## EVE 225: Linear mixed modeling in ecology & evolution

### Taught by: Kate Laskowski (klaskowski@ucdavis.edu)

### Meeting times:

- Lecture: Tu/Thurs 1:40pm 3:00pm in Wellman 109
- Lab: Wednes 9:00am 9:50am in TLC 3211
- Office hours: Mondays 4:00 5:00pm in Storer 2206

**Overview & goals:** This course will cover the statistical theory and practical application of general linear models and general linear mixed models using examples drawn from evolutionary and behavioral ecology. It will focus specifically on the analysis of clustered data, e.g. samples taken from the same lake, or measurements made on the same animal, which are common in ecological and evolutionary research. Students will learn 1) the assumptions of traditional linear models and 2) how such hierarchical or nested data violate these assumptions. Students will then learn 3) to build, select and validate mixed models that include random effects and 4) how to interpret and report such results for publication. The lecture portion of the course will focus on building the students' conceptual framework of the underlying statistics of such models and the discussion/lab section of the course will focus on the statistical computing language R. The course is designed to build on knowledge students would have gained in a basic statistics (e.g. ANOVA, regression) or experimental design course and provide a firm conceptual foundation for students who wish to take more advanced statistical or modeling courses.

**Books & readings:** Many of the example datasets will come from textbooks such as Zuur et al.; however buying this book (or any of the other listed books) is not necessary for the course. All readings are considered supplementary to the course and to act as references in case there are topics you want more information on. The most appropriate papers (as I see them) are listed in the topics table below and all these pdfs are available in the Class Readings folder. The Files section has many more papers that you may find useful grouped by topic - have a look!

<u>**Pre-requisites:**</u> Comfortable with R – students must be able to load packages, import data and have some understanding of basic coding in R. Registered students will be required to download and install R and several example data sets (links provided prior to course start).

Basic statistics – this course will assume knowledge of basic statistical concepts such as means, variances, covariates, etc. A basic understanding of t-tests, ANOVAs, regressions is strongly encouraged.

Data sets – students who have datasets that may be appropriate for use in the course should prepare the datasets to be shared. This includes formatting them into a "tidy" format (each observation is a row; "long" format) and being able to explain the structure and motivation of the study. Note: not all datasets may be able to be analyzed; this will be determined at the discretion of the instructor.

Attendance policy: All lectures and labs will be held in person. There is a high demand for this course, with a long wait list so in order to guarantee your spot, you must attend the first lecture and lab meetings (January 10 & 11)! After this, I will not be taking attendance, but please be aware that you are expected to make every effort to attend in person during designated 'group work' days. If you need to be absent for these days, you'll need to make arrangements with your group members. Participation in group work will be evaluated through the group member rating that each member will submit with their final report. Group member ratings are worth 15% of the total grade so if someone is rated as not participating and contributing as expected, this can drop your score by an entire letter grade.

**Final projects:** A big component of this class is hands-on data analysis. The final project will be done in small groups by data provided by one of the group members. I will ultimately decide whether a dataset is appropriate for use in the final project and not all datasets may be chosen. Even if yours it not chosen, please know that you are still expected to participate fully in your group's analysis. This group work is consistently listed as one of the most valuable experiences by past students, even when they are analyzing someone else's data.

The goal of the final project is to give you experience conducting mixed model analyses, communicating your methods and results and then critiquing the analyses of others. We will build up to the final project by first conducting guided analyses in lab. Then you will perform an independent analysis with your group and write this up including the motivating questions, methods and results. This first draft will go through a round of 'peer review' with another group. Rubrics will be provided in class for the expectations of what should be included in the report. After this review, you will have an opportunity to revise your final report before submission to me. Finally, you will also provide a 'rating' for your fellow group members; this is done to help ensure equal commitment and contribution by each member of the group (i.e. no one does the lion's share and no one gets to freeload). Rubrics will be provided in class for expectations for each draft, the peer review process and the group member rating.

Grading: Letter grading.

| Component                               | Due date                           | Amount of grade |
|---|------------------------------------|-----------------|
| 'Practice' analysis report              | Emailed to Kate 11:59pm Feb 17     | 20%             |
| Independent analysis                    |                                    |                 |
| - Initial draft                         | Printed & brought to class March 9 | 25%             |
| - Final draft                           | Emailed to Kate 11:59pm March 21   | 40%             |
| <ul> <li>Group member rating</li> </ul> | (submitted with final draft)       | 15%             |

<u>Class expectations and working together:</u> Everyone is coming into this course from different fields and with different prior knowledge of and relationship towards statistics. The goal of this course is to give you a better foundation and confidence in doing basic (and not so basic) linear statistical modeling. This foundation and confidence can only come if you are honest about your own level of understanding. I would rather we discuss basic concepts in class then have folks feel left behind and get less out of the course than they otherwise could.

<u>Sickness/Care responsibilities/absences</u>: I understand that, especially during this global pandemic, everyone has unique situations and responsibilities which are constantly changing. My primary goal is to support you and your learning and I know that doing so sometimes requires flexibility. If you have illnesses, care responsibilities, or other scenarios that require you to be absent from class or are affecting your learning, please contact me so that we can work with you to develop a plan.

Even barring world events and personal situations, grad school can be a stressful time. If you are feeling especially stressed or just need to talk to someone, you should take advantage of the free counseling services offered on campus: <u>https://shcs.ucdavis.edu/services/counseling-services</u>. More links to mental health resources for graduate students can be found at: <u>https://grad.ucdavis.edu/resources/help-and-support/mental-health-and-counseling</u>. Finally, if you are living in Davis and you are having a hard time finding a healthy meal or getting basic necessities, please visit the UC Davis Pantry: <u>https://thepantry.ucdavis.edu/resources/faq-student-resources/</u>

# **Overall course learning objectives:**

## Students will be able to:

- Identify each parameter in a linear (mixed) and explain what it is estimating including the difference between 'fixed' and 'random' effects
- Translate between statistical models, experimental designs/research questions and graphs of results. (Your model = your question = your graph)
- Describe the assumptions of linear (mixed) models, how and when they are violated and what can be done to correct such violations
- Perform biologically-informed model selection analyses
- Clearly present and describe the methods used in analyses and the results in written format similar to what would be done in a scientific manuscript
- Perform constructive peer review of the methods and results of other researchers
- Use google more effectively to find the answers to statistical and coding problems

