Une analyse de la capturabilité à grande échelle et petite échelle

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et tous les participants de la campagne CHAPAUV!

Study of the various components of hake-trawler catchability

Assuming a static model, a linear relationship and separability

- $F = q * E$
- $C \sim= F * N$

$\Rightarrow$ $C / E \sim= q * N$

F: Fishing Mortality

C: Catch

E: Fishing Effort

q: Catchability

N: Abundance

- $q = p*a$

p:Fishing power (Technico-human component : technology, gear characteristics, skipper effect)

a:availability (large scale – annual and seasonal variations in abundance - and small scale – spatial and diurnal variations in abundance)

Demersal fishery of the Bay of biscay

- French fleet exploiting Hake (12 and 24 meters)
- Bay of Biscay (ICES VIIIa)
- between 1999 et 2003 - métier = Nephrops and demersal
- Logbooks data (EFLALO) and interviews (TECVESS, TECGEAR)

	Logbooks	Logbooks & Techvess	Logbooks & Techgear
Number of vessels	311	52	38
Number of Fishing Trips	1457	692	577
Number of Fishing Sequences	8114	1511	1078
Vessel length (m.)	17.2	17.31	18.24
Vessel tonnage (t.)	4756	4831	5447
Average Hake CPUE ($kg*hr^{-1}$)	0.08	0.1	0.09

Analysis

Step 1 : FISHING POWER ANALYSIS

- **Vessel effect**
- **Technical factors**
- **large scale factors** : ICES–rectangle, Month , Year

Step 2 : SMALL SCALE AVAILABILITY ANALYSIS

- Scientific survey - CHAPAUV :
  - **Standardized fishing process : 3 trawlers with similar caracteristics, using the same gear, at the same time and in the same area**
  - **Analysis of hake catch (removed from fishing power effect)**

STEP 1 : FISHING POWER

CPUE VARIABILITY between fishing sequences

CPUE > 0

CPUE standardized with abundance index

Métiers Nephrops & Demersal

Navires > 12m & < 24m

- If we assume that annual variation in abundance can be approached using an index of abundance (IA), we can removed this effect from Catch by standardising Catches using the IA : Catches (year)/ IA(year)
- IA is calculated from scientific survey (constant catchability)
- Multiplicative model fit to Standardised CPUE observation can used to estimate catchability and identify structures of variations in catchability

1. Assessing fishing strategy (scale=year) and tactics (scale=trip) effects

   Log(E(CPUEstd)) ~ Vessel+ Area + Month + Year + Metier

   - Vessel effect = skipper + crew + vessel + gear
   - Area = population + tactic
   - Month = population + strategy
   - Metier = tactic
   - Year = skill creeping

3. Assessing fleet/vessel effects (general characteristics of the vessel) – remove the vessel effect and integrate vessels'characteristics (length, age, tonnage, horse power, port…)

   Log(E(CPUE))~ Area + Month + Year + Metier + EngineRotation + Material + Age + Sounders

6. Assessing gear characteristics – remove the vessel effect and integrate gear's characteristics (bollar pull, weight of doors, length of headline, trawling speed, hawl speed …)

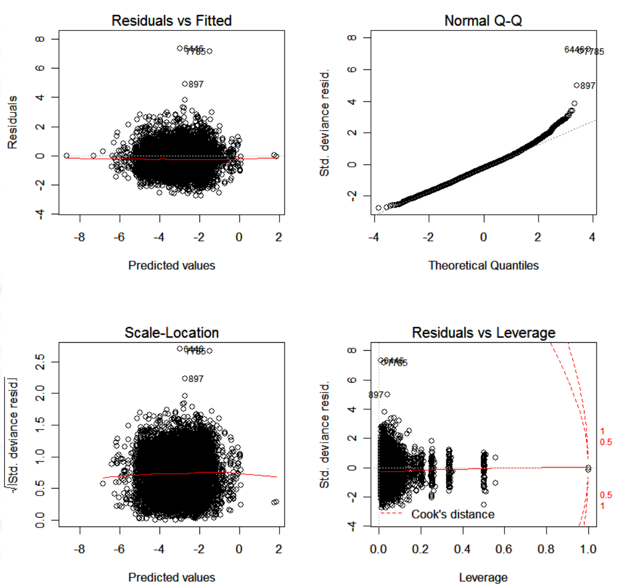
Log(E(CPUE))~ Area + Month + Year + Metier + bollar pull + weightDoors + LengthHeadline + trawlingSpeed + haulDuration

ANALYSIS

Glm (CPUE ~ Vessel+ Area + Month + Year + Metier, family = Gamma)

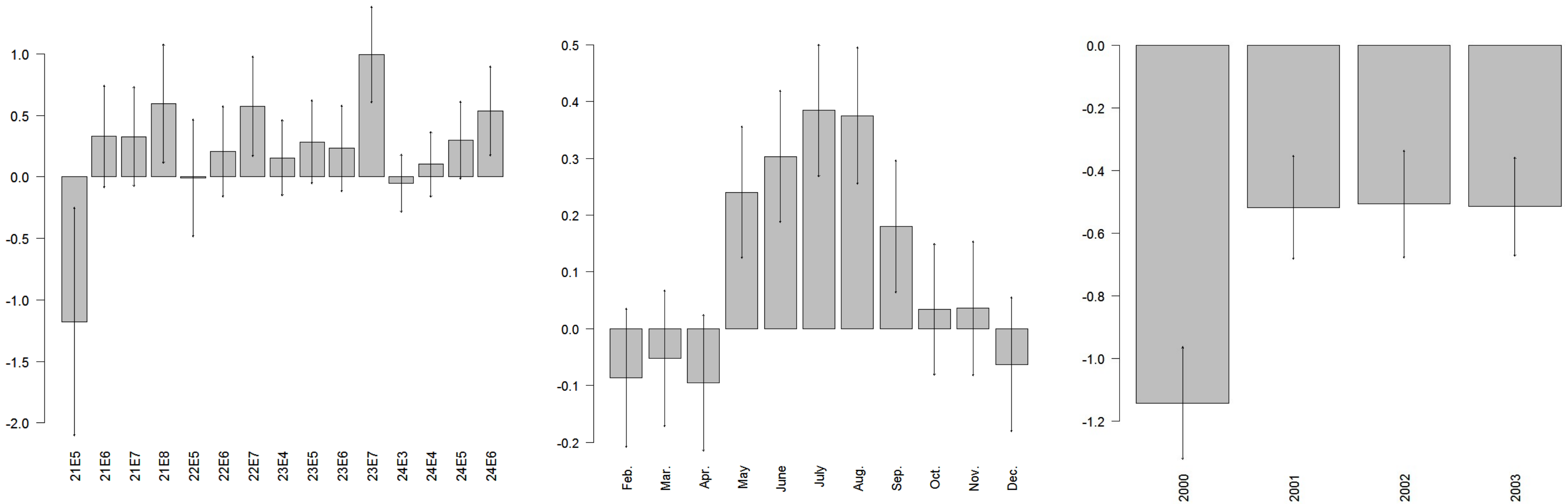
Nested models : interest in respective contributions of the various factors

	Resid. Df	Resid. Dev	Df	Pr(>F)	AIC	% Dev. Expl.
1	8113	13583.8			-25144.32	
VE_REF	7803	6468.9	310	< 2.2e-16	-31609.85	52.4
VE_REF + FO_RECT	7788	6370.8	15	1.89E-12	-31609.85	53.1
VE_REF + FO_RECT + Month	7777	6094.5	11	< 2.2e-16	-31719.4	55.1
VE_REF + FO_RECT + Month + FT_YEAR	7773	5926.2	4	< 2.2e-16	-32346.98	56.4
VE_REF + FO_RECT + Month + FT_YEAR + Metier	7772	5853.5	1	5.50E-16	-32456.72	56.9



