Using ringing data to inform a geolocator study: when and which birds to equip?*

true true

Abstract

This document provides an introduction to R Markdown, argues for its…

Introduction

The Spotted Ground Thrush (Geokichla guttata) was still relatively common on the coastal forest of Kenya in the 70s and 80s, but since, they have become much scarser with an estimated >80% decline between 1980-2000 ((Ndang'ang'a et al. 2008)). The reason for this decline hasn't been fully elluciated as their wintering ground has been protected for the entire period, while their breeding grounds had remains largely unkown.

The tragedy of the Spotted Ground Thrush is likely not the only one intra-african migrant, although little is known about African bird population trend. Indeed, afro-tropical migration is complex and diverse (Benson 1982), and are the result of a fine-tuning with the climate and habiat constrains (Hockey 2000). The combined effect of the rapid habitat destruction and climate change impacting the african continent can be expected to affect migrant bird more than resident as their migration route, timing relies on the predicatbility of food which itselft depends on habitat and weather (Vickery et al. 2014). Effective protection of intra-african migrant species, as in the exemple of SGT, has to start with a better understanding their migration: its route, stoppover site, timing, trigger (rain? temperautre, etc), the variability of route, the influence of age and sex…

Uncovering some of these question has been made easier in recent year thanks to the deployement of geolocator (ref). Their low cost, low weight and additional measurement (pressure, temperature etc..) (Meier et al. 2018) have allowed to study various aspect of the migration strategy (McKinnon and Love 2018).

Arguably, a major limitation with this technology is the necessity to recapture the bird equip in the following year(s) to retrieve the data [ref to the 20% threashold]. Several controle factor affect the recapture rate such as - location of equipement (breeding site, wintering, stopover), - the timing (in link with location or within season early in the year, or late), - sex, - age, - breeeder/non-breeder, - size or weight. In general, - male : greate site fidelity for shorebird ((Weiser et al. 2015)) - previously tagged individual improve return rate (Weiser et al. 2015) - breeding succes improve return rate (Weiser et al. 2015) - early breeder have higher return rate (Weiser et al. 2015)

Because of juvenile mortality and fidelity of breeding/wintering site, most study focus on adult bird.

These have to be consider with care in link to the study objectiv as to not biais result.

Blackburn2017 connectivity study equpping paleartic migrant at their wintering site.

All study have focuse on the effect of geolocator on bird, here we focus on the pre-deployement analysis using existing ringing database with the aim to optimize the equipement ringing session effort Most study have focus on long-distant migrant with relatively well-known migration timing and route. Here intra-african which have more complex and variable movement. Most study on breeding site, here on wintering site.

*Replication files are available on the author's Github account…

In this study, we aims at showing an exemple of how a ringing database can help to plan the equipment of geolocator. The utlimate objectif is optimize the equipement planification as to maximize the recovery rate of the geolocator. The parameters to controle this optimization is how many geolactor can be deploy, when to deploy them, on which bird (age and sex). This has obviously be done in link with the research question and hypothesis of the study.

We are applying this methodology on RCRC two intra-african migrant arriving in mid-May in the coast of kenya and leaving in the last months of the years.

Materials and methods

Ringing Site and Database

Mwamba field study center is located on the coast of Kenya (3°22'36.3"S 39°59'16.9"E) on a strips of residential costal scrub/forest that have benefit from little change over the last 50 years (Alemayehu2016). More generally, it is located on the coastal flyway, and locally a green belt along the coast (creek blocking/forest disapeared elswhere). For instance, in 2018, while the rest of the area was expericenced a dry year, the site remained the last one wet which resulted in an higher-than-usual capture of paleartic migrant.

The ringing station started in 1998 but it was mainly in 2002. Still ongoiong but data up to mid-2019. - 332 ringing session, 98 species, 3419 entries.

The ringing sessions are relatively well-spread throughout the year, although with a higher intensity in Spring. Over the years, there is a more heterogenous distribution: very good coverage between 2003 and 2007, variable from 2008 to 2012.

Ringing effort: - weather: assumed to averaged out over the year. - Total nets length is 149.9358974m in average () number and length of nets. 254/332 have no net lengths recorded. - duration of ringing: 207/332 4.1802667 (std=1.2020916)

How many capture possible

In the plannification stage, an important question of design is the number of the targeted specie that is possible to equip during a ringing season. This question has to be asked in link with the ringing effort planned (number of session, duration of session, ringing nets, duration of surveys etc).

To address this question, we modeled the number of RCRC captured per session using a generalized additive model (GAM) model assuming the count to follow a Poisson distribution. Because each RCRC can only be equipped once a year, only bird never capture before in the year are used for the count. The predictors variables included in the model are (1) year, (2) day-of-year (or Julian day), (3) duration (in hours) of the sessions and (4) total length of nets (in meters). Because the duration and length of nets was missing in many cases, we substitute the missing component by a simple random effects model. The model was implemented with the bam functions of the mgcv package.

For our ringing season of 2020, we planned to ring every week for 4 hours using 156m of nets. Using the model and these information, we can estimate (with uncertainty) the number of RCRC that will be captured. We assume that the session are independent conditional to the model (which is not entirely true), and estimate the total number by simply summing the estimated number of capture each week. The standard error estimate is computed as the square root of the sum of the square standard error. A simple sensitivity analysis is performed by changing the ringing session and analysing the number of RCRC capture at the end of the year.

When to equip to improve the recapture rate

The data collected by geolocator can only be retrived if the bird equiped it retraped. Consequently, to optimize the study, it is essential to equip the bird that are more likely to be retrap. Ringing database can inform this decision by providing the annual variation of bird recapture which allows the ringer to know weather to realse the bird without a backpack or realease it with one.

We model the probability that a captured bird is recaptured in the following seasons as a function of the day of the year at which it it capture. This means that we considered that an individual is retrap if the bird has been recapture at least once in any of the following year and this independantly to if it was already catpure in the the past.

Adult or Juvenile?

Finally we can performed the same analysis of total number of capture and retrap rate for each class/population of bird. For the RCRC, only adult vs juvenil class can be identify in the hand (as opposed to male female, breeder/non-breeder etc…)

Result

How many capture possible

The model statistic are presented in Appendix with figure.

The model fits strong decreasing trend in number at the annual level with a rate of almost 1 bird less every 2-5 years.

