WLE 650 – Demographic Estimation

Spring 2018 Course Description and Syllabus

Instructor:

Dr. Erik Blomberg
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Phone: 207-581-2904

Number of credit hours: 3

Class Meeting Times and Locations:
Lecture: Mondays 9 a.m. to 10 a.m. Room 218 Nutting
Lab: Tuesday 2 p.m. to 5 p.m. Room 254 Nutting.
Discussion: Wednesdays 9 a.m. to 10 a.m. Room 218 Nutting

Office Hours: By appointment or whenever my door is open

Course Overview: Understanding spatial and temporal change in the abundance of organisms is a unifying theme across many ecological disciplines. These changes represent the dynamics of populations, and in order to understand them fully, we need to critically evaluate underlying demographics: rates of reproduction, survival, and dispersal. In this course we will explore the quantitative methods available for estimating and evaluating sources of variation in animal demographics, based largely on field studies of marked animals. We will use a combination of lecture material, discussion of relevant primary literature, and applied computer exercises to explore these topics.

Learning Outcomes:

Goals and objectives - This course is designed to provide a survey of many (although certainly not all) of the analysis methods commonly used to evaluate animal demographics. My objective here is to give you enough theoretical background and practical experience with available methods that you will feel comfortable exploring them in your own research. During the semester we will focus on analysis using the software Program MARK, and its companion R package, rMark, to conduct capture-mark-recapture analyses. During the latter half of the semester we will also spend some time on distance sampling, spatial mark-recapture, and other topics also implemented in Program R using a variety of packages. You will leave the course able to better apply demographic methods implemented in R to your own research. I also hope to give you

an expanded perspective on demographic estimation and data analysis in general, which will help you to explore additional methods on your own in the future as needed for specific applications.

Outcomes – You will leave this course able to conduct demographic analyses on data collected from marked and unmarked animals, interpret the results of these analyses, and present them in peer-reviewed publications. This knowledge will also improve your abilities to conduct appropriate field sampling for studies of marked animals.

Class Format: The course will be a mix of lecture material, computer lab exercises, and discussion of primary literature. A tentative schedule is listed below.

There will also be a required independent project, which will be presented during the last week of class.

Required Texts:

We will use two primary texts for the course, both of which are available free and online. I've listed assigned chapters for most weeks, and these are split between assigned readings and supplemental lab materials. You should do the readings in advance of lecture for each week, as they will give you a greater capacity to grasp the materials we cover in class. You may find the supplemental readings useful for completing the lab assignments, but I leave it up to you whether you want to invest this time or not. There are no quizzes or exams in the course, so readings are "required" only in that they will help you with self-learning and in taking as much away from the course as possible. I recommend completing readings prior to the class the week they are listed.

Estimation of Parameters for Animal Populations by Powel and Gale will be our main conceptual text for most weeks. This book is available for free as a downloadable e-book from the author's webpage:

http://larkinpowell.wixsite.com/larkinpowell/estimation-of-parameters-for-animal-pop

You can also purchase a hard copy if you like for the bargain price of $17.50 – see purchasing links on the same website linked above.

Program MARK: A Gentle Introduction by Evan Cooch and Gary White (note that Gary White is an Alumni of our graduate program). This text is available for free (!) at http://www.phidot.org/software/mark/docs/book/. In addition to being an extremely useful user's manual for Program MARK, it also provides very accessible introductory detail on many demographic estimation techniques. In some cases the Gentle Introduction contains information that is not readily available from other published sources. You will see chapters of the Gentle Introduction assigned for most weeks, and I will supplement these readings with other required readings as needed.