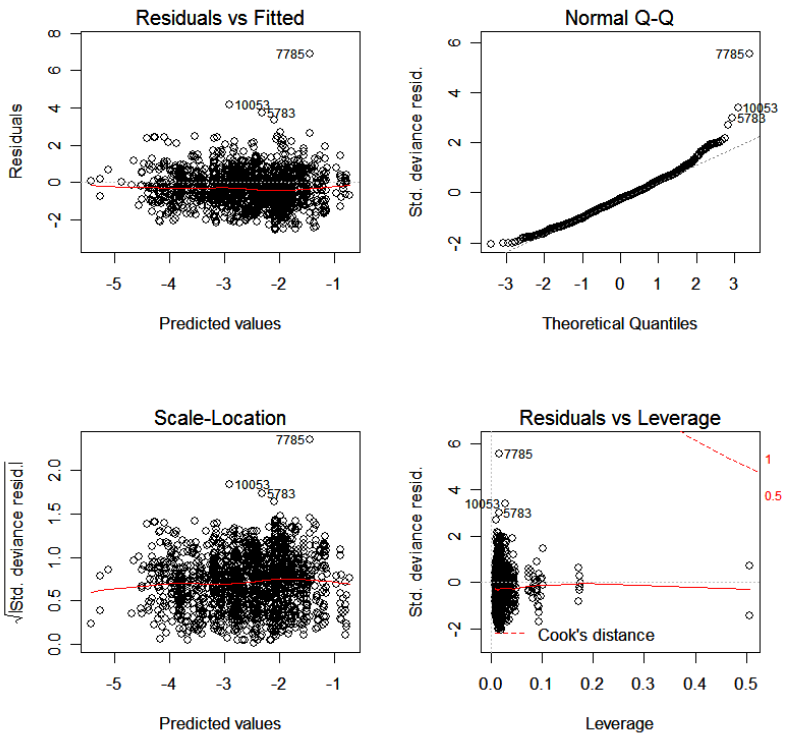
Importance of the vessel effect

~52 % of explained deviance



1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
21E5
21E6
21E7
21E8
22E5
22E6
22E7
23E4
23E5
23E6
23E7
24E3
24E4
24E5
24E6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
Feb.
Mar.
Apr.
May
June
July
Aug.
Sep.
Oct.
Nov.
Dec.
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
2000
2001
2002
2003

CPUE~Area+Month+Year+Metier+ + TECVESS



Glm= FO_RECT + Month + FT_YEAR + Metier

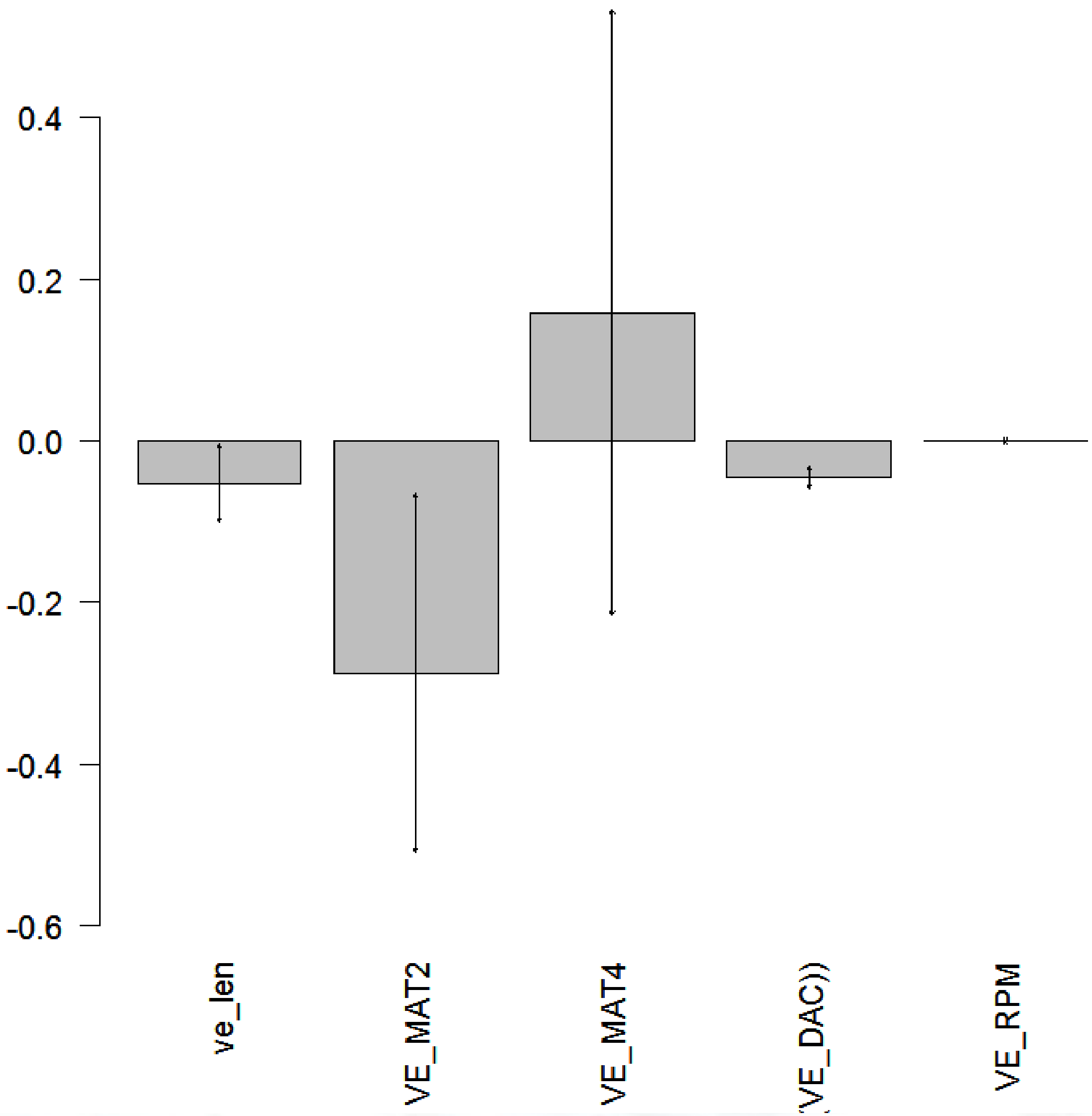
	df	AIC
glmSOU	35	-4871.983
glmBUL	34	-4867.586
glmDAC	34	-4929.297
glmGPS	34	-4868.757
glmhp	34	-4864.439
glmton	34	-4888.15
glmROL	36	-4861.363
glmMat	35	-4938.701
glmRPM	34	-4887.603
glmPRP	34	-4866.619
glmLen	34	-4910.188

Horse power and RPM not significant

Material and Age significant

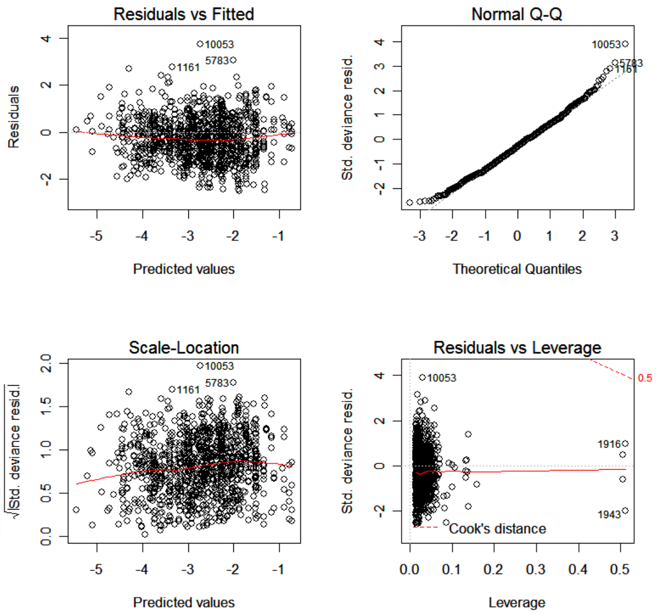
	AIC
VE_REF+FO_RECT+FT_Year+Month+Metier	-5457
FO_RECT+FT_Year+Month+Metier+VE_MAT + VE_DAC	-4908

