Preliminary analysis of the Icelandic Gyrfalcon CMR dataset - v2

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Here I attempt to explore the CMR dataset, before we go to inferential models to estimate survival and perhaps link this to an integrated pop. model.

Basic statistics

How many birds have been ringed?

```
dringed<-read.csv("data/Gyrs_ringed.csv")
head(dringed) # What's in the data table
```

```
##   Ring_No Ringed_date Ringed_day Ringed_month Ringed_year EurAgeCode
## 1   15551   7/12/1975         12            7        1975          1
## 2   15552   7/12/1975         12            7        1975          1
## 3   15553   7/12/1975         12            7        1975          1
## 4   15554   6/20/1976         20            6        1976          1
## 5   15555   6/20/1976         20            6        1976          1
## 6   15556   6/20/1976         20            6        1976          1
##   EurAgeText SEX
## 1     Pullus   0
## 2     Pullus   0
## 3     Pullus   0
## 4     Pullus   0
## 5     Pullus   0
## 6     Pullus   0
```

```r
length(unique(dringed$Ring_No)) #How many unique bird IDs
```

[1] 1653

OK, so we have 1653 unique IDs. Let's compare to how many gyrs have been recovered.

```r
drecov<-read.csv("data/Gyrs_recovered.csv")
head(drecov)
```

```
##   Ring_No Date_recovered Day_recorded Month_recorded Year_recorded
## 1   15554     10/15/1976           15             10          1976
## 2   15556      9/18/1980           18              9          1980
## 3   15559      6/18/1980           18              6          1980
## 4   15560      4/15/1979           15              4          1979
## 5   15562      8/20/1987           20              8          1987
## 6   15567      5/13/1995           13              5          1995
##   Accurancy_of_date_Euring_code Condition_Euring_code
## 1                             5                     3
## 2                             