| Week 1<br>Jan 10 - 12Conceptual and statistical difference<br>between categorical versus continuous<br>predictorsZuur Appendix A<br>Zuur & leno 2016.<br>Gelman & Hill Chapter 3<br>West et al. Chapter 2Linear model<br>parametersTranslating between research questions,<br>statistical models and results' graphsGelman & Hill Chapter 3<br>West et al. Chapter 2Week 2<br>Jan 17 - 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur a prendix A<br>Zuur Chapter 2Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 21 - Feb 2<br>Nodel<br>selectionModel selection philosophies<br>statisticallyHarrison et al. 2018<br>Harrison et al. 2018Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2010Week 6<br>Feb 7 - 9Familiarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2010<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2010Week 6<br>Feb 7 - 9Model interpretation including interaction<br>effects and buildi  | Week 1<br>Jan 10 - 12<br>InterpretConceptual and statistical difference<br>between categorical versus continuous<br>predictorsZuur & Appendix A<br>Zuur & leno 2016.<br>Gelman & Hill Chapter 3<br>West et al. Chapter 2Linear model<br>parametersTranslating between research questions,<br>statistical models and results' graphsZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Uset et al. Chapter 2Week 2<br>Jan 17 - 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Relationship between random effects,<br>degrees of freedom and replicationZuur Chapter 5<br>Sullivan et al. 1007<br>Schielzeth et al. 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 2018Week 4<br>Jan 31 - Feb 2<br>Types of research and how they differ<br>statisticallyModel selection with RIKZ data<br>Forstmeier & Schielzeth 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & Ieno. 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & Ieno. 2016<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2010<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2010<br>Schielzeth & Nakagawa 2013<br>Forstmeier  | Dates           | Topics   | Further readings             |
|---|---|-----------------|--|------------------------------|
| Jan 10 – 12between categorical versus continuous<br>predictorsZuur & leno 2016.<br>Gelman & Hill Chapter 3<br>West et al. Chapter 2Linear model<br>parametersTranslating between research questions,<br>statistical models and results' graphsWest et al. Chapter 2Lab 1: Identify and explain how to interpret<br>values in 'summary' (clam data)Zuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur Appendix A<br>Zuur Chapter 5<br>Sullivan et al. 2010model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationZuur Chapter 5<br>Sullivan et al. 2010Week 3<br>Jan 24 – 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology 'ls it fixed<br>or random effects'Week 4<br>Jan 31 – Feb 2<br>Model<br>selectionModel selection with RIKZ data<br>Harrison et al. 2018Harrison et al. 2018<br>Zuur Chapter 5<br>Zuur & leno 2016<br>Jager & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 – 9Ffects and building results' tablesHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth & Nakagawa 2013Week 5<br>Feb 7 – 9Familiarize yourselves with group work<br>research questionsHarr   | Jan 10 - 12between categorical versus continuous<br>predictorsZuur & leno 2016.<br>Gelman & Hill Chapter 3Jan 17 - 19Translating between research questions,<br>statistical models and results' graphsWest et al. Chapter 2Week 2Jan 17 - 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationZuur Chapter 2Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5Jan 31 - Feb 2<br>Types of research and how they differ<br>statisticallySulivan et al. 1999.<br>Dynamic Ecology 'ls it fixed<br>or random effect?"Week 4<br>Jan 31 - Feb 2<br>Types of research and how they differ<br>selectionModel selection philosophies<br>statisticallyHarrison et al. 2018<br>Zuur & leno 2016.<br>Jaaeger & Halliday 1998<br>Schielzeth text 5Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno 2016<br>Jaaeger & Halliday 1998<br>Schielzeth 2011<br>Bar et al. 2013Week 6<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Jaaeger & Halliday 1998<br>Schielzeth 2011<br>Bar et al. 2013Week 6<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013<br>Forstneier & Schielzeth 2011<br>Schielzeth & Nakagawa 2013<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance component  | Week 1          | Conceptual and statistical difference                                  | Zuur Appendix A              |
| Linear model<br>parameterspredictorsGelman & Hill Chapter 3<br>West et al. Chapter 2Linear model<br>parametersTranslating between research questions,<br>statistical models and results' graphsWest et al. Chapter 2Lab 1: Identify and explain how to interpret<br>values in 'summary' (clam data)Zuur Chapter 2Week 2<br>Jan 17 - 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur at 2010model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationZuur Chapter 5<br>Sullivan et al. 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2<br>Model<br>selectionModel selection philosophies<br>statisticallyHarrison et al. 2018<br>Zuur & leno 2016<br>Jaeger & Helliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Ffects and building results' tables<br>ffects and building results' tablesHarrison et al. 2018<br>Sullivan et al. 2016<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 6<br>InterpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2016<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2010<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2010Week 6<br>InterpretationFamiliarize yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010 </td <td>Linear model<br/>parameterspredictorsGelman &amp; Hill Chapter 3<br/>West et al. Chapter 2<br/>West et al. Chapter 2Linear model<br/>parametersTranslating between research questions,<br/>statistical models and results' graphsZuur Chapter 2<br/>Gelman &amp; Hill Chapter 3<br/>Jacqmin-Gadda et al. 2007Week 2<br/>Jan 17 – 19Assumptions of linear model and<br/>when/how they are violatedZuur Chapter 2<br/>Gelman &amp; Hill Chapter 3<br/>Jacqmin-Gadda et al. 2007<br/>Schielzeth et al. 2020<br/>Zuur Appendix A<br/>Zuur et al 2010Week 3<br/>Jan 24 – 26Conceptual and statistical difference<br/>between 'random' effects and 'fixed' effectsZuur Chapter 5<br/>Sullivan et al. 1999.<br/>Dynamic Ecology "Is it fixed<br/>or random effect?"<br/>Harrison et al. 2018Week 4<br/>Jan 31 – Feb 2Model selection philosophies<br/>Types of research and how they differ<br/>statisticallyHarrison et al. 2018<br/>Zuur &amp; leno 2016<br/>Jaeger &amp; Halliday 1998<br/>Schielzeth 2011<br/>Barr et al. 2013Week 5<br/>Feb 7 – 9Model interpretation including interaction<br/>effects and building results' tablesHarrison et al. 2018<br/>Zuur &amp; leno. 2016<br/>Jaeger &amp; Halliday 1998<br/>Schielzeth 2011<br/>Barr et al. 2013Week 5<br/>Feb 7 – 9Familiarize yourselves with group work<br/>research questionsHarrison et al. 2018<br/>Zuur &amp; leno. 2016<br/>Schielzeth &amp; Nakagawa 2013<br/>Forstnier &amp; Schielzeth 2010Week 6<br/>Feb 14 – 16Multiple variance components including<br/>nested and crossed effectsNakagawa &amp; Schielzeth 2010<br/>Nakagawa &amp; Schielzeth 2013Multiple<br/>variance<br/>research questionsSchielzeth 2013Nakagawa &amp; Schielzeth 2013MultipleEstimating proportion of variance explained<br/>(repeatability and R-squared for mixed<td>Jan 10 – 12</td><td>between categorical versus continuous</td><td>Zuur &amp; Ieno 2016.</td></td> | Linear model<br>parameterspredictorsGelman & Hill Chapter 3<br>West et al. Chapter 2<br>West et al. Chapter 2Linear model<br>parametersTranslating between research questions,<br>statistical models and results' graphsZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007Week 2<br>Jan 17 – 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 – 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 – Feb 2Model selection philosophies<br>Types of research and how they differ<br>statisticallyHarrison et al. 2018<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Jaeger & Halliday 1998<br>Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 – 9Familiarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013<br>Forstnier & Schielzeth 2010Week 6<br>Feb 14 – 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>research questionsSchielzeth 2013Nakagawa & Schielzeth 2013MultipleEstimating proportion of variance explained<br>(repeatability and R-squared for mixed <td>Jan 10 – 12</td> <td>between categorical versus continuous</td> <td>Zuur &amp; Ieno 2016.</td>  | Jan 10 – 12     | between categorical versus continuous                                  | Zuur & Ieno 2016.            |
| Linear model<br>parametersTranslating between research questions,<br>statistical models and results' graphsWest et al. Chapter 2Lab 1: Identify and explain how to interpret<br>values in 'summary' (clam data)Zuur Chapter 2Week 2<br>Jan 17 – 19Assumptions of linear model and<br>model<br>assumptionsZuur Chapter 2Relationship between random effects,<br>degrees of freedom and replicationZuur Appendix A<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jac 24 – 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology 'ls it fixed<br>or random effect?'<br>Harrison et al. 2018Week 4<br>Jan 17 – F9Model selection with RIKZ data<br>statisticallyHarrison et al. 2018Week 4<br>Jan 31 – Feb 2<br>SelectionModel selection philosophies<br>statisticallyHarrison et al. 2018<br>Zuur Chapter 5<br>Sullivan et al. 2016<br>Jaeger & Halliday 1998<br>Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 – 9Effects' analysis with owl dataset<br>research and building results' tablesHarrison et al. 2018<br>Zuur & leno 2016<br>Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 – 9Familiarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>interpretationFamiliarize yourselves into groups of<br><b>3-4 on selected datasets</b> Nakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010Week 6<br>interpretationMultiple variance components including<br>Practice' analysis with owl datasetNakagawa & Schielzeth 2010   | Linear model<br>parametersTranslating between research questions,<br>statistical models and results' graphsWest et al. Chapter 2Week 2<br>Jan 17 - 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effects<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology 'ls it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2<br>Nodel<br>selectionModel selection philosophies<br>tatisticallyHarrison et al. 2018<br>Sullivan et al. 2018Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Sullivan et al. 2018Week 6<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Sullivan et al. 2018<br>Uur & leno. 2016<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006<br>Schielzeth & Nakagawa 2013<br>Fostmeier & Schielzeth 2011<br>Barr et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>econdedEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>econdedNakagawa & Schielzeth 2013   |                 | predictors   | Gelman & Hill Chapter 3      |
| parametersTranslating between research questions,<br>statistical models and results' graphsLab 1: Identify and explain how to interpret<br>values in 'summary' (clam data)Zuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur Chapter 5<br>Schielzeth et al. 2020model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur Chapter 5Week 3<br>Ja 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>statisticallyHarrison et al. 2018<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth & Nakagawa 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>iffects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>iffects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>interpretationLab 5: 'Practice' analysis with owl dataset<br>By Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNak  | parametersTranslating between research questions,<br>statistical models and results' graphsLab 1: Identify and explain how to interpret<br>values in 'summary' (clam data)Zuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020Week 2<br>an 17 - 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationZuur chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology 'lis i fixed<br>or random effect?"<br>Harrison et al. 2018Introduction to<br>random effectsLab 3: model selection philosophies<br>tatisticallyHarrison et al. 2018<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth 2011<br>Barr et al. 2013Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>tatisticallyHarrison et al. 2018<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstneier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effects   | Linear model    |  | West et al. Chapter 2        |