Skipper effect larger than technical effects



0.4
0.2
0.0
-0.2
-0.4
-0.6
ve_len
VE_MAT2
VE_MAT4
VE_DAC))
VE_RPM

CPUE~Area+Month+Year+Metier+Groundrope +OtterBoardsWeight



Glm= FO_RECT + Month + FT_YEAR + Metier

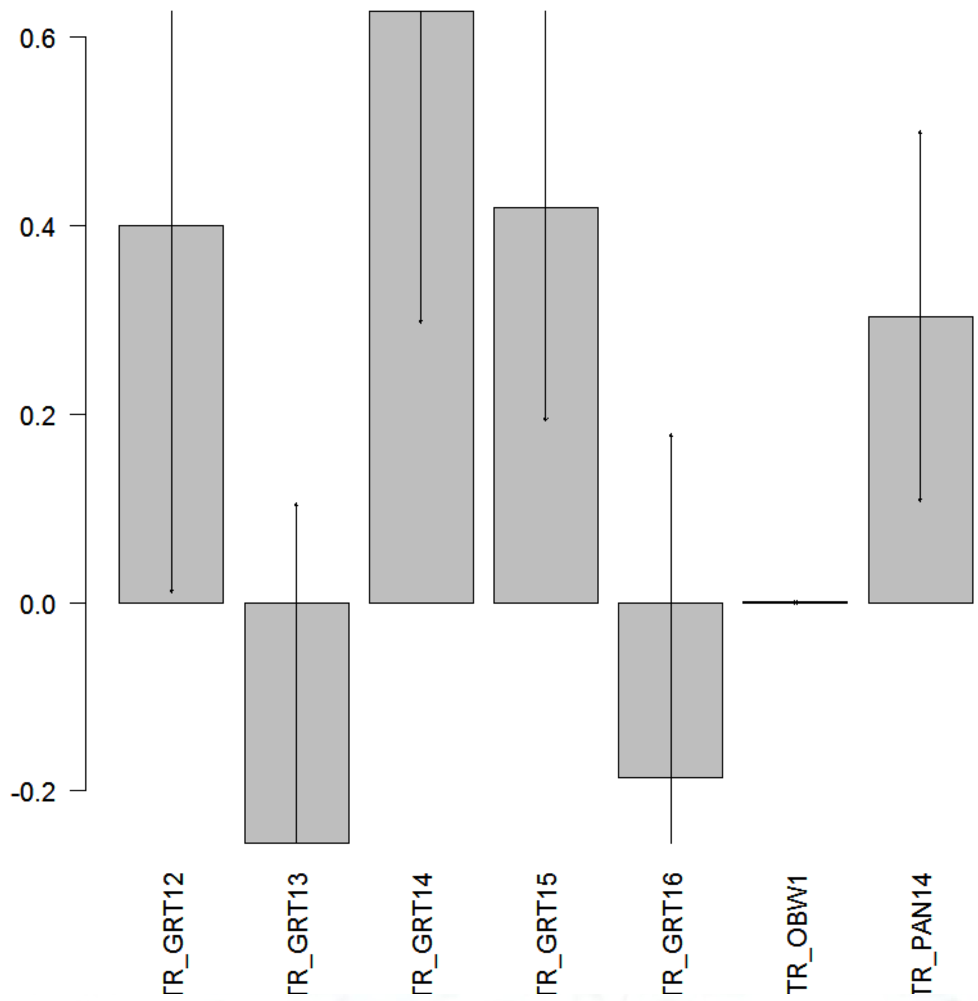
	df	AIC
Glm+OBW1	34	-3887
Glm+GRT1	38	-3901
Glm+LHD1	34	-3878
Glm+PAN1	34	-3894
Glm+WRP1	34	-3892

The length of headline is the less significant

The type of Groundrope and the number of panels are the two most significant

	AIC
VE_REF+FO_RECT+Month+Metier	-4141
FO_RECT+Month+Metier+TR_GRT1+TR_OBW1+PAN	-3826

Skipper effect larger than technical gear effects

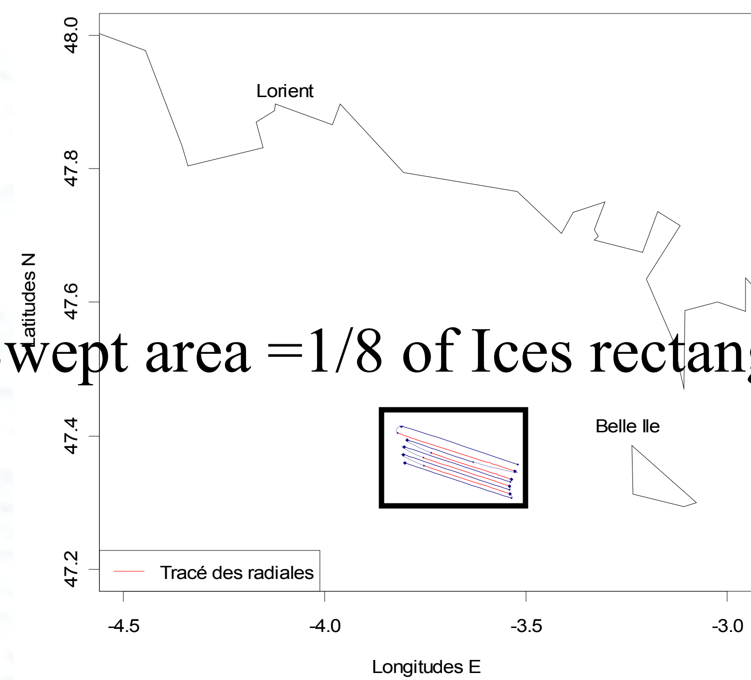

0.6
0.4
0.2
0.0
-0.2
TR_GRT12
TR_GRT13
TR_GRT14
TR_GRT15
TR_GRT16
TR_OBW1
TR_PAN14

STEP 2 : Small scale Availability

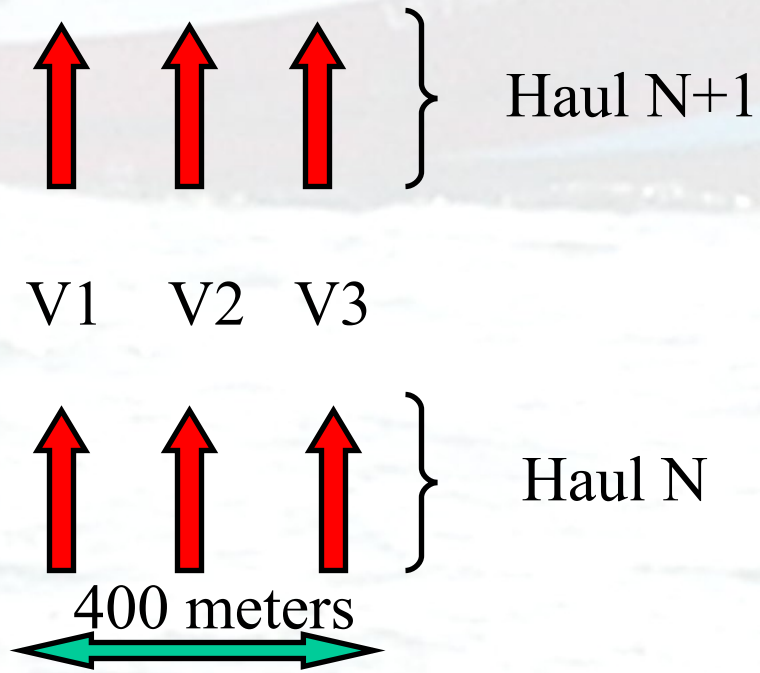
CHAPAUV survey

- 3 volunteers fishing vessels (Davidson, Hebeilan, Océanie),
- belonging (in 2006) to the studied fleet
- displaying similar caracteristics

- 114 hauls (38 for each vessel)



