Fitting rates of change

Prediction C and D

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Overview

This report investigates the estimation of the rates of change between seasons. The data is in a similar structure as historically used for estimation of numerical and functional responses.

Introduction

Generally look at thesis drafts here.

These files are the supporting documetation to the data-wrangling code in the Beech forest manuscript here.

But there is also many other supporting resources and less formal tutorials on my website.

Methods

This report breaks down the parameter estimates from the bayesian hierarical model in the context of our predictions and the data we collected.

Data

First the data for each parameter needs to be extracted and plotted. It can be hard to extract the information needed from a Bayesian output so I have left this for another vignette. For now I have just extracted the needed inforamtion for this paper.

I Have used the following two datasets generated from the `Davidson_2019_Data_warngling.RMD` file

```
# A tibble: 144 x 31
       N  se.N lcl.N ucl.N var   grid   trip grid.n trip.no valley control
   <dbl> <dbl> <dbl> <dbl> <chr> <chr> <dbl>  <dbl>   <dbl> <chr>  <chr>
 1  85.2  17.3    53   114 N[1,~ egl ~     1      1       1 egl    control
 2 141.   24.8   103   200 N[2,~ egl ~     2      1       2 egl    control
 3 126.   15.7   100   162 N[3,~ egl ~     3      1       3 egl    control
 4  23.8   1.66   22    28 N[4,~ egl ~     4      1       4 egl    control
 5  89.5  18.5    57   125 N[5,~ egl ~     5      1       5 egl    control
 6 133.   24.6    88   179 N[6,~ egl ~     6      1       6 egl    control
 7 122.   18.1    93   164 N[7,~ egl ~     7      1       7 egl    control
 8  31.7   4.55   25    43 N[8,~ egl ~     8      1       8 egl    control
 9  17.8   3.50   13    26 N[9,~ egl ~     9      1       9 egl    control
10   1.73  1.48    0     5 N[10~ egl ~    10      1      10 egl    control
# ... with 134 more rows, and 20 more variables: Valley <fct>, year <dbl>,
#   month <chr>, cum.seed <dbl>, seed.account.N <dbl>, log.seed <dbl>,
#   valley.rep <chr>, grid.rats <chr>, Conditions <chr>, grouping.1 <chr>,
#   grouping.2 <chr>, grouping.3 <chr>, grouping.4 <chr>,
#   true.date <date>, treat.six <chr>, Rats <chr>, Control <chr>,
#   Date <date>, Treatments <chr>, Prediction <chr>
```

Style points

- valley = `egl` and `hol`
- Valley = `eglinton` and `hollyford`
- Control =
- Control =
- trip = trip.no
- true.date = Date
- var = raw data parameter

Reduce dataset

```
# A tibble: 144 x 9
        N lcl.N ucl.N var     grid   Control Valley    trip grid.n
    <dbl> <dbl> <dbl> <chr>   <chr>  <chr>   <fct>    <dbl>  <dbl>
 1  85.2     53   114 N[1,1]  egl M1 Yes     Eglinton     1      1
 2 141.     103   200 N[2,1]  egl M1 Yes     Eglinton     2      1
 3 126.     100   162 N[3,1]  egl M1 Yes     Eglinton     3      1
 4  23.8     22    28 N[4,1]  egl M1 Yes     Eglinton     4      1
 5  89.5     57   125 N[5,1]  egl M1 Yes     Eglinton     5      1
 6 133.      88   179 N[6,1]  egl M1 Yes     Eglinton     6      1
 7 122.      93   164 N[7,1]  egl M1 Yes     Eglinton     7      1
 8  31.7     25    43 N[8,1]  egl M1 Yes     Eglinton     8      1
 9  17.8     13    26 N[9,1]  egl M1 Yes     Eglinton     9      1
10   1.73     0     5 N[10,1] egl M1 Yes     Eglinton    10      1
# ... with 134 more rows
```

Wrangling

```
# A tibble: 144 x 34
        N  se.N lcl.N ucl.N var   grid   trip grid.n trip.no valley control
    <dbl> <dbl> <dbl> <dbl> <chr> <chr> <dbl>  <dbl>   <dbl> <chr>  <chr>
 1  85.2  17.3     53   114 N[1,~ egl ~     1      1       1 egl    control
 2 141.   24.8    103   200 N[2,~ egl ~     2      1       2 egl    control
 3 126.   15.7    100   162 N[3,~ egl ~     3      1       3 egl    control
 4  23.8   1.66    22    28 N[4,~ egl ~     4      1       4 egl    control
 5  89.5  18.5     57   125 N[5,~ egl ~     5      1       5 egl    control
 6 133.   24.6     88   179 N[6,~ egl ~     6      1       6 egl    control
 7 122.   18.1     93   164 N[7,~ egl ~     7      1       7 egl    control
 8  31.7   4.55    25    43 N[8,~ egl ~     8      1       8 egl    control
 9  17.8   3.50    13    26 N[9,~ egl ~     9      1       9 egl    control
10   1.73  1.48     0     5 N[10~ egl ~    10      1      10 egl    control
# ... with 134 more rows, and 23 more variables: Valley <fct>, year <dbl>,
#   month <chr>, cum.seed <dbl>, seed.account.N <dbl>, log.seed <dbl>,
#   valley.rep <chr>, grid.rats <chr>, Conditions <chr>, grouping.1 <chr>,
#   grouping.2 <chr>, grouping.3 <chr>, grouping.4 <chr>,
#   true.date <date>, treat.six <chr>, Rats <chr>, Control <chr>,
#   Date <date>, Treatments <chr>, Prediction <chr>, n <dbl>,
#   rat.mna <dbl>, lag.rat.mna <dbl>
```

Extracting rates from model outputs

```
# A tibble: 144 x 38
        N  se.N lcl.N ucl.N var   grid   trip grid.n trip.no valley control
    <dbl> <dbl> <dbl> <dbl> <chr> <chr> <dbl>  <dbl>   <dbl> <chr>  <chr>
```

```
 1  85.2  17.3     53   114 N[1,~ egl ~     1      1       1 egl    control
 2 141.   24.8    103   200 N[2,~ egl ~     2      1       2 egl    control
 3 126.   15.7    100   162 N[3,~ egl ~     3      1       3 egl    control
 4  23.8   1.66    22    28 N[4,~ egl ~     4      1       4 egl    control
 5  89.5  18.5     57   125 N[5,~ egl ~     5      1       5 egl    control
 6 133.   24.6     88   179 N[6,~ egl ~     6      1       6 egl    control
 7 122.   18.1     93   164 N[7,~ egl ~     7      1       7 egl    control
 8  31.7   4.55    25    43 N[8,~ egl ~     8      1       8 egl    control
 9  17.8   3.50    13    26 N[9,~ egl ~     9      1       9 egl    control
10   1.73  1.48     0     5 N[10~ egl ~    10      1      10 egl    control
# ... with 134 more rows, and 27 more variables: Valley <fct>, year <dbl>,
#   month <chr>, cum.seed <dbl>, seed.account.N <dbl>, log.seed <dbl>,
#   valley.rep <chr>, grid.rats <chr>, Conditions <chr>, grouping.1 <chr>,
#   grouping.2 <chr>, grouping.3 <chr>, grouping.4 <chr>,
#   true.date <date>, treat.six <chr>, Rats <chr>, Control <chr>,
#   Date <date>, Treatments <chr>, Prediction <chr>, n <dbl>,
#   rat.mna <dbl>, lag.rat.mna <dbl>, mean.r <dbl>, se.r <dbl>,
#   lcl.r <dbl>, ucl.r <dbl>
```