9                     3
## 3                             9                     3
## 4                             9                     3
## 5                             0                     3
## 6                             9                     3
##   Circumstances_Euring_code      Circumstances_Euring_text
## 1                         1                Bird found dead
## 2                         1           Bird found long dead
## 3                         1           Bird found long dead
## 4                         1           Bird found long dead
## 5                         1 Bird found dead (less than month)
## 6                         1           Bird found long dead
##             When.dead Date_reported
## 1                        14.09.1985
## 2   Died summer 1980    22.09.1980
```
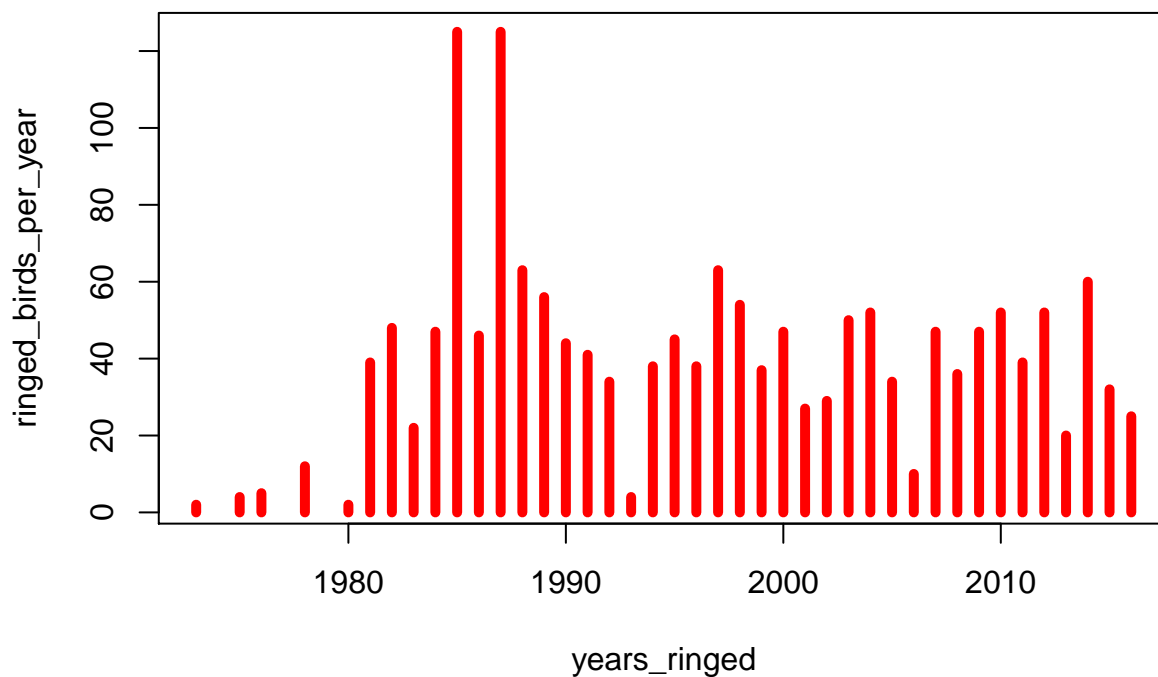
```
## 3                              18.12.1980
## 4 Died winter 1978-1979    29.06.1984
## 5       Died summer 1987    25.08.1987
## 6                              26.05.1995
```

```r
length(unique(drecov$Ring_No)) #How many unique bird IDs in Gyrs_recovered.csv
```
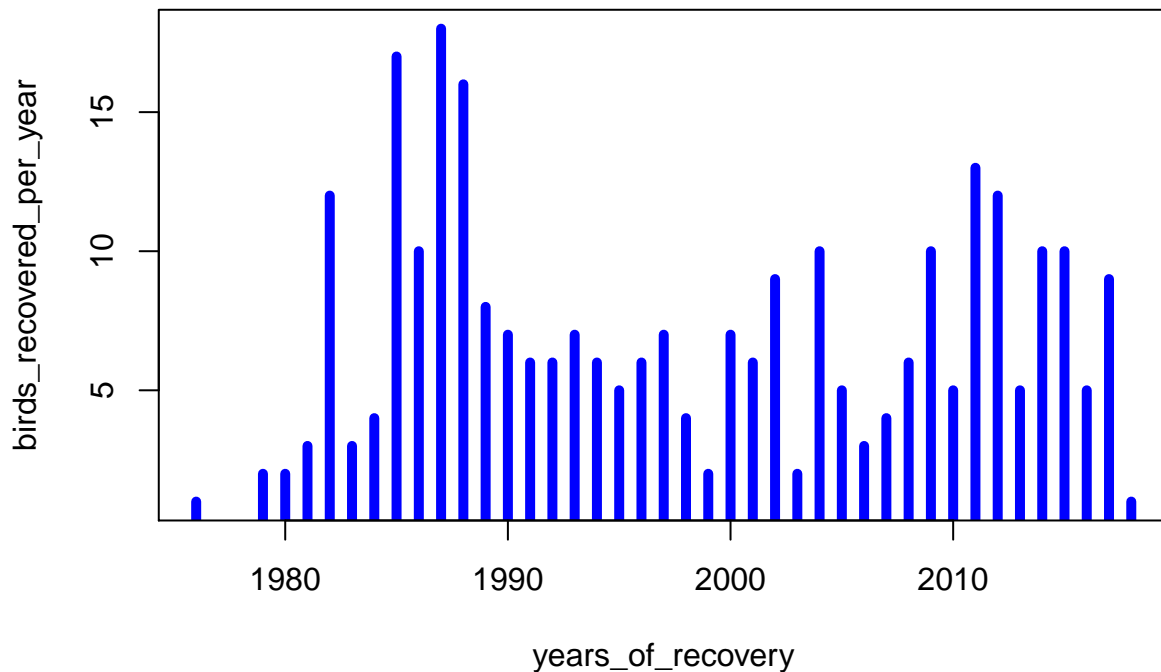
```
## [1] 270
```

Let's now analyse the number of birds that have been ringed as a function of the year

We now analyse the patterns of recovery (and resighting)

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Now how many birds have been seen several times? We see below that very few birds have been recovered

more than once (also this tends to be recent?).

Question: when did the change from recovery of dead birds to resighting of live birds occur?

I can infer the earliest date at which a bird has been resighted a second time, but given few birds have been

resighted, but it might be preferable to allow later for a change in protocol (in the CMR models) using a

predefined time (we can use several if unsure). I have noted 2006 earlier but I am unsure.