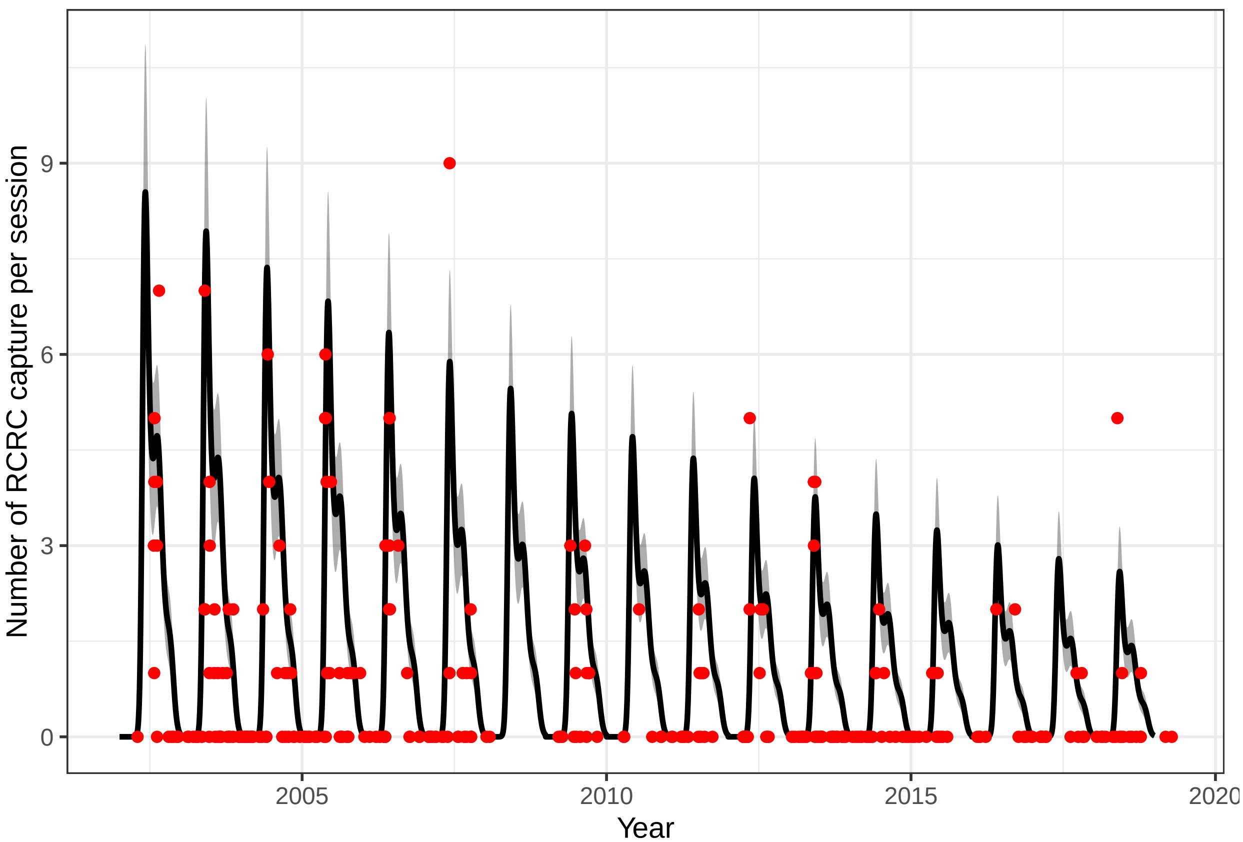
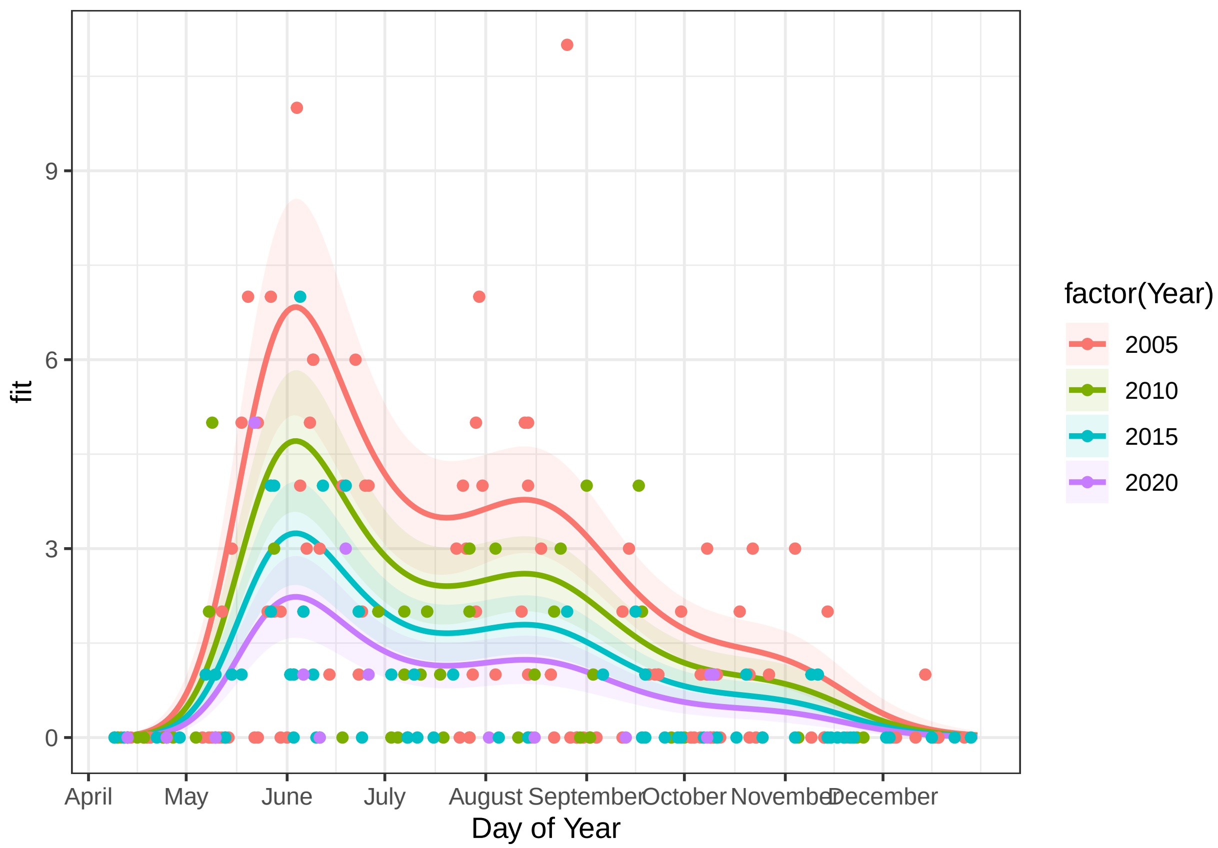
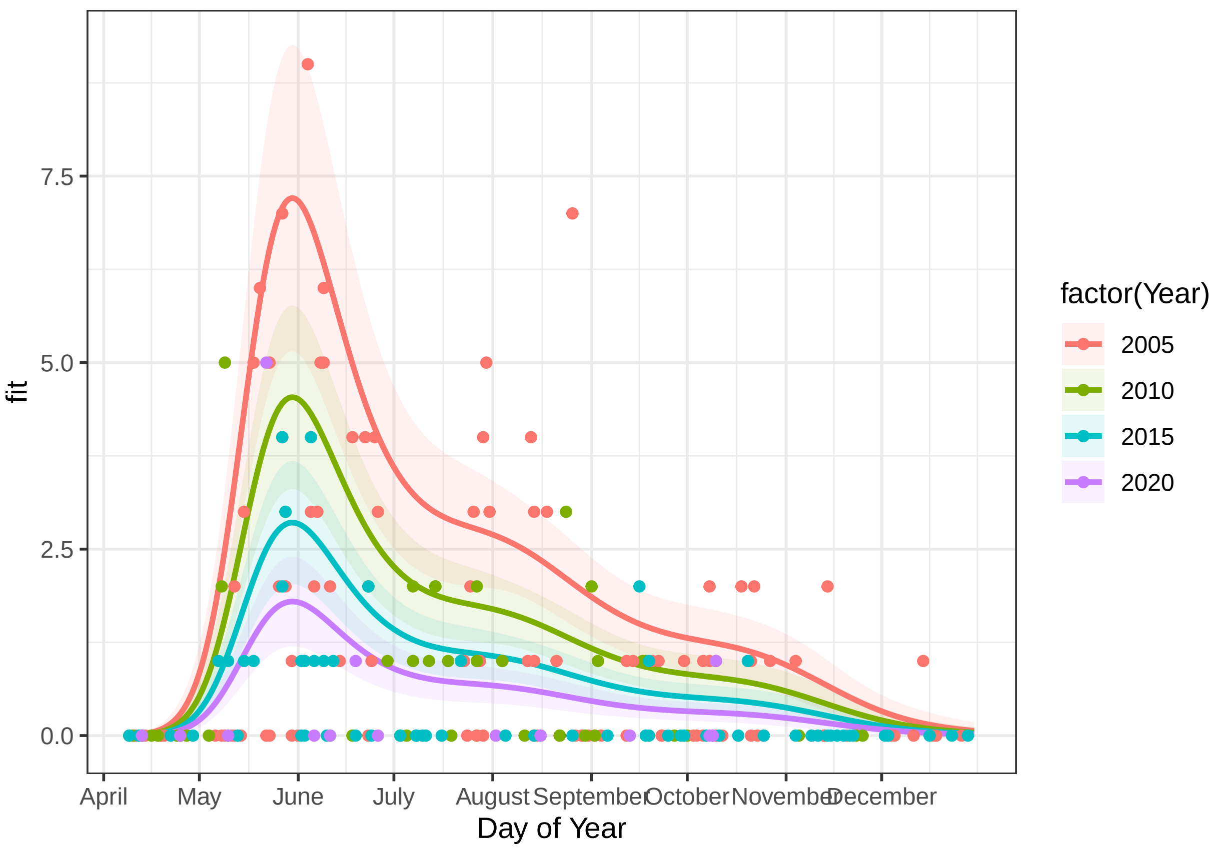