Other Suggested Texts: These texts provide supplemental reference to the information that will be presented in class. They are not necessary to do well in the course, but they will provide you with additional resources if needed. The first three are available from the library, and Burnham and Anderson is available as an online e-book. If you wanted to add a single book to your library as a reference to mark-recapture, Amstrup et al. would be my recommendation, but recognize much of the material is redundant to that contained in the Gentle Introduction. The last three books are not currently in the library but I have copies if you'd like to look at them. Kery and Royle is related much more to occupancy analysis and its extensions, but they have a LOT of great introductory materials that relate to doing simulations and coding demographic analyses in R. Hobbs and Hooten and Kery and Shaub cover Bayesian analyses which we will only touch on briefly; Hobbs and Hooten gives an awesome math/stats background that generalizes into maximum likelihood estimation in general, and Kery and Shaub is the best source for starting code for Bayesian mark-recapture; supposedly Kery and Royle will be publishing a Volume 2 soon which will cover open capture models.

Analysis and Management of Animal Populations by Williams, Nichols and Conroy.

Model Selection and Multimodel Inference by Burnham and Anderson.

Handbook of Capture-Recapture Analysis by Amstrup, McDonald, and Manly

Applied Hierarchical Modeling in Ecology by Kery and Royle.

Bayesian Models: A Statistical Primer for Ecologists. Hobbs and Hooten.

Bayesian Population Analysis Using WinBUGS. Kery and Shaub.

Other Reference Papers: There are a number of published articles that I find to be great resources for demographic analysis in general. I've listed some as required readings for lab, and others as background reference materials for the weekly discussions. I don't necessarily expect you to read all of the reference papers I've listed during the semester, but I hope this list will provide you with starting points for your projects, and also will serve as a useful reference for you in the future. A few general references I would encourage you to become familiar with are: Arnold 2010, Beissinger et al. 2006, Sandercock 2006, Powell 2007, Johnson and Omland 2004, and Lebreton et al. 1992. (Full citations listed below).

Software: All the software we will use during the course that are available as free downloads. These include Program MARK (http://www.phidot.org/software/mark/), Program R (http://www.r-project.org/), R Studio (https://www.rstudio.com/), and JAGS (http://mcmc-jags.sourceforge.net/). These will be available in the Nutting Hall

Computer Lab, but I recommend you also download and install them on your personal machines so that you can work outside of the lab. We may also use the PopTools add-in for Excel, another free download (http://www.poptools.org/), and a number of different R packages.

Course Requirements and Grading:

Participation: The success of a course like this depends on meaningful participation from all involved (including the instructor!). For that reason active participation in both the computer lab exercises and the class discussions are two major course requirements. I will not be taking attendance, but naturally participation is contingent on regular presence in class. If you have to miss class, I appreciate the courtesy of being informed ahead of time. 20% of your class grade will come from participation.

Discussion: In addition to being an active participant in the class, you will be required to lead discussion for one of the assigned articles during the semester. This will require a greater amount of preparation compared to a typical week, including additional background readings on your part. For example, you should read the suggested background readings as a starting point, and also follow up on citations contained in the article that are necessary to fully understand the paper. You will need to sufficiently understand the materials presented in the paper to guide the rest of the class through discussion, answer any questions that may arise, and to steer us through the inevitable awkward silences. You should come to class prepared with a handout or short power-point that contains a breakdown of the article and some questions to guide discussion. To assist you in this process, we should meet individually the week prior to your assigned discussion to go over the article and discuss the most salient points. Leading this discussion will constitute 20% of your class grade.

Assignments: Each week there will be a short assignment that will parallel that week's lab, which I'll expect you to complete outside of class. My goal with these assignments is not to burden you with busy work, but instead to reinforce the skills we covered during class that particular week. These assignments will typically consist of an additional analysis to complete on your own that will be very similar to the analysis we conduct together in lab. Deliverables will be simple (e.g. AIC tables or screen shots of your MARK set ups) and I will mainly be checking the assignments to make sure you completed the analysis correctly. Assignments will be graded as pass/fail, and you have an infinite number of chances, conditioned on the end of the semester, to complete the assignment correctly. Your cumulative assignment grade will be the proportion of correct assignments you complete, and it will be worth 30% of your course grade.