Swept area =1/8 of Ices rectangle



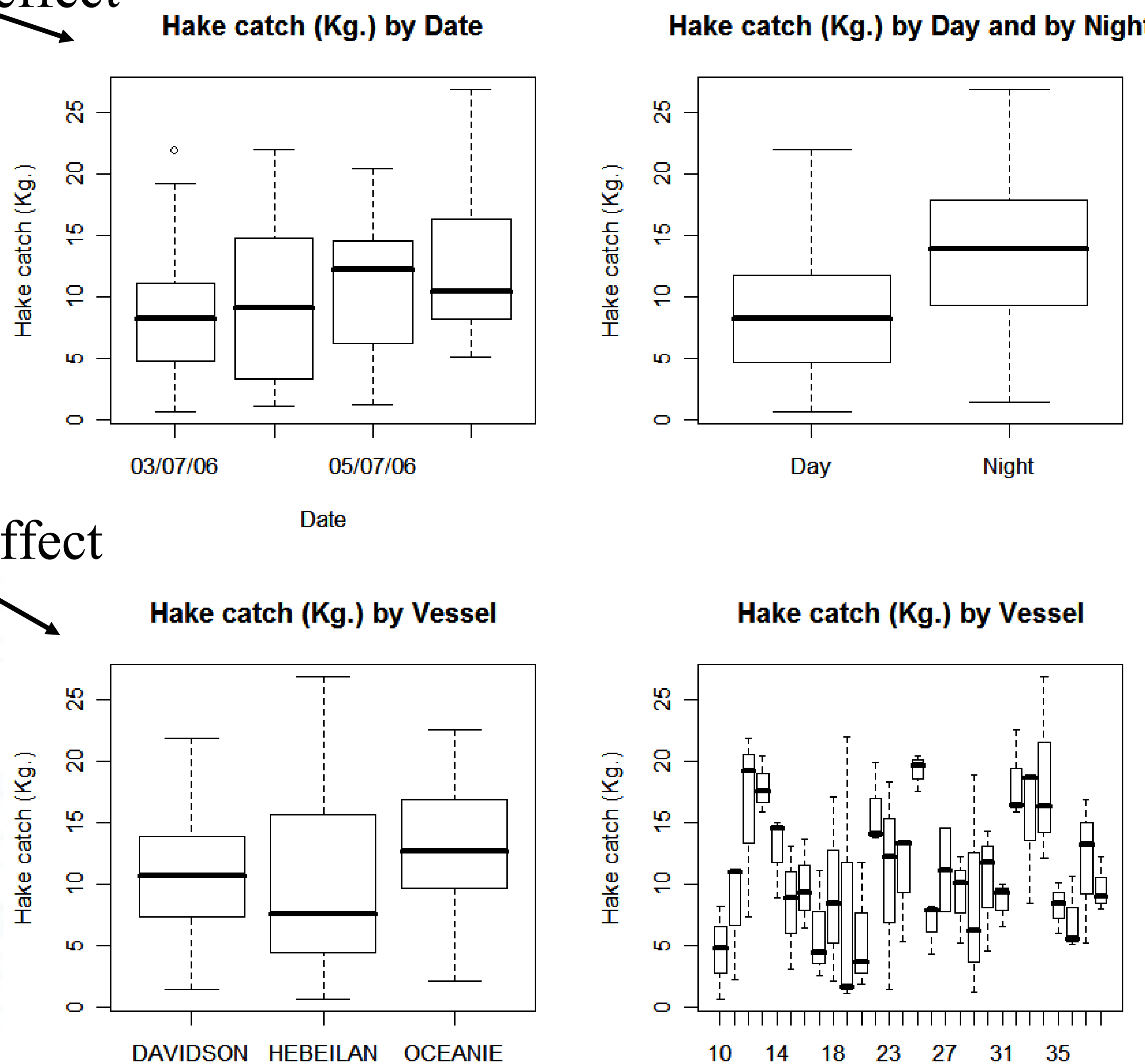
Exploratory analysis

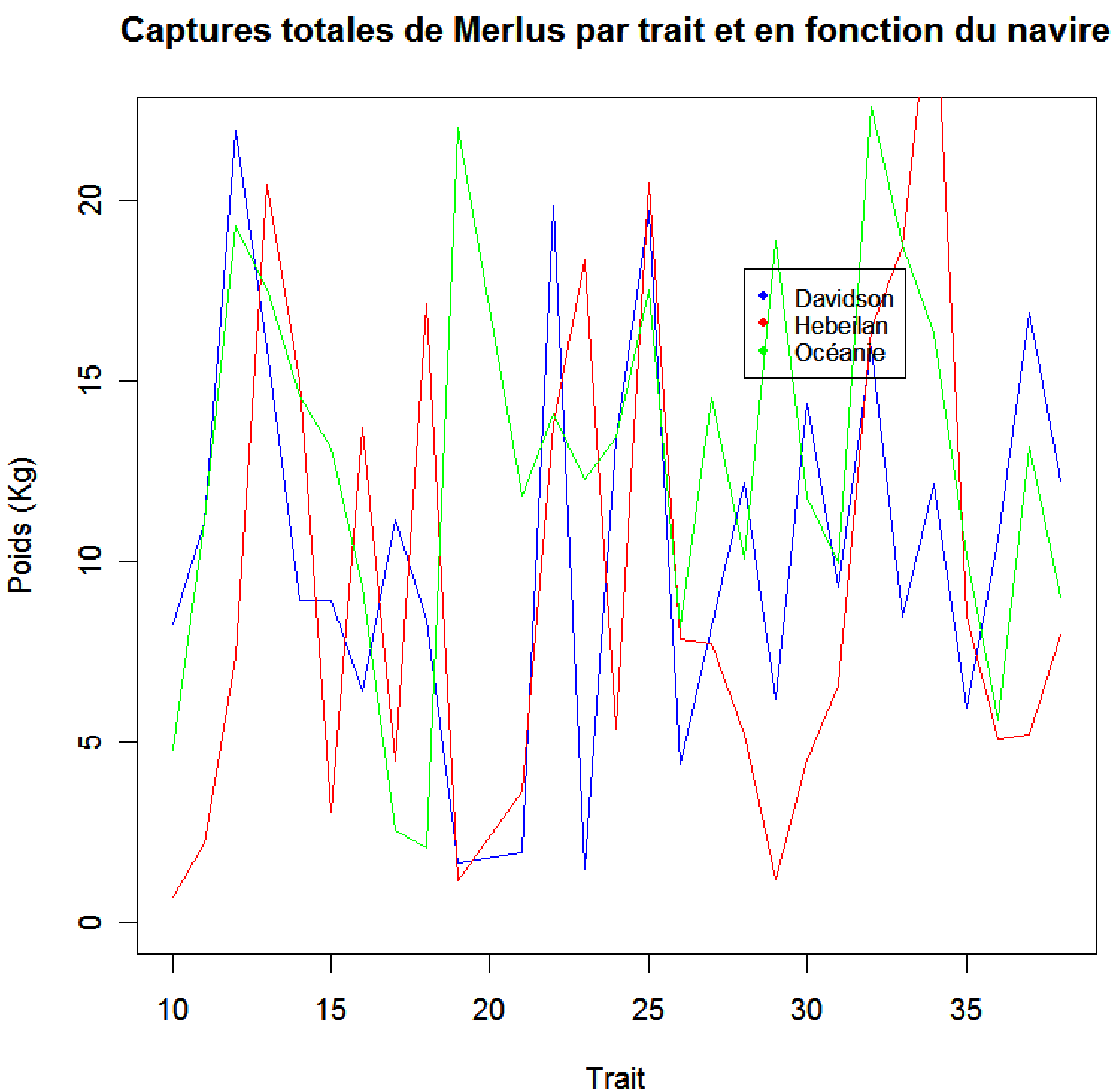
Day effect

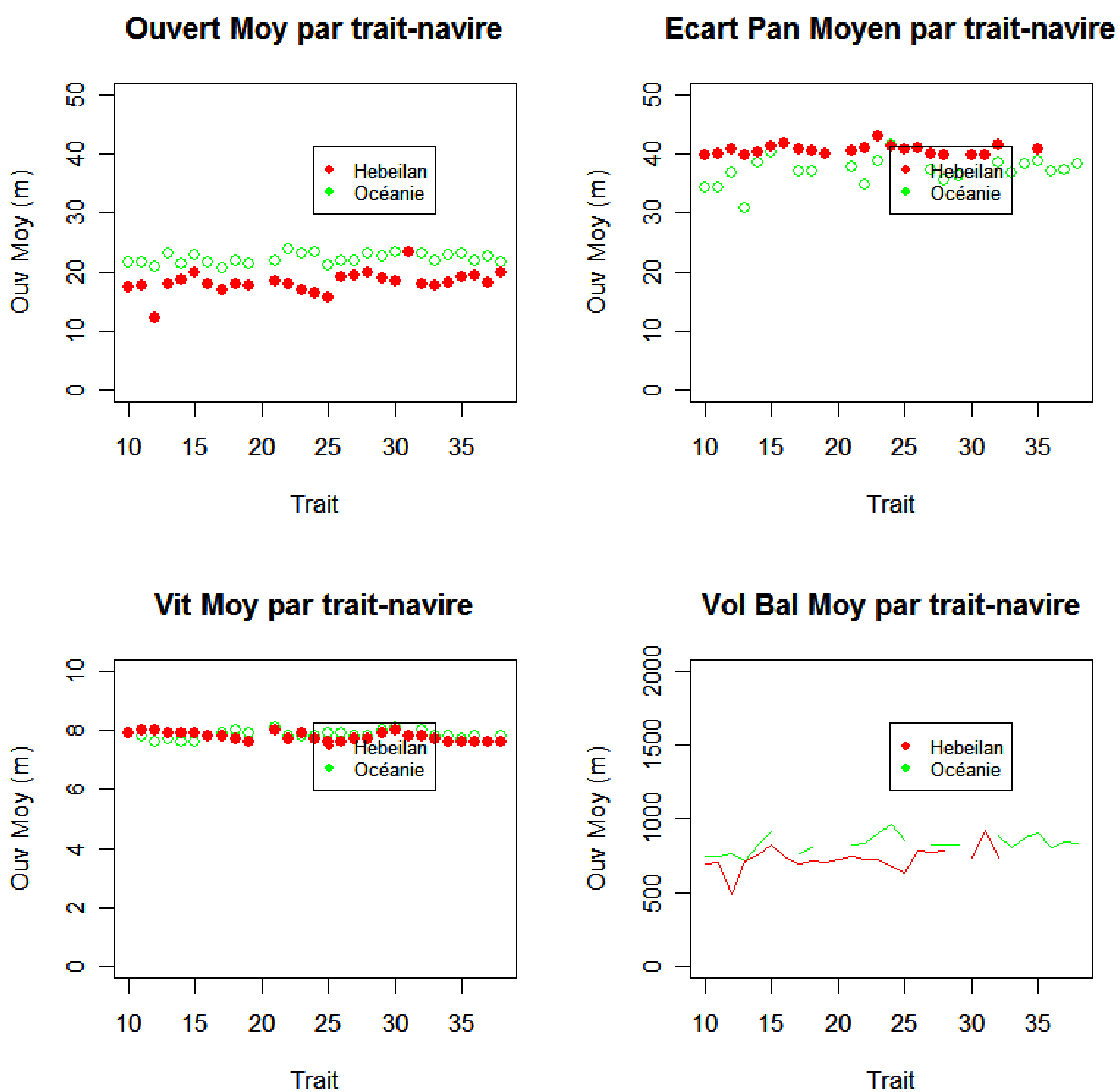
Behaviour effect

Vessel effect

Trawl effect



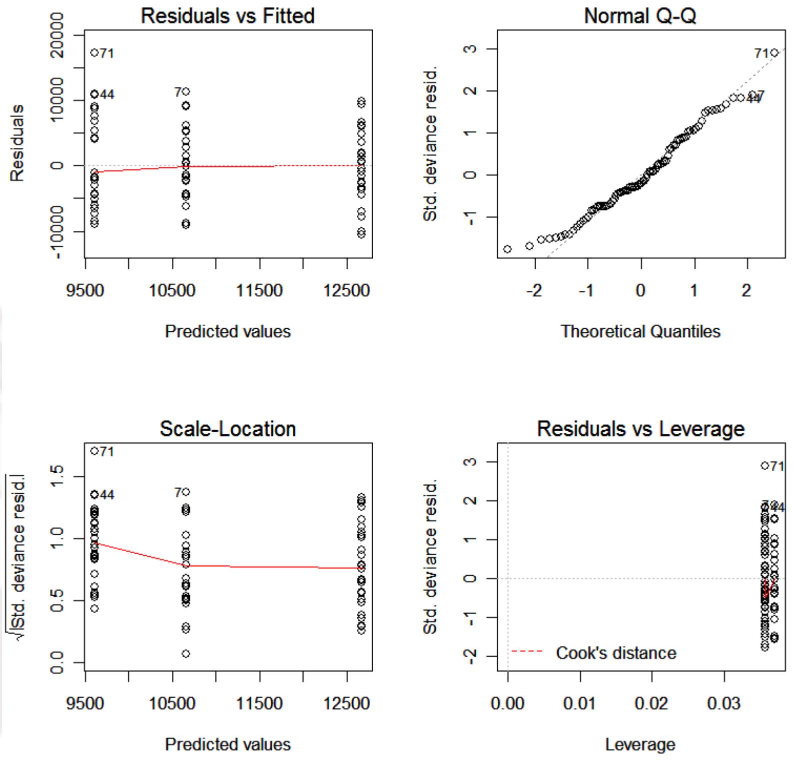

Captures totales de Merlus par trait et en fonction du navire
Davidson
Hebeilan
Océanie
Poids (Kg)
Trait
0
5
10
15
20
10
15
20
25
30
35



Volume balayé Océanie > d'Hebeilan mais différences très faibles

lm(CaptPoids ~ vessel,   contrasts = "contr.treatment«)

		Df	Deviance	Resid.Df	Resid. Dev	F	Pr(>F)
1	NULL			82	3068230519		
	vessel	2	136016005	80	2932214513	2	0.163