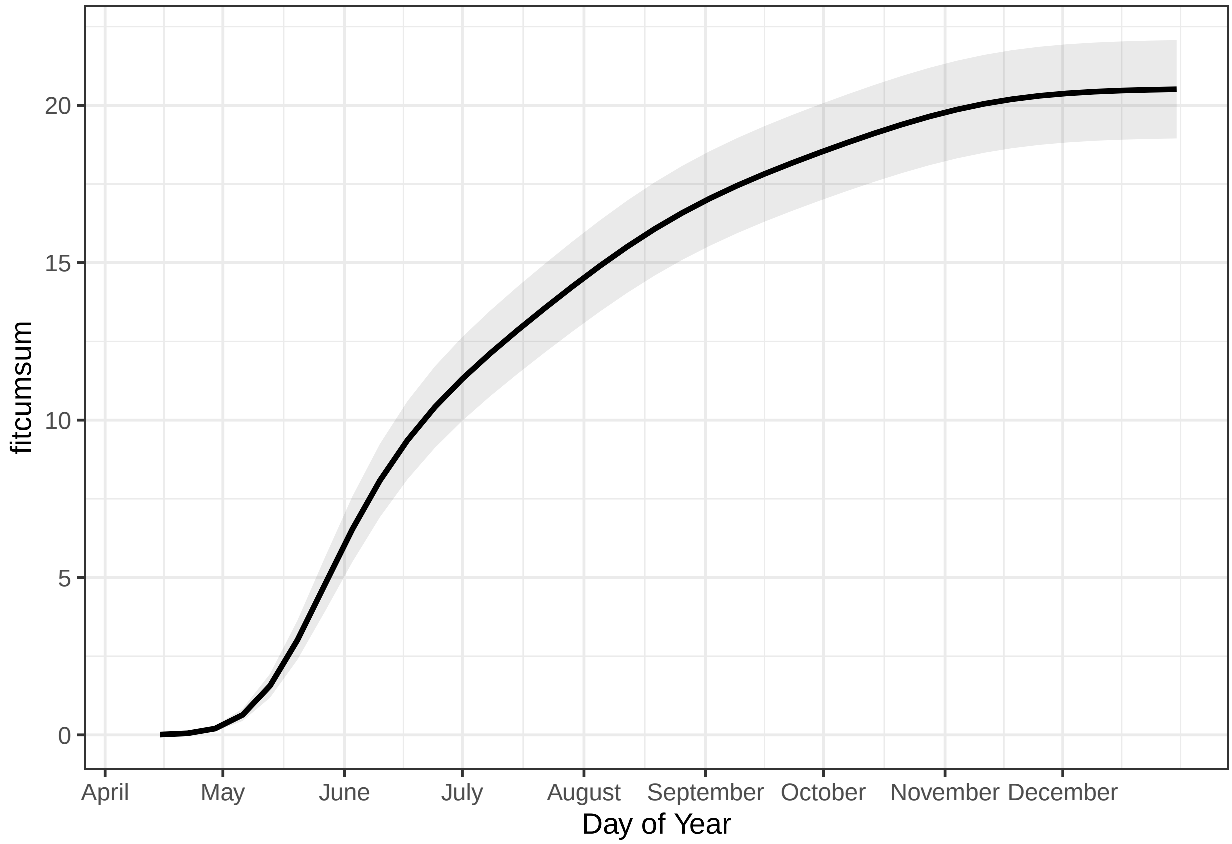
Figure 1: Evolution of the number of Red-capped Robin-chat capture for each session over the 20 years fo the rinting database.Red dots are the actual data and the black line/shaded area are the model prediction with uncertainty range.



fit
9
6
3
0
April
May
June
July
August
September
October
November
December
Day of Year
factor(Year)
2005
2010
2015
2020

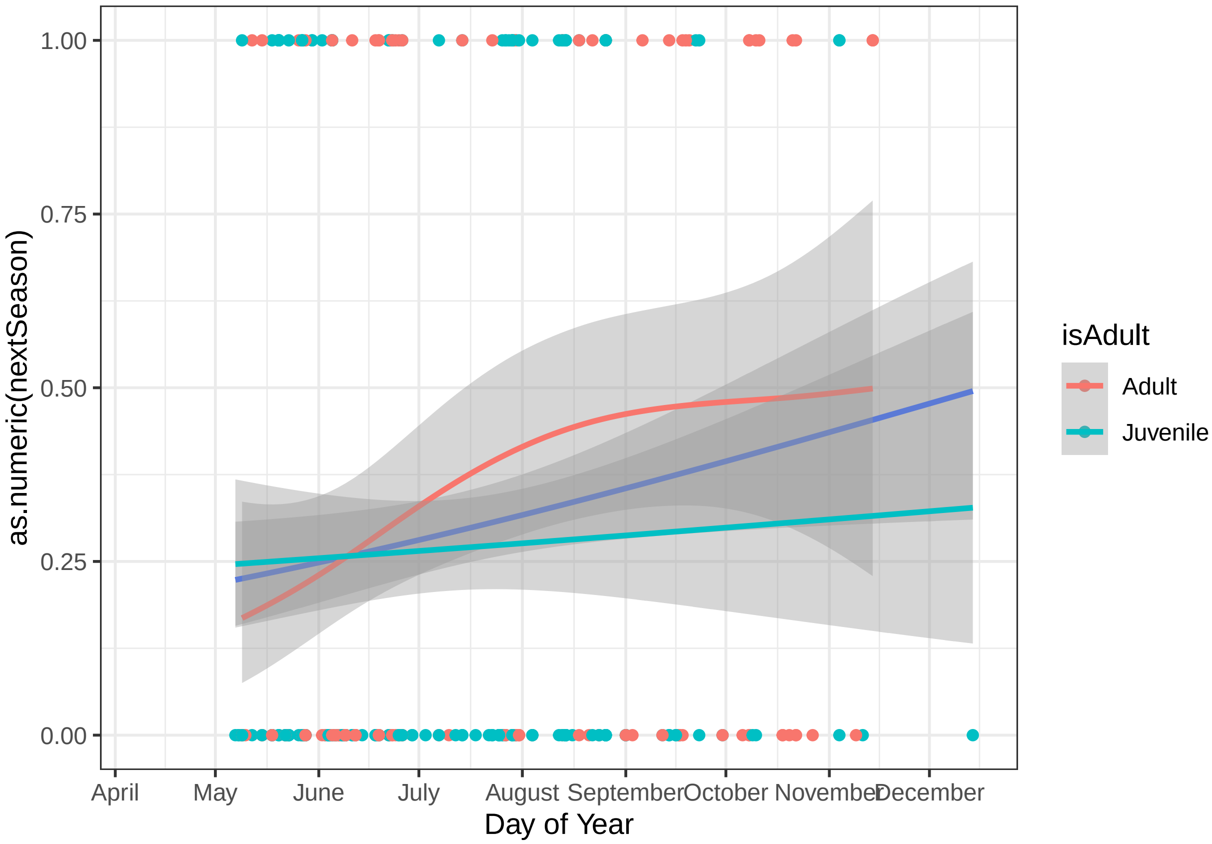


fit
7.5
5.0
2.5
0.0
April
May
June
July
August
September
October
November
December
Day of Year
factor(Year)
2005
2010
2015
2020



When to equip to improve the recapture rate

Over the **163** unique RCRC individu captured, **67** were retraped of them (41.1042945%). Considering birds which have been retraped a following season, the number of retraps decreases to **39** (23.9263804%).



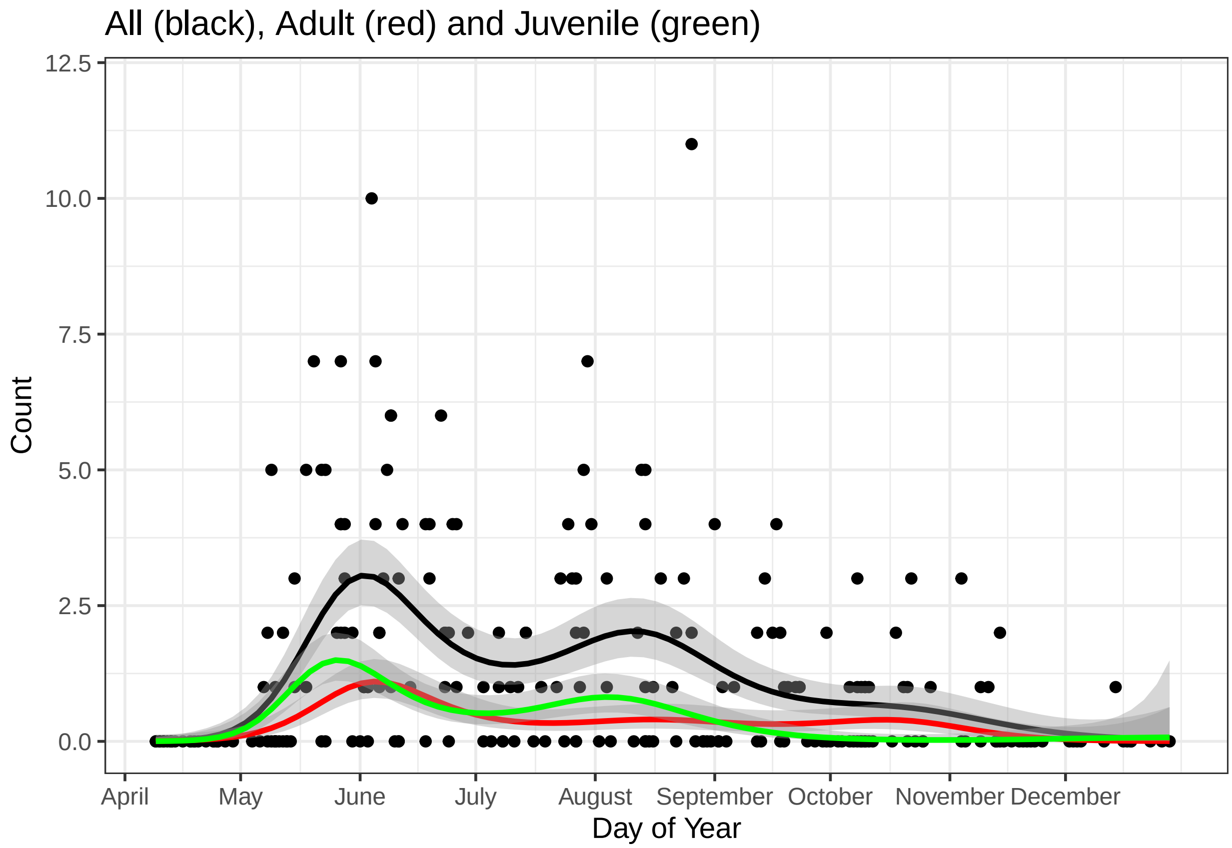
The temporal pattern of retrap shows **a higher retrap rate for bird capture between July and August**. This correspond probably to resident bird. Note that the uncertainty is larger during this period compared to May-July where more bird were captured (cf above figure) thus providing a better estimate of the retraping rate during these month. The artificial increase of the uncertainty from October is an artifact of the GAM which can be ignored.