| Statistical models and results' graphsLab 1: Identify and explain how to interpret<br>values in 'summary' (clam data)Week 2<br>Jan 17 - 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationZuur Chapter 5<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Ja 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>Types of research and how they differ<br>statisticallyHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur & Ieno 2016<br>Jaeger & Halliday 1998<br>Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & Ieno. 2016<br>Schielzeth 2011<br>Barr et al. 2018<br>Zuur & Ieno. 2016<br>Schielzeth & Nakagawa 2013<br>For Stmeier & Schielzeth 2011<br>Barr et al. 2018<br>Zuur & Ieno. 2016<br>Schielzeth & Nakagawa 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesWeek 6<br>interpretationLab 5: 'Practice' analysis with owl dataset<br>By Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6<br>both 14 = 15Multiple variance components including<br>For Stime and and croscod affortWeek 6<br>both 14 = 16Multiple variance comp  | Lab 1: Identify and explain how to interpret<br>values in 'summary' (clam data)Zuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007Week 2<br>Jan 17 - 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationZuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2<br>Week 5<br>selectionModel selection philosophies<br>tatisticallyHarrison et al. 2018<br>Zuur & leno 2016Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 6<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2010<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>companenteEstimating proportion of variance explained <br< td=""><td>parameters</td><td>Translating between research questions,</td><td></td></br<>  | parameters      | Translating between research questions,                                |                              |
| Lab 1: Identify and explain how to interpret<br>values in 'summary' (clam data)Zuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gada et al. 2007<br>Schielzeth et al. 2020<br>assumptionsWeek 2<br>assumptionsRelationship between random effects,<br>degrees of freedom and replication<br>Lab 2: graphically check assumptions (clam,<br>Loyn data); data explorationZuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>statisticallyHarrison et al. 2018<br>Zuur Chapter 5<br>Sullivan et al. 2018<br>Zuur Chapter 5<br>Zuur S leno 2016<br>Jaeger & Halliday 1998<br>Schielzetth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzetth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzetth & Nakagawa 2013Week 6<br>interpretationLab 5: 'Practice' analysis with owl dataset<br>By Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010Week 6<br>bet 4 = 16Multiple variance components includi   | Lab 1: Identify and explain how to interpret<br>values in 'summary' (clam data)Zuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jacqmin-Gadda et al. 2007<br>Model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jac 47 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is I fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>selectionHarrison et al. 2018<br>Zuur Chapter 5<br>Sullivan et al. 2018<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Bar et al. 2013<br>Whittingham et al 2006<br>sheet1Week 5<br>Feb 7 - 9Familiarize yourselves with group work<br>research questionsInterpretationLab 5: 'Practice' analysis with owl dataset<br>By Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsWuetiple<br>variance<br>ecomponentsSchielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>e  |                 | statistical models and results' graphs                                 |                              |
| Lab 1: Identify and explain how to interpret<br>values in 'summary' (clam data)Week 2<br>Jan 17 - 19Assumptions of linear model and<br>Men/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationGelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>Types of research and how they differ<br>statisticallyHarrison et al. 2018<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010Week 6<br>bet 4 and corected effect<br>week 6Multiple variance components including<br>selected and corected effectNakagawa & Schielzeth 2010  | Lab 1: Identify and explain how to interpret<br>values in 'summary' (clam data)Week 2<br>Jan 17 - 19Assumptions of linear model and<br>summary' (clam data)Zuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationSchielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5<br>Sullivan et al. 2018Model<br>selectionstatistically<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Model<br>selectionFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Lab 4: 'Practice' analysis with owl dataset<br>By Feb 2: Describe datasets in google<br>sheet!Week 5<br>Feb 7 - 9Familiarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>variance<br>variance<br>varianceMultiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2013   |                 |  |                              |
| Veek 2<br>Jan 17 - 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationSchielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Ja 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>statisticallyHarrison et al. 2018<br>Zuur Chapter 5<br>Sullivan et al. 2018Model<br>selectionStatistically<br>statisticallyJaeger & Halliday 1998<br>Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth 2011<br>Barr et al. 2013Week 6<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>interpretationFamiliarize yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010Week 6<br>bet 4 a 16Multiple variance components including<br>chied and corecide dataset<br>By Feb 2: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010   | Values in 'summary' (clam data)Week 2<br>Jan 17 - 19Assumptions of linear model and<br>Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur Chapter 5model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationGelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur Chapter 5Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2<br>SelectionModel selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur All 2018<br>Zuur Chapter 5<br>Zuur Chapter 4<br>Jacger 8 Halliday 1998<br>Schielzeth 2011<br>Barr et al. 2018<br>Zuur 5<br>Schielzeth 2011<br>Barr et al. 2018<br>Zuur 6<br>Schielzeth 2011<br>Barr et al. 2018<br>Zuur 8<br>Lab 5: 'Practice' analysis with owl dataset<br>By Feb 2: Assign yourselves into groups of<br>3-4 on selected datasetsHarrison et al. 2018<br>Chielzeth & Nakagawa 2013<br>Schielzeth 2010<br>Nakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2011<br>Nakagawa & Sc  |                 | Lab 1: Identify and explain how to interpret                           |                              |
| Week 2<br>Jan 17 - 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Relationship between random effects,<br>degrees of freedom and replicationZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>statisticallyZuur Chapter 5<br>Sullivan et al. 2018Week 5<br>Feb 7 - 9Types of research and how they differ<br>statisticallyZuur Chapter 5<br>Sullivan et al. 2018Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth & Nakagawa 2013Model<br>selectionFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>by Feb 2: Assign yourselves with owl datasetHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>modelFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>by Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010Week 6<br>by Heth = 16Multiple variance components including<br>Duranse & Schielzeth 2010   | Week 2<br>Jan 17 - 19Assumptions of linear model and<br>when/how they are violatedZuur Chapter 2<br>Gelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationGelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology 'fis it fixed<br>or random effect?''<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>Types of research and how they differ<br>statisticallyHarrison et al. 2018<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Jaeger & Halliday 1998<br>Schielzeth 2011<br>Barr et al. 2013Week 6<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013<br>Forstneier & Schielzeth 2010<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>componentEstimating proportion of variance explained<br>(repeatability and R-squared for mixedNakagawa & Schielzeth 2013  |                 | values in 'summary' (clam data)  |                              |
| Jan 17 - 19when/how they are violatedGelman & Hill Chapter 3<br>Jacqmin-Gada et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationGelman & Hill Chapter 3<br>Jacqmin-Gada et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Lab 2: graphically check assumptions (clam,<br>Loyn data); data explorationZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Introduction to<br>random effectsLab 3: model selection with RIKZ dataDynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5Model<br>selectionLab 4: 'Practice' analysis with owl dataset<br>By Feb 2: Describe datasets in google<br>sheet!Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2018Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013  | Jan 17 - 19when/how they are violatedGelman & Hill Chapter 3<br>Jacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>selectionHarrison et al. 2018<br>Zuur Chapter 5<br>Sullivan et al. 2018Model<br>selectionStatisticallyJacger & Halliday 1998<br>Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>companenterEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>companenterNakagawa & Schielzeth 2013  | Week 2          | Assumptions of linear model and  | Zuur Chapter 2               |
| model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationJacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 – 26Lab 2: graphically check assumptions (clam,<br>Loyn data); data explorationZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effects"Week 4<br>Jan 31 – Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effects"Model<br>selectionTypes of research and how they differ<br>statisticallyZuur Chapter 5<br>Sullivan et al. 2018<br>Zuur Chapter 5<br>Zuur Chapter 5<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 5<br>Feb 7 – 9Familiarize yourselves with group work<br>research questionsLab 5: 'Practice' analysis with owl dataset<br>By Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6<br>Multiple variance components including<br>Schielzeth 2010Week 6<br>Ceh 14 – 16 <td>model<br/>assumptionsRelationship between random effects,<br/>degrees of freedom and replicationJacqmin-Gadda et al. 2007<br/>Schielzeth et al. 2020<br/>Zuur Appendix A<br/>Zuur et al 2010Week 3<br/>Jan 24 - 26Lab 2: graphically check assumptions (clam,<br/>Loyn data); data explorationZuur Chapter 5<br/>Sullivan et al. 1999.<br/>Dynamic Ecology "Is it fixed<br/>or random effectsIntroduction to<br/>random effectsLab 3: model selection with RIKZ dataZuur Chapter 5<br/>Sullivan et al. 2018Week 4<br/>Jan 31 - Feb 2Model selection philosophiesHarrison et al. 2018<br/>Zuur Chapter 5Model<br/>selectionLab 4: 'Practice' analysis with owl datasetBar et al. 2013<br/>Zuur &amp; leno 2016<br/>Jaeger &amp; Halliday 1998<br/>Schielzeth &amp; Nakagawa 2013<br/>Forstmeier &amp; Schielzeth 2011<br/>Bar et al. 2018Week 5<br/>Feb 7 - 9Model interpretation including interaction<br/>effects and building results' tablesHarrison et al. 2018<br/>Zuur &amp; leno. 2016<br/>Jaeger &amp; Halliday 1998<br/>Schielzeth &amp; Nakagawa 2013Week 6<br/>Feb 7 - 9Familiarize yourselves with group work<br/>research questionsHarrison et al. 2018<br/>Zuur &amp; leno. 2016<br/>Jaeger &amp; Halliday 1998<br/>Schielzeth &amp; Nakagawa 2013Week 6<br/>Feb 14 - 16Multiple variance components including<br/>nested and crossed effectsNakagawa &amp; Schielzeth 2010<br/>Nakagawa &amp; Schielzeth 2013Multiple<br/>variance<br/>componenter<br/>repeatability and R-squared for mixed<br/>componenterNakagawa &amp; Schielzeth 2013</td> <td>Jan 17 – 19</td> <td>when/how they are violated</td> <td>Gelman &amp; Hill Chapter 3</td>   | model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationJacqmin-Gadda et al. 2007<br>Schielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Lab 2: graphically check assumptions (clam,<br>Loyn data); data explorationZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effectsIntroduction to<br>random effectsLab 3: model selection with RIKZ dataZuur Chapter 5<br>Sullivan et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5Model<br>selectionLab 4: 'Practice' analysis with owl datasetBar et al. 2013<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Bar et al. 2018Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 7 - 9Familiarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>componenter<br>repeatability and R-squared for mixed<br>componenterNakagawa & Schielzeth 2013  | Jan 17 – 19     | when/how they are violated   | Gelman & Hill Chapter 3      |
| model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationSchielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5Model<br>selectionTypes of research and how they differ<br>statisticallyZuur Chapter 5<br>Sullivan et al. 2018<br>Zuur Chapter 5Model<br>selectionLab 4: 'Practice' analysis with owl dataset<br><i>By Feb 2: Describe datasets in google<br/>sheet1</i> Harrison et al. 2018<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2018<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010Week 6<br>Exh 14 = 16Multiple variance components including<br>Austagawa & Schielzeth 2010Nakagawa & Schielzeth 2010  | model<br>assumptionsRelationship between random effects,<br>degrees of freedom and replicationSchielzeth et al. 2020<br>Zuur Appendix A<br>Zuur et al 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effects<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>statisticallyHarrison et al. 2018<br>Uur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2018Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>componenteEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>componenteNakagawa & Schielzeth 2013  |                 |  | Jacqmin-Gadda et al. 2007    |