Effet bateau non significatif

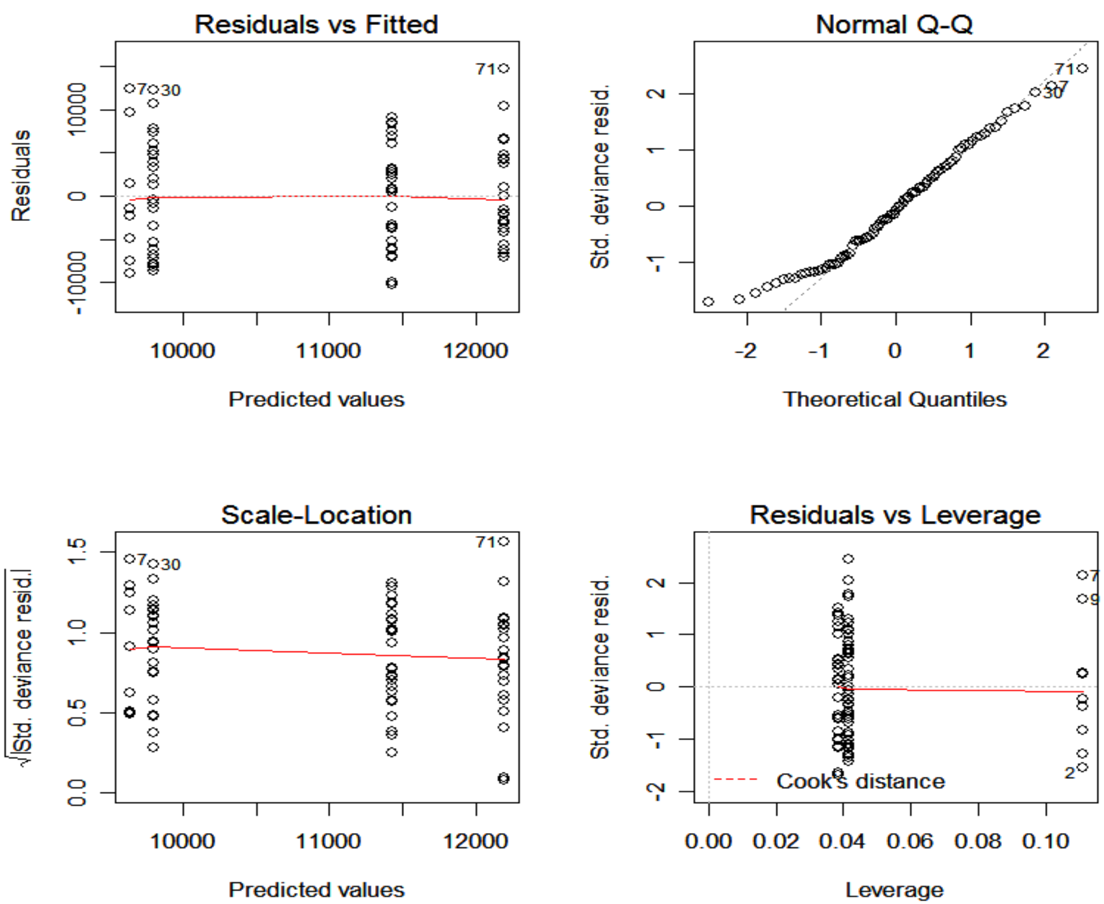
⇒ bateaux ont une même puissance de Pêche – standardisation réussie

⇒Hypothèse : si l’accéssibilité au merlu est la même pour les navires, alors la variable Capture/bateau est la réalisation d’une variable aléatoire capture

⇒ On peut estimer la variabilité des captures à petite échelle

Day<-glm(formula = totW ~ day, data = CapNbr, contrasts = "contr.treatment")

	Df	Deviance	Resid. Df	Resid. Dev	F	Pr(>F)
NULL			82	3068230519		
day	3	90355870	79	2977874649	0.799	0.4981

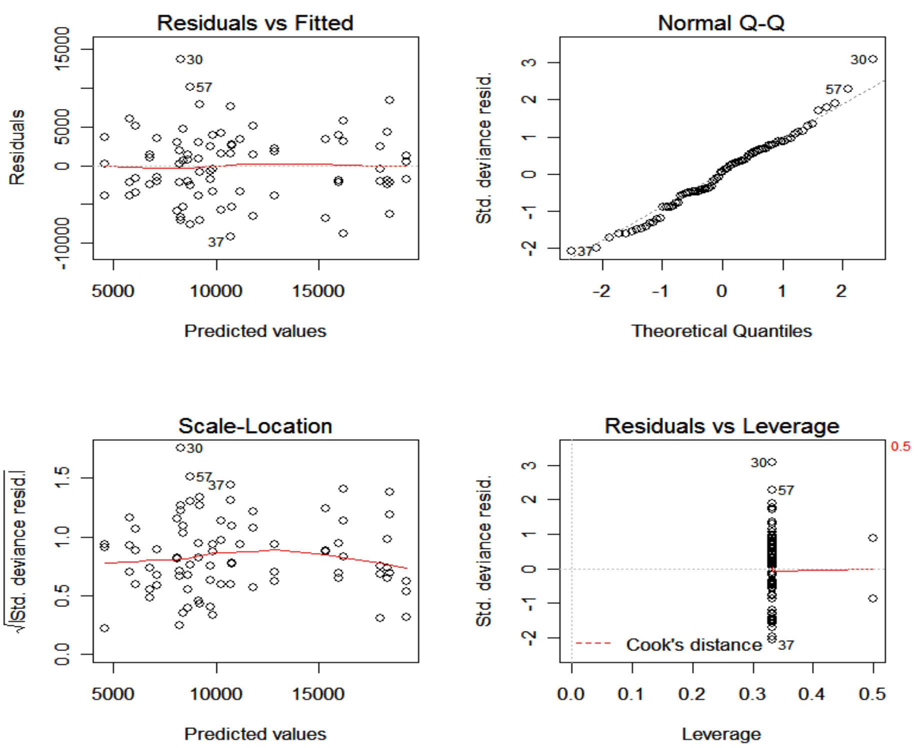


Effet date non significatif : pas de différence dans les captures entre les jours

