Wildlife Survival Modeling

WBIO 595 – Section 03 – 3 Credits

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Course Syllabus

Course Description: Death is final, the ultimate selective force in ecology and evolutionary biology. The study of mortality and its inverse, survival, constitutes one of the cornerstones of ecology and wildlife management. This course will investigate the philosophy, methodology, and new techniques in the study of survival through readings, discussion, student-lead presentations, and individual student analysis projects. The course will focus on modeling survival in situations where the fate of animals is known, such as with radiocollar data, although students with an interest in capture-mark-recapture (CMR) data will also benefit from this course. The course will focus on the application of the Cox-proportional hazards model, and its extensions, to wildlife survival modeling. As an additional teaching tool, we will have the opportunity to participate in the analysis of two large datasets on mule deer fawns from Idaho and elk calves from across the Pacific Northwest with cooperating agency biologists. There will be no lab component to this class, and the focus will be on conceptual foundations of survival modeling moreso than technical.

Course Time: The class will meet during two, 90 minute seminars per week, on Tuesday and Thursday from 1-230 in a location to be determined, depending on class enrollment. First class meeting will be in FOR 311b.

Course Format: Class format will consist of readings and discussion, starting with foundational papers and statistics, moving on towards ecological applications. Students will prepare an annotated bibliography on a survival modeling topic of their choice. Students will lead a lecture on a survival modeling topic of interest, and finally, a student-lead analysis project and presentation will form the bulk of the grade for this class.

Course Grade:

Class Participation	20
Student Presentation	15
Annotated Bibliography	10
Analysis Proposal	15
Research Presentation	20
Final Paper	20
Total	100

Course Requirements: This class is geared towards graduate students dealing with the analysis of survival data, and students will be encouraged to use their own data in the class assignments. Knowledge of statistical modeling including Generalized Linear Models and Regression, Model selection, and some basic knowledge of survival modeling is required. This is not an introductory statistics class, and if you do not have much statistical background, this class will be quite difficult. An ability and desire to read the primary statistical literature and textbooks is critical. Auditing is not encouraged.

Student Presentation: Students will lead a lecture on a survival modeling topic of their choice that is of interest to them. Topics will be discussed in the first few lectures, and some advanced topics are listed below and can also be found in the literature cited. Students will be responsible for selecting at least 1 relevant reading >1 week before class and developing an informal lecture and discussion format for the class.

Annotated Bibliography: Students will select ~ 10 scientific papers on a survival modeling topic of their choice from the ecological and statistical literature, and prepare an annotated bibliography summarizing the paper including its major contributions, methods, and results. An example annotated bibliography will be given, and the survival modeling topic is expected to relate to the students own research, analysis proposal and survival paper in the class.

Analysis Proposal: A brief, 5-page (double spaced) proposal briefly describing the background of your survival modeling topic, you research question, data and proposed methods. Focus here is on development of the methodological details of the analysis.

Presentation: Students will develop a 20-30 minute presentation on their proposal, survival modeling research question, and results in an informal, discussion style format for class. Analyses and conclusions need not be complete, but generation of discussion and thoughtful presentations will be the model.

Final Paper: A brief, 10-page paper (double spaced) summarizing the results of the independent research project in standard IMRAD format will be required of each student. The goal of this paper is to not be an exhaustive manuscript, but a focused, method-oriented paper describing a survival modeling exercise of the student's choice. Papers must be well written, but the focus is on methodological development. Figures and tables encouraged.

Potential Survival Modeling Topics: Topics should focus on both ecological and statistical elements of survival modeling, for example; nest survival modeling, capture-recapture models, Kaplan maier survival estimation, linking survival to habitat covariates, epidemiological applications, mixed-frailty models, multi-state survival models using CMR data, failure time analysis, and other extensions to the Cox-model including weibull regression, competing risks, etc.

