

## Frances E. Buderman

Department of Fish, Wildlife, and Conservation Biology  
Colorado State University  
Fort Collins, CO 80523-1484  
franny.buderman@colostate.edu  
<http://fbuderman.net>

Education

- 2017 Ph.D., Fish, Wildlife, and Conservation Biology, Colorado State University  
Dissertation: *Statistical methods for modeling the movement and space-use of carnivores*  
Adviser: Mevin B. Hooten
- 2012 M.Sc., Wildlife and Fisheries Science, Pennsylvania State University  
Thesis: *A joint Kaplan-Meier known-fate and Brownie tag-recovery model to estimate harvest and survival rates*  
Adviser: Duane R. Diefenbach
- 2010 B.Sc., Natural Resources, Cornell University  
Concentration: Applied Ecology

Employment

- 2017- Post-Doctoral Fellow, Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins, CO  
Supervisor: David N. Koons  
Description: Developing models that evaluate the contribution of climate and land-use changes to waterfowl abundance across the Prairie Pothole Region from 1958 to 2017 using data from the Waterfowl Breeding Population and Habitat Survey (WBPHS), a noninvasive monitoring program. I am developing both single-species models for northern pintail and multi-species models to determine if life-history strategies contribute to differences in population dynamics and responses to landscape changes, while accounting for spatial and temporal autocorrelation. By treating the segments as repeated samples and scaling the intensity up to the transect-level, and ultimately the strata, I am modeling the effect of transect- and strata-level processes on the intensity of the data-level Poisson process governing abundance.
- 2017 Instructor, FW 370: Design of Fish and Wildlife Studies. Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins, CO  
Description: Instructed junior and senior-level students in the philosophy of science, development of research questions, design of field studies, analytical methods for fish and wildlife data, and statistical programming in R. Lectured, graded, and facilitated self-guided computer labs.
- 2013-17 Graduate Research Assistant, Colorado Cooperative Fish and Wildlife Research Unit, Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins, CO  
Supervisor: Mevin B. Hooten  
Description: Developed movement models for carnivores, including cougars and Canada lynx in the western U.S. I used a newly developed movement model called a continuous-time discrete space model to determine the time-varying effect of landscape covariates, including those related to anthropogenic use, on cougar movement rate and directionality in a wildland-urban corridor. Using a Bayesian hierarchical model, we extended the method to make inference on the population mean response and individual variation. I also accounted for species interactions and predator-prey dynamics by using two proxy covariates for prey distribution: distance to nearest kill site and the probability of mule deer using the habitat. This work was done in collaboration