Haul<-glm(formula = totW ~ haul , data = CapNbr, contrasts = "contr.treatment")

	Df	Deviance	Resid. Df	Resid. Dev	F	Pr(>F)	
NULL			82	3068230519			
haul	27	1433170215	55	1635060304	1.7855	0.03451	*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

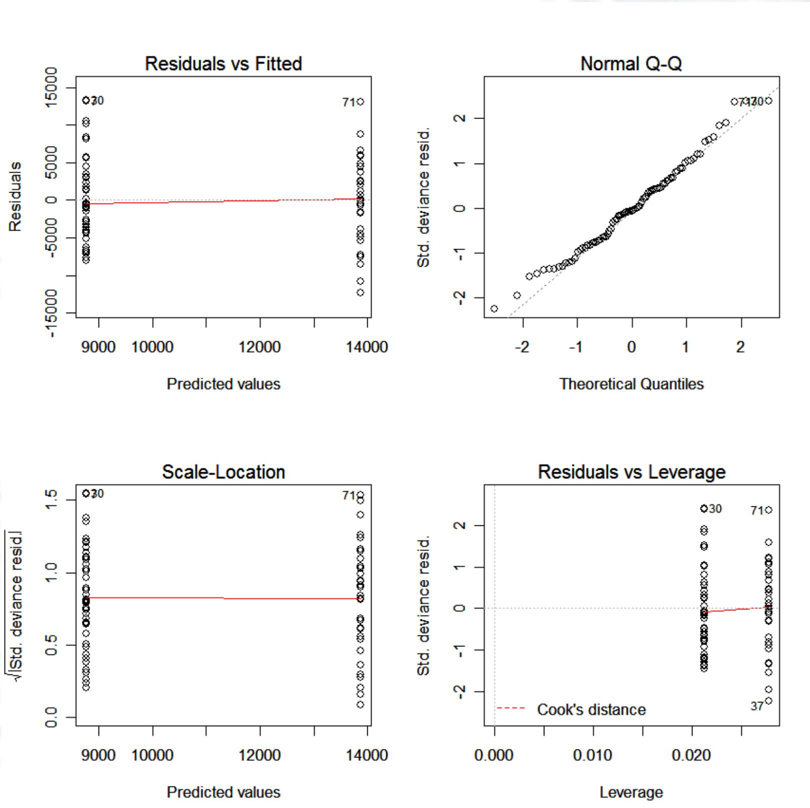


Effet trait significatif mais attention au nb de degres de liberte (voir AIC): Peut-on dire que les variations moyennes des captures à petite Échelle sont significatives?

– évaluer la variance avec un modèle mixte (effet trait aléatoire)

DN<-glm(formula = totW ~ DN, data = CapNbr, contrasts = "contr.treatment")

	Df	Deviance	Resid. Df	Resid. Dev	P(>|Chi|)
NULL			82	3068230519	
DN	1	529412705	81	2538817814	3.959e-05



Effet jour/nuit **significatif**

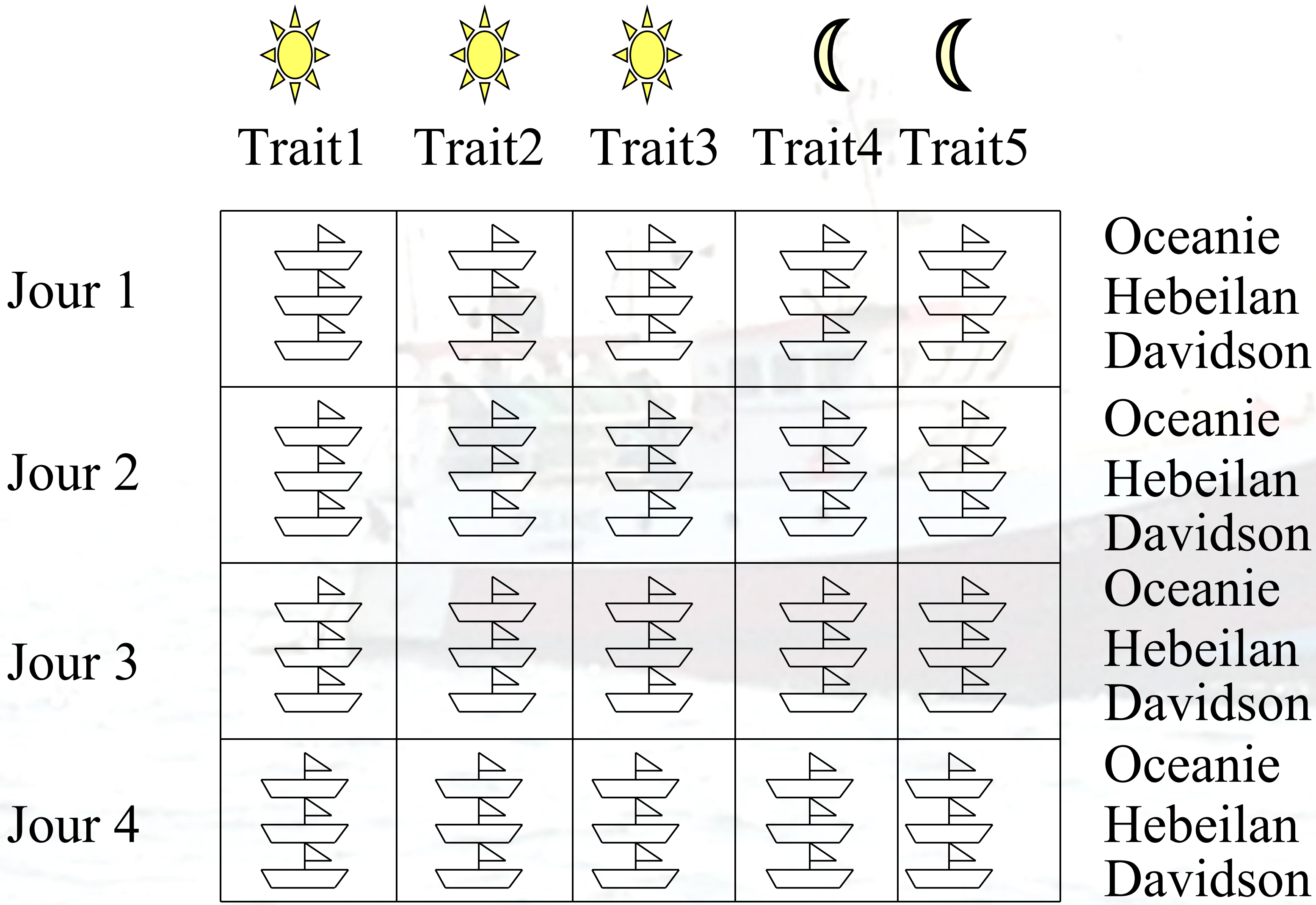
Pourtant avec l'AIC :

AIC(Vessel2,DN,Day,Haul)

	df	AIC
Vessel2	4	1686.099
DN	3	1672.142
Day	5	1689.382
Haul	29	1687.621

Au regard de l'AIC, l'effet Jour/nuit est le modele le + explicatif de la Variabilité de captures

Estimation des variabilités à petites échelles



- on ne peut pas tester trait avec jour car trait inclu dans jour
- intra/inter trait, intra/inter jour, intra/inter bateau

Variabilité de captures entre les navires?

$$CaptPoids \sim DN + V \sim N(O, \sigma_{vessel}) + \varepsilon \sim N(0, \sigma)$$

Fixed effects: totW ~ DN

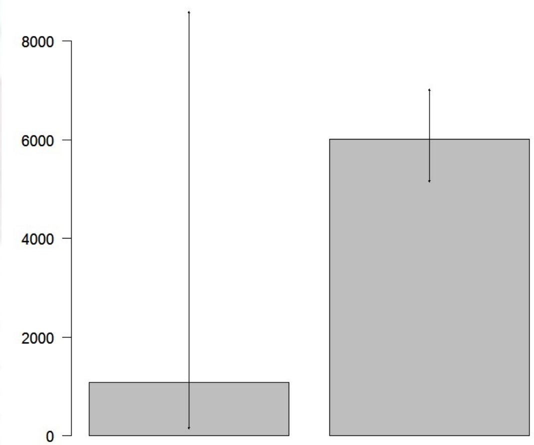
	lower	**est.**	upper
(Intercept)	6675.163	**8770.661**	10866.158
DN2	2669.988	**5100.493**	7530.999

