trigger}$  (161). Prices were high in 2018, which would normally result in a caught TAC and the number of fishermen also increased. However, the weather situation (long winter) made fishing more difficult than normal, which explains some of the discrepancy between the TAC (1 300 t) and the actual catch (1 002 t).

Both the number of fishermen and the number of fished field codes increased in 2018. Data does not allow us to evaluate if the expansion of the fishery was into sub-optimal areas, and therefor potentially causing a drop in LPUE irrespective of the amount of lumpfish in the “normal” areas. However, the main decline was

in 1D, and in other areas where the fishery expanded, the LPUE remained close to constant. Also, the current situation closely resembles that of 2012 in terms of participants and coverage, and then the LPUE was 25% higher.

Hence, the LPUE decline is most likely a reflection of a decline in the number of spawning females. It is worth noting, that this LPUE decline follows two consecutive years where the TAC has not been caught. So a lower than expected catch has resulted in a LPUE decline.

The advice for number of fishing days and quantity for roe catches (TAC) is generated by applying the decision tree in figure 6. An elaboration of this procedure is given in the current management plan. The advice for lumpfish is a two year advice. **The current advice was provided in 2017 and is valid for 2018 and 2019. Hence, the next scientific advice will be given following the 2019 fishery. The advice for 2019 is 1 300 t and 41 fishing days.** It is however worth noting, that the 2018 LPUE is below the limit reference point  $B_{trigger}$ .

The reason for having a two year advice is to dampen large year-to-year fluctuation, which are expected due to biology of lumpfish and the data (e.g. fishery dependent, relatively low level of detail). However, falling below LPUE should be given consideration when setting the 2019 TAC.

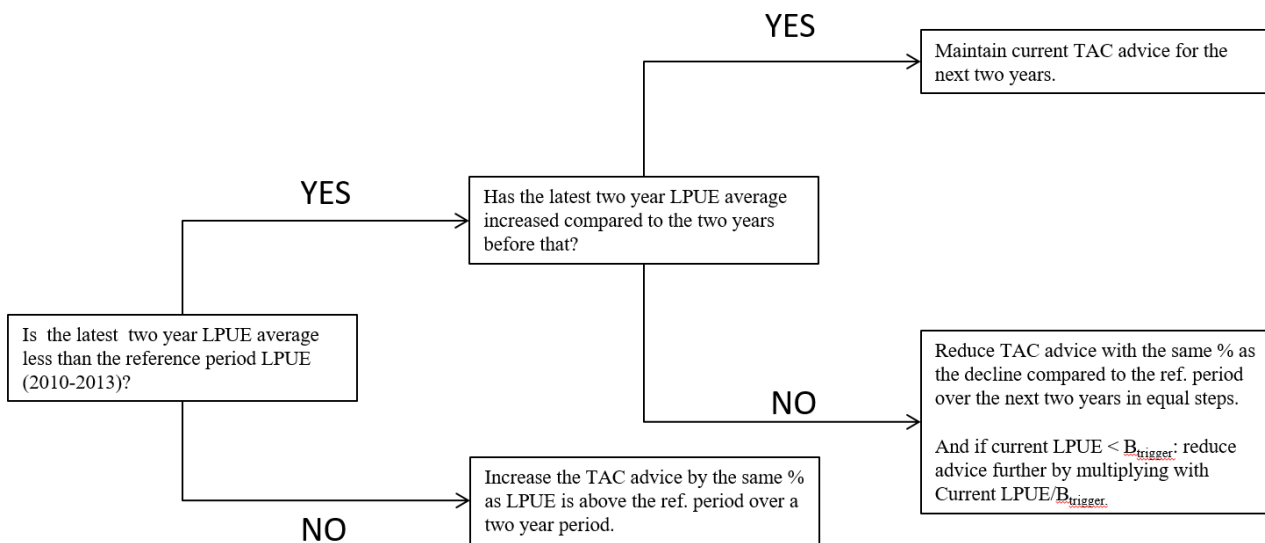


Figure 6: Advisory decision tree.

Large year-to-year fluctuations in the number of spawners can be a result of 1-2 yearclasses comprising the vast majority of the spawning component (Hedeholm et al. 2013). Single year recruitment anomalies are expected to affect the fishing 3-4 years later. This also means that an assessment based on historical landings is sub-optimal but since there is no measure of the juvenile stock component it provides the only option.