Parameter dataset

```
# A tibble: 12 x 11
   Valley Control month dat.seed.mean dat.rat.mean dat.mice.min
   <fct>  <chr>   <chr>         <dbl>        <dbl>        <dbl>
 1 Eglin~ Yes     Aug           2.01          1.75        1.43
 2 Eglin~ Yes     Feb           0.473         5.5         0.967
 3 Eglin~ Yes     May           1.57          2.88        0.598
 4 Eglin~ Yes     Nov           2.01          2           0.560
 5 Holly~ No      Aug           1.33          5.38        1.20
 6 Holly~ No      Feb           0.707         4.62        5.83
 7 Holly~ No      May           1.12          3.77        0.429
 8 Holly~ No      Nov           1.45          4.5         0.481
 9 Holly~ Yes     Aug           1.90          3.67        2.32
10 Holly~ Yes     Feb           0.338         2.4         0.528
11 Holly~ Yes     May           1.62          5           1.51
12 Holly~ Yes     Nov           2.05          3.33        0.414
# ... with 5 more variables: dat.seed.min <dbl>, dat.rat.min <dbl>,
#   dat.mice.max <dbl>, dat.seed.max <dbl>, dat.rat.max <dbl>
```

Reconstructing parameter dataset

```
Observations: 48
Variables: 6
$ mean.b   <dbl> 0.46081204, -0.25878996, -0.16741136, -0.51423246, -0...
$ Control  <chr> "control", "no control", "control", "control", "no co...
$ Valley   <chr> "egl", "hol", "hol", "egl", "hol", "hol", "egl", "hol...
$ month    <chr> "Feb", "Feb", "Feb", "May", "May", "May", "Aug", "Aug...
$ para     <fct> Intercept, Intercept, Intercept, Intercept, Intercept...
$ Estimate <dbl> 0.46081204, -0.25878996, -0.16741136, -0.51423246, -0...
```

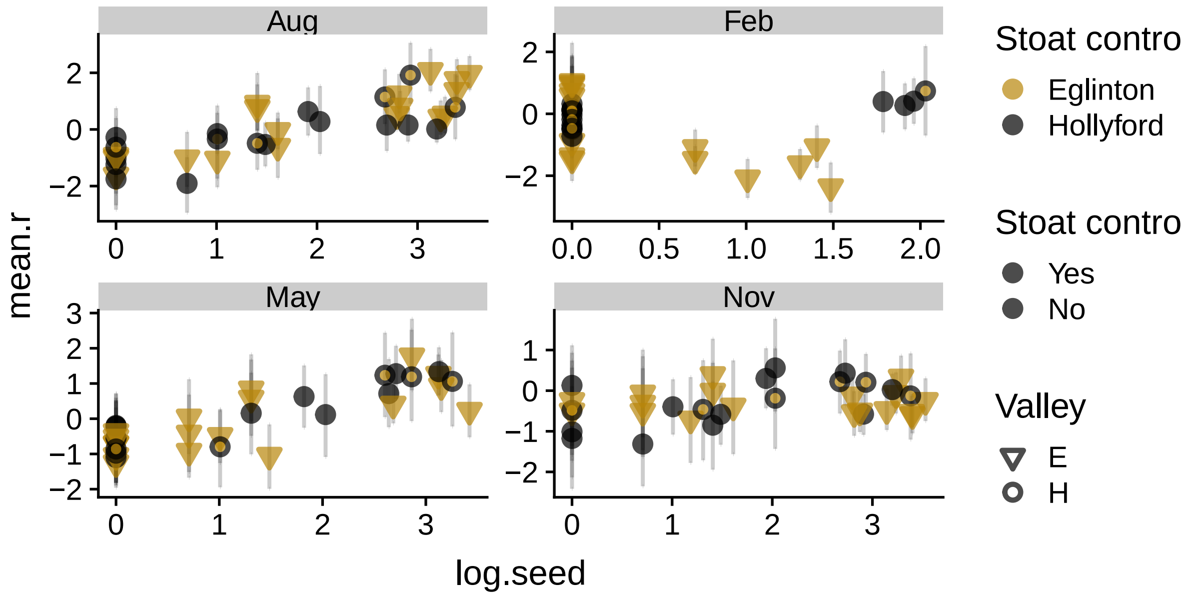
Output datasets for modelling

- Parameter estimates: $n = \mathbf{48}$
- Rate of change: $n = \mathbf{136}$
- Abundance $n = \mathbf{144}$

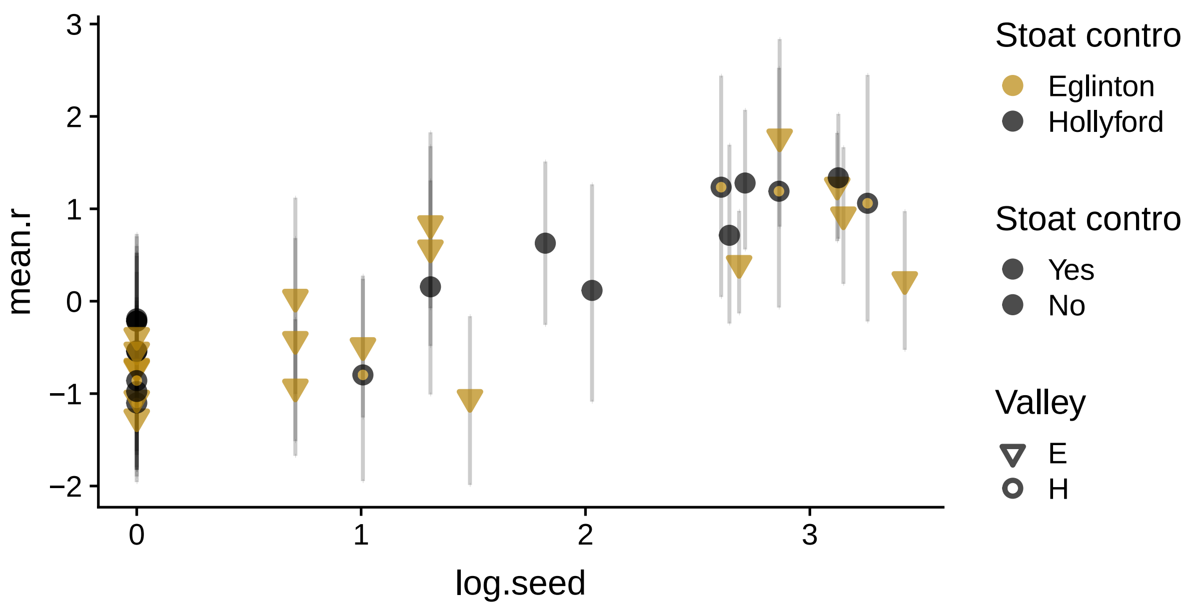
Plots

Overall there are many combinations of plots that can be produced from a bayesian hierarichal model.