- with Colorado Parks and Wildlife to inform human-wildlife conflict management. In another aspect of my work, I developed an integrated data model and a phenomenological movement model within a hierarchical Bayesian context to estimate the unobserved movements of 165 Canada lynx that were reintroduced to Colorado from 1999-2006. The model I developed is computational fast, flexible, and easy to implement, and offers a way to analyze data that was collected with large time periods between observations, which is common in survival monitoring. In addition, the model was used to analyze 11 years of data across nine states. This work was done in collaboration with Colorado Parks and Wildlife, Colorado Department of Transportation, and the National Park Service, and has provided the only state-wide analysis of Canada lynx movement behavior, which will be useful for managing land for lynx conservation.
- 2010-12 Graduate Research Assistant, Pennsylvania Cooperative Fish and Wildlife Research Unit, School of Forest Resources, Pennsylvania State University, University Park, PA  
Supervisor: Duane R. Diefenbach  
Description: Developed a capture-recapture model that extends the Brownie tag-recovery estimator, a traditional model used for estimating population dynamics of harvested species, to incorporate auxiliary known-fate data to correct for bias induced by tagging-to-harvest mortality. I evaluated the performance of this model using three terrestrial wildlife species with varying population dynamics. The model successfully provides less biased estimates of harvest than a traditional Brownie tag-recovery estimator. I used the model to analytically determine if collared deer in Pennsylvania are harvested at the same rate as non-collared deer, a critical assumption for using collared deer to estimate harvest rates. This work was done in cooperation with the Pennsylvania Game Commission; PGC used harvest estimates to inform management practices and the lack of observed hunter selection against collared deer supported the use of future radio-collar studies. I also forecasted deer population dynamics under different harvest strategies using an integrated population model. Additional duties included managing an active database for deer capture, locations, and mortality, and interfacing with four field crews of approximately twenty people across the state of Pennsylvania, including day-to-day questions about data collection and field activities.
- 2009 Intern, NSF Research Experiences for Undergraduates Program, Mountain Lake Biological Station, University of Virginia, Pembroke, VA  
Supervisor: Edmund D. Brodie III and Eric B. Liebgold  
Description: Investigated variation in salamander encounter probabilities for different age classes and search methods. Salamanders are typically surveyed during nocturnal transect surveys or daytime cover board surveys. Using Pollock's robust design, a modeling technique that separately estimates initial and subsequent capture using marked individuals, I determined that the two survey methods sample different subpopulations of the population, which can lead to differences in inference on population dynamics. This work has direct implications for managers using these survey methods for monitoring. I completed independent surveys for both methods, including marking individuals with fluorescent polymer, and maintained a capture-recapture database.
- 2008 Intern, NSF Research Internship in Ocean Sciences, Marine Field Station, Department of Marine and Coastal Sciences, Rutgers University, Tuckerton, NJ  
Supervisor: Ken W. Able and Thomas M. Grothues  
Description: Developed methodology for analyzing multi-species data collected with dual frequency identification sonar and used principle components analysis to evaluate fish association with pier habitat in the Hudson River.

### Publications

#### Peer-Reviewed Publications

*Buderman, F.E.*, M.B. Hooten, M. Alldredge, E.M. Hanks, J.S. Ivan. In Review. Predatory behavior is

- primary predictor of movement of wildland-urban cougars. bioRxiv 10.1101/257295.
- Buderman, F.E.*, M.B. Hooten, J.S. Ivan, T.M. Shenk. 2018. Large-scale movement behavior in a reintroduced predator population. *Ecography* 41: 126–139.
- Hefley, T.J., K.M. Broms, B.M. Brost, *F.E. Buderman*, S. Kay, H.R. Scharf, J.R. Tipton, P.J., Williams, M.B. Hooten. 2017. The basis function approach to modeling dependent ecological data. *Ecology* 98(3):632-646.
- Hooten, M.B., *F.E. Buderman*, B.M. Brost, E.M. Hanks, J.S. Ivan. 2016. Hierarchical animal movement models for population-level inference. *Environmetrics* 27(6):322-333.
- Buderman, F.E.*, M.B. Hooten, J.S. Ivan, T.M. Shenk. 2016. A functional model for characterizing long distance movement behavior. *Methods in Ecology and Evolution* 7(3):264–273.
- Buderman, F.E.*, D.R. Diefenbach, C.S. Rosenberry, B.D. Wallingford, and E. S. Long. 2014. Effect of hunter selectivity on harvest rates of radio-collared white-tailed deer in Pennsylvania. *Journal of Wildlife Management* 78(8):1456-1465.
- Buderman, F.E.*, D.R. Diefenbach, M.J. Casalena, C.S. Rosenberry, and B.D. Wallingford. 2014. Accounting for tagging-to-harvest mortality in a Brownie tag-recovery model by incorporating radio-telemetry data. *Ecology and Evolution* 4(8):1439–1450.
- Able, K.W., T.M. Grothues, J.L. Rackovan, *F.E. Buderman*. 2014. Application of mobile dual frequency identification sonar (DIDSON) to fish in estuarine habitats. *Northeastern Naturalist* 21(2):192-209.
- Buderman, F.E.* and E.B. Liebgold. 2012. Effect of search method and age class on mark-recapture parameter estimation in a population of red-backed salamanders. *Population Ecology* 54(1):157-167.

#### Manuscripts in Prep

- Allredge, M. and *F.E. Buderman*. Human-cougar interaction along the urban front-range of Colorado.
- Buderman, F.E.* and D.N. Koons. Modeling multi-scale drivers of northern pintail demography in the Prairie Pothole Region.