Tentative Course Schedule:

	Date	Topic	Reading(s)	Assignments
1	26-Aug	Class organization, discussion	None	

2	28-Aug	Introduction to survival modeling	Murray and Patterson - 2 papers	
3	2-Sep	Program MARK	Bird Study, White and Burnham	
4	4-Sep	Introduction to survival modeling continued	Chap 1 Hosmer and Lemeshow, Chap 1 Cleves et al.	
5	9-Sep	Hugh Robinson - Guest Lecture	TBA	
6	11-Sep	Mark Hurley - Guest Lecture	Unsworth et al. Mule Deer	
7	16-Sep	*No Class - work on annotated bibliographies*		
8	18-Sep	*Student lecture - nest survival modeling?*	Nest survival, Mayfield, Dinsmore	
9	23-Sep	Describing survival times	C hap 2 Hosmer & Lemeshow, Chap 2 Cleves	
10	25-Sep	*No Class - work on annotated bibliographies*		
11	30-Sep	Regression models for survival	Chap3 H&L, Chap 3 Cleves	Annotated Bibliographies Due
12	2-Oct	*Student lecture*		
13	7-Oct	Censoring, data management	Chap 4, 5 Cleves	
14	9-Oct	*Guest lecture TBA*		
15	14-Oct	*Student lecture - nonparametric analysis*	Chap 8 Cleves, additional reading	Analysis Proposal Due
16	16-Oct	The Cox proportional hazards model	Chap 9 Cleves, Chap 4 H&L	
17	21-Oct	*Student lecture - model development*	Chap 5 H&L	
18	23-Oct	Assesment of model adequacy	Chap 6 H&L, Chap 11 Cleves	
19	28-Oct	*Student lecture(s)*		
20	30-Oct	Extensions - Time Varying Covariates	Aydemir et al., Cleves Chap 10, H&L Chap 7	
21	4-Nov	*Student lecture(s)*		
22	6-Nov	Extensions - Competing risks	Frair et al.(2007), H&L Chap 9	
23	11-Nov	*Student lecture(s)*		
24	13-Nov	Extensions - Shared frailty models	Wintrebert et al., H&L chap 9, Cleves chapter 15.	
25	18-Nov	*Student lecture(s)*		

26	20-Nov	The final frontier - linking survival to habitat and evolutionary biology	Cooch, Johnson, McLoughlin, Franklin	
27	25-Nov	No Class		
28	27-Nov	Thanksgiving Holiday - No Class		
29	2-Dec	No Class		
30	5-Dec	Student project presentations	1-5 PM	Student Presentations & Papers Due

Course Readings: Readings will be assigned, and many will draw from the following book, which is recommended for graduate students to have in their libraries.

Hosmer & Lemeshow. 2008. Applied survival analysis. Regression modeling of time to event data. Wiley-Interscience. 2nd edition (MAKE SURE IT'S THE 2nd edition).

Another useful *technical* book for users of STATA is
Cleves et al. 2008. An introduction to survival analysis using STATA, 2nd edition. STATA Press.

Other key readings will be distributed and include:

Andersen, P.K. and R.D. Gill. 1982. Cox's regression model for counting processes: a large sample study. The Annals of Statistics 10: 1100-1120.

Andersen, P. K. (1991) Survival Analysis 1982-1991 - the 2nd Decade of the Proportional Hazards Regression-Model. Statistics in Medicine, 10, 1931-1941.

Aydemir, L., Aydemir, S. & Dirschedl, P. (1999) Analysis of Time-Dependent Covariates in Failure Time Data. Statistics in Medicine , 18, 2123-2134.

Boyce, M.S., L.L. Irwin, and R. Barker. 2005. Demographic meta-analysis: synthesizing vital rates for spotted owls. Journal of Applied Ecology 42: 38-49 .

Cooch, E.G., E. Cam, and W. Link. 2002. Occam's Shadow: Levels of Analysis in Evolutionary Ecology - Where to Next? Journal of Applied Statistics 29:19-48.