Seed by month



All May data

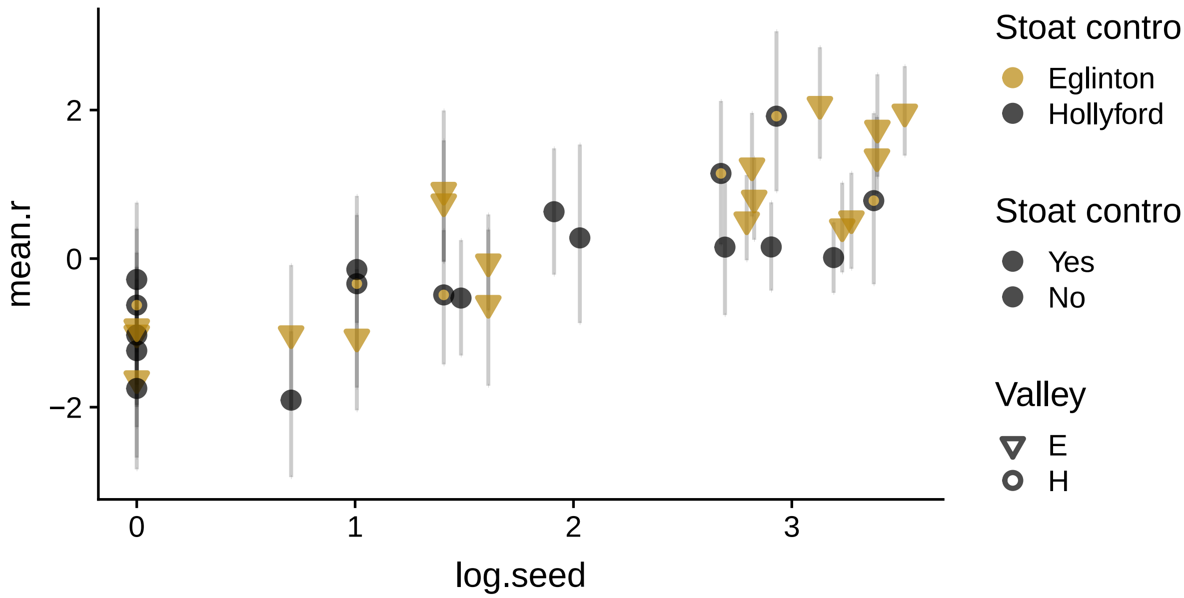


All August data

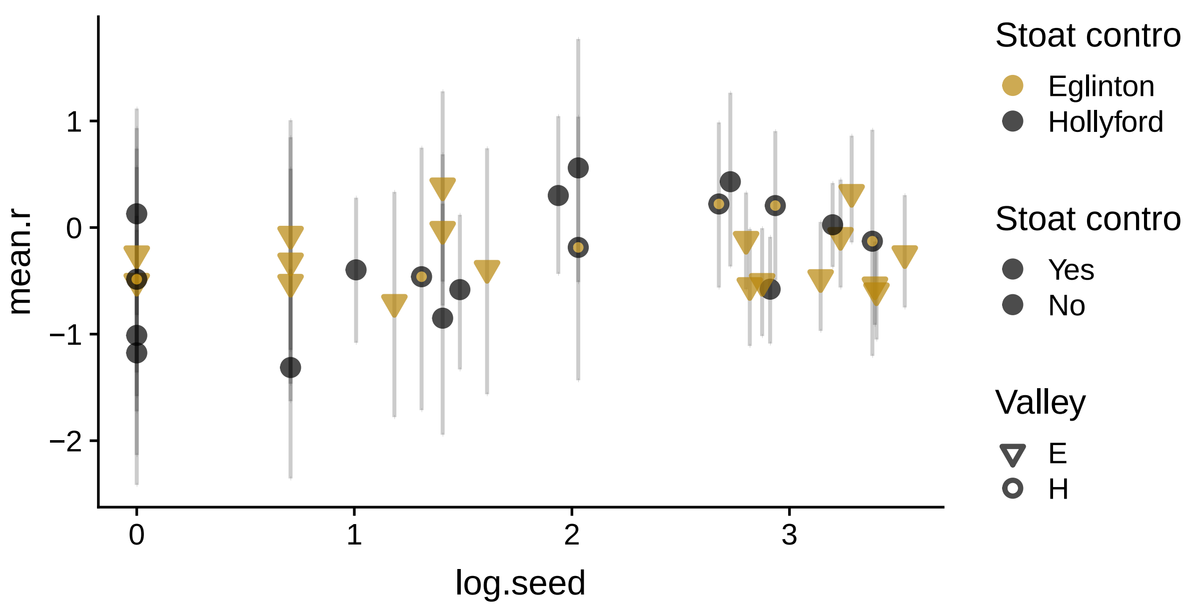
Autumn and Winter trends

- Rate of increase between Autumn and Winter

- (May and August rate of change)
- May mice abundace, seed and rat data



All November data



Estimating lines

This is where it gets really tricky. I have done this in a way that works. I am sure there are better ways to code this but that is for a later date.

My steps are:

1. `out.final1` and filter out only month of interest
2. Find max values

- background points

2. `spread` data across the different parameter estimates
3. reduce the `out.full.136` to only `feb`
4. Merge with parameter dataset (steps1-2)
5. Plot away using `ggplot2`