We do not provide any estimate of male lumpfish landings as these are unreported. However, given the mesh size of the gill nets (260mm) and the significant sexual size dimorphism (Hedeholm et al. 2013) we believe that male catches are very low. Davenport J. (1985) states that based on Icelandic data males are predominantly caught in 170-190 mm gill nets. However, small amounts of males are landed and sold on the domestic market, but catches are surely small and amounts to only a few tonnes. There is also a recreational fishery for females that is not accounted for in this study. The recreational landings are also from 260mm gill nets, but there is no estimate of the amount. Based on personal communication it is however estimated, that total recreational roe landings are less than 25 t pr. year, and therefore negligible.

The LPUE estimates presented here rests on vital assumptions. If the fleet change effort (i.e. number of nets pr. boat) the LPUE time series will not only reflect population changes. Currently, data does not allow us to evaluate the validity of this assumption, but based on seminars and personal communication the fishermen appear to carry the same number of nets regardless of catch rates – the small boats are simply saturated.

A vital assumption for this assessment is that the fishermen land their catch just after capture, even if this means having only some fraction of the maximum capacity in the boat. We believe this is justified, as lumpfish roe will not stay at premium quality for days after capture, and the fishermen have no storage facility in their small boats. This has also been confirmed in seminars. This “net saturation assumption” also implies that a fisherman does not change “set up” between years, meaning that the effort in regards to nets is fixed. We cannot, however, rule out that certain fishermen changes boat/gear type in the period.

The LPUE times series is based on high quality data, but given the assumptions, the relatively short time series and the lack of biological knowledge on lumpfish means that LPUE estimates are associated with some uncertainty, and hence the fishery should be managed based on precautionary approach until more data is available. Also, the field codes fished is not currently implemented in a formal way in the management plan, which ideally should be considered.

## References

Davenport J. 1985. Synopsis of the biological data on lumpsucker *Cyclopterus lumpus* (Linnaeus, 1758). FAO Fisheries synopsis No. 147. Rome 1985.

Hedeholm, R., et al. 2013. First estimates of age and production of lumpsucker (*Cyclopterus lumpus*) in Greenland. Fish. Res. (2013), <http://dx.doi.org/10.1016/j.fishres.2013.08.016>

Hedeholm, R., et al. 2017. Life history trait variation of Greenland lumpfish (*Cyclopterus lumpus*) along a 1600 km latitudinal gradient. Polar Biology. Doi 10.1007/s00300-017-2160-x.

Hutchings J. 1996. Spatial and temporal variation in the density of northern cod and a review of hypotheses for the stock's collapse. Can J Fish Aquat Sci 53:943–962

R Core Team (2014). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>.