Independent Project: The final major requirement of the course will be to conduct a demographic analysis, which you will present and defend during the last week of classes. Ideally the project will involve your own data, but I can also provide you with a dataset if needed. I'll cover my expectations for the project during the first week of class, and we should meet individually during the first few weeks of the semester to talk about your plan for completing your analysis. I also expect that we will meet somewhat regularly throughout the semester to check in on the project and so I can help you with issues as they arise. You should take the initiative to set these meetings, but I will check in periodically if I haven't heard anything from you. The independent project will be worth 30% of your class grade.

The formal breakdown for grading in the course will be as follows:

Assignments – 30%; Discussion Lead – 20%; Participation – 20%; Analysis and Presentation – 30%.

Your final grade will be assigned as follows:

A 90 – 100%

B 80-89%

C 70-79%

D 60-69%

F < 60%

Online Resources: I've created a Blackboard site for the course that you should be able to access through your Mainestreet or MyCampus Portals. On this page I will post relevant course materials such as the syllabus, assignments, data files for lab, etc. All required readings for discussion will be posted in the "Class Readings" folder on the content page, but you will have to retrieve reference readings and Gentle Introduction chapters on your own. All reference readings are accessible through the Library web page.

Academic and Professional Integrity: I expect that students in my courses will hold themselves to high professional standards. University policies on Academic Honesty may be found at the website of the Division of Student Affairs (http://umaine.edu/studentaffairs/jad/) and the Universities Academic Honest Statement is listed at the end of this syllabus. In addition to University policies, our respective

professional societies provide us with guidance on standards of professional conduct and ethics.

The Wildlife Society:

http://joomla.wildlife.org/index.php?option=com_content&task=view&id=769)

The American Fisheries Society:

http://fisheries.org/cert_standardsofprofessionalconduct

The Society for Conservation Biology:

http://www.conbio.org/about-scb/who-we-are/code-of-ethics

Course Schedule (Subject to change at my discretion)

Week 1 (22 Jan). Introduction to course, Program MARK and Capture-Mark-Recapture.

Readings: Powell and Gayle Chapters 3, 4, 7 (read Ch 1 and 2 if you want to be really thorough)

Supplements for Lab: “Gentle” Introduction Chapters 1 and 3 (and I suppose Ch2 also if you want to be thorough).

Week 2 (29 Jan). Use of the Design Matrix and Linear Models in Program MARK.

Readings: Powell and Gayle Chapters 6, 10.

Supplements for Lab: “Gentle” Introduction Chapters 4 and 6

Week 3 (5 Feb). Use of continuous covariates in Program MARK and approaches to inference.

Supplements for Lab: “Gentle” Introduction Chapter 11

Week 4 (12 Feb). Goodness-of-fit testing and variance approximation.

Readings: Powell and Gayle Chapter 5

Supplements for Lab: “Gentle” Introduction Chapter 5 and Appendix B.

Week 5 (19 Feb; No Class on Monday the 19th). Introduction to Program R.

Readings: None

Week 6 (26 Feb) Introduction to the RMark package and nest survival analysis.

Readings: “Gentle” Introduction Chapter 17 and Appendix C.

Week 7 (5 Mar) Closed capture models using RMark.

Readings: Powell and Gayle Chapter 8

Supplement for lab: “Gentle” Introduction Chapter 14.

March 12-16 (Spring Break)

Week 8 (19 Mar) Multi-state capture-mark-recapture using RMark

Readings: Powell and Gayle Chapter 12

Supplements for Lab: “Gentle” Introduction Chapter 10.

Week 9 (26 Mar) Robust design capture-mark-recapture using RMark

Readings: Powell and Gayle Chapter 13

Supplements for Lab: “Gentle” Introduction Chapter 15.

Week 10 (2 Apr) Spatially-explicit mark-recapture using the SECR package

Readings: Efford and Fewster 2013

Week 11 (9 Apr – Erik at AOS Conference) No Class, independent project work period.

Week 12 (16 Apr) Distance sampling using the unmarked package

Readings: Powell and Gayle Chapter 19

Week 13 (23 Apr) Primer of Bayesian analysis and implementation in JAGS

Readings: Kery and Shaub Chapter 5

Week 14 (30 Apr) **– Project Presentations.** *These will be held during lecture, lab and discussion periods to accommodate all students.*

Discussion Schedule: *Note – I've listed additional references for some but not all weeks. These are largely to benefit the discussion leader, rather than for all to read.*

Week 1 – Brief meeting to plan discussion schedule.