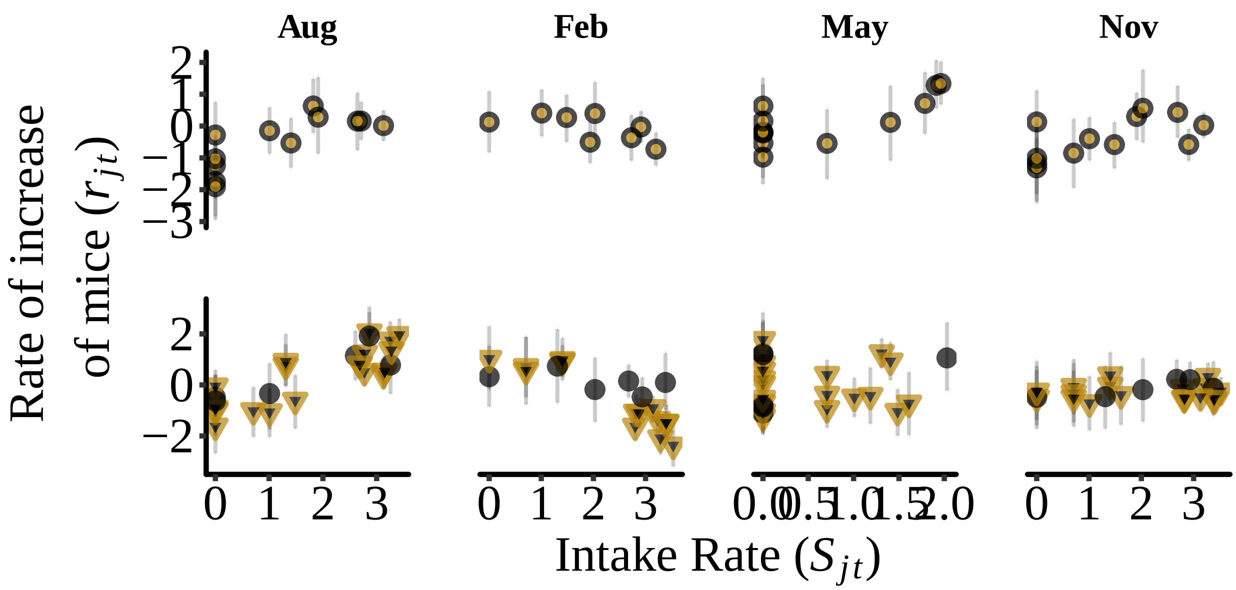
Seed

All months

This is ok becuase the average estimates of line will all use the same average to estimate the trend line for each parameter and variable.

It comes difficult to combine plots when we want to compare differences between varaibles and rate of increase for a fixed time (month = “).

Fitted plot



August trend

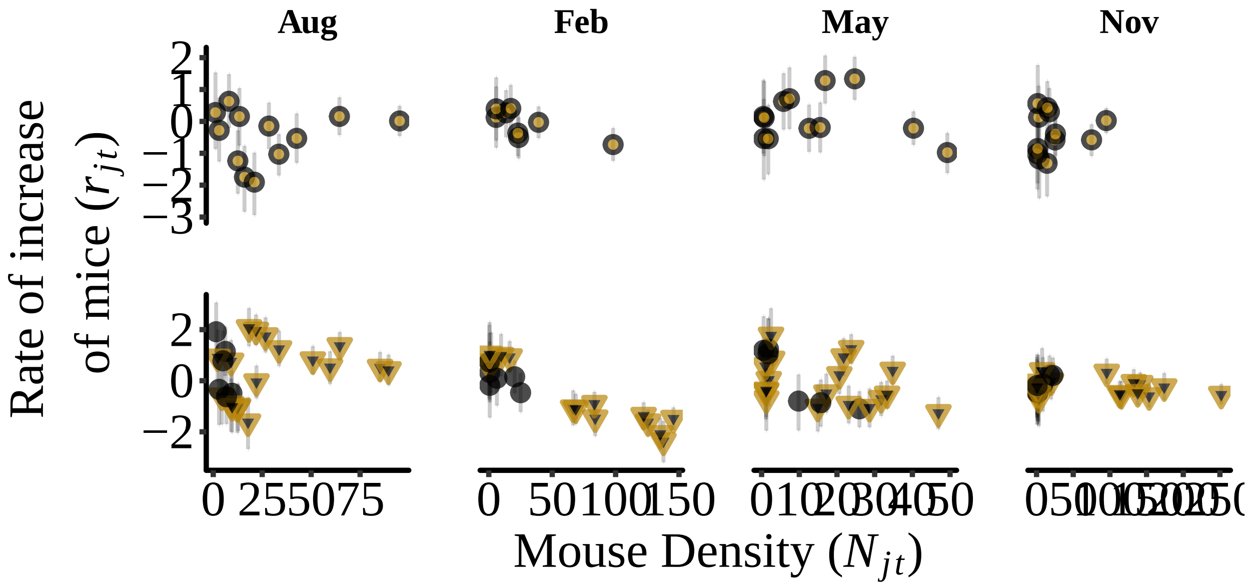
This phase (Autumn to winter) has the strongest effect of `intake rate` on the population growth rates (r_{jt}).