## Appendix I

R script used in LPUE calculations.

```
#
# HUSK AT ÆNDRE ", " TIL "." I DATAARKET FØR GROGRAMMET KØRES!
#####
#####
# - Beregner LPUE for stenbider og laver tre Excel filer - Første til brug i SAS til at beregne gps pos,
# der senere benyttes til at lave et fangstkort. Anden og tredje fil giver vægтет LPUE pr område og år henholdsvis.
# - HEL og MHUI kattergorierne frasorteres.
# - Se dokumentet "LPUE procedure brugt i rådgivningen for den vestgrønlandske stenbider.doc" for nærmere beskrivelse af proceduren.
# - Script lavet af RaHe og SoPo 2014. R version 3.1.1
#####
#####

#Oprydning af idligere arbejder i R.
rm(list = ls(all.names=TRUE))
#Arbejdssti
setwd('F:/20-39 FiSk/37 Andre fiskarter, invertebrater, blan. forsøgsfiskeri/00 Rådgivning og sagsbehandling/02 Stenbider/00 Data/Oparbejdning/2017')
#data1 <- read.csv('Z:/31 Andre fisk/2015 data/LUM2010_2015.csv', sep=',', header=T)
#data1 <- read.table('Z:/31 Andre fisk/2015 data/LUM2010_2015.txt', sep=';', header=T)
data1 <- read.csv('F:/20-39 FiSk/37 Andre fiskarter, invertebrater, blan. forsøgsfiskeri/00 Rådgivning og sagsbehandling/02 Stenbider/00 Data/Oparbejdning/2017/LUM2010_2017.csv', sep=';', header=T)
#data1 <- read.table('C:/Users/rahe/Desktop/LUM2010_2016.txt', sep='\t', header=T)
#data1 <- read.csv('C:/Users/rahe/Desktop/LUM2010_2016_2.csv', sep=';', header=T)

data1$day <- as.numeric(as.character(substring(data1$INDHANDLINGSDATO, 1,2)))
data1$month <- as.numeric(as.character(substring(data1$INDHANDLINGSDATO, 4,5)))
data1$year <- as.numeric(as.character(substring(data1$INDHANDLINGSDATO, 7,10)))

data2a <- data1[,c('year','month','day','BEHGRD_KODE','MAENGDE','INDHANDLINGSTED_GFLKNR','FISKER_GFLKNR','VAERDI','FANGSTFELT')]
names(data2a)[1:9] <- c('year','month','day','BEHGRD','MAENGDE','Location','SAELGER','VAERDI','FELTKODE')
data2a$MAENGDE <- as.numeric(as.character( sub(",",".", data2a$MAENGDE)))
data2a$VAERDI <- as.numeric(as.character( sub(",",".", data2a$VAERDI)))

data1<-data2a #work-around for at få resten af programmet til at køre

#install.packages('car')
library("car")
data2<-subset(data1, month=='3')
data3<-subset(data1, month=='4')
data4<-subset(data1, month=='5')
data5<-subset(data1, month=='6')
data6<-rbind(data2,data3)
data7<-rbind(data6,data4)
```

```

data8<-rbind(data7,data5)

data9<-subset(data8,BEHGRD!='MHUI')
data9b<-subset(data9,BEHGRD!='HEL')

write.table(data9b, file = "tilsas2.csv", sep = ";", na = "NA", row.names = F)

#der er linjer uden angivelse af behgrd. For at tjekke om det rogn eller MHUI/HEL regnes en kg pris ud.
#Herefter smides de linjer ud, hvor kg.prisen er under 5 kr.
data9b$value <- data9b$VAERDI / data9b$MAENGDE #kg.prisen udregnes
data9b <- subset(data9b, value>5)

#der er enkelte fejl i data, blandt andet negative mængder, som smides ud her.
data10<-subset(data9b, MAENGDE>0)

#her droppes ligegyldige variable.
data10$ART <- data10$KVALITET <- data10$BEHGRD <- data10$KVOTE <- data10$VAERDI <- data10$value <- NULL

#her laves location om til en kategorisk variabel.
data10$Location = as.factor(data10$Location)

data10$Location_2<-recode(data10$Location,"c(1010)='Nanortalik';c(1040)='Narsaq';c(1050)='Paamiut';c(1060)='Nuuk';c(1070)='Maniitsoq';
c(1080)='Sisimiut';c(1100)='Aasiaat';c(1110)='Qasigiannugit';c(1120)='Ilulissat';c(1121)='Ilulissat';c(1122)='Ilulissat';
c(1123)='Ilulissat';c(1124)='Ilulissat';c(1140)='Qeqertarsuaq';c(1150)='Uummannaq';c(1151)='Uummannaq';c(1152)='Uummannaq';
c(1153)='Uummannaq';c(1154)='Uummannaq';c(1155)='Uummannaq';c(1156)='Uummannaq';c(1157)='Uummannaq';c(1210)='Arsuk';
c(1211)='Nuuk';c(1212)='Nuuk';c(1213)='Maniitsoq';c(1214)='Maniitsoq';c(1217)='Kangaatsiaq';c(1218)='Aasiaat';c(1219)='Aasiaat';
c(22111)='Nanortalik';c(22167)='Upernavik';c(22532)='Qaqortoq';c(22597)='Innaarsuit';c(22619)='Ship';c(22761)='Ilulissat';
c(22810)='Kangersuatsiaq';c(22815)='Attu';c(22818)='Upernavik';c(22835)='Qaanaaq';c(22857)='Sisimiut';c(22874)='Sisimiut';c(22876)='Kuumi-
ut';c(22928)='Sisimiut';
c(22930)='Maniitsoq';c(23011)='Maniitsoq';c(23039)='Ilimanaq';c(23049)='Maniitsoq';
c(23137)='Qeqertarsuaq';c(23139)='Aasiaat';c(1616)='Ship';c(1651)='Ship';c(1653)='Ship';c(22111)='Nanortalik';c(22162)='Uummannaq';
c(22167)='Upernavik';c(22479)='Ilulissat';c(22532)='Qaqortoq';c(22597)='Upernavik';c(22619)='Ship';c(22761)='Ilulissat';
c(22810)='Upernavik';c(22815)='Aasiaat';c(22818)='Upernavik';c(22835)='Qaanaaq';c(22857)='Sisimiut';c(22874)='Sisimiut';c(22876)='Tasiilaq';
c(22928)='Sisimiut';c(22930)='Qaqortoq';c(23103)='Upernavik';c(23104)='Upernavik';c(23105)='Upernavik';c(23106)='Upernavik';
c(23108)='Uummannaq';c(23011)='Maniitsoq';c(23039)='Ilulissat';c(23049)='Nanortalik';c(23137)='Qeqertarsuaq';c(23139)='Aasiaat';
c(23275)='Sisimiut';c(23338)='Sisimiut';c(23286)='Upernavik';c(23395)='Upernavik';c(22821)='Nuuk';c(22992)='Maniitsoq';c(22993)='Aasi-
aat';c(23114)='Nanortalik';
c(23325)='Qeqertarsuaq';c(23691)='Upernavik';c(23733)='Ilulis-
sat';c(29500)='Narsaq';c(68)='Nuuk';c(23374)='Narsaq';c(24052)='Maniitsoq';c(27557)='Narsaq';c(23502)='Maniitsoq';
c(23514)='Sisimiut';c(23505)='Attu';c(23581)='Aasiaat';c('29501)='Nuuk';c('23692)='Uummannaq';c('23978)='Maniitsoq';c(23503)='Ikamiut'")
unique(data10$Location_2) #Tjekker om der er nogle feltkoder som ikke omskrives til område
#efter snak med GFLK er der lavet ændringer i område allokeringen 8-12-2016, RaHe.

data10$Location_2 <- as.factor(data10$Location_2)