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Bird ID

```
## ntimes_recovered
##   1   2   3   4
## 255  11   3   1
```
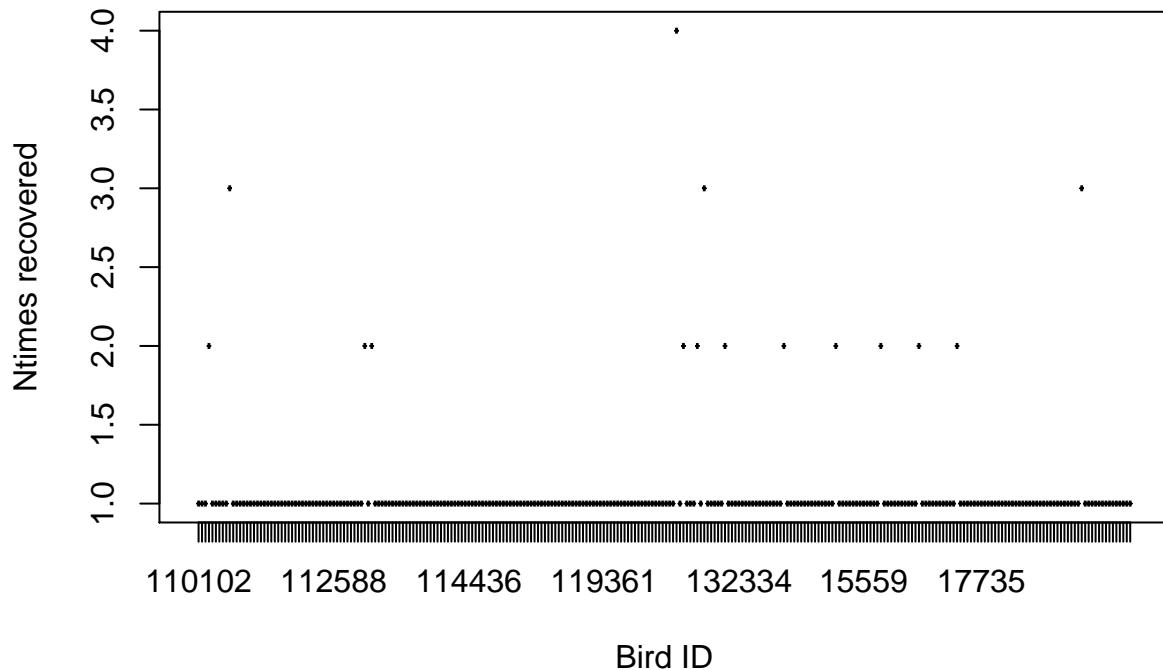
This is coherent with the info given by Oli – 1 bird recovered 4 times, 3 birds 3 times, 11 birds two times and the rest 1 time.

Thus for all practical purposes, we can consider that such data consists mainly of individual that are either recovered or not recovered/resighted. We'll now turn to whether the individuals have been found live or dead, and how this varies in time.

Also whether the recoveries of dead birds are of young vs. adult birds (which may provide quick and dirty estimates of survival rates, at least for the youngs...)

```
## these are all the recovery codes that we have (top row), and how many of those we have in the dataset

table(drecov$Condition_Euring_code)
```

```
##
##   1   2   3   4   5   7   8
##   2  66 136   8  26  31  21
```

```
### [previous comment: For instance, we can see 15 read colourmarks.

### We need to simplify this complexity to some extent by aggregating some values. ]
```

Now we need some more info on the codes

These are defined according to The EURING EXCHANGE Code 2000+ https://euring.org/files/documents/
E2000PLUSExchangeCodeV117.pdf

Condition Code	Meaning
0	Condition completely unknown
1	Dead but no information on how recently died/killed
2	Freshly dead – within about a week
3	dead for $>$ a week. If $>>$, use 9 in Accuracy of Date, and 3 here
4	Found sick/wounded and released afterwards
5	Found sick/wounded and NOT released afterwards
6	Alive and probably healthy but taken into captivity.
7	Alive and probably healthy and certainly released (ring seen without the bird having being caught).
8	Alive and probably healthy and released by a ringer
9	Alive and probably healthy but ultimate fate of bird is not known