| assumptionsdegrees of freedom and replicationZuur Appendix A<br>Zuur et al 2010Lab 2:graphically check assumptions (clam,<br>Loyn data); data explorationZuur Chapter 5Week 3Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5Jan 24 - 26between 'random' effects and 'fixed' effectsSullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4Model selection philosophiesHarrison et al. 2018Jan 31 - Feb 2Types of research and how they differ<br>statisticallyZuur Chapter 5Model<br>selectionSchielzeth & Nakagawa 2013By Feb 2: Describe datasets in google<br>sheet1Forstmeier & Schielzeth 2011<br>Barr et al. 2018Week 5<br>Feb 7 - 9Familiarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010Week 6<br>Exh 14 = 16Multiple variance components including<br>Schielzeth 2012Nakagawa & Schielzeth 2010   | assumptionsdegrees of freedom and replicationZuur Appendix A<br>Zuur et al 2010Lab 2:graphically check assumptions (clam,<br>Loyn data); data explorationZuur Chapter 5Week 3Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5Introduction to<br>random effectsLab 3: model selection with RIKZ data<br>Harrison et al. 2018Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>Types of research and how they differ<br>statisticallyHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur Chapter 5<br>Zuur Chapter 5<br>Zuur Chapter 5<br>Zuur Chapter 5<br>Zuur Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>ormonemeterEstimating proportion of variance explained<br>(repeatability and R-squared for mixedNakagawa & Schielzeth 2013   | model           | Relationship between random effects,                                   | Schielzeth et al. 2020       |
| Lab 2:<br>Loyn data); data explorationZuur et al 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>Types of research and how they differ<br>statisticallyHarrison et al. 2018<br>Zuur Chapter 5Model<br>selectionLab 4: 'Practice' analysis with owl dataset<br>sheet!Jarr et al. 2013<br>Zuur & leno 2016<br>Jarger & Halliday 1998<br>Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>sheet!Familiarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>by Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010Week 6<br>beh 14 = 16Multiple variance components including<br>Nakagawa & Schielzeth 2010   | Lab 2:graphically check assumptions (clam,<br>Loyn data); data explorationZuur et al 2010Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Introduction to<br>random effectsLab 3: model selection with RIKZ dataDynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>Types of research and how they differ<br>statisticallyHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Model<br>selectionLab 4: 'Practice' analysis with owl dataset<br>By Feb 2: Describe datasets in google<br>sheet!Harrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2018Week 5<br>Feb 7 - 9Familiarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>remenementEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>remenementNakagawa & Schielzeth 2013   | assumptions     | degrees of freedom and replication                                     | Zuur Appendix A              |
| Lab 2:graphically check assumptions (clam,<br>Loyn data); data explorationWeek 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>Types of research and how they differ<br>statisticallyHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur & leno 2016Model<br>selectionLab 4: 'Practice' analysis with owl datasetSchielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno 2016Week 6<br>be 5: Practice' analysis with owl datasetFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>both 14 - 16Multiple variance components including<br>accesed affectr.Nakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010  | Lab 2:<br>graphically check assumptions (clam,<br>Loyn data); data explorationZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effectsIntroduction to<br>random effectsLab 3: model selection with RIKZ dataZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 – Feb 2Model selection philosophies<br>Types of research and how they differ<br>statisticallyHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 1 – 16Familiarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>InterpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>InterpretationFamiliarize yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>reseand questionEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>reseaned for mixedNakagawa & Schielzeth 2013   |                 |  | Zuur et al 2010              |
| Loyn data); data explorationWeek 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"Introduction to<br>random effectsLab 3: model selection with RIKZ dataor random effect?"Week 4<br>Jan 31 - Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5Model<br>selectionTypes of research and how they differ<br>statisticallyJaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>sheet1Familiarize yourselves into groups of<br>3-4 on selected datasetsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010Week 6<br>beh 14 - 16Multiple variance components including<br>Makagawa & Schielzeth 2010  | Loyn data); data explorationWeek 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5Model<br>selectionTypes of research and how they differ<br>statisticallyHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>het 1Fyractice' analysis with owl datasetHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>componentEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>componentNakagawa & Schielzeth 2013   |                 | Lab 2: graphically check assumptions (clam,                            |                              |
| Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Introduction to<br>random effectsLab 3: model selection with RIKZ dataor random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur Chapter 5Model<br>selectionTypes of research and how they differ<br>statisticallyZuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Schielzeth & Nakagawa 2013Model<br>sheet!Familiarize yourselves with group work<br>research questionsHarrison et al. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>model<br>interpretationFamiliarize yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010Week 6<br>ceh 14 = 16Multiple variance components including<br>Partag and corsced affectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010  | Week 3<br>Jan 24 - 26Conceptual and statistical difference<br>between 'random' effects and 'fixed' effectsZuur Chapter 5<br>Sullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophies<br>Types of research and how they differ<br>statisticallyHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur Chapter 5<br>Zuur Chapter 5<br>Zuur Chapter 5<br>Zuur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2018Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>componenter<br>modelEstimating proportion of variance explained<br>(repeatability and R-squared for mixedNakagawa & Schielzeth 2013  |                 | Loyn data); data exploration   |                              |
| Jan 24 - 26between 'random' effects and 'fixed' effectsSullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Introduction to<br>random effectsLab 3: model selection with RIKZ dataor random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 - Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Model<br>selectionLab 4: 'Practice' analysis with owl datasetSchielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010Week 6<br>interpretationMultiple variance components including<br>and crossed affectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010  | Jan 24 - 26between 'random' effects and 'fixed' effectsSullivan et al. 1999.<br>Dynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Introduction to<br>random effectsLab 3: model selection with RIKZ dataOr random effect?"<br>Harrison et al. 2018Week 4Model selection philosophiesHarrison et al. 2018Jan 31 - Feb 2Types of research and how they differ<br>statisticallyJaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013Model<br>selectionLab 4: 'Practice' analysis with owl datasetForstmeier & Schielzeth 2011<br>Barr et al. 2013By Feb 2: Describe datasets in google<br>sheet1Harrison et al. 2018<br>Zuur & leno. 2016Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>remensenterEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>model)Nakagawa & Schielzeth 2013  | Week 3          | Conceptual and statistical difference                                  | Zuur Chapter 5               |
| Introduction to<br>random effectsLab 3: model selection with RIKZ dataDynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 – Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Model<br>selectionLab 4: 'Practice' analysis with owl dataset<br>sheet!Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>by Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Schielzeth 2010<br>Schielzeth 2010  | Introduction to<br>random effectsLab 3: model selection with RIKZ dataDynamic Ecology "Is it fixed<br>or random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 – Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Model<br>selectionLab 4: 'Practice' analysis with owl datasetForstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>hotelMultiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>researchEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>medel)Nakagawa & Schielzeth 2013   | Jan 24 – 26     | between 'random' effects and 'fixed' effects                           | Sullivan et al. 1999.        |
| Introduction to<br>random effectsLab 3: model selection with RIKZ dataor random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 – Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Model<br>selectionLab 4: 'Practice' analysis with owl dataset<br>sheet!Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>hothelBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Schielzeth 2010<br>Schielzeth 2010   | Introduction to<br>random effectsLab 3: model selection with RIKZ dataor random effect?"<br>Harrison et al. 2018Week 4<br>Jan 31 – Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5Model<br>selectionTypes of research and how they differ<br>statisticallyZuur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Barr et al. 2013Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 – 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>companenterEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>model)Nakagawa & Schielzeth 2013   |                 |  | Dynamic Ecology "Is it fixed |
| random effectsHarrison et al. 2018Week 4Model selection philosophiesHarrison et al. 2018Jan 31 – Feb 2Types of research and how they differZuur Chapter 5ModelstatisticallyJaeger & Halliday 1998selectionLab 4: 'Practice' analysis with owl datasetForstmeier & Schielzeth & Nakagawa 2013By Feb 2: Describe datasets in googleSchielzeth & Nakagawa 2013By Feb 2: Describe datasets in googleWhittingham et al 2006sheet!Model interpretation including interactionHarrison et al. 2018Week 5Model interpretation including interactionHarrison et al. 2018Feb 7 – 9effects and building results' tablesZuur & Ieno. 2016modelFamiliarize yourselves with group workSchielzeth & Nakagawa 2013modelFamiliarize yourselves with group workSchielzeth & Nakagawa 2013modelEab 5: 'Practice' analysis with owl datasetSchielzeth & Nakagawa 2013Meke 6Multiple variance components includingNakagawa & Schielzeth 2010Week 6Multiple variance components includingNakagawa & Schielzeth 2010  | random effectsHarrison et al. 2018Week 4Model selection philosophiesHarrison et al. 2018Jan 31 – Feb 2Types of research and how they differZuur Chapter 5ModelstatisticallyJaeger & Halliday 1998selectionLab 4: 'Practice' analysis with owl datasetForstmeier & Schielzeth & Nakagawa 2013By Feb 2: Describe datasets in googleWhittingham et al 2006sheet!Model interpretation including interactionHarrison et al. 2018Week 5Model interpretation including interactionHarrison et al. 2018Feb 7 – 9effects and building results' tablesZuur & leno. 2016Schielzeth & Nakagawa 2013Familiarize yourselves with group workZuur & leno. 2016interpretationFamiliarize yourselves with group workSchielzeth & Nakagawa 2013modelFamiliarize yourselves into groups ofSchielzeth & Nakagawa 2013Week 6Multiple variance components includingNakagawa & Schielzeth 2010Nakagawa & Schielzeth 2013Nakagawa & Schielzeth 2010Week 6Multiple variance components includingNakagawa & Schielzeth 2013MultipleEstimating proportion of variance explainedNakagawa & Schielzeth 2013MultipleEstimating proportion of variance explainedNakagawa & Schielzeth 2013  | Introduction to | Lab 3: model selection with RIKZ data                                  | or random effect?"           |
| Week 4<br>Jan 31 – Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Model<br>selectionLab 4: 'Practice' analysis with owl datasetForstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>week 6<br>conductBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Partice of analysis with owl dataset  | Week 4<br>Jan 31 – Feb 2Model selection philosophiesHarrison et al. 2018<br>Zuur Chapter 5<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 – 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>repeatability and R-squared for mixed<br>repeatability and R-squared for mixed<br>transpace  | random effects  |  | Harrison et al. 2018         |
| Jan 31 – Feb 2Zuur Chapter 5Model<br>selectionTypes of research and how they differ<br>statisticallyZuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013By Feb 2: Describe datasets in google<br>sheet!By Feb 2: Describe datasets in google<br>sheet!Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl dataset<br>By Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010   | Jan 31 – Feb 2Zuur Chapter 5Model<br>selectionTypes of research and how they differ<br>statisticallyZuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 – 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>commenterEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>medule)Nakagawa & Schielzeth 2013   | Week 4          | Model selection philosophies   | Harrison et al. 2018         |