#data10<-subset(data10, Location!='27501') #Fjerner bifangst fra loddefiskeriet i Island

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data10$NAFO<-recode(data10$Location_2,"c('Nanortalik')='1F';c('Narsaq')='1F';c('Paamiut')='1E';c('Nuuk')='1D';c('Maniitsoq')='1C';
c('Sisimiut')='1B'; c('Aasiaat')='1B'; c('Qasigiannguit')='1B';c('Ilulissat')='1A';c('Qeqertarsuaq')='1A';c('Uummannaq')='1A';c('Arsuk')='1E';
c('Kangaatsiaq')='1B';c('Upernavik')='1A';c('Qaqortoq')='1F';c('Innaarsuit')='1A';c('Kangersuatsiaq')='1A'; c('Attu')='1B';
c('Qaanaaq')='1A';c('Sisimiut')='1B';c('Kuumiut')='XIVb';c('Ilimanaq')='1A';c('Tasiilaq')='XIVb'; c('Ikamiut')='1B'")
summary(data10)

summary_table1 <- aggregate(data10[,c('MAENGDE')],list(Location_2=data10$Location_2, year=data10$year),sum,na.rm=T)
summary_table1$tons <- summary_table1$x/1000
summary_table2 <- aggregate(data10[,c('MAENGDE')],list(year=data10$year, NAFO=data10$NAFO),sum,na.rm=T)
summary_table2$tons <- summary_table2$x/1000

#herunder skal de fiskere som skal indgå i beregningerne udvælges. Det sker efter flere kriterier:
#først regnes antallet af år en fisk har været aktiv
data10$dummy <-1
indhandling_pr_fisherman_pr_aar <- aggregate(data10[,c('dummy')],list(SAELGER=data10$SAELGER, year=data10$year),sum,na.rm=T) #giver
antal indhandling pr år pr. fisker
indhandling_pr_fisherman_pr_aar$dummy2 <-1 #en ny dummy variable som vi summerer herunder
antal_aktive_fiskeaar <- aggregate(indhandling_pr_fisherman_pr_aar[,c('dummy2')],list(SAELGER=indhandling_pr_fisherman_pr_aar$SAEL-
GER),sum,na.rm=T) #giver antal år med indhandling pr. fisker

data11 <- merge(data10, antal_aktive_fiskeaar,by='SAELGER') #de to datark kombineres

#nu smides der linjer ud efter følgende kriterier:
#1) en fisker skal have været aktiv i mindst 3 år i perioden 2008-20XX for at indgå i beregningerne
data12 <- subset(data11, x >2)

#2) en fisker skal have fanget minimum 500 kg er perioden 2008-20xx for at indgå
#først regnes den totale fangstmængde for hver fisker
total_indhandling_pr_fisker <- aggregate(data11[,c('MAENGDE')],list(SAELGER=data11$SAELGER), sum,na.rm=T)
data13 <- merge(data12, total_indhandling_pr_fisker, by='SAELGER')
#og fiskerne slettes
data14 <- subset(data13, x.y>500)

#3) Vi har vurderet at data før 2010 er af for dårlig kvalitet og derfor udelades de.
data15<-subset(data14, year>2009)
head(data15)

#her gøres hver sælger unik - dvs, at hvis en sælger flytter område er han betragtet som en anden sælger
data15$SAELGER_unik <- paste(data15$SAELGER, data15$NAFO, sep='_')

#nu udskrives en fil osm skal bruges til at lave et kort med fiskeintensitet. Dette er gjort 2014
write.table(data15, file = "tilsas2.csv", sep = ";", na = "NA", row.names = F)

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#herunder begynder selve analysen
data16 <- aggregate(data15$MAENGDE,list(SAELGER_unik=data15$SAELGER_unik, year=data15$year, NAFO=data15$NAFO), sum,na.rm=T) #her
summeres mængden for hver sælger i hvert område i hvert år.
data17 <- aggregate(data15$dummy,list(SAELGER_unik=data15$SAELGER_unik, year=data15$year, NAFO=data15$NAFO), sum,na.rm=T) #her tælles
hvordan mange indhandlinger hver sælger har i hvert område i hvert år.
data18 <- cbind(data16,data17$x) #de to datasæt sættes sammen, og herunder omdøbes de nye variable.
#install.packages('plyr')
library(plyr)
names(data18)[names(data18)=='x']<-'rogn_saelger_pr_år_pr_område'
names(data18)[names(data18)=='data17$x']<-'antal_indhandlinger_pr_år_pr_område_pr_fanger'

#der regnes nu et CPUE for hver unik sælger i hver område i hvert år.
data18$CPUE_kg_pr_indhandling <- data18$rogn_saelger_pr_år_pr_område/data18$antal_indhandlinger_pr_år_pr_område_pr_fanger

#der laves en tabel som viser antallet af indhandlinger for hver sælger i hvert område, og den sættes sammen med tabellen med CPUE'en
data19 <- aggregate(data18$antal_indhandlinger_pr_år_pr_område_pr_fanger,list(year=data18$year, NAFO=data18$NAFO), sum,na.rm=T)
data20 <- merge(data18,data19, by=c('year','NAFO'))
#de nye variable omdøbes.
names(data20)[names(data20)=='x']<-'antal_indhandlinger_pr_år_pr_område'

#der laves en vægtning idet sælgere med flest indhandlinger skal vægte tungest.
#vægten defineres som en sælgers antal indhandlinger pr. år pr område / antal indhandlinger i det område i det år (altså andelen).
data20$weight_til_CPUE <- data20$antal_indhandlinger_pr_år_pr_område_pr_fanger/data20$antal_indhandlinger_pr_år_pr_område
#herunder ganges vægten sammen med det rå CPUE
data20$vægtet_CPUE <- data20$CPUE_kg_pr_indhandling * data20$weight_til_CPUE

#disse linjer regner område- og årsspecifikke CPUE'er og tilhørende standard deviation
data21 <- aggregate(data20$vægtet_CPUE,list(year=data20$year, NAFO=data20$NAFO), sum,na.rm=T)
data21b <- aggregate(data20$vægtet_CPUE,list(year=data20$year, NAFO=data20$NAFO), FUN=sd)
names(data21)[names(data21)=='x']<-'CPUE_pr_område_pr_år'
names(data21b)[names(data21b)=='x']<-'SD'

#disse linjer regner SE for estimaterne
data21b$nrow <- nrow(data20)
data21b$SE <- data21b$SD/sqrt(data21b$nrow)
data22 <- merge (data21,data21b, by=c('year','NAFO'))

#denne linje giver en excel fil med et vægtet CPUE for hvert område i hvert år med SE.
#write.table(data22, file = "CPUE_pr_område.xls", sep = "\t", row.names = F)

#herunder regnes nu CPUE for de enkelte år.
#denne linje regner hvor meget der er indhandlet i hvert område i hvert år