#### Technical Reports

- Rosenberry, C., B.D. Wallingford, J.T. Fleegle, *F.E. Buderman*, and D.R. Diefenbach. 2012. Biological and social implications of a 7-day concurrent firearms season. Pennsylvania Game Commission Bureau of Wildlife Management, Project Annual Job Report.
- Wallingford, B.D., C. Rosenberry, *F.E. Buderman*, and D.R. Diefenbach. 2011. Biological and social implications of a 7-day concurrent firearms season. Pennsylvania Game Commission Bureau of Wildlife Management, Project Annual Job Report.

#### Popular Press

- F.E. Buderman*. 2016. On the Tail of Reintroduced Canada Lynx: Leveraging Archival Telemetry Data to Model Animal Movement. *methods.blog*: Official blog of *Methods in Ecology and Evolution*. March 3, 2016.
- Liebgold, E.B. and *F.E. Buderman*. 2012. Effect of search method and age on mark-recapture abundance estimation in salamanders. *FrogLog* 100:77.

#### Presentations

##### Professional Oral Presentations

- Buderman, F.E.*, M.B. Hooten, M.W. Allredge. 2017. Timing of predation and carnivore movement in an urban-wildland interface. The Wildlife Society 24<sup>th</sup> Annual Conference, Albuquerque, NM.
- Buderman, F.E.*, M.B. Hooten, M.W. Allredge. 2016. Mountain lion movement dynamics in the wildland-urban interface. The Wildlife Society 23<sup>rd</sup> Annual Conference, Raleigh, NC.

- Buderman, F.E.*, M.B. Hooten, M.W. Alldredge. 2016. Drivers of mountain lion movement in the Colorado Front Range. Central Mountains and Plains Section of The Wildlife Society Annual Meeting, Steamboat Springs, CO.
- Buderman, F.E.*, M.B. Hooten, J.S. Ivan, T.M. Shenk. 2015. Spatial ecology and movement of reintroduced Canada lynx. The Wildlife Society 22<sup>nd</sup> Annual Conference, Winnipeg, MB.
- Buderman, F.E.*, M.B. Hooten, J.S. Ivan, T.M. Shenk. 2014. Characterizing dispersal behavior in Canada lynx using a multi-scale integrated data movement model. The Wildlife Society 21<sup>st</sup> Annual Conference, Pittsburgh, PA.
- Buderman, F.E.* and D.R. Diefenbach. 2012. Using auxiliary known-fate data to improve harvest rate estimates from tag-recovery models. The Wildlife Society 19<sup>th</sup> Annual Conference, Portland, OR.
- Buderman, F.E.*, D.R. Diefenbach, C.S. Rosenberry, and B.D. Wallingford. 2012. An integrated population model approach to monitoring response of white-tailed deer populations to regulation changes. Pennsylvania Chapter of The Wildlife Society 19<sup>th</sup> Annual Meeting, State College, PA.
- Buderman, F.E.*, D.R. Diefenbach, C.S. Rosenberry, and B.D. Wallingford. 2012. An integrated population model approach to monitoring response of white-tailed deer populations to regulation changes. Southeast Deer Study Group 35<sup>th</sup> Annual Meeting, Sandestin, FL.
- Buderman, F.E.* and D.R. Diefenbach. Improving harvest estimates using known-fate data to inform a band-recovery model. 2011. Northeast Fish and Wildlife 67<sup>th</sup> Annual Conference, Manchester, NH.

#### Invited Oral Presentations

- Buderman, F.E.*, M.B. Hooten, J.S. Ivan, M.W. Alldredge. 2018 (fall). Using basis functions for continuous-time inference on animal movement. The Wildlife Society 25<sup>th</sup> Annual Conference, Cleveland, OH.
- Buderman, F.E.*, 2018. Modeling movement and spatial ecology of mammals. University of Wyoming, Laramie, WY.
- Buderman, F.E.*, 2017. Development of mark-recapture and movement modeling techniques for applied wildlife questions. National Oceanic and Atmospheric Administration: Marine Mammal Lab, Seattle, WA.