| Model<br>selectionTypes of research and how they differ<br>statisticallyZuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Lab 4: 'Practice' analysis with owl dataset<br><i>By Feb 2: Describe datasets in google</i><br><i>sheet!</i> Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013ModelFamiliarize yourselves with group work<br>research questionsLab 5: 'Practice' analysis with owl dataset <i>By Feb 9: Assign yourselves into groups of<br/>3-4 on selected datasets</i> Nakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010Week 6<br>Fab 14 - 16Multiple variance components including<br>researd and crossed effectsNakagawa & Schielzeth 2010   | Model<br>selectionTypes of research and how they differ<br>statisticallyZuur & leno 2016<br>Jaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Barr et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>research<br>(repeatability and R-squared for mixed<br>research (repeatability and R-squared for mixed<br>research or mixedNakagawa & Schielzeth 2013  | Jan 31 – Feb 2  |  | Zuur Chapter 5               |
| Model<br>selectionstatisticallyJaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Lab 4: 'Practice' analysis with owl datasetForstmeier & Schielzeth 2011<br>Barr et al. 2013By Feb 2: Describe datasets in google<br>sheet!Whittingham et al 2006Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesModel<br>interpretationFamiliarize yourselves with group work<br>research questionsLab 5: 'Practice' analysis with owl datasetSchielzeth & Nakagawa 2013Week 6<br>Fab 14 - 16Multiple variance components including<br>nested and crossed effectsWeek 6<br>Fab 14 - 16Multiple variance components including<br>Nakagawa & Schielzeth 2010  | Model<br>selectionstatisticallyJaeger & Halliday 1998<br>Schielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013Lab 4: 'Practice' analysis with owl dataset<br>By Feb 2: Describe datasets in google<br>sheet!Forstmeier & Schielzeth 2011<br>Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>(repeatability and R-squared for mixed<br>commenter)Estimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>commenter)Nakagawa & Schielzeth 2013  |                 | Types of research and how they differ                                  | Zuur & leno 2016             |
| selectionLab 4: 'Practice' analysis with owl datasetSchielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Meek 6<br>Week 6Multiple variance components including<br>pasted and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010  | selectionLab 4: 'Practice' analysis with owl datasetSchielzeth & Nakagawa 2013<br>Forstmeier & Schielzeth 2011<br>Barr et al. 2013<br>Whittingham et al 2006Week 5<br>Feb 7 – 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 – 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>(repeatability and R-squared for mixed<br>commonter)Estimating proportion of variance explained<br>(repeatability and R-squared for mixed  | Model           | statistically  | Jaeger & Halliday 1998       |
| Lab 4: 'Practice' analysis with owl datasetForstmeier & Schielzeth 2011By Feb 2: Describe datasets in google<br>sheet!Barr et al. 2013Week 5Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018Teb 7 - 9Familiarize yourselves with group work<br>research questionsHarrison et al. 2016Schielzeth & Nakagawa 2013Schielzeth & Nakagawa 2013ModelFamiliarize yourselves with group work<br>research questionsSchielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010Week 6Multiple variance components including<br>pasted and crossed effectsNakagawa & Schielzeth 2010   | Lab 4: 'Practice' analysis with owl datasetForstmeier & Schielzeth 2011By Feb 2: Describe datasets in google<br>sheet!Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>(repeatability and R-squared for mixed<br>componentsEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>componentsNakagawa & Schielzeth 2013  | selection       |  | Schielzeth & Nakagawa 2013   |
| By Feb 2: Describe datasets in google<br>sheet!Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010  | Barr et al. 2013By Feb 2: Describe datasets in google<br>sheet!Barr et al. 2013Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl dataset<br>By Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2013Multiple<br>variance<br>componentEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>componentNakagawa & Schielzeth 2013  |                 | Lab 4: 'Practice' analysis with owl dataset                            | Forstmeier & Schielzeth 2011 |
| By Feb 2: Describe datasets in google<br>sheet!Whittingham et al 2006Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010  | By Feb 2: Describe datasets in google<br>sheet!Whittingham et al 2006Week 5<br>Feb 7 - 9Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl dataset<br>By Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2013Multiple<br>variance<br>componentsEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>particele)Nakagawa & Schielzeth 2013  |                 |  | Barr et al. 2013             |
| sheet!Week 5Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsHarrison et al. 2016<br>Schielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010   | sheet!Week 5Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & Ieno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsSchielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2013Multiple<br>variance<br>componentsEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>components)Nakagawa & Schielzeth 2013  |                 | By Feb 2: Describe datasets in google                                  | Whittingham et al 2006       |
| Week 5Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsFamiliarize yourselves with group work<br>research questionsSchielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010Week 6Multiple variance components including<br>nected and crossed effectsNakagawa & Schielzeth 2010   | Week 5Model interpretation including interaction<br>effects and building results' tablesHarrison et al. 2018<br>Zuur & leno. 2016<br>Schielzeth & Nakagawa 2013model<br>interpretationFamiliarize yourselves with group work<br>research questionsSchielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>remembersenteEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>remembersentemadels)  |                 | sheet!   |                              |
| Feb 7 - 9effects and building results' tablesZuur & leno. 2016modelFamiliarize yourselves with group work<br>research questionsSchielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010Week 6Multiple variance components includingNakagawa & Schielzeth 2010  | Feb 7 - 9effects and building results' tablesZuur & Ieno. 2016modelFamiliarize yourselves with group work<br>research questionsSchielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Week 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>componentsEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>components)Nakagawa & Schielzeth 2013   | Week 5          | Model interpretation including interaction                             | Harrison et al. 2018         |
| model<br>interpretationFamiliarize yourselves with group work<br>research questionsSchielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl datasetLab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6Multiple variance components including<br>pested and crossed effectsNakagawa & Schielzeth 2010Nakagawa & Schielzeth 2010   | model<br>interpretationFamiliarize yourselves with group work<br>research questionsSchielzeth & Nakagawa 2013Lab 5: 'Practice' analysis with owl datasetLab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6<br>Feb 14 – 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>componentsEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>madels)Nakagawa & Schielzeth 2013  | Feb 7 – 9       | effects and building results' tables                                   | Zuur & leno. 2016            |
| model<br>interpretationFamiliarize yourselves with group work<br>research questionsLab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010  | model<br>interpretationFamiliarize yourselves with group work<br>research questionsLab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>componentsEstimating proportion of variance explained<br>(repeatability and R-squared for mixed  |                 |  | Schielzeth & Nakagawa 2013   |
| interpretation       research questions         Lab 5: 'Practice' analysis with owl dataset         By Feb 9: Assign yourselves into groups of         3-4 on selected datasets         Week 6         Multiple variance components including         Nakagawa & Schielzeth 2010         Nakagawa & Schielzeth 2012   | interpretationresearch questionsLab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6Feb 14 – 16Multiple<br>varianceEstimating proportion of variance explained<br>varianceVerence<br>(repeatability and R-squared for mixed<br>models)   | model           | Familiarize yourselves with group work                                 |                              |
| Lab 5: 'Practice' analysis with owl dataset         By Feb 9: Assign yourselves into groups of         3-4 on selected datasets         Week 6         Multiple variance components including         Nakagawa & Schielzeth 2010         Nakagawa & Schielzeth 2010   | Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013Multiple<br>variance<br>componentsEstimating proportion of variance explained<br>(repeatability and R-squared for mixed<br>models)  | interpretation  | research questions   |                              |
| Lab 5: 'Practice' analysis with owl dataset         By Feb 9: Assign yourselves into groups of         3-4 on selected datasets         Week 6         Multiple variance components including         Nakagawa & Schielzeth 2010         Feb 14 – 16  | Lab 5: 'Practice' analysis with owl datasetBy Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013MultipleEstimating proportion of variance explained<br>variance<br>(repeatability and R-squared for mixed<br>models)madels   |                 |  |                              |
| By Feb 9: Assign yourselves into groups of<br>3-4 on selected datasets         Week 6       Multiple variance components including         Nakagawa & Schielzeth 2010         Feb 14 – 16   | By Feb 9: Assign yourselves into groups of<br>3-4 on selected datasetsWeek 6<br>Feb 14 - 16Multiple variance components including<br>nested and crossed effectsNakagawa & Schielzeth 2010<br>   |                 | Lab 5: 'Practice' analysis with owl dataset                            |                              |
| By Feb 9. Assign yourselves into groups of<br>3-4 on selected datasets         Week 6       Multiple variance components including         Nakagawa & Schielzeth 2010         Feb 14 – 16       pested and crossed effects  | By rep 5. Assign yourselves into groups of<br>3-4 on selected datasets         Week 6       Multiple variance components including<br>nested and crossed effects       Nakagawa & Schielzeth 2010<br>Nakagawa & Schielzeth 2013         Multiple       Estimating proportion of variance explained<br>variance       Image: Component of the second sec |                 | By Eah O: Assign yoursalyas into around of                             |                              |
| Week 6     Multiple variance components including     Nakagawa & Schielzeth 2010       Feb 14 – 16     nested and crossed effects     Nakagawa & Schielzeth 2012  | Week 6       Multiple variance components including       Nakagawa & Schielzeth 2010         Feb 14 – 16       nested and crossed effects       Nakagawa & Schielzeth 2013         Multiple       Estimating proportion of variance explained       Variance         variance       (repeatability and R-squared for mixed       models)  |                 | By reb 5. Assign yourselves into groups of<br>3-4 on selected datasets |                              |
| Each $14 - 16$ nected and crossed effects Network Schielzeth 2010   | Feb 14 – 16nested and crossed effectsNakagawa & Schielzeth 2010MultipleEstimating proportion of variance explained<br>varianceNakagawa & Schielzeth 2013MultipleEstimating proportion of variance explained<br>varianceNakagawa & Schielzeth 2013   | Week 6          | Multiple variance components including                                 | Nakagawa & Schielzeth 2010   |
|   | Multiple     Estimating proportion of variance explained       variance     (repeatability and R-squared for mixed  | Feh 14 - 16     | nested and crossed effects   | Nakagawa & Schielzeth 2010   |
|   | MultipleEstimating proportion of variance explainedvariance(repeatability and R-squared for mixedcomponentsmodels)  | 1 CD 14 - 10    |  |                              |
| Multiple Estimating proportion of variance explained  | variance (repeatability and R-squared for mixed   | Multiple        | Estimating proportion of variance explained                            |                              |
| variance (reneatability and R-squared for mixed   | components models)  | variance        | (reneatability and R-squared for mixed                                 |                              |
|   |   | components      | models)  |                              |