```

```

data23 <- aggregate(data20$rogn_saelger_pr_år_pr_område,list(year=data20$year, NAFO=data20$NAFO),sum,na.rm=T)
#denne linje regner hvor meget der er indhandlet i hvert år
data23b <- aggregate(data20$rogn_saelger_pr_år_pr_område,list(year=data20$year),sum,na.rm=T)
#de nye variable omdøbes
names(data23)[names(data23)=='x']<-'kg_pr_område_pr_år'
names(data23b)[names(data23b)=='x']<-'kg_pr_år'

#de to tabeller sættes sammen, og den viser hvor meget der er indhandlet i hvert område i hvert år, og den samlede mængde i hvert år
data24 <-merge (data23, data23b, by='year')

#idet der ikke fanges lige meget i hvert område i hvert år vægtes de enkelte områder.
#vægten regnes som mængden pr område pr år / mængden det pågældende år
data24$weight_til_CPUE <- data24$kg_pr_område_pr_år/data24$kg_pr_år

#denne tabel indeholder antal indhandlinger pr år pr område, som bruges til CPUE beregning.
data25 <- aggregate (data20$antal_indhandlinger_pr_år_pr_område_pr_fanger,list(year=data20$year,NAFO=data20$NAFO), sum,na.rm=T)
names(data25)[names(data25)=='x']<-'indhandlinger_pr_område_pr_år'

#tabellerne med vægten (data22) og antal indhandlinger (data23) sættes sammen.
data26 <- merge (data24,data25, by=c('year','NAFO'))
#der regnes et CPUE for hvert område i hvert år: kg pr område pr år / antal indhandlinger pr område pr år og disse vægtes
data26$CPUE_pr_område_pr_år <- data26$kg_pr_område_pr_år / data26$indhandlinger_pr_område_pr_år
data26$svægtet_CPUE <- data26$CPUE_pr_område_pr_år * data26$weight_til_CPUE

#de vægtede CPUE lægges sammen for hvert år, og der regnes en SD
data27 <- aggregate(data26$svægtet_CPUE,list(year=data26$year), sum,na.rm=T)
data27b <- aggregate(data26$svægtet_CPUE,list(year=data26$year), FUN=sd)
names(data27)[names(data27)=='x']<-'CPUE_pr_år'
names(data27b)[names(data27b)=='x']<-'SD'

#der regnes SE for estimerne
data27b$nrow <- nrow(data27)
data27b$SE <- data27b$SD/sqrt(data27b$nrow)
data28 <- merge (data27,data27b, by=c('year'))

#denne tabel giver et vægtet CPUE for hvert år med tilhørende SE:
#write.table(data26, file = "CPUE_pr_år.csv", sep = "\t", row.names = F)

#data2015 <- subset(data10, year=="2015") # Bruges til at chekke om 2015 tallene er korrekte
#summary
#write.table(data2015, file = "datacheck.csv", sep = "\t", row.names = F)

# Positioner på indhandlingssteder