Fitted plot

Density

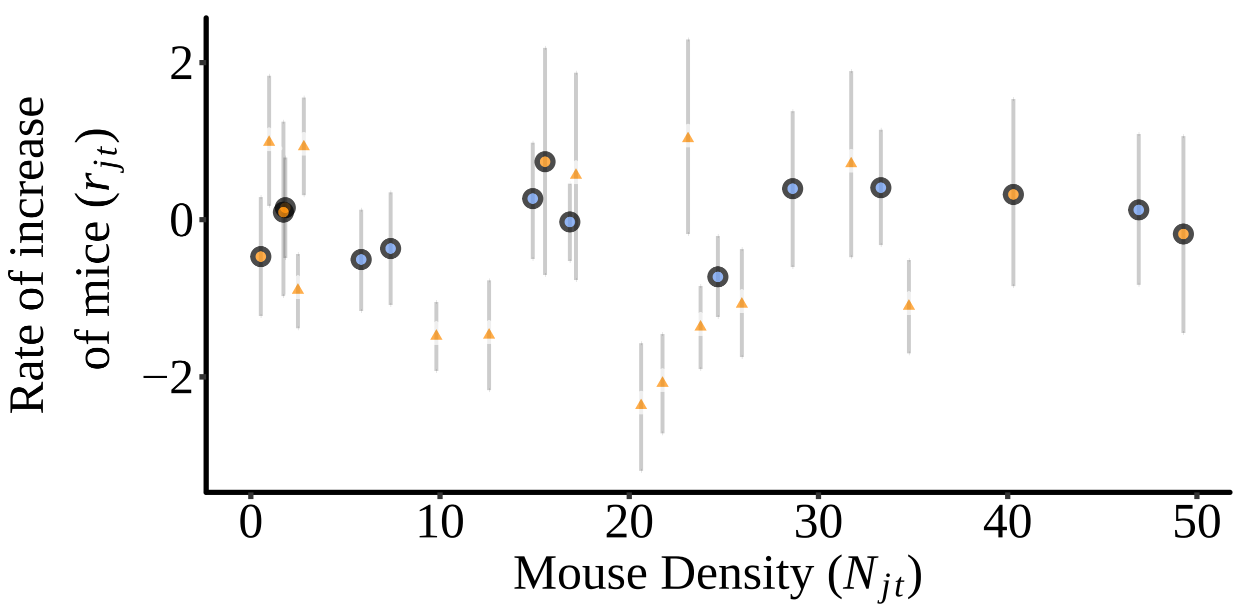
All months

Fitted plot



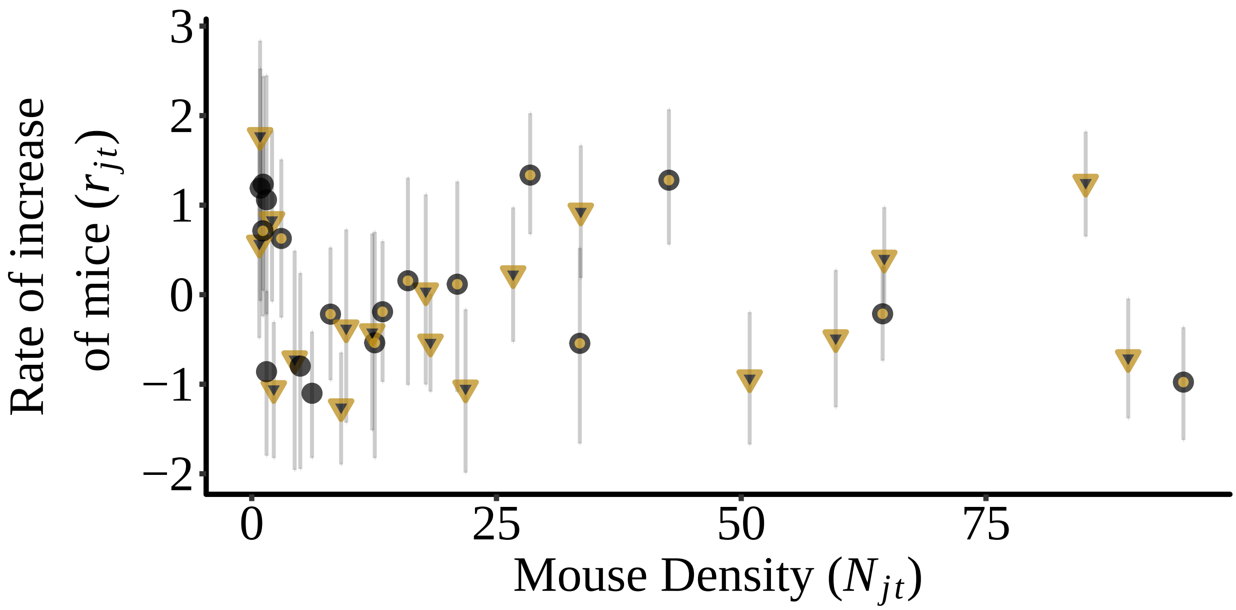
February

Fitted plot



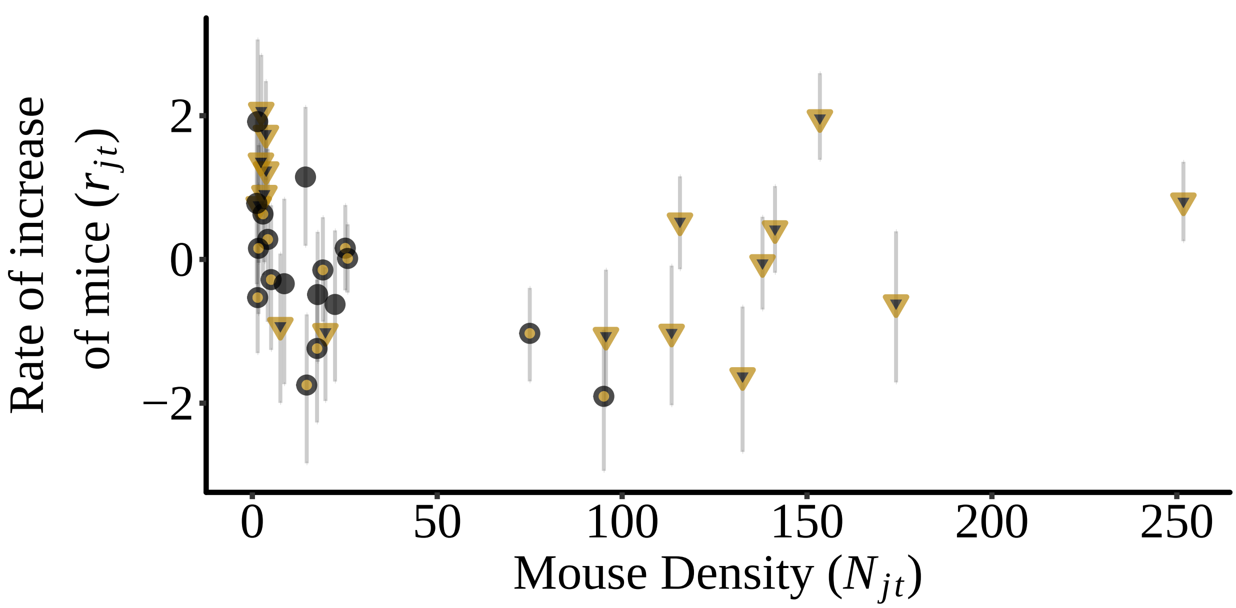
May

Fitted plot



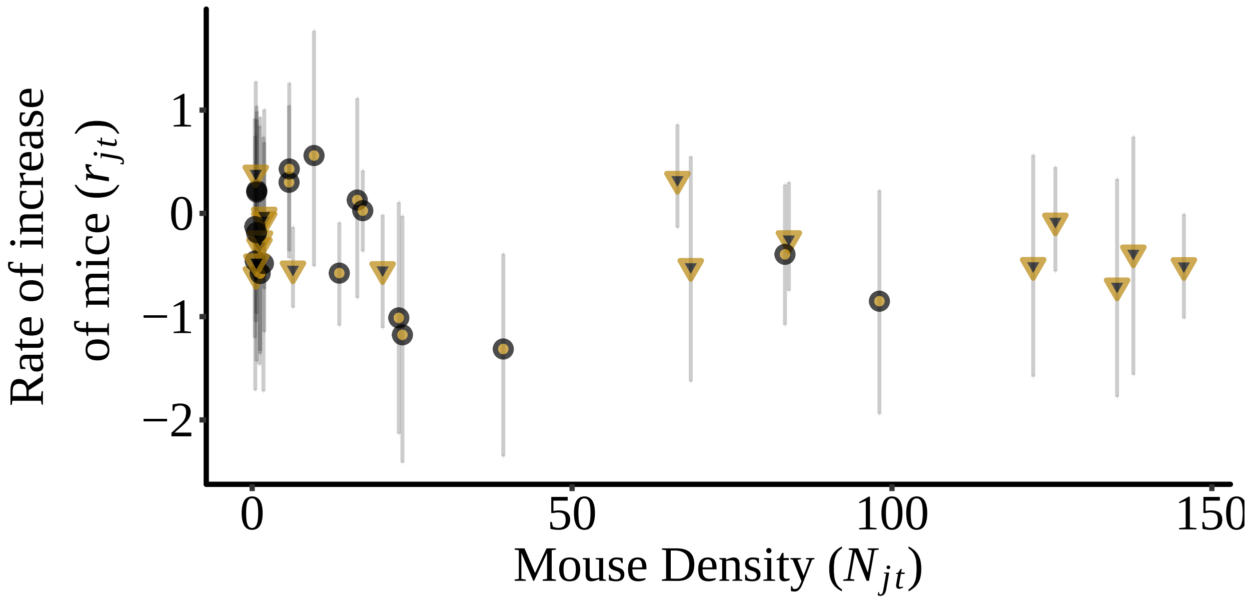
Aug