|                  | Lab 6: R-squared                                       |                           |
|------------------|--|---------------------------|
|                  | Owl analysis report due 11:59pm Feb 17 <sup>th</sup> ! |                           |
| Week 7           | Standardizing predictors to ease                       | Schielzeth 2010           |
| Feb 21 – 23      | interpretation and comparison                          | Nakagawa & Cuthill 2007   |
|                  |  | Gelman & Hill Chapter 4   |
| Increasing       | Centering (including within-subject) of                | Van de Pol & Wright 2009. |
| interpretability | predictors   |                           |
| of model         |  |                           |
| outputs          | Lab 7: model selection with cetacean                   |                           |
|                  | dataset  |                           |
|                  |  |                           |
| Week 8           | Random regression models                               | Barnett et al. 2010       |
| Feb 28 – Mar 2   |  | Martin et al. 2011        |
|                  | lemporal auto-correlation                              |                           |
| Random           |  |                           |
| regression       | Lab 8: Group work – build analysis plan                |                           |
| Week 9           | Group work analysis together                           |                           |
| Iviar 7 – 9      |  |                           |
| Indonondont      | Lab 9: group work analysis                             |                           |
| analysis         | Analysis drafts must be printed and                    |                           |
| allalysis        | hrought to class on Mar 9 <sup>th</sup>                |                           |
| Week 10          | (Tues) Group work: provide peer review to              |                           |
| Mar 14 – 16      | each other's groups                                    |                           |
|                  | Give Kate conv of peer review (written on              |                           |
| Peer review      | draft report is okay)                                  |                           |
|                  |  |                           |
|                  | (Thurs) Group work: Any final group                    |                           |
|                  | analysis details!                                      |                           |
|                  | ,  |                           |
|                  | Lab 10: Group work analysis together                   |                           |
| Final            | Final draft to Kate 11:59pm on March 21                |                           |