#### Professional Poster Presentations

- Duane R. Diefenbach, *F.E. Buderman*, L.C. Gigliotti. 2017. Efficiency of joint-known fate and tag-recovery models for estimating harvest rates of large animals. EURING 2017 Analytical Meeting & Workshop, Barcelona, Spain.
- Buderman, F.E.*, M.B. Hooten, J.S. Ivan, T.M. Shenk. 2014. Characterizing dispersal behavior in *Lynx canadensis* using a multi-scale integrated movement model. Joint 24<sup>th</sup> ICSA Applied Statistics Symposium and 13<sup>th</sup> Graybill Conference, Fort Collins, CO.
- Buderman, F.E.*, M.B. Hooten, J.S. Ivan, T.M. Shenk. 2014. Identifying dispersal in *Lynx canadensis* using a coupled telemetry model. Front Range Student Ecology Symposium, Fort Collins, CO.
- Buderman, F.E.*, M.B. Hooten, J.S. Ivan, T.M. Shenk. 2014. Identifying dispersal in *Lynx canadensis* using a coupled telemetry model. Colorado Chapter of The Wildlife Society Annual Meeting, Fort Collins, CO.
- Buderman, F.E.*, and D.R. Diefenbach. 2013. Accounting for tagging-harvest mortality in a Brownie dead-recovery model by incorporating radio-telemetry data. EURING 2013 Analytical Meeting & Workshop, Athens, GA.

#### Stakeholder Presentations

- Buderman, F.E.*, M.B. Hooten, M.W. Alldredge. 2016. Hierarchical models for drivers of animal movement. Colorado Parks and Wildlife, Fort Collins, CO.
- Buderman, F.E.*, M.B. Hooten, J.S. Ivan, T.M. Shenk. 2014. Characterizing large scale lynx movement in Colorado. National Park Service, Fort Collins, CO.

- Buderman, F.E.*, M.B. Hooten, J.S. Ivan, T.M. Shenk. 2014. Characterizing large scale lynx movement in Colorado. Colorado Parks and Wildlife, Fort Collins, CO.
- Buderman, F.E.*, M.B. Hooten, J.S. Ivan, T.M. Shenk. 2014. Characterizing large scale lynx movement in Colorado. Colorado Department of Transportation, Denver, CO.
- Buderman, F.E.* Deer and Beer: One Graduate Student's Journey. 2011. Summer Seminar Series, Mountain Lake Biological Station, University of Virginia, Pembroke, VA.

#### Internship Presentations

- Buderman, F.E.* and E.B. Liebgold. 2009. Effect of age class and search method on parameter estimation in *Plethodon cinereus*. Research Experiences for Undergraduates Final Report, Mountain Lake Biological Station, University of Virginia, Pembroke, VA.
- Buderman, F.E.*, T.M. Grothues, and K.W. Able. 2008. Effect of Pier Shading on Prey Fish in the Hudson River, Using Dual Frequency Identification Sonar. Research Experiences for Undergraduates, Department of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ.

#### Teaching Experience

##### Courses

- 2017 Instructor. FW 370: Design of Fish and Wildlife Studies. Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins, CO
- 2015 Graduate Teaching Assistant. FW/STAT 673: Hierarchical Models in Ecology. Fish, Wildlife, and Conservation Biology/Statistics, Colorado State University, Fort Collins, CO
- 2008 Undergraduate Teaching Assistant. NTRES 210: Introductory Field Biology. Natural Resources, Cornell University, Ithaca, NY.

##### Workshops and Short Courses

- 2017 Instructor and Organizer. Introductory R. The Wildlife Society 24<sup>th</sup> Annual Conference, Albuquerque, NM.
- 2016 Instructor. R Workshop. R for Wildlife Biologists. Central Mountains and Plains Section of The Wildlife Society Annual Meeting, Steamboat Springs, CO.
- 2016 Teaching Assistant. Training in Bayesian Modeling for Practicing Ecologists. NSF. Colorado State University, Fort Collins, CO.
- 2015 Instructor. R Workshop. Colorado Cooperative Fish and Wildlife Research Unit. Colorado State University, Fort Collins, CO.
- 2015 Teaching Assistant. Training in Bayesian Modeling for Practicing Ecologists. NSF. Colorado State University, Fort Collins, CO.
- 2014 Teaching Assistant. Training in Bayesian Modeling for Practicing Ecologists. NSF. Colorado State University, Fort Collins, CO.
- 2013 Teaching Assistant. R Workshop. Colorado Cooperative Fish and Wildlife Research Unit. Colorado State University, Fort Collins, CO.