Fitted plot



Nov

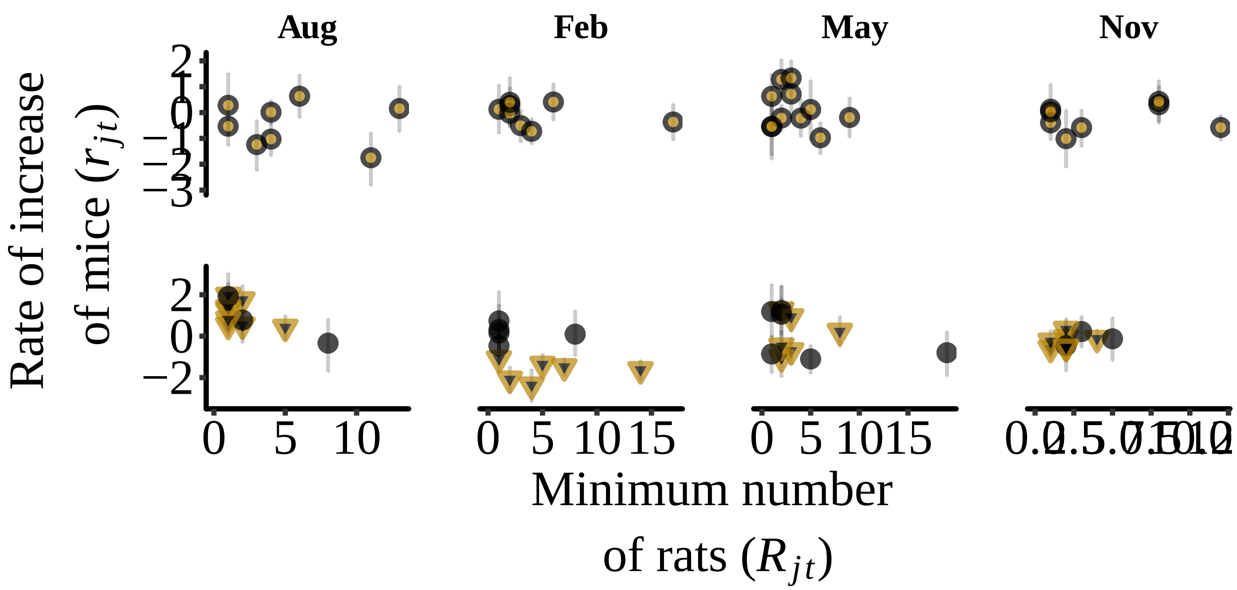
Fitted plot



Rats

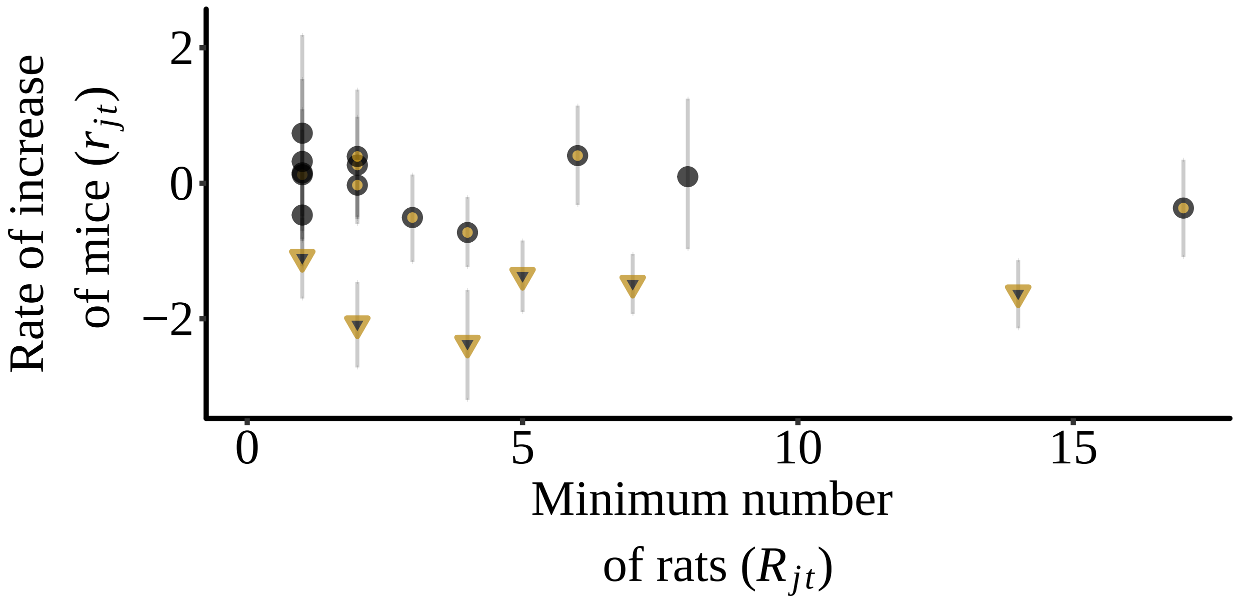
All months

Fitted plot

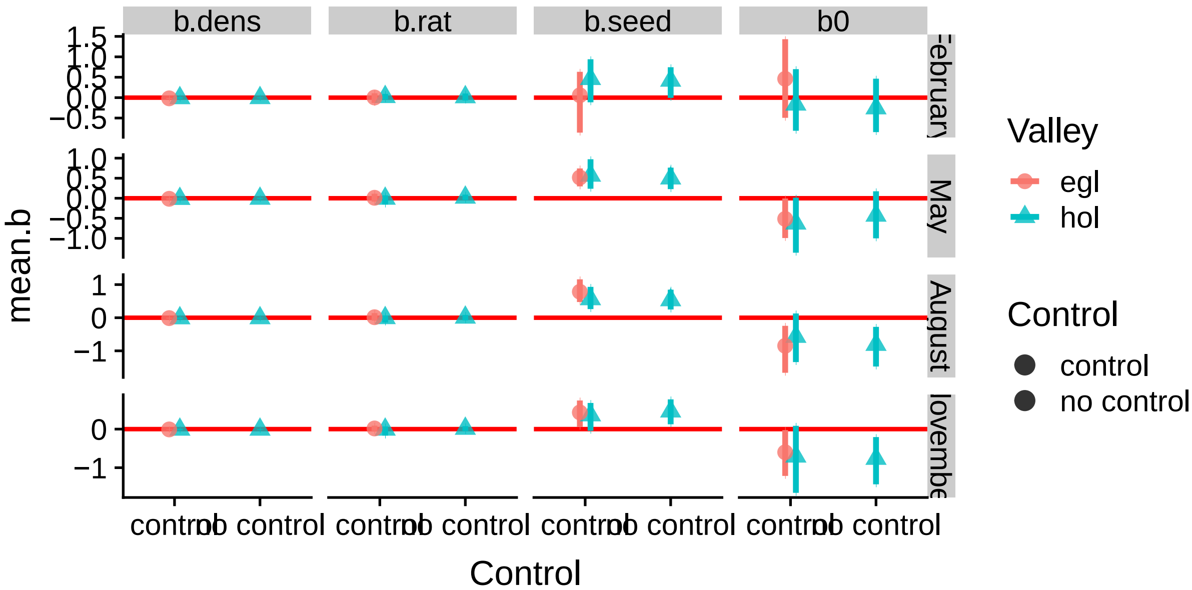


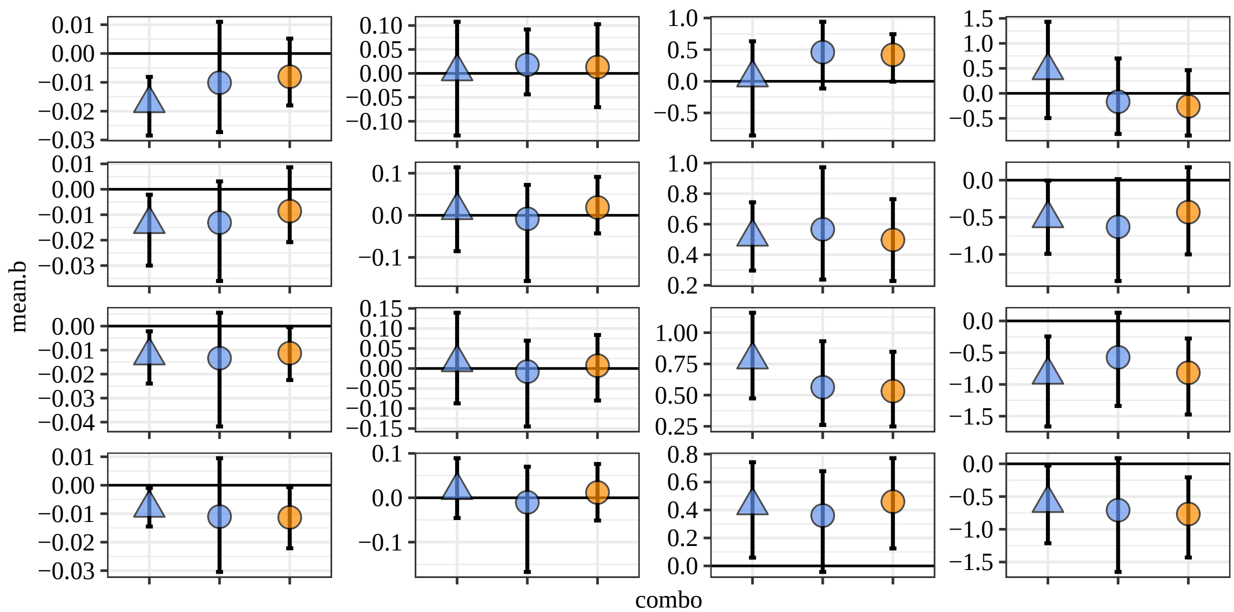
February

Fitted plot