Week 2 – Philosophy of science - Anderson 2001, 2003, Engman 2003

Week 3 – CJS and individual covariates – Zabel et al. 2005

Week 4 – Experimental design - Sandercock et al. 2011

Week 5 – Application of GOF test - Pilastro et al. 2003

Week 6 – Nest survival – Saab et al. 2011.

Reference: Mayfield 1975, Dinsmore et al. 2002, Rotella et al. 2004

Week 7 – Pradel Models – Alisauskas and Kellett 2014.

Reference: Pradel 1996, Nichols et al. 2000, Chapter 13.

Week 8 – Multistate models – Rivalan et al. 2005

Reference: Nichols and Kendall 1995, Lebraton and Pradel 2002, White et al. 2006.

Week 9 – Robust Design – Frick et al. 2010

Reference: Pollock 1982, Kendal and Nichols 1995, Kendall et al. 1997, CH 15.

Week 10 – Spatially explicit mark recapture – Drewry et al. 2013

Reference: Efford and Fewster 2013

Week 11 – No Class

Week 12 – Distance Sampling – Harihar et al. 2014

Reference: Anderson et al. 1978, Burnham and Anderson 1984.

Week 13 – State Space Models – Flesh 2014

Reference: Buckland 2004

Week 14 – Project Presentations

Finals Week – There will be no scheduled final to allow students to get an early start on summer field work. I will be available during our final exam period to provide feedback on student projects.

Course Bibliography: *All citations given above should be listed below, plus some bonus references!*

Alisauskas, R. T., and D. K. Kellet. 2014. Age-specific in situ recruitment of female king eiders estimated with mark-recapture. The Auk 131:129-140.

Anderson, D. R. 2001. The need to get the basics right in wildlife field studies. The Wildlife Society Bulletin 29: 1294-1297.

Anderson, D. R. 2003. Response to Engeman: Index values rarely contribute to reliable information. Wildlife Society Bulletin 31:288-291.

Anderson, D. R., K. P. Burnham, and B. R. Crain. 1978. A log-linear approach to estimation of population size using the line transect method. Ecology 59:190-193.

Arnold, T. W. 2010. Uninformative parameters and model selection using Akaike's Information Criterion. Journal of Wildlife Management 74: 1175–1178.

Beissinger, S. R., et al. 2006. Modelling approaches in avian conservation and the role of field biologists. Ornithological Monographs No. 59.

Brownie, C., J. E. Hines, J. D. Nichols, K. H. Pollock, and J. B. Hestbeck. 1993. Capture–recapture studies for multiple strata including non-Markovian transitions. Biometrics 49:1173–1187.

Burnham, K. P., and D. R. Anderson. 1984. The need for distance data in transect counts. Journal of Wildlife Management. 48: 1248-1254.

Drewry, J. M., F. T. Van Manen, D. M. Ruth. 2013. Density and Genetic Structure of black bears in coastal South Carolina. Journal of Wildlife Management 77: 153-164.

Dinsmore, S. J., G. C. White, and F. L. Knopf. 2002. Advanced techniques for modeling avian nest success. Ecology 83: 3476-3488.

Engeman, R. M. 2003. More on the need to get the basics right: population indices. Wildlife Society Bulletin 31: 286-287

Frick, W. F., D. S. Reynolds, and T. H. Kunz. 2010. Influence of climate and reproductive timing on demography of little brown myotis *Myotis lucifugus*. Journal of Animal Ecology 79: 128-136.

Harihar, A., Pandav, B., MacMillan, D. C. 2014. Identifying realistic recovery targets and conservation actions for tigers in a human-dominated landscape using spatially explicit densities of wild prey and their determinants. Diversity and Distributions DOI: 10.1111/ddi.12174

Johnson, J. B., and K. S. Omland. 2004. Model selection in ecology and evolution. Trends in Ecology and Evolution 19: 100-108.