Thus categories 4, 7 and 8 (respectively 8, 31 and 21 birds) correspond to cases where the bird is 'released'
alive, i.e. effectively resighted rather than recovered (when dead).

```
drecov$Date_recovered[drecov$Condition_Euring_code %in% c(4,7,8)]
```

```
## [1] 7/16/1986  5/16/1985  5/17/1987  5/14/1987  4/22/1985  2/4/1988
## [7] 5/6/1988   5/6/1987   5/21/1988  6/3/1982   5/15/1985  5/16/1987
## [13] 5/10/1985  3/17/1984  5/28/1984  5/15/1987  10/30/1985 11/29/1986
## [19] 5/9/1988   7/28/1988  1/4/1988   9/13/1990  6/9/2009   8/27/2000
## [25] 3/6/2005   12/12/2001 6/5/2011   6/30/2007  10/23/2008 6/14/2014
## [31] 6/14/2015  6/5/2016   6/17/2017  5/4/2012   11/1/2011  10/1/2012
## [37] 1/2/2013   6/17/2010  6/16/2011  6/13/2012  6/16/2016  3/7/2015
## [43] 6/19/2017  6/17/2017  5/5/2012   2/26/2012  7/21/2012  6/11/2014
## [49] 1/22/2018  3/14/2016  1/5/2017   3/10/2017  6/9/2015   11/11/2014
```

```
## [55] 2/6/2016    3/10/2017   8/28/2015   8/13/2015   8/17/2016   10/19/2017
## 269 Levels: 10/10/2008 10/1/2012 10/15/1976 10/15/1981 ... 9/8/1982
```

```r
drecov$Year[drecov$Condition_Euring_code %in% c(4,7,8)]
```

```
##  [1] "1986" "1985" "1987" "1987" "1985" "1988" "1988" "1987" "1988" "1982"
## [11] "1985" "1987" "1985" "1984" "1984" "1987" "1985" "1986" "1988" "1988"
## [21] "1988" "1990" "2009" "2000" "2005" "2001" "2011" "2007" "2008" "2014"
## [31] "2015" "2016" "2017" "2012" "2011" "2012" "2013" "2010" "2011" "2012"
## [41] "2016" "2015" "2017" "2017" "2012" "2012" "2012" "2014" "2018" "2016"
## [51] "2017" "2017" "2015" "2014" "2016" "2017" "2015" "2015" "2016" "2017"
```
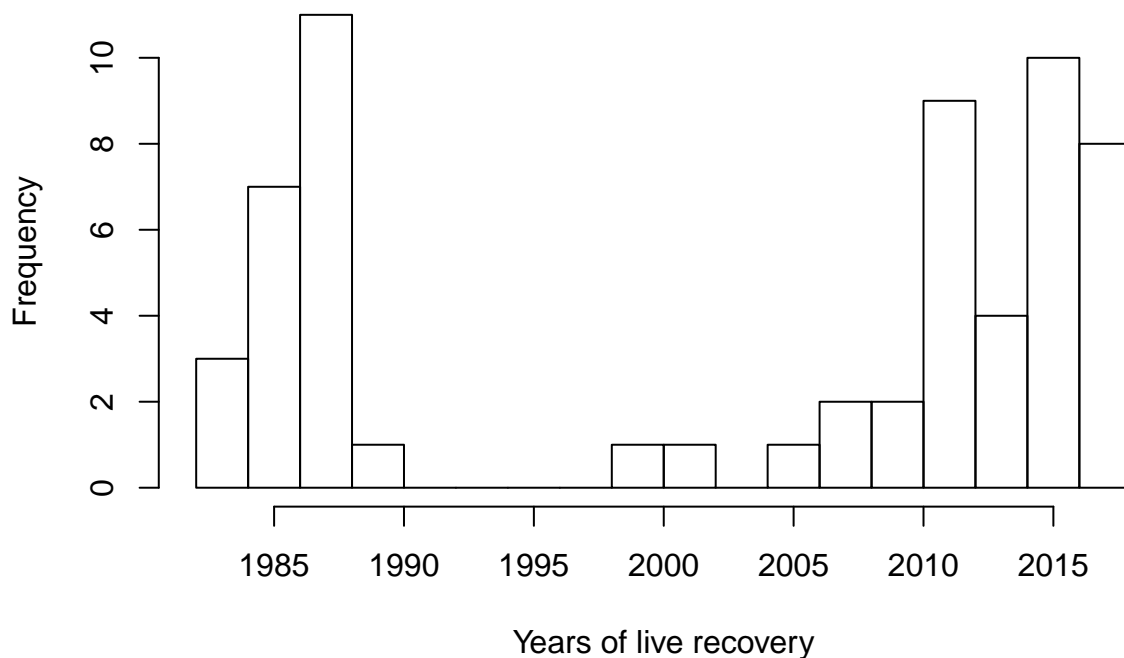
```r
vec_year_recovered_live = as.numeric(drecov$Year[drecov$Condition_Euring_code %in% c(4,7,8)])
hist(vec_year_recovered_live,breaks=20,xlab = "Years of live recovery", main = "Live recaptures (Euring
```