Co-effiecents

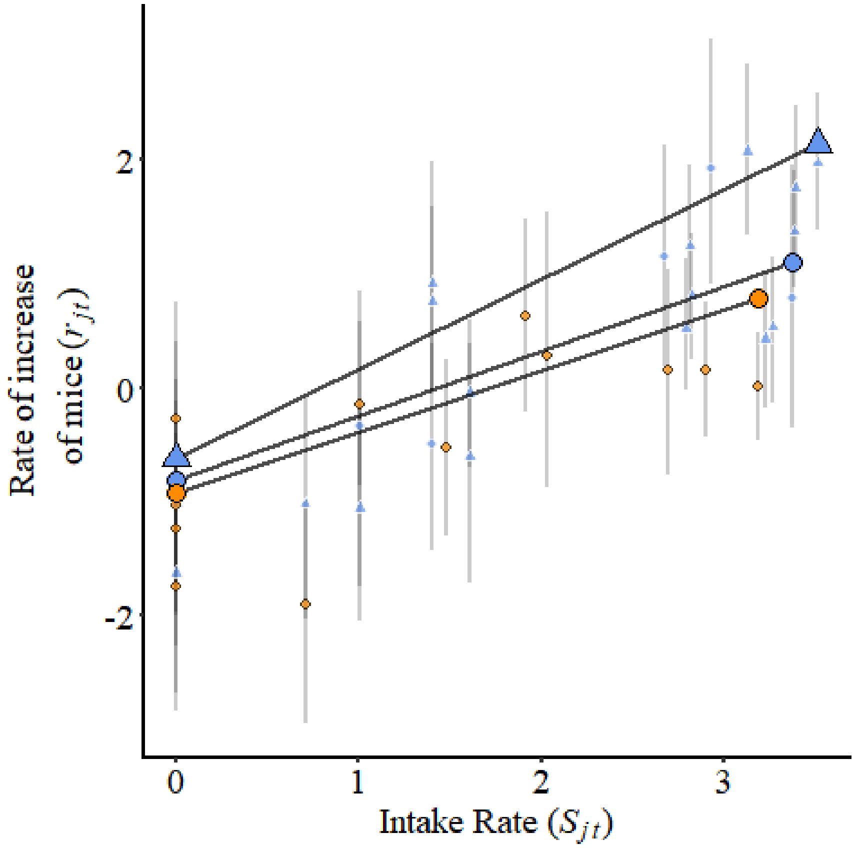




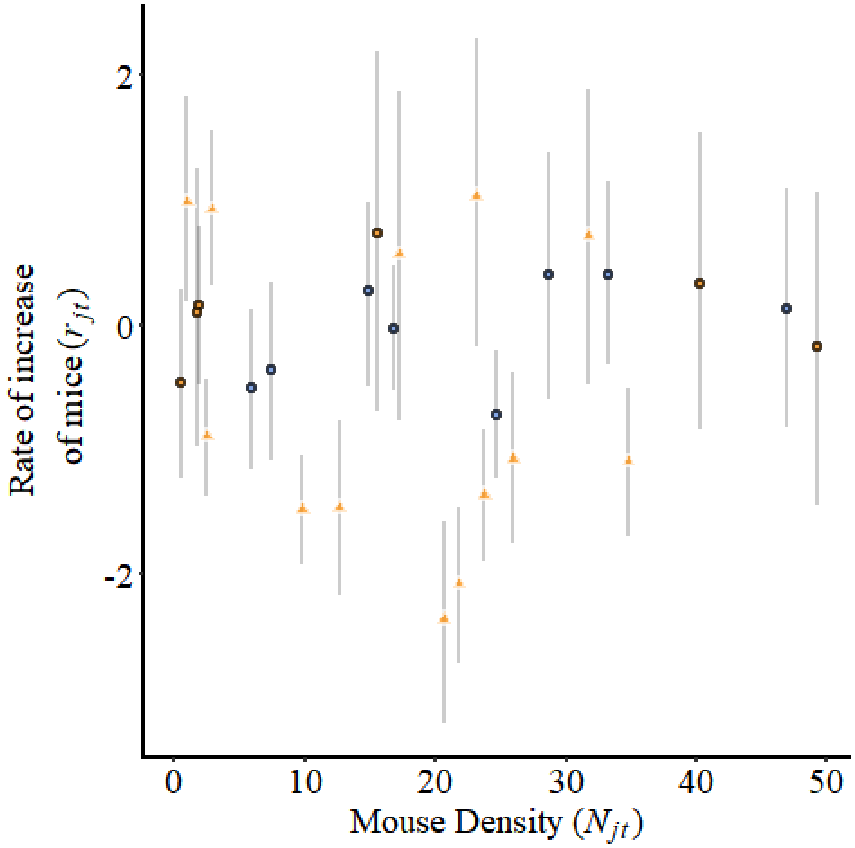
Results

Prediction C: Autumn and Winter trends

- Rate of increase between Autumn and Winter
- (May and August rate of change)
- May mice abundace, seed and rat data