For the purpose of our study, we want to equip 15 RCRC. While waiting for July August seems preferable to increase the retrap rate, the number of capture bird do decrease and might corespond to the same bird (resident). In addition, in order to learn more about the age difference pattern observed in the ringing data, we think that is best **to start equipping some bird already in end of June and wait for mid-July to equip the others**.

The life history of each RCRC is more complicated to interpretaed in this figure because there are many. Some birds are capture several over a single year (only small dots), while other have been capture over 5-10 years (large icon)!

Adult vs Juv

The ringing data indicates that two passage in June and mid-October for adult while juvenile number have only a shallow peak in August. Are the adult moving faster to choose the best location? Are they moving further north then juvenile? These are the sort of questions that we wish to answer with our study with geolocators.



Appendix

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

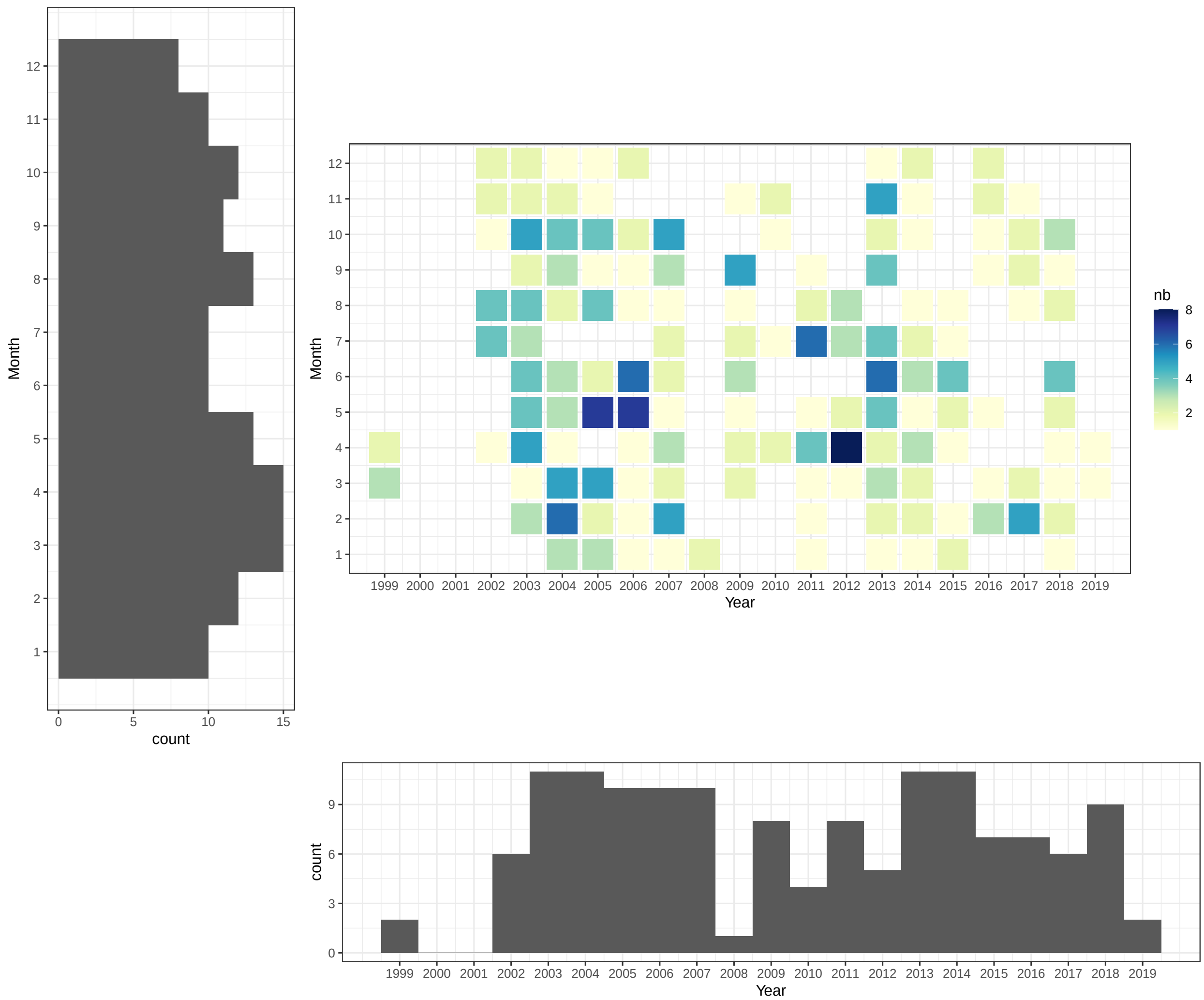
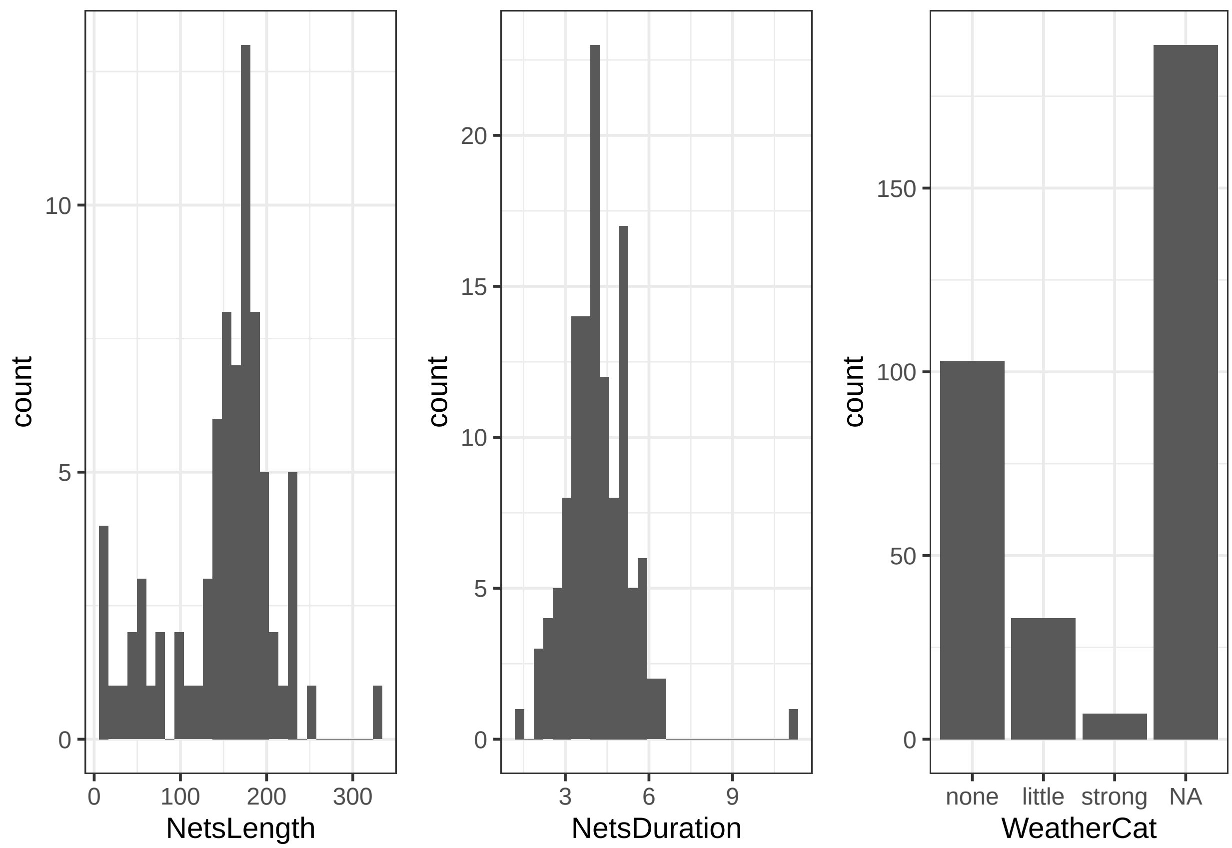
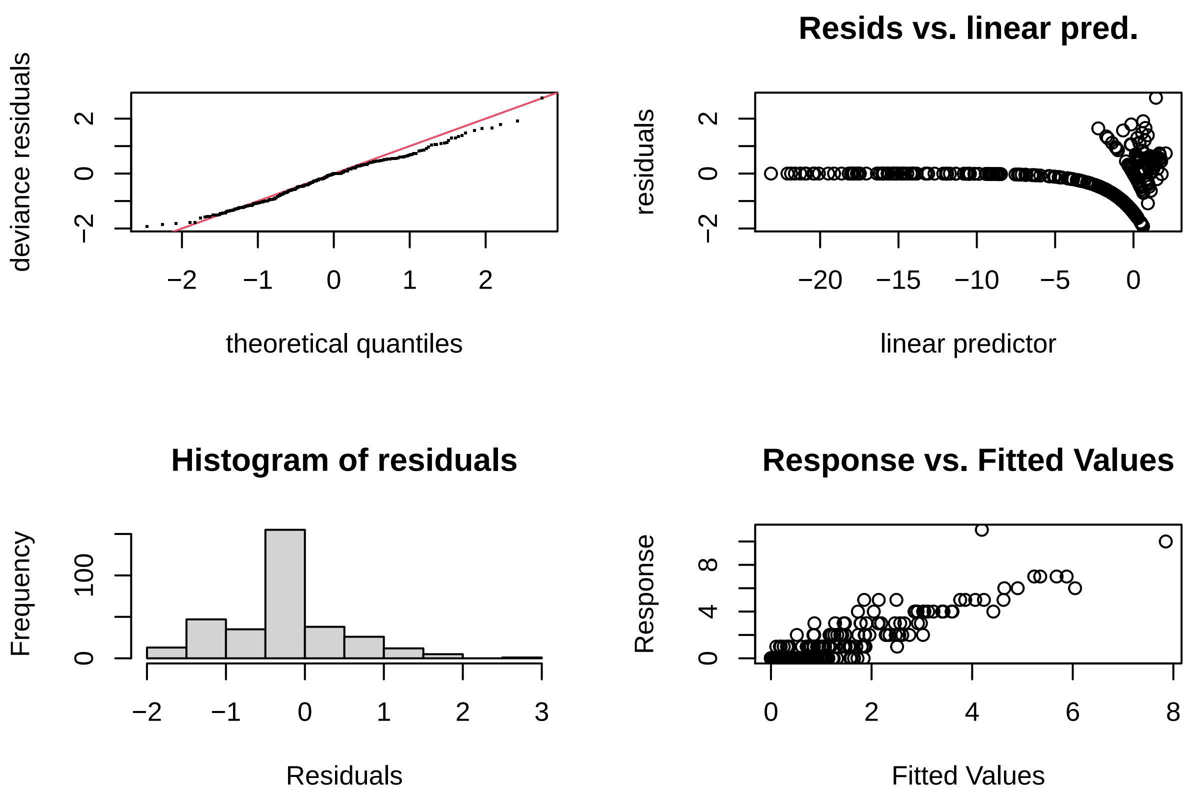