### Books:

Zuur et al. "Mixed effects models and extensions in ecology with R". Springer Press

Gelman & Hill. "Data analysis using regression and multilevel/hierarchical models." Cambridge University Press

West, Welch & Galecki. "Linear mixed models: A practical guide using statistical software." CRC Press

Shumway & Stoffer. "Time series analysis and its applications." Springer press. FREE pdf: <u>https://www.stat.pitt.edu/stoffer/tsa4/tsa4.pdf</u>

#### Articles:

Barnett et al. 2010. Using information criteria to select the correct variance-covariance structure for longitudinal data in ecology. *Methods in Ecology & Evolution 1.* 

Barr, D.J., Levy, R., Scheepers, C., Tily, H.J., 2013. Random effects structure for confirmatory hypothesis testing: Keep it maximal. Journal of Memory and Language 68, 255–278. https://doi.org/10.1016/j.jml.2012.11.001

Andrew Gelman post on standardizing: <u>http://www.stat.columbia.edu/~gelman/research/unpublished/standardizing.pdf</u>

Forstmeier & Schielzeth. 2011. Cryptic multiple hypotheses testing in linear models: overestimated effect sizes and the winner's curse. *Behav Ecol Sociobiol 65* 

Harrison, X.A., Donaldson, L., Correa-Cano, M.E., Evans, J., Fisher, D.N., Goodwin, C.E.D., Robinson, B.S., Hodgson, D.J., Inger, R., 2018. A brief introduction to mixed effects modelling and multi-model inference in ecology. PeerJ 6, e4794. <u>https://doi.org/10.7717/peerj.4794</u>

Jacqmin-Gadda et al. 2007. Robustness of the linear mixed model to misspecified error distribution. *Comp Stats & Data Analysis* 51

Martin, J.G., Nussey, D.H., Wilson, A.J., Réale, D., 2011. Measuring individual differences in reaction norms in field and experimental studies: a power analysis of random regression models. Methods in Ecology and Evolution 2, 362–374.