Live recaptures (Euring 4,7,8)


```r
drecov$Date_recovered[drecov$Condition_Euring_code %in% c(7,8)]
```

```
##  [1] 5/16/1985   5/17/1987   5/14/1987   2/4/1988    5/6/1988    5/6/1987
##  [7] 5/21/1988   6/3/1982    5/15/1985   5/16/1987   5/10/1985   3/17/1984
```

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```
## [13] 5/15/1987   10/30/1985 11/29/1986 5/9/1988   6/9/2009   8/27/2000
## [19] 3/6/2005    12/12/2001 6/5/2011   6/30/2007  10/23/2008 6/14/2014
## [25] 6/14/2015  6/5/2016   6/17/2017  5/4/2012   11/1/2011  10/1/2012
## [31] 1/2/2013   6/17/2010  6/16/2011  6/13/2012  6/16/2016  3/7/2015
## [37] 6/19/2017  6/17/2017  5/5/2012   2/26/2012  7/21/2012  6/11/2014
## [43] 1/22/2018  3/14/2016  1/5/2017   3/10/2017  11/11/2014 2/6/2016
## [49] 3/10/2017  8/13/2015  8/17/2016  10/19/2017
## 269 Levels: 10/10/2008 10/1/2012 10/15/1976 10/15/1981 ... 9/8/1982
```

```
drecov$Date_recovered[drecov$Condition_Euring_code ==7]
```

```
##  [1] 2/4/1988    10/30/1985 11/29/1986 6/9/2009   8/27/2000  3/6/2005
##  [7] 12/12/2001 6/5/2011   6/30/2007  10/23/2008 6/5/2016   5/4/2012
## [13] 10/1/2012  1/2/2013   6/17/2010  6/16/2011  6/13/2012  3/7/2015
## [19] 5/5/2012   2/26/2012  7/21/2012  6/11/2014  1/22/2018  3/14/2016
## [25] 1/5/2017   3/10/2017  11/11/2014 3/10/2017  8/13/2015  8/17/2016
## [31] 10/19/2017
## 269 Levels: 10/10/2008 10/1/2012 10/15/1976 10/15/1981 ... 9/8/1982
```

```
drecov$Date_recovered[drecov$Condition_Euring_code ==8]
```

```
##  [1] 5/16/1985 5/17/1987 5/14/1987 5/6/1988  5/6/1987  5/21/1988 6/3/1982
##  [8] 5/15/1985 5/16/1987 5/10/1985 3/17/1984 5/15/1987 5/9/1988  6/14/2014
## [15] 6/14/2015 6/17/2017 11/1/2011 6/16/2016 6/19/2017 6/17/2017 2/6/2016
## 269 Levels: 10/10/2008 10/1/2012 10/15/1976 10/15/1981 ... 9/8/1982
```

Check not a problem of date recording
```
drecov$Year[(drecov$Condition_Euring_code %in% c(4,7,8))&(drecov$Accurancy_of_date_Euring_code!=9)]
```