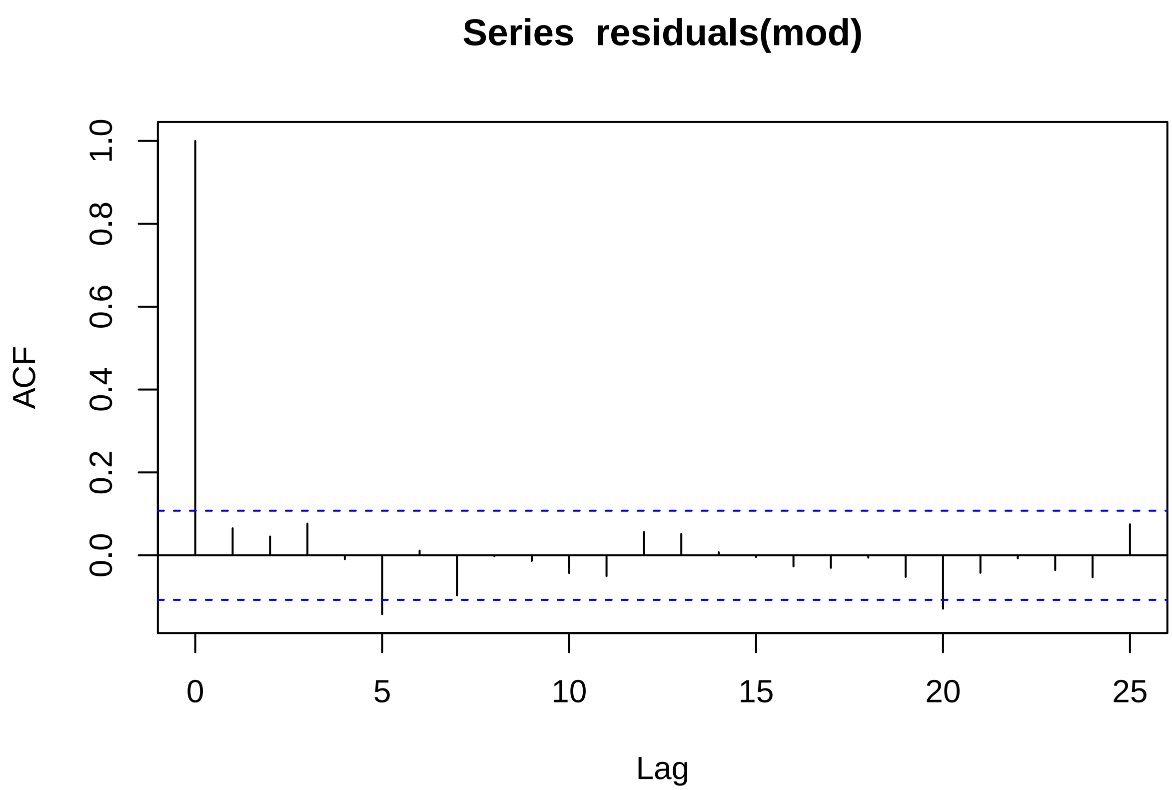
Figure 2: Distribution of the ringing sessions according to year and month. Colorscale indicates the number of ringing session