Nakagawa, S., Schielzeth, H., 2010. Repeatability for Gaussian and non-Gaussian data: a practical guide for biologists. Biological Reviews 85, 935–956

Nakagawa & Schielzeth. 2013. A general and simple method for obtaining R2 from generalized linear mixed-effects models. Methods Ecol & Evol 4

Nakagawa & Cuthill. 2007. Effect size, confidence interval and statistical significance: a practical guide for biologists. *Biol. Reviews 82* 

Sullivan et al. 1999. Tutorial in biostatistics: an introduction to hierarchical linear modeling. *Statistics in Medicine 18* 

Schielzeth 2010. Simple means to improve the interpretability of regression coefficients. *Methods Ecol Evol* 

Schielzeth & Nakagawa. 2013. Nested by design: model fitting and interpretation in a mixed model era. *Methods Ecol Evol 4.* 

Schielzeth, H., Dingemanse, N.J., Nakagawa, S., Westneat, D.F., Allegue, H., Teplitsky, C., Réale, D., Dochtermann, N.A., Garamszegi, L.Z., Araya-Ajoy, Y.G., 2020. Robustness of linear mixed-effects models to violations of distributional assumptions. Methods in Ecology and Evolution 11, 1141–1152.

Van de Pol & Wright 2009. A simple method for distinguishing within- and between-subject effects using mixed models. Anim Behav 77

Zuur et al. 2010. A protocol for data exploration to avoid common statistical problems. *Methods in Ecology & Evolution* 1, 3-14

Zuur & Ieno. 2016. A protocol for conducting and presenting results of regression-type analyses. *Methods Ecol Evol* 7.

538 graphic: <a href="https://fivethirtyeight.com/features/science-isnt-broken/#part1">https://fivethirtyeight.com/features/science-isnt-broken/#part1</a>

# Other useful resources:

- http://ase.tufts.edu/gsc/gradresources/guidetomixedmodelsinr/mixed%20model%20guide.html
- <u>https://ourcodingclub.github.io/</u> Seriously helpful tutorials on lots of stats/R stuff (written by ecologists!)
- <u>http://m-clark.github.io/documents.html</u> More in depth tutorials, also more advanced topics (Bayesian, SEM, Generalized)
- <u>http://www.bioinfo.org.cn/~wangchao/maa/w.statistic.pdf</u> Wasserman's 'All of Statistics' book available as a pdf online

# Extra reading on other topics you might be interested in:

Araya-Ajoy, Y.G., Mathot, K.J., Dingemanse, N.J., 2015. An approach to estimate short-term, long-term and reaction norm repeatability. Methods in Ecology and Evolution 6, 1462–1473. https://doi.org/10.1111/2041-210X.12430

Arnold, T.W., 2010. Uninformative Parameters and Model Selection Using Akaike's Information Criterion. The Journal of Wildlife Management 74, 1175–1178. <u>https://doi.org/10.1111/j.1937-</u> 2817.2010.tb01236.x

Banner, K.M., Irvine, K.M., Rodhouse, T., 2020. The Use of Bayesian Priors in Ecology: The Good, The Bad, and The Not Great. Methods in Ecology and Evolution n/a. <u>https://doi.org/10.1111/2041-210X.13407</u>

Björklund, M., 2019. Be careful with your principal components. Evolution 73, 2151–2158. https://doi.org/10.1111/evo.13835

Bolker, B.M., Brooks, M.E., Clark, C.J., Geange, S.W., Poulsen, J.R., Stevens, M.H.H., White, J.-S.S., 2009. Generalized linear mixed models: a practical guide for ecology and evolution. Trends in Ecology & Evolution 24, 127–135. <u>https://doi.org/10.1016/j.tree.2008.10.008</u>

Brommer, J.E., Kontiainen, P., Pietiäinen, H., 2012. Selection on plasticity of seasonal life-history traits using random regression mixed model analysis. Ecology and Evolution 2, 695–704. <u>https://doi.org/10.1002/ece3.60</u>

Dingemanse, N.J., Dochtermann, N.A., 2013. Quantifying individual variation in behaviour: mixed-effect modelling approaches. Journal of Animal Ecology 82, 39–54. <u>https://doi.org/10.1111/1365-2656.12013</u>

Gomes, D.G.E., 2022. Should I use fixed effects or random effects when I have fewer than five levels of a grouping factor in a mixed-effects model? PeerJ 10, e12794. <u>https://doi.org/10.7717/peerj.12794</u>

Grueber, C.E., Nakagawa, S., Laws, R.J., Jamieson, I.G., 2011. Multimodel inference in ecology and evolution: challenges and solutions. Journal of Evolutionary Biology 24, 699–711. https://doi.org/10.1111/j.1420-9101.2010.02210.x

Hadfield, J.D., Wilson, A.J., Garant, D., Sheldon, B.C., Kruuk, L.E.B., 2010. The Misuse of BLUP in Ecology and Evolution. The American Naturalist 175, 116–125. <u>https://doi.org/10.1086/648604</u>

Harrison, X.A., 2015. A comparison of observation-level random effect and Beta-Binomial models for modelling overdispersion in Binomial data in ecology & evolution. PeerJ 3, e1114. <u>https://doi.org/10.7717/peerj.1114</u>

Harrison, X.A., 2014. Using observation-level random effects to model overdispersion in count data in ecology and evolution. PeerJ 2, e616. <u>https://doi.org/10.7717/peerj.616</u>

Jaeger, R.G., Halliday, T.R., 1998. On confirmatory versus exploratory research. Herpetologica 54, S64–S66.

Mitchell, D.J., Dujon, A.M., Beckmann, C., Biro, P.A., 2020 Temporal autocorrelation: a neglected factor in the study of behavioral repeatability and plasticity. Behav Ecol. <u>https://doi.org/10.1093/beheco/arz180</u>

Morrissey, M.B.; R., 2018. Multiple Regression Is Not Multiple Regressions: The Meaning of Multiple Regression and the Non-Problem of Collinearity. Philosophy, Theory, and Practice in Biology 10. https://doi.org/10.3998/ptpbio.16039257.0010.003

O'Hara & Kotze. 2010. Do not log transform count data. *Methods Ecol Evol 1.* 

Whittingham, M.J., Stephens, P.A., Bradbury, R.B., Freckleton, R.P., 2006. Why do we still use stepwise modelling in ecology and behaviour? Journal of Animal Ecology 75, 1182–1189. https://doi.org/10.1111/j.1365-2656.2006.01141.x