```
##  [1] "1986" "1985" "1987" "1987" "1985" "1988" "1988" "1987" "1988" "1982"
## [11] "1985" "1987" "1985" "1984" "1984" "1987" "1985" "1986" "1988" "1988"
## [21] "1988" "1990" "2009" "2000" "2005" "2001" "2011" "2007" "2008" "2014"
## [31] "2015" "2016" "2017" "2012" "2011" "2012" "2013" "2010" "2011" "2012"
## [41] "2016" "2015" "2017" "2017" "2012" "2012" "2012" "2014" "2018" "2016"
## [51] "2017" "2017" "2015" "2014" "2016" "2017" "2015" "2015" "2016" "2017"
```

```
drecov$Accurancy_of_date_Euring_code[drecov$Condition_Euring_code %in% c(4,7,8)]
```

```
## [1] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## [36] 0 0 0 0 0 0 0 0 0 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

```
table(drecov$Accurancy_of_date_Euring_code)
```

```
##
##   0   1   2   3   4   5   9
## 212   8   5   9   6   5  45
```

```
## Check the birds whose dying dates are poorly known
drecov$Year[(drecov$Accurancy_of_date_Euring_code %in% c(8,9))]
```

```
##  [1] "1980" "1980" "1979" "1995" "1996" "1990" "2000" "1987" "2011" "1996"
## [11] "1994" "1985" "1987" "1986" "1988" "1986" "1993" "1988" "1987" "2002"
## [21] "1987" "1996" "1993" "1987" "1997" "1994" "1994" "1988" "1992" "1996"
## [31] "1996" "1998" "1998" "2017" "2003" "2002" "2006" "2008" "2013" "2014"
## [41] "2005" "2009" "2014" "2012" "2017"
```

```
drecov$Condition_Euring_code[(drecov$Accurancy_of_date_Euring_code %in% c(8,9))]
```

```
##  [1] 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
## [36] 3 3 3 3 3 3 3 1 3 3 3
```

```
## New dataframe for looking into those patterns
long_dead_birds=drecov[(drecov$Accurancy_of_date_Euring_code %in% c(8,9)),]
head(long_dead_birds)
```

```
##   Ring_No Date_recovered Day_recorded Month_recorded Year_recorded
## 2   15556      9/18/1980           18              9          1980
## 3   15559      6/18/1980           18              6          1980
## 4   15560      4/15/1979           15              4          1979
## 6   15567      5/13/1995           13              5          1995
```

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```
## 15    15980       6/1/1996                1               6           1996
## 17    15995       9/23/1990              23               9           1990
##     Accurancy_of_date_Euring_code Condition_Euring_code
## 2                               9                     3
## 3                               9                     3
## 4                               9                     3
## 6                               9                     3
## 15                              9                     3
## 17                              9                     3
##     Circumstances_Euring_code Circumstances_Euring_text
## 2                           1       Bird found long dead
## 3                           1       Bird found long dead
## 4                           1       Bird found long dead
## 6                           1       Bird found long dead
## 15                          1       Bird found long dead
## 17                          1       Bird found long dead
##               When.dead Date_reported Year
## 2        Died summer 1980   22.09.1980 1980
## 3                          18.12.1980 1980
## 4  Died winter 1978-1979   29.06.1984 1979
## 6                          26.05.1995 1995
## 15 Died winter 1994-1995   06.06.1996 1996
## 17 Died winter 1989-1990   25.09.1990 1990
```

```r
### Possible to correct the date using the When.dead column
nrow(long_dead_birds)
```