Karanth, K. U., A. M. Gopalaswamy, N. S. Kumar, S. Vaidyanathan, J. D. Nichols, and D. I. Mackenzie. 2011. Monitoring carnivore populations at the landscape scale: occupancy modeling of tigers from sign surveys. Journal of Applied Ecology

Kendall, W. L., and J. D. Nichols. 1995. On the use of secondary capture-recapture samples to estimate temporary emigration and breeding proportions. Journal of Applied Statistics 22: 751-762.

Kendall, W. L., J. D. Nichols, and J. E. Hines. 1997. Estimating temporary emigration using capture-recapture data with Pollock's robust design. Ecology 78: 563-578.

Kendall, W. L., J. E. Hines, and J. D. Nichols. 2003. Adjusting multi-state capture–recapture models for misclassification bias: manatee breeding proportions. Ecology 84:1058–1066

Lebreton, J. D., K. P. Burnham, J. Clobert, and D. R. Anderson. 1992. Modeling survival and testing biological hypotheses using marked animals: a unified approach with case studies.

Lebreton, J. D., and R. Pradel. 2002. Multistate recapture models: modelling incomplete individual histories. Journal of Applied Statistics 29: 353-369.

Mayfield, H. F. 1975. Suggestions for calculating nest success. The Willson Bulletin 87: 456-466.

MacKenzie, D. I., and J. A. Royle. 2005. Designing occupancy studies: general advice and allocating survey effort. Journal of Applied Ecology 42: 1105-1114.

MacKenzie, D. I., J. D. Nicholas, J. E. Hines, M. G. Knutson, and A. B. Franklin. 2003. Estimating site occupancy, colonization, and local extinction when a species is detected imperfectly. Ecology 84: 2200-2207

Nichols, J. D., and W. L. Kendall. 1995. The use of multi-state capture-recapture models to address questions in evolutionary ecology. Journal of Applied Statistics 22: 835-846.

Nichols, J. D., J. E. Hines, J. D. Lebreton, and R. Pradel. 2000. Estimation of contributions to population growth: a reverse-time capture-recapture approach. Ecology 81: 3362-3376.

Pilastro, A., G. Tavecchia, and G. Marin. 2003. Long living and reproduction skipping in the fat dormouse. Ecology 84:1784-1792.

Pollock, K. H. 1982. A capture-recapture design robust to unequal probability of capture. Journal of Wildlife Management 46: 752-757.

Pollock, K. H., Winterstein, S. R., Bunk C. M., & Curtis, P. D. 1989. Survival analysis in telemetry studies: the staggered entry design. Journal of Wildlife Management 53: 7-15.

Powell, L. A. 2007. Approximating variance of demographic parameters using the delta method: a reference for avian biologists. Condor 109:949–954.

Pradel, R. 1996. Utilization of capture-mark-recapture for the study of recruitment and population growth rate. Biometrics 52: 703-709.

Rice, M. B., D. A. Haukos, J. A. Dubovsky, and M. C. Runge. 2010. Continental survival and recovery of northern pintails using band-recovery data. Journal of Wildlife Management 74: 778-787.

Rivalan, P. et al. 2005. Trade-off between current reproductive effort and delay to next reproduction in the leatherback sea turtle. Oecologia 145:564-574.

Romesburg, H.C. 1981. Wildlife science: gaining reliable knowledge. Journal of Wildlife management 45: 293-313.

Rotella, J. J., S. J. Dinsmore, and T. L. Shaffer. 2004. Modelling nest-survival data: a comparison of recently developed methods that can be implemented in MARK and SAS. Animal Biodiversity and Conservation 27:187-204.

Rotella, J. J., W. A. Link, T. Chambert, G. E. Stauffer, and R. A. Garrott. 2012. Evaluating the demographic buffering hypothesis with vital rates estimated for Weddell seals from 30 years of mark-recapture data. Journal of Animal Ecology 81: 162-173.