Number of Observations: 83

Number of Groups: 3

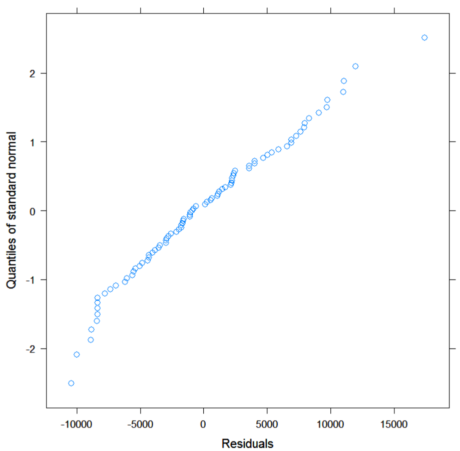
Random effect ~1/vessel

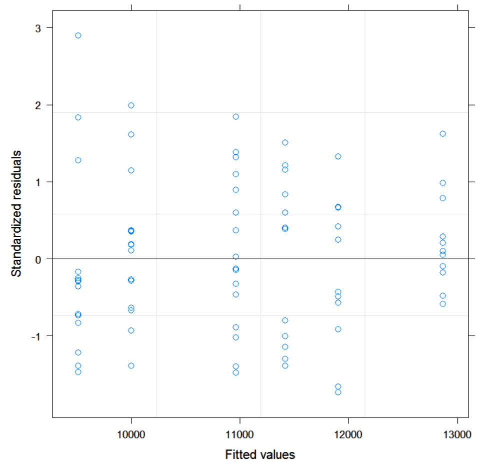
	lower	**est.**	upper
σvessel	203.7941	**1176.665**	6793.823
σ	4717.042	**5512.889**	6443.009



σvessel σ

Entre bateaux *Intra bateau*





Variabilité de captures entre les jours?

CaptPoids~DN+J~N(O,σ_{jour})+ ε~ N(0, σ)

Fixed effects: totW ~ DN

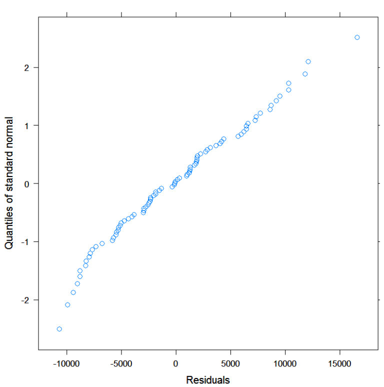
	lower	est.	upper
(Intercept)	7139.526	**8775.260**	10410.995
DN2	2629.711	**5098.684**	7567.658

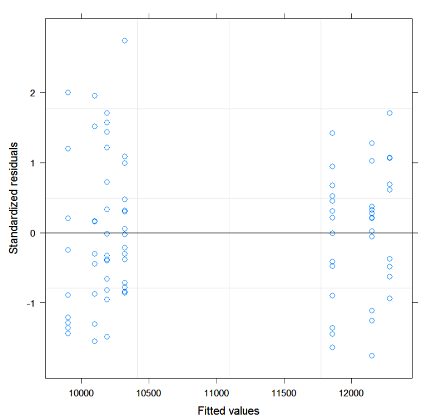
Random effects: ~1 | day

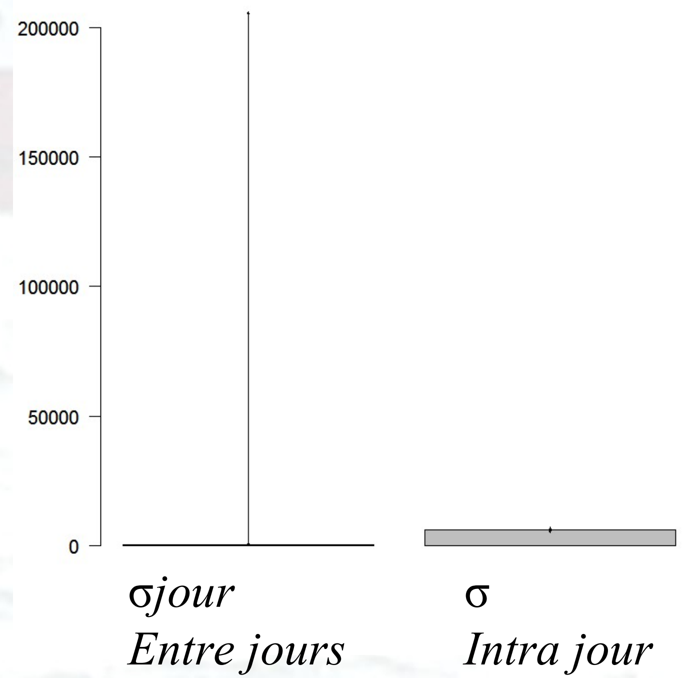
	lower	est.	upper
σjour	2.350459e-14	**184.6651**	1.450832e+18
σ	4785.247	**5596.299**	6544.817

Number of Observations: 83

Number of Groups: 4







Variabilité de captures entre les traits?

$CaptPoids \sim DN + T \sim N(O, \sigma_{trait}) + \varepsilon \sim N(0, \sigma)$

Fixed effects: totW ~ DN

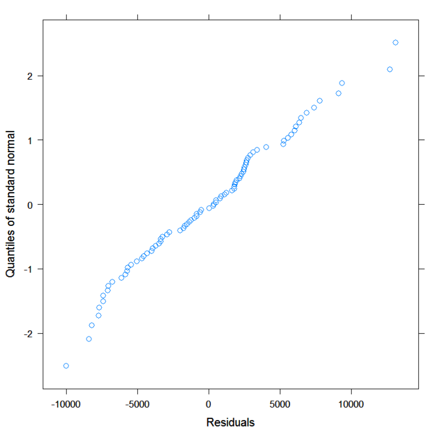
(Intercept)	7052.412	8780.551	10508.690
DN2	2397.419	5090.603	7783.786

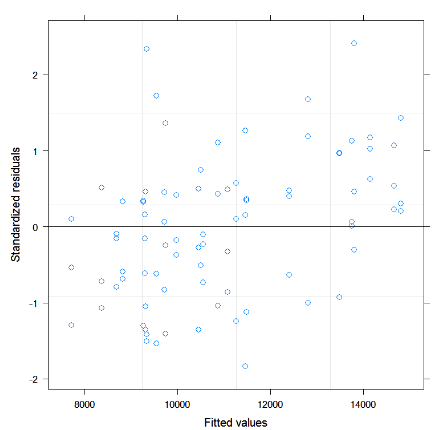
Number of Observations: 83

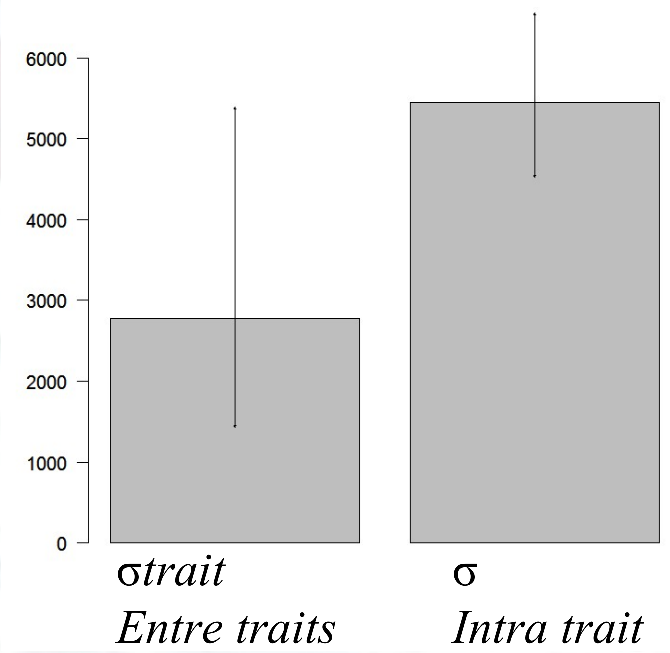
Number of Groups: 28

Random effects: ~1 | haul

	lower	**est.**	upper
σtrait	173.9076	**1341.669**	10350.76
σ	4518.144	**5443.325**	6557.956