##### Guest Lectures

- 2015 Spatial Statistics. FW/STAT 673: Hierarchical Models in Ecology. Fish, Wildlife, and Conservation Biology/Statistics, Colorado State University, Fort Collins, CO.
- 2015 Bayesian P-Values. FW/STAT 673: Hierarchical Models in Ecology. Fish, Wildlife, and Conservation Biology/Statistics, Colorado State University, Fort Collins, CO.
- 2011 Deer Trapping and Monitoring. BIOL 3510: Field Methods in Wildlife Ecology. Mountain Lake Biological Station, University of Virginia, Pembroke, VA.

Research Funding

- 2016 Travel Grant, Biometrics Working Group, The Wildlife Society, \$625  
2016 Oscar and Isabel Anderson Graduate Research Fellowship, Warner College of Natural Resources, Colorado State University, \$1650  
2015 Annual Conference Travel Grant, Colorado Chapter, The Wildlife Society, \$2000  
2015 Travel Grant, Biometrics Working Group of The Wildlife Society, \$625 (*declined*)  
2014 Travel Grant, The Wildlife Society, \$350  
2014 Robert L. Tate Research Fellowship, Warner College of Natural Resources, Colorado State University, \$4400  
2010 Robert W. Graham Endowed Graduate Research Fellowship, Pennsylvania State University, \$4000

Awards

- 2008 Harlan B. Brunsted Scholarship, Cornell University, \$3350

Professional Activities and ServiceAppointments

- 2017- The Wildlife Society Biometrics Working Group Board Member – Technical Sessions

Professional Affiliations

- 2011- The Wildlife Society (2011-present): Biometrics Working Group (2015-present), Colorado Chapter (2014 present), Pennsylvania Chapter (2011-2013)

Journal Referee

Biological Conservation, Ecology and Evolution, Environmental Management, Journal of Animal Ecology, Journal of Applied Ecology, Journal of North American Herpetology, The Condor

References

Mevin Hooten, *Ph.D. Advisor*

Associate Professor and Assistant Unit Leader

U.S. Geological Survey, Colorado Cooperative Fish and Wildlife Research Unit

Department of Fish, Wildlife, and Conservation Biology & Department of Statistics

Colorado State University

Contact Information: mevin.hooten@colostate.edu - 970.491.1415

Jake Ivan, *Ph.D. Committee Member and Collaborator*

Wildlife Researcher

Mammals Research Section

Colorado Parks and Wildlife

Department of Natural Resources

Contact Information: jake.ivan@state.co.us - 970.472.4310

Duane Diefenbach, M.Sc. Advisor

Adjunct Professor and Unit Leader

U.S. Geological Survey, Pennsylvania Cooperative Fish and Wildlife Research Unit

Department of Ecosystem Science and Management

Pennsylvania State University

Contact Information: ddiefenbach@psu.edu - 814.865.3992

### Brief Research Statement

My primary research interest is to better understand the mechanisms that govern the distributions and population dynamics of wildlife in space and time, at both an individual and population-level. I strive to address applied management questions, such as estimating population demographic parameters, and gaps in ecological knowledge, such as difficult to observe processes (e.g., fine-scale animal movement, multi-species dynamics). My research program focuses on three aspects of ecological investigation: 1) investigating the processes that give rise to individual locations on the landscape, 2) addressing ecological questions at large spatial and temporal scales, and 3) developing Bayesian hierarchical models to integrate information from multiple individuals and data sources (e.g., mark-recapture, radio-collaring, non-invasive camera/genetic monitoring) into analyses and decision making. These three components allow me to integrate the increasingly fine level of detail available on individual animals through time and space, which may be obtained through a variety of methods, with novel statistical methods. I prefer to work with state and federal agencies to address pressing questions in which the answers can be used to refine management actions and decisions related to wildlife, and I am actively involved in teaching statistical methods to wildlife professionals.