Saab, V. A., R. E. Russell, J. Rotella, J. G. Dudley. 2011. Modeling nest survival of cavity-nesting birds in relation to postfire salvage logging. Journal of Wildlife Management 75: 794-804.

Sandercock, B.K. 2006. Estimation of demographic parameters from live encounter data: a summary review. Journal of Wildlife Management 70:1504-1520.

Smith, H. C., K. Pollock, K. Waples, S. Bradley, and L. Bejder. 2013. Use of robust design to estimate seasonal abundance and demographic parameters of a coastal bottlenose dolphin population. http://dx.doi.org/10.1371/annotation/369119db-d9ca-4473-9390-89ee0c2a532f

White, G. C., W. L. Kendall, R. J. Barker. 2005. Mulitstate survival models and their extensions in Program MARK. Journal of Wildlife Management 70:1521-1529.

Zabel, R. W., et al. 2005. Survival and selection of migrating salmon from capture-recapture models with individual traits. Ecological Applications 15:1427-1439.

Additional Items:

University of Maine administrative policy statements

Academic honesty:

Academic honesty is very important. It is dishonest to cheat on exams, to copy term papers, to submit papers written by another person, to fake experimental results, or to copy or reword parts of books or articles into your own papers without appropriately citing the source. Students committing or aiding in any of these violations may be given failing grades for an assignment or for an entire course, at the discretion of the instructor. In addition to any academic action taken by an instructor, these violations are also subject to action under the University of Maine Student Conduct Code. The maximum possible sanction under the student conduct code is dismissal from the University.

Students with disabilities:

If you have a disability for which you may be requesting an accommodation, please contact Disabilities Services, 121 East Annex, 581-2319, as early as possible in the term.

Course schedule disclaimer (disruption clause):

In the event of an extended disruption of normal classroom activities, the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

Sexual violence policy:

Sexual discrimination reporting: The University of Maine is committed to making campus a safe place for students. Because of this commitment, if you tell any of your teachers about sexual discrimination involving members of the campus, **your teacher is required to report** this information to the campus Office of Sexual Assault & Violence Prevention or the Office of Equal Opportunity.

Behaviors that can be “sexual discrimination” include sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct, and gender discrimination. Therefore, all of these behaviors must be reported.

Why do teachers have to report sexual discrimination?

The university can better support students in trouble if we know about what is happening. Reporting also helps us to identify patterns that might arise– for example, if more than one victim reports having been assaulted or harassed by the same individual.

What will happen to a student if a teacher reports?
An employee from the Office of Sexual Assault & Violence Prevention or the Office of Equal Opportunity will reach out to you and offer support, resources, and information. You will be invited to meet with the employee to discuss the situation and the various options available to you.

If you have requested confidentiality, the University will weigh your request that no action be taken against the institution's obligation to provide a safe, nondiscriminatory environment for all students. If the University determines that it can maintain confidentiality, you must understand that the institution's ability to meaningfully investigate the incident and pursue disciplinary action, if warranted, may be limited. There are times when the University may not be able to honor a request for confidentiality because doing so would pose a risk to its ability to provide a safe, nondiscriminatory environment for everyone. If the University determines that it cannot maintain confidentiality, the University will advise you, prior to starting an investigation and, to the extent possible, will share information only with those responsible for handling the institution's response.

The University is committed to the well-being of all students and will take steps to protect all involved from retaliation or harm.

If you want to talk in confidence to someone about an experience of sexual discrimination, please contact these resources:

For *confidential resources on campus*: **Counseling Center: 207-581-1392** or **Cutler Health Center: at 207-581-4000**.

For *confidential resources off campus*: **Rape Response Services:** 1-800-310-0000 or **Spruce Run**: 1-800-863-9909.

Other resources: The resources listed below can offer support but may have to report the incident to others who can help:

For *support services on campus*: **Office of Sexual Assault & Violence Prevention: 207-581-1406**, **Office of Community Standards: 207-581-1409**, **University of Maine Police: 207-581-4040 or 911**. Or see the OSAVP website for a complete list of services at http://www.umaine.edu/osavp/