```
## [1] 45
```

```r
long_dead_birds$When.dead
```

```
##  [1] Died summer 1980
##  [2]
##  [3] Died winter 1978-1979
```

```
##  [4]
##  [5] Died winter 1994-1995
##  [6] Died winter 1989-1990
##  [7] Died winter 1998-1999
##  [8]
##  [9] Dead 3-5 years
## [10] No estimate
## [11] Died winter 1993-1994
## [12] Died winter 1984-1985
## [13]
## [14] Died winter 1985-1986
## [15] No estimate
## [16] Died winter 1985-1986
## [17] No estimate
## [18] Died winter 1987-1988
## [19] Died winter 1986-1987
## [20] Died winter 2001-2002
## [21] Died winter 1986-1987
## [22] Died fall 1995
## [23] Died winter 1992-1993
## [24] Died winter 1986-1987
## [25] Dead at least 3-4 years
## [26] Died 1993
## [27] Died autumn 1993
## [28] Died winter 1987-1988
## [29] Died winter 1991-1992
## [30] Died June 1995
## [31] Died autumn 1996 based on intact carcass
## [32] Died winter 1997-1998
## [33] Died late winter 1997-1998
## [34] No estimate
## [35] No estimate
## [36] Died winter 2001-2002
```

[37] No estimate

[38] No estimate

[39] Died spring 2012

[40] Died winter 2013-2014

[41] Died winter 2004-2005

[42] No estimate

[43] No estimate

[44] Died winter 2011-2012

[45] Died winter 2016-2017

54 Levels: Dead 3-5 years Dead at least 3-4 years ... No estimate

```
## For which do we have information?
long_dead_birds$When.dead[grepl("D",long_dead_birds$When.dead)]
```

[1] Died summer 1980

[2] Died winter 1978-1979

[3] Died winter 1994-1995

[4] Died winter 1989-1990

[5] Died winter 1998-1999

[6] Dead 3-5 years

[7] Died winter 1993-1994

[8] Died winter 1984-1985

[9] Died winter 1985-1986

[10] Died winter 1985-1986

[11] Died winter 1987-1988

[12] Died winter 1986-1987

[13] Died winter 2001-2002

[14] Died winter 1986-1987

[15] Died fall 1995

[16] Died winter 1992-1993

[17] Died winter 1986-1987

[18] Dead at least 3-4 years

[19] Died 1993

12

```
## [20] Died autumn 1993
## [21] Died winter 1987-1988
## [22] Died winter 1991-1992
## [23] Died June 1995
## [24] Died autumn 1996 based on intact carcass
## [25] Died winter 1997-1998
## [26] Died late winter 1997-1998
## [27] Died winter 2001-2002
## [28] Died spring 2012
## [29] Died winter 2013-2014
## [30] Died winter 2004-2005
## [31] Died winter 2011-2012
## [32] Died winter 2016-2017
## 54 Levels:  Dead 3-5 years Dead at least 3-4 years ... No estimate
```

```
long_dead_birds$Ring_No[grepl("D",long_dead_birds$When.dead)]
```

```
##  [1] 15556      15560      15980      15995      17637      17743
##  [7] 112524     112528     112540     112562     112588     112598
## [13] 113468     113474     113489     113509     113514     113660
## [19] 113661     113676     113697     113704     114987     115203
## [25] 115214     115229     117935     123526     124362     132341
## [31] 137158     V_FARU0096
## 270 Levels: 110102 110115 110117 110118 110124 110126 110157 ... V_FARU0096
```

Accuracy of date Code	Meaning
0	Accurate to the day
1	Accurate to within 1 day either side of date coded.
2	Accurate to within 3 days either side of date coded.
3	Accurate to within 1 week either side of date coded.
4	Accurate to within 2 weeks either side of date coded.
5	Accurate to within 6 weeks either side of date coded.
6	Accurate to within 3 months either side of date coded.

Accuracy of date Code	Meaning
7	Accurate to within 6 months either side of date coded.
8	Accurate to within some years only
9	Date of earliest possible use of ring (EURING for details)

For the circumstances, see the EURING pdf. Here are the numbers for the various categories

```
table(drecov$Circumstances_Euring_code)
```

```
##
##   1   2  11  20  28  29  32  35  40  43  46  48  50  58  62  63
## 110   2   7  14   7  25   3   1  23  17   5   1  23  50   1   1
```

———————————— Old codes ————————————

AGE Code	Meaning
100	unfledged young
101	unfledged young at the nest
501	adult at the nest

RECOVERY Code	Meaning
100	found dead
120	found dead for a long time
121	found dead with one tag only?
146	found dead just outside the nest
5700	read colourmark
981,996	found injured and had to kill it