### Qualifying Coursework

OPM Requirements Wildlife Biology Series (0486 Research)	Credit Description (number, full course title, credits and university) Additional description if course content is unclear
Training applicable to wildlife biology in such subjects as mammalogy, ornithology, animal ecology, wildlife management, principles of population dynamics, or related course work in the field of wildlife biology (9)	NTRES 101: Environmental Science and Management (3, Cornell) NTRES 201: Environmental Conservation (3, Cornell) NTRES 220: Society and Natural Resources (3, Cornell) NTRES 3100: Applied Population Ecology (3, Cornell) NTRES 3300: Natural Resources Planning and Management (4, Cornell ) NTRES 3140: Conservation of Birds (2, Cornell) NTRES 4120: Wildlife Population Analysis: Techniques and Models (3, Cornell) NTRES 4100: Conservation Biology: Concepts and Techniques (3, Cornell) BIOEE 4750: Ornithology (4, Cornell) WFS 597B: Special Topics: Quantitative Methods in Ecology (3, PSU) WFS 560: Wildlife and Fisheries Population Estimation and Modeling (4, PSU) ECOL 620: Applications in Landscape Ecology (4, CSU) FW 673: Hierarchical Modeling in Ecology (3, CSU) ESS 575: Models for Ecological Data (4, CSU) Total: 43
Zoological subjects such as invertebrate zoology, vertebrate zoology, comparative anatomy of the vertebrates, embryology, animal physiology, entomology, herpetology, parasitology, and	BIONB 221: Neurobiology and Behavior I: Intro to Behavior (4, Cornell) BIOEE 274: Vertebrates: Structure, Function, and Evolution (4, Cornell) NTRES 2830: Genetics for Population Biologists (4, Cornell) BIONB 4220: Modeling Behavioral Evolution (4, Cornell) Application of population-genetic and game-theoretic methods to evolution of optimal foraging, sexual selection, sex ratio, animal communication, and cooperation NTRES 4971: Independent Study in Applied Ecology & Cons. Biology (3, Cornell) Topic: Genetics - Measuring migration with, and the future utility of, the Fst parameter Total: 19

genetics (12)	
Botany and related plant science (9)	BIOPL 241: Introductory Botany (3, Cornell) NTRES 210: Introductory Field Biology (4, Cornell) Field identification of 80 woody plants, knowledge of geographic ranges and uses BIOEE 261: Ecology and the Environment (4, Cornell) Role of plants in terrestrial and aquatic ecosystem functions BIOEE 2780: Evolutionary Biology (3, Cornell) Plant evolutionary and diversity NTRES 3260: Applied Conservation Ecology (3, Cornell) Sampling methods for woody and herbaceous plants, seed bank sampling, seed and seedling identification NTRES 4980: Undergraduate Teaching in Natural Resources (4, Cornell) Taught students in NTRES 210 to identify 80 woody plants and led plant-focused field trips and review sessions Total: 21
Training in any combination of two or more of the following: chemistry, physics, mathematics, statistics (15) soils, and/or geology	MATH 106: Calculus for Life and Social Sciences (3, Cornell) CHEM 206: Introduction to General Chemistry (4, Cornell) CHEM 257: Introduction to Organic and Biological Chemistry (3, Cornell) NTRES 313: Biological Statistics I (4, Cornell) NTRES 4130: Biological Statistics II (4, Cornell) STAT 414: Introduction to Probability Theory (3; PSU) STAT 415: Introduction to Mathematical Statistics (3, PSU) STAT 501: Regression Methods (3; PSU) STAT 506: Sampling Theory and Methods (3, PSU) NR 523: Quantitative Spatial Analysis (3, CSU) STAA 573: Analysis of Time Series (2, CSU) Total: 35