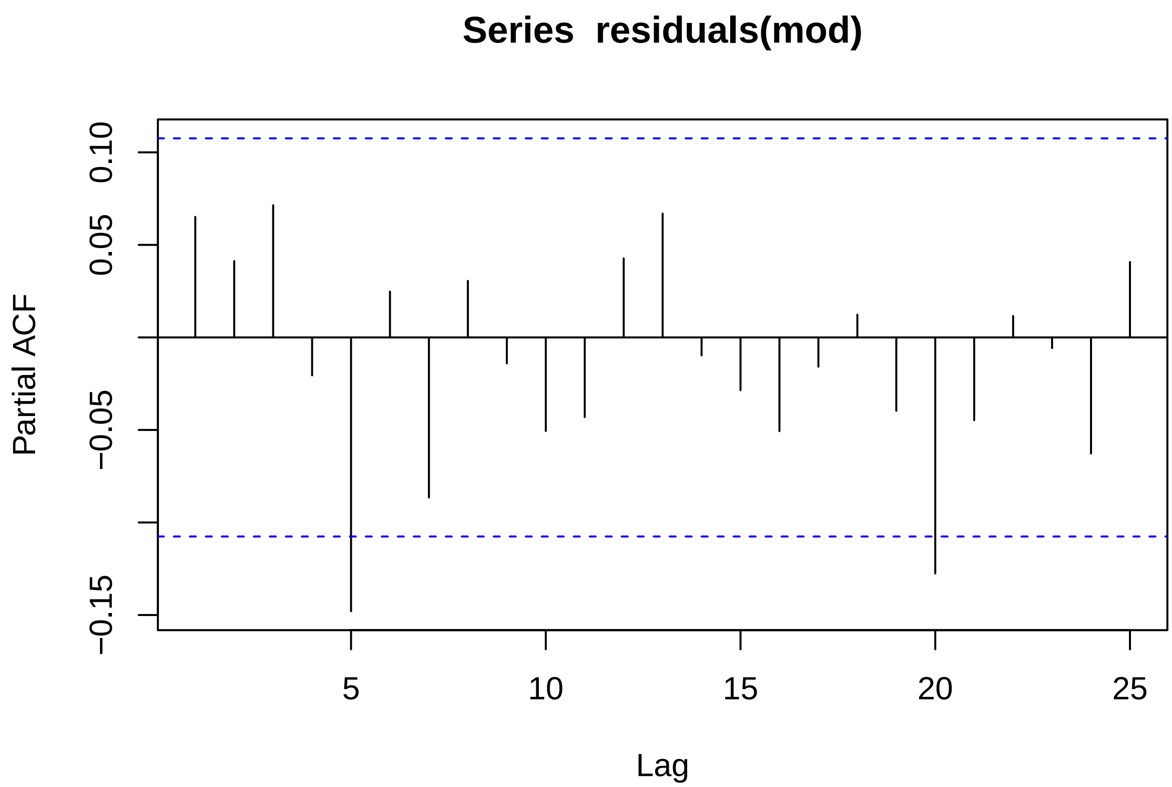

count
10
5
0
0
100
200
300
NetsLength
count
20
15
10
5
0
3
6
9
NetsDuration
count
150
100
50
0
none
little
strong
NA
WeatherCat



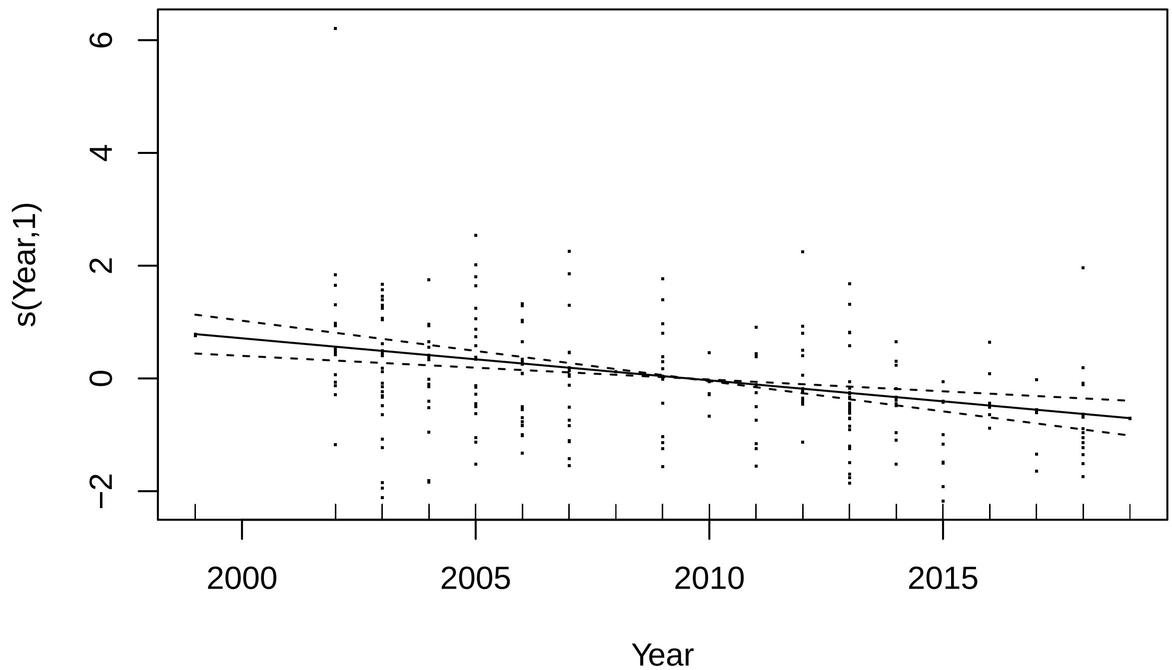

```
##
## Method: fREML   Optimizer: perf chol
## $grad
## [1] -1.395458e-06  7.655319e-09  2.227419e-09  6.561090e-09  3.393262e-07
## [6]  1.324045e-07
##
## $hess
##               [,1]          [,2]          [,3]          [,4]          [,5]
## [1,]  1.395455e-06  5.510725e-08 -4.402136e-08  1.092478e-07 -5.190121e-07
## [2,]  5.510725e-08  1.369750e+00  1.040874e-02 -5.715943e-03  8.889653e-02
## [3,] -4.402136e-08  1.040874e-02  1.775625e-02 -2.746898e-04  3.565405e-02
## [4,]  1.092478e-07 -5.715943e-03 -2.746898e-04  6.943707e-01 -1.093136e-01
## [5,] -5.190121e-07  8.889653e-02  3.565405e-02 -1.093136e-01  7.396757e+00
## [6,] -2.028041e-07  5.788359e-02  1.643874e-02 -1.869429e-02  1.416179e+00
##               [,6]
## [1,] -2.028041e-07
## [2,]  5.788359e-02
## [3,]  1.643874e-02
## [4,] -1.869429e-02
## [5,]  1.416179e+00
## [6,]  5.186088e-01
##
## Model rank =  498 / 498
##
## Basis dimension (k) checking results. Low p-value (k-index<1) may
## indicate that k is too low, especially if edf is close to k'.
```