Delgiudice, G.D., M.R. Riggs, P. Joly, and W. Pan. 2002. Winter Severity, Survival, and Cause-Specific Mortality of Female White-Tailed Deer in North-Central Minnesota. Journal of Wildlife Management 66:698-717.

Dinsmore, S.J., G.C. White, and F.L. Knopf. 2002. Advanced Techniques for Modeling Avian Nest Survival. Ecology 83:3476-3488.

East, M. L., Hofer, H., Cox, J. H., Wulle, U., Wiik, H. & Pitra, C. (2001) Regular Exposure to Rabies Virus and Lack of Symptomatic Disease in Serengeti Spotted Hyenas. Proceedings of the National Academy of Sciences of the United States of America, 98, 15026-15031.

Fieberg, J. and G. Delgiudice. 2008. Exploring Migration Data Using Interval-Censored Time-to-Event Models. Journal of Wildlife Management 72:1211-1219.

Frair, J.L., E.H. Merrill, J.R. Allen, and M.S. Boyce. 2007. Know thy enemy: experience affects translocation success in risky landscapes. Journal of Wildlife Management In Press.

Franklin, A.B., D.R. Anderson, and K.P. Burnham. 2002. Estimation of Long-Term Trends and Variation in Avian Survival Probabilities Using Random Effects Models. Journal of Applied Statistics 29:267-287.

Franklin, A.B., D.R. Anderson, R.J. Gutierrez, and K.P. Burnham. 2000. Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California. Ecological Monographs 70: 539-590.

Gaillard, J.-M., M. Festa-Bianchet, N.G. Yoccoz, A. Loison, and C. Toigo. 2000. Temporal variation in fitness components and population dynamics of large herbivores. Annual Review of Ecology and Systematics 31: 367-393.

Gaillard, J.M. and N.G. Yoccoz. 2003. Temporal Variation in Survival of Mammals: a Case of Environmental Canalization? Ecology 84:3294-3306.

Heisey, D.M. and B.R. Patterson. 2006. A Review of Methods to Estimate Cause-Specific Mortality in Presence of Competing Risks. Journal of Wildlife Management 70:1544-1555.

Heisey, D.M. and T.K. Fuller. 1985. Evaluation of survival and cause-specific mortality rates using telemetry data. Journal of Wildlife Management 49: 668-674.

Johnson, C.J., M.S. Boyce, C.C. Schwartz, and M.A. Haroldson. 2004. Modeling survival: application of the multiplicative hazards model to Yellowstone grizzly bear. Journal of Wildlife Management 68: 966-974.

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

McLoughlin, P. D., Dunford, J. S. & Boutin, S. (2005) Relating Predation Mortality to Broad-Scale Habitat Selection. Journal of Animal Ecology, 74, 701-707.

Murray, D.L.. 2006. On Improving Telemetry-Based Survival Estimation. Journal of Wildlife Management 70:1530-1543.

Murray, D.L. and B.R. Patterson. 2006. Wildlife Survival Estimation: Recent Advances and Future Directions. Journal of Wildlife Management 70:1499-1503.

Schemper, M.. 2000. Predictive Accuracy and Explained Variation in Cox Regression. Biometrics 56:249-255.

Therneau, T. M. & Grambsch, P. M. (2000) Modeling survival data: extending the Cox-model. Springer-Verlag, New York, NY, USA.

Unsworth, J.A., D.F. PAc, G.C. White, and R.M. Bartmann. 1999. Mule deer survival in Colorado, Idaho, and Montana. Journal of Wildlife Management 63: 315-326.

White, G.C. and K.P. Burnham. 1999. Program Mark: Survival Estimation from Populations of Marked Animals. Bird Study 46:120-139.

Wintrebert, C.M.A., A.H. Zwinderman, E. Cam, R. Pradel, and J.C. Van Houwelingen. 2005 . Joint Modeling of Breeding and Survival in the Kittiwake Using Frailty Models. Ecological Modeling 181:203-213.