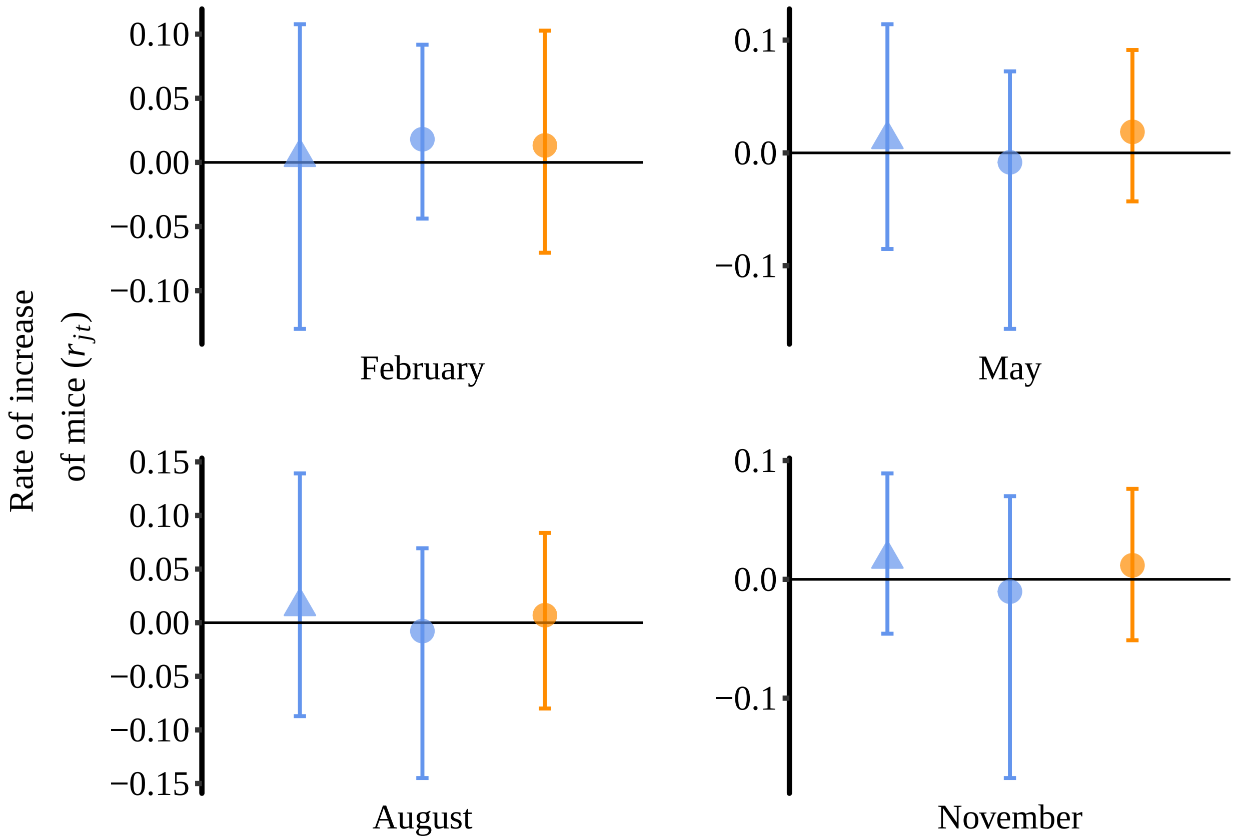

Rate of increase of mice (r_{jt})
2
0
-2
0
1
2
3
Intake Rate (S_{jt})

Prediction D: Spring and Summer trends

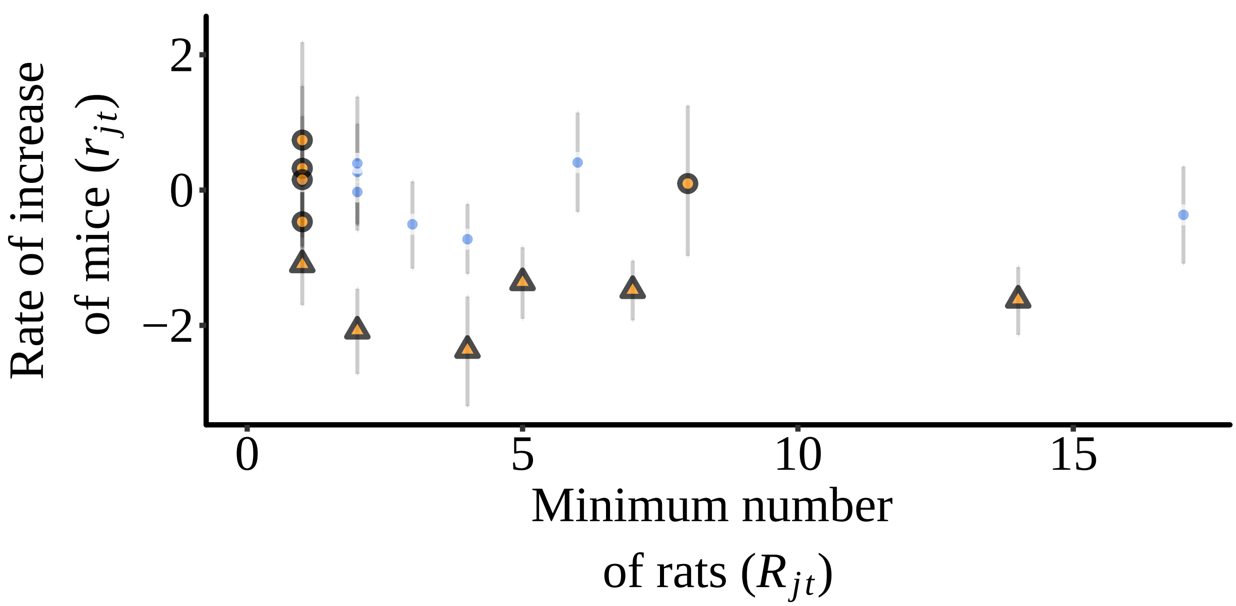


Prediction E: Effect of rats

Co-effiecents



Plot



`pdf`
`2`

`pdf`
`2`

Discussion

Saving

Saving

Must be `png`

Appendix

References