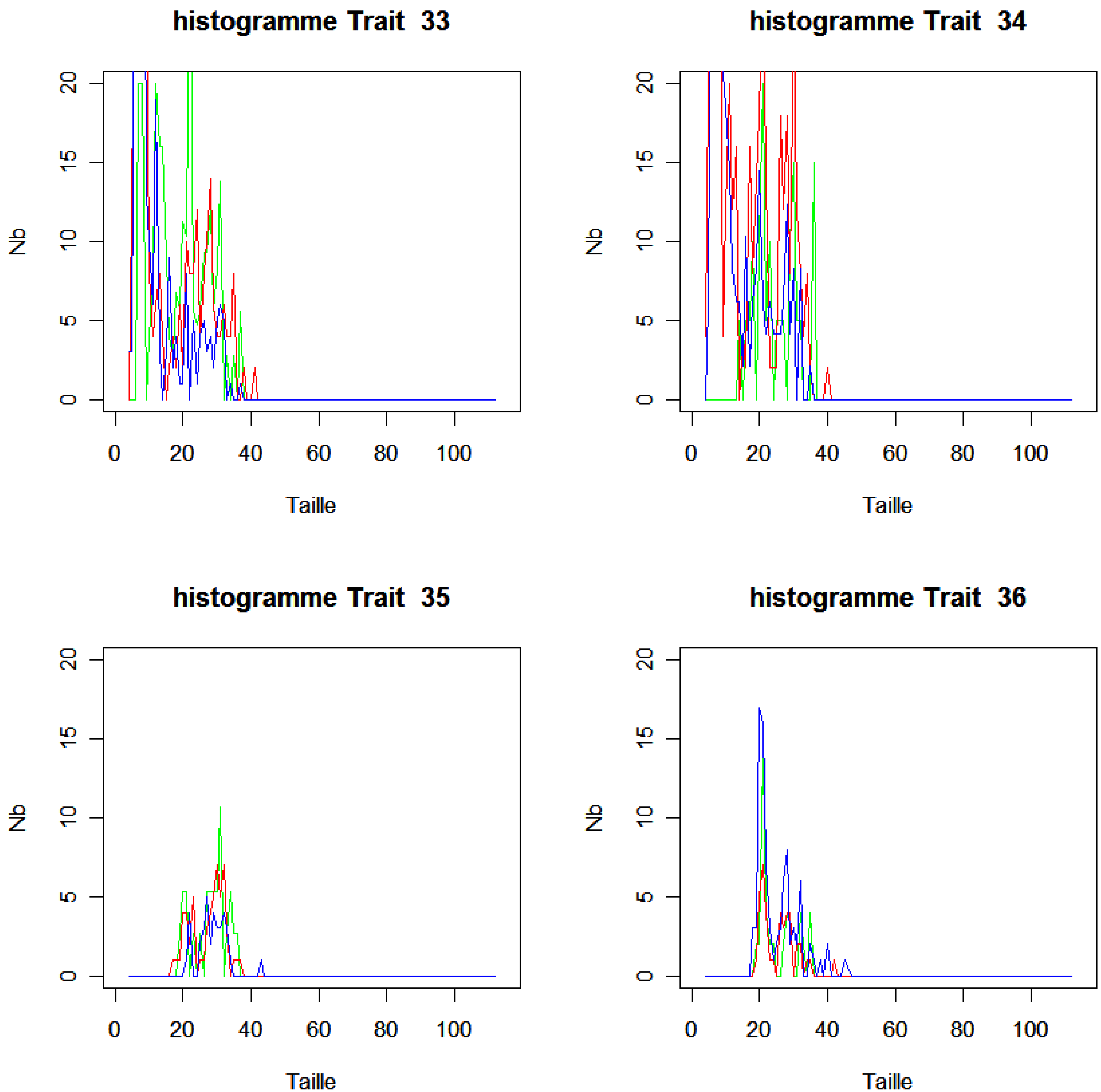


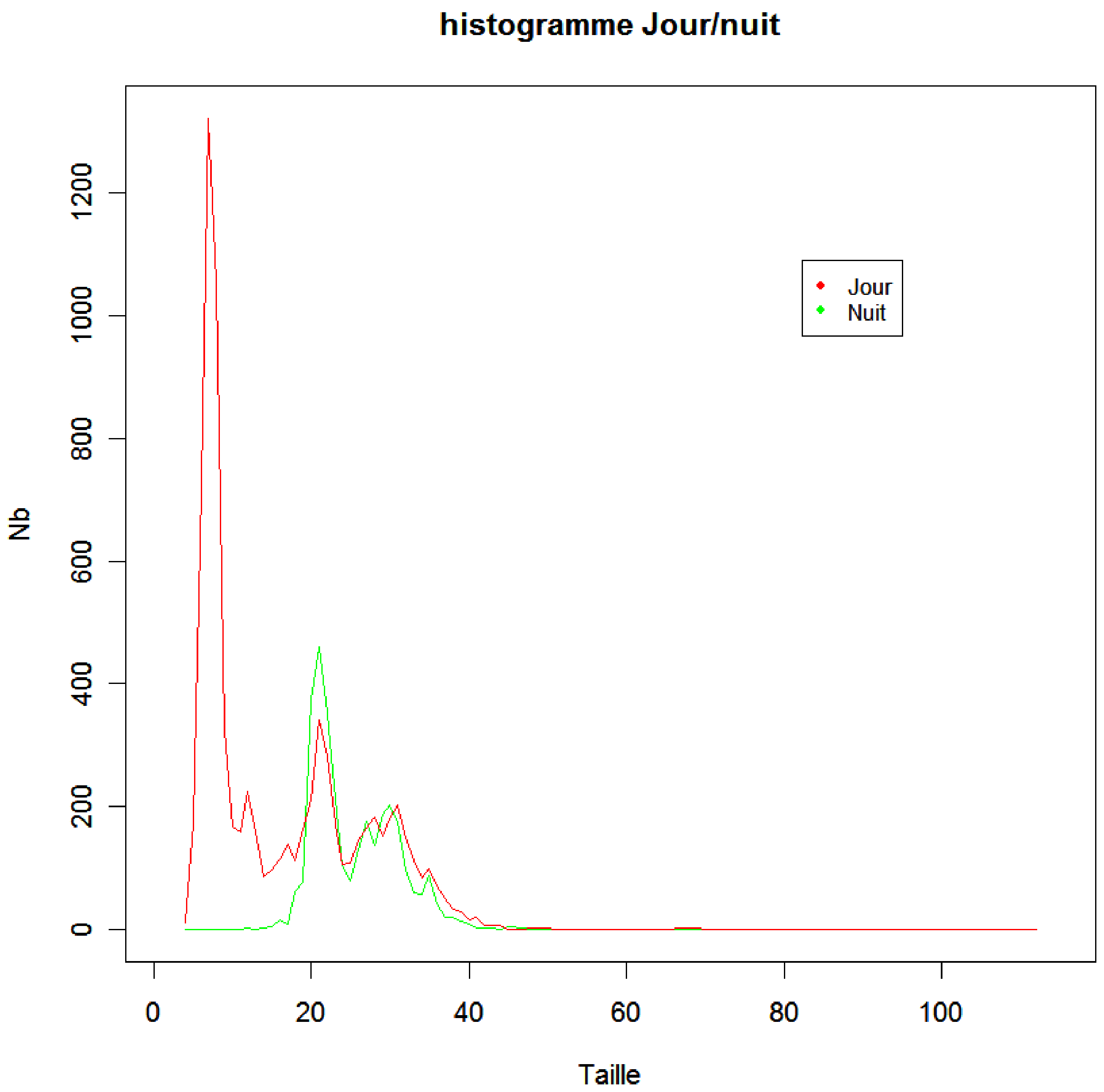
```
>   AIC(m1,m2,m3,DN)
            df    AIC
~vessel  4   1642.537
~jour    4   1643.403
~trait   4   1643.152
DN       3   1672.142
```

Difference de structure en taille des captures merlu Jour/nuit
limite de frequence de taille jour/nuit:18cm (de jour uniquement >= 19cm)

NUIT

JOUR




histogramme Jour/nuit
Jour
Nuit
Nb
0
200
400
600
800
1000
1200
0
20
40
60
80
100
Taille

Analyse des grands en Nombre

	df	AIC	
DNGrand	3	880.4172	significatif
HaulGrand	29	876.3492	significatif
DayGrand	5	884.1186	non significatif
Vessel2Grand	4	882.4541	non significatif

Analyse des petits en Nombre

	df	AIC	
DNPetit	3	1022.793	significatif
HaulPetit	29	1004.482	significatif
DayPetit	5	1048.242	non significatif
Vessel2Petit	4	1046.232	non significatif

Conclusions/perspectives 1

- Puissance de pêche : différence entre équipages plus forte qu'entre caractéristiques techniques navires et engins
  - Anciens et petits bateaux en bois plus efficaces au merlu
  - Variables attendues non significatives : nb tours/minute moteur
  - Manque Traction au point fixe
  - Engin 4 panneaux avec 2 types de racleurs (4 et 5??)
  - Longueur de corde de dos non significative
- Utiliser ces coefficients pour corriger effort de pêche
- Attention à ne pas négliger les différences de savoir faire entre équipages
- Données:
  - Améliorer la qualité des données techniques
  - Descendre à l'échelle du trait : données obsmer
  - Utiliser temps de pêche : données VMS

Conclusions/perspectives 2

- Plan d'expériences standardisé : évaluation de la variabilité spatio-temporelle de la ressource à petite échelle
- Effet Jour nuit :
  - Captures plus importantes de nuit
  - Décollement du fond des juvéniles la nuit
  - Pas d'effet significatif de variation de captures à petites échelles (traits, jour) : grosses variabilités à petites échelles spatio-temporelles – difficiles à quantifier –
- Comparaison avec les observations accoustiques – estimation de la capturabilite