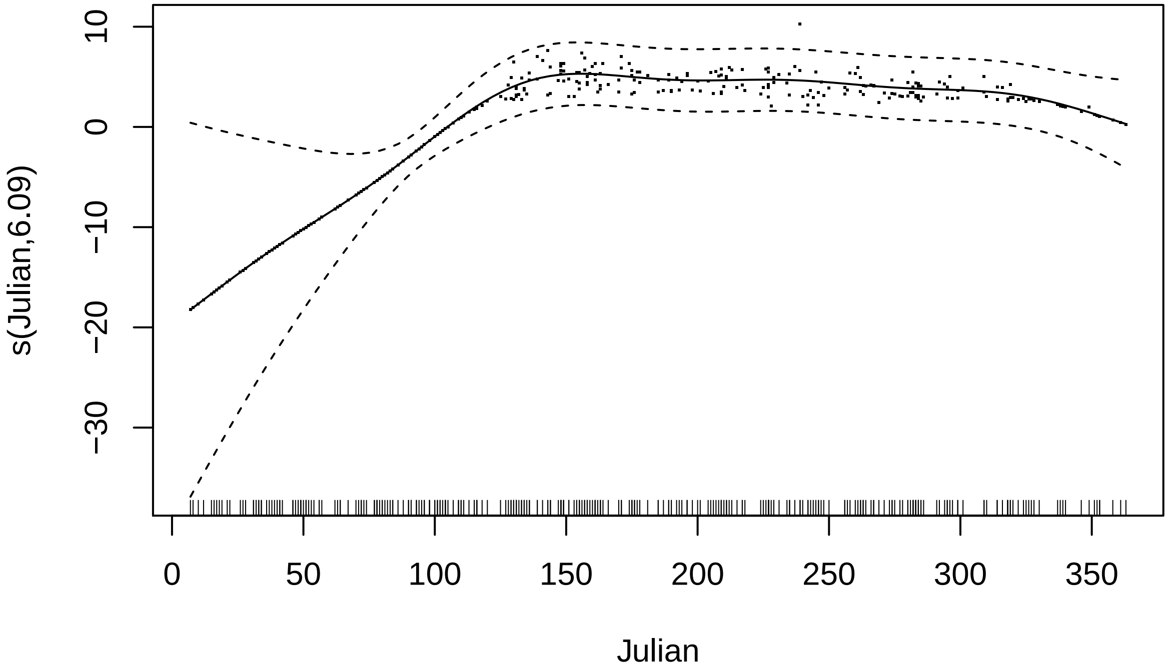
```
##
##                                                    k'    edf k-index p-value
## s(Year)                                          9.00   1.00    0.89    0.21
## s(Julian)                                        9.00   6.09    0.87    0.14
## s(NetsDuration):ordered(!mNetsDuration)TRUE     9.00   1.22    0.98    0.85
## s(NetsLength):ordered(!mNetsLength)TRUE         9.00   2.70    0.82    0.01 **
## s(idNetsDuration):mNetsDuration                207.00  40.91      NA      NA
## s(idNetsLength):mNetsLength                    254.00  11.38      NA      NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```



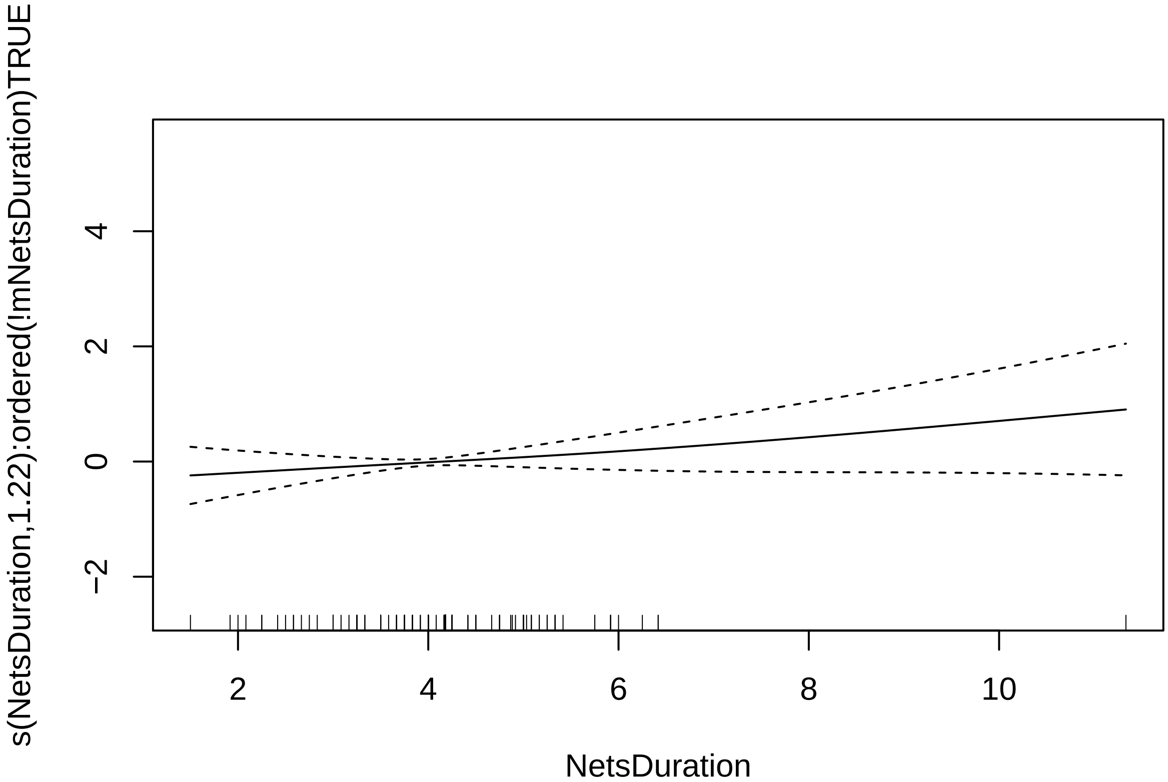


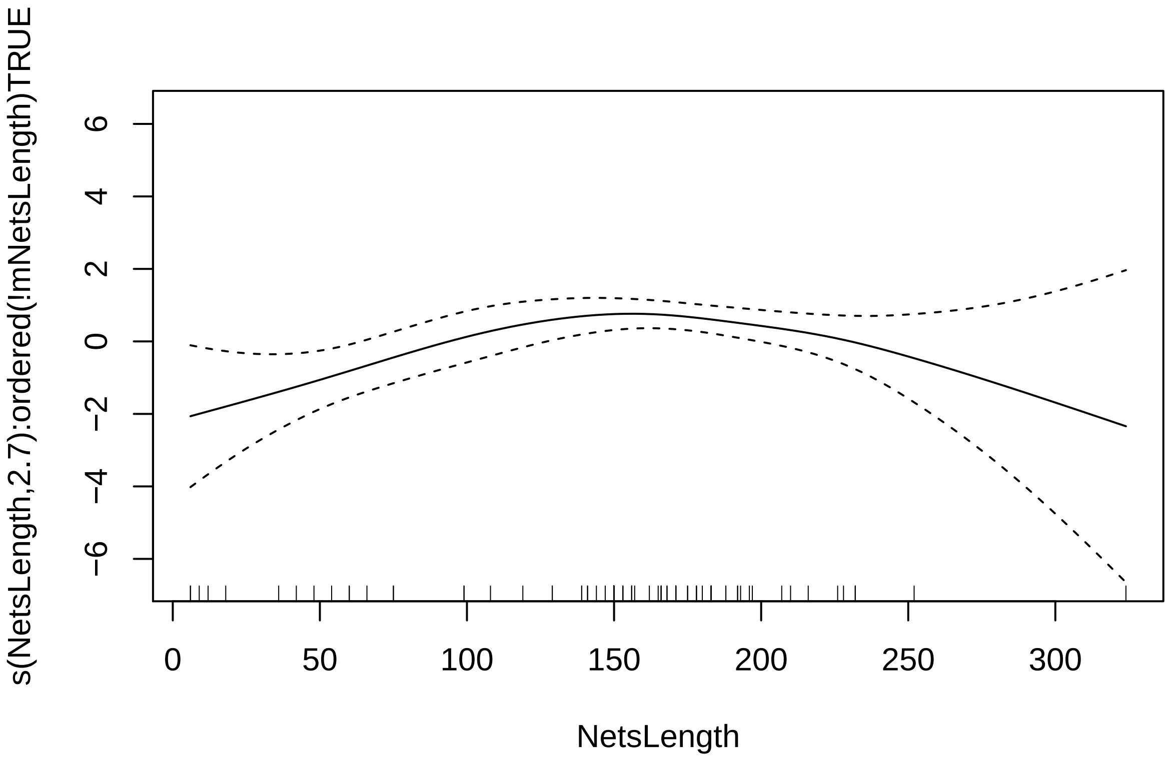
Series residuals(mod)
Partial ACF
0.10
0.05
−0.05
−0.15
5
10
15
20
25
Lag

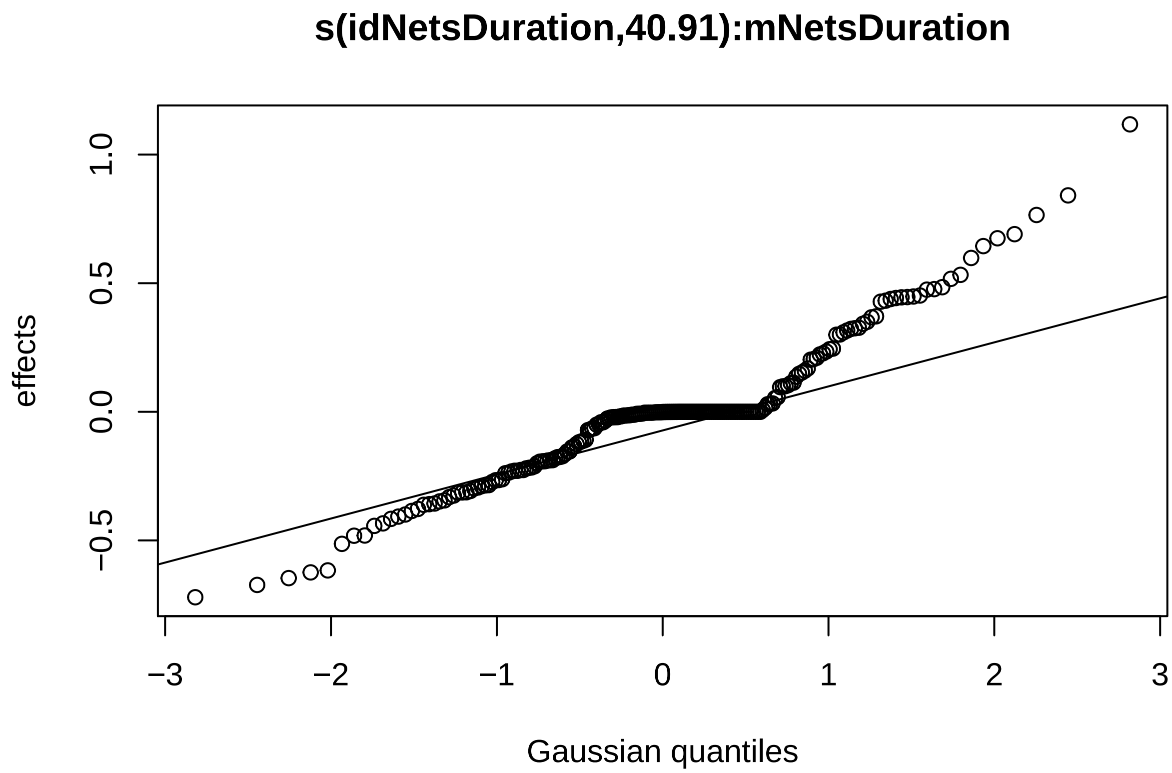

s(Year,1)
6
4
2
0
−2
2000
2005
2010
2015
Year