```

```

#df_Indhandlingssteder <- unique(data10$Location_2)
#df_Indhandlingssteder <- sort(df_Indhandlingssteder)
df_Indhandlingssteder <- c("Arsuk","Attu","Ikamiut","Ilulissat","Kangaatsiaq","Maniitsoq","Narsaq","Nuuk","Paamiut","Qaqortoq","Qasigiann-
guit","Qeqertarsuaq","Sisimiut","Upernavik","Uummannaq","Aasiaat")
df_Indhandlingssteder <- as.data.frame(df_Indhandlingssteder)
names(df_Indhandlingssteder)[1] <- 'Indhandlingssted'
df_Indhandlingssteder$lat <- 0
df_Indhandlingssteder$lon <- 0
#df_Indhandlingssteder <- df_Indhandlingssteder[order(df_Indhandlingssteder$Indhandlingssted),]
df_Indhandlingssteder$lat <- c(61.17, 67.94, 68.63, 69.22, 68.30, 65.41, 60.91, 64.18, 61.99, 60.72, 68.82, 69.24, 66.94, 72.79, 70.68, 68.70)
df_Indhandlingssteder$lon <- c(-48.48,-53.62, -52.16, -51.1, -53.45, -52.90, -46.05, -51.70, -49.67, -46.03, -51.18, -53.54, -53.68, -56.14, -52.13, -
52.86)
names(df_Indhandlingssteder)[1] <- 'Landing_Place'

```