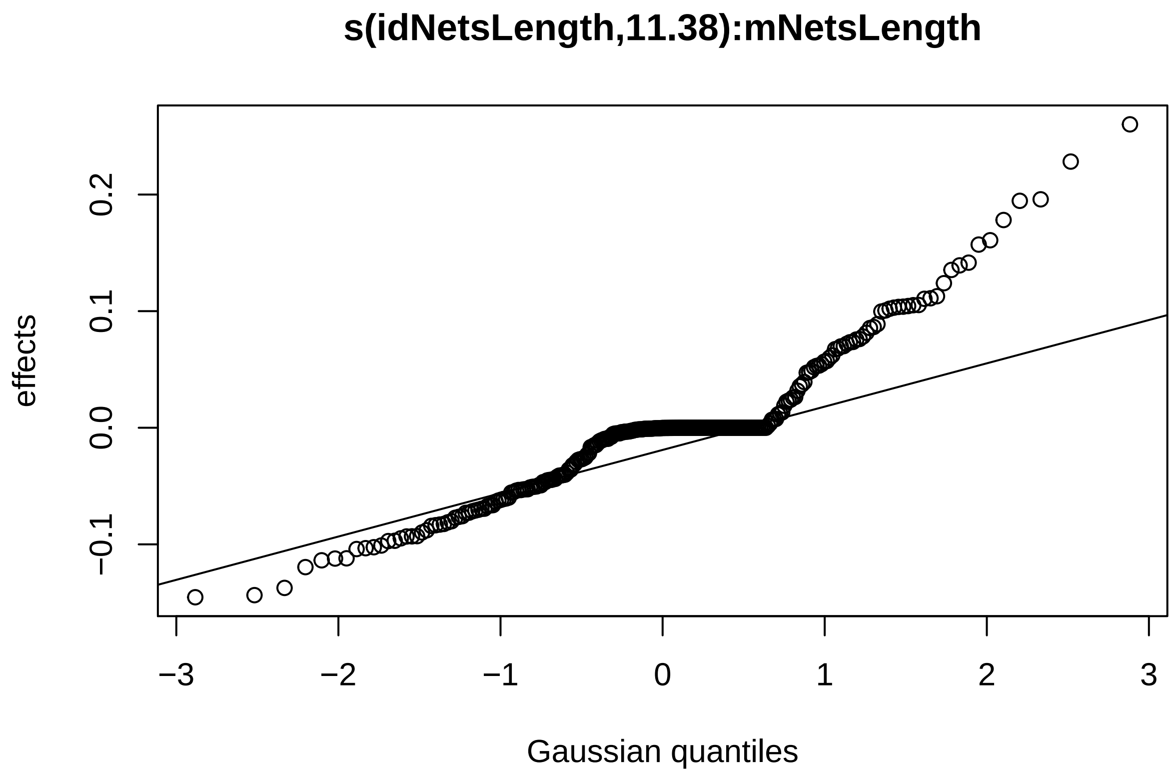


s(Julian,6.09)
10
0
−10
−20
−30
0
50
100
150
200
250
300
350
Julian

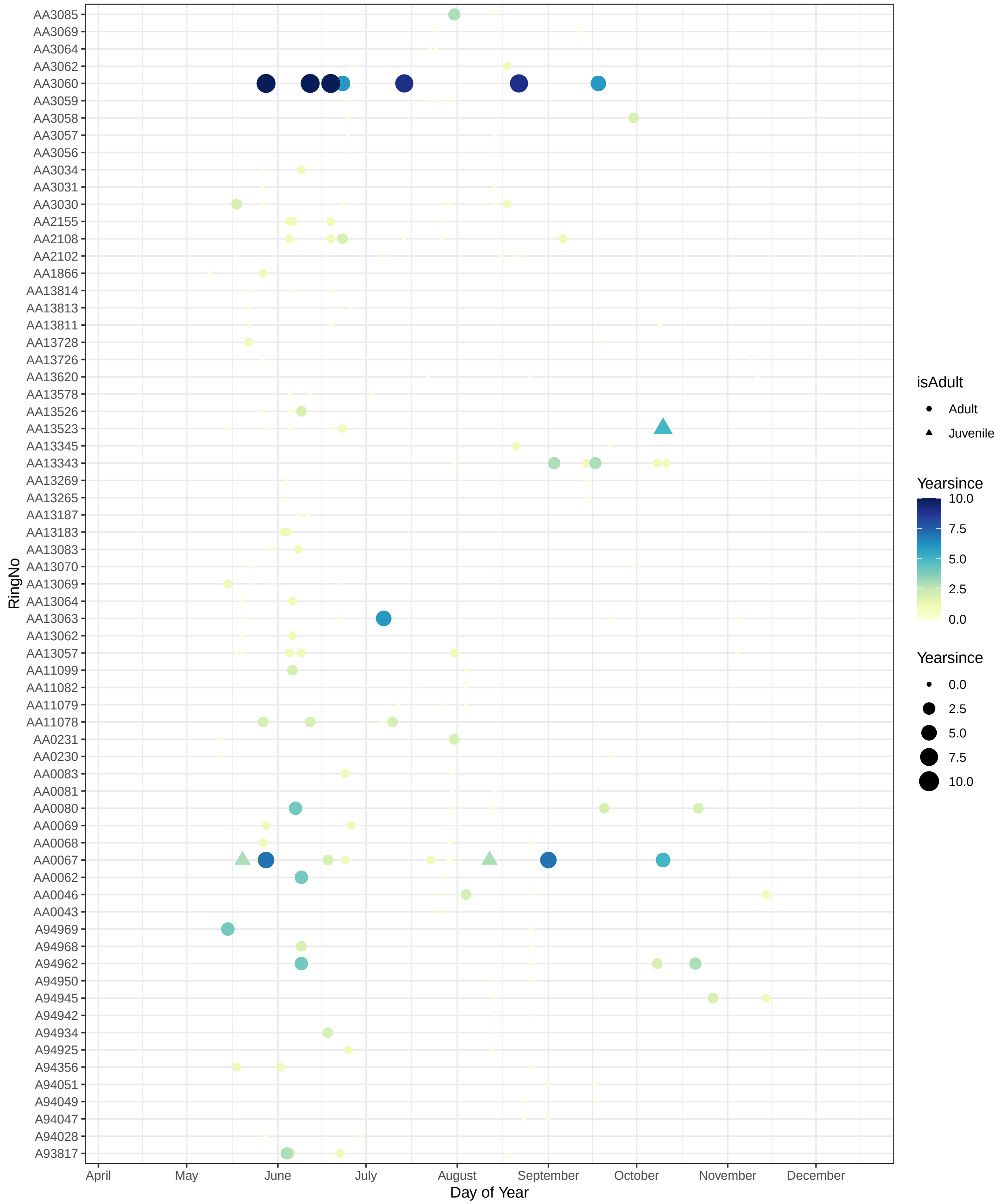

s(NetsDuration,1.22):ordered(!lmNetsDuration)TRUE
4
2
0
−2
2
4
6
8
10
NetsDuration


s(NetsLength,2.7):ordered(!lmNetsLength)TRUE
6
4
2
0
−2
−4
−6
0
50
100
150
200
250
300
NetsLength


s(idNetsDuration,40.91):mNetsDuration
effects
1.0
0.5
0.0
−0.5
−3
−2
−1
0
1
2
3
Gaussian quantiles




```r
## Figure 3: Capture recapture
dr %>%
  filter(any(isRetrap==1)) %>%
  ggplot( aes(x=Julian,y=RingNo)) +
  scale_colour_gradientn(colours = brewer.pal(9, 'YlGnBu')) +
  geom_point(aes(shape = isAdult, colour = Yearsince, size = Yearsince )) +
  scale_x_continuous(breaks=as.numeric(format(ISOdate(2004,1:12,1),"%j")),
                     labels=format(ISOdate(2004,1:12,1),"%B"),
                     limits = c(100,350)) +
  xlab('Day of Year')
```



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