Todd Bartholomew Cross

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EDUCATION

University of Montana
Missoula, Montana 59812
College of Forestry and Conservation
Doctor of Philosophy — Fish and Wildlife Biology
August 2011–May 2017
Advisors: David E. Naugle & Michael K. Schwartz

University of Colorado
Boulder, Colorado 80309
Postbaccalaureate — Ecology and Evolutionary Biology
August 2009-May 2010

Wheaton College
Wheaton, Illinois 60187
Bachelor of Science — Biology
Date of Diploma: May 2006

RESEARCH POSITIONS HELD

Post-Doctoral Researcher. National Genomics Center for Wildlife and Fish Conservation, Wildlife and Terrestrial Ecosystems, Rocky Mountain Research Station, USDA Forest Service & USDA Natural Resources Conservation Service – Sage Grouse Initiative. Missoula, Montana. May 2017–March 2018. Supervisors: Brady Allred & David E. Naugle.

- Given the vast expanse across which the greater sage-grouse ranges, knowing where to target conservation investments to get the greatest return can be an overwhelming task. This position focuses on providing spatial data-driven conservation prioritization tools made publicly available using Google Earth Engine and SGI Map. As part of this position, I have optimized research products from my dissertation and recent work for this interface, so that data and results can be interacted with and downloaded for stakeholders. Tools provided will include a network prioritization tool that ranks greater sage-grouse (*Centrocercus urophasianus*) leks for their importance to maintaining genetic connectivity, and a map of pathways of range-wide genetic connectivity (pathways of gene flow) among leks. Concurrently, I have developed and am testing a genome-wide marker panel of 70,000 genic single nucleotide polymorphisms for greater sage-grouse.

Wildlife Biologist Student Trainee, Ph. D. Candidate. National Genomics Center for Wildlife and Fish Conservation, Wildlife and Terrestrial Ecosystems, Rocky Mountain Research Station, USDA Forest Service. Missoula, Montana. January 2015–May 2017.

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Graduate Research Assistant, Ph. D. Candidate. Wildlife Biology, College of Forestry and Conservation, University of Montana. Missoula, Montana. August 2011–May 2017.

- Dispersal, genetic structure, network connectivity, and conservation of an at-risk, large-landscape species. Advisors: David. E. Naugle & Michael K. Schwartz.

  My dissertation research was centered on using large scale, high resolution, non-invasive genetic sampling, and spatial data analysis to inform conservation and management. Using network analysis, I quantified range-wide genetic connectivity and identified hubs of genetic exchange, providing a way to prioritize populations for conservation. Using genetic mark recapture, I discovered long distance breeding dispersal in Idaho, Montana, North Dakota, and South Dakota, with special focus on sex-biased dispersal and patterns of movement among state-identified areas of conservation priority. Using Bayesian clustering algorithms, I determined spatial population structure and then used spatial analyses to identify potential landscape drivers of genetic population structure, and I quantified genetic population structure alignment with existing management boundaries. Using simulated populations, I tested the Bayesian clustering algorithm used to detect subpopulation structure in order to provide insight into the interpretation of the evolutionary history leading to subpopulation divergence. This project involved a collaboration with scientists from USGS, University of Montana, University of Waterloo, and biologists from state and federal agencies across eleven western states to collect over 16,000 feather samples. To accomplish this task, I trained and led a team of four laboratory technicians to catalogue, extract, and genotype over 8,000 samples. With their help, I constructed and maintained a spatial genetic database for 7,000 individual greater sage-grouse.

Laboratory Technician. Wildlife and Terrestrial Ecosystems – Wildlife Genetics Lab, Rocky Mountain Research Station, USDA Forest Service. Missoula, Montana. May 2010–August 2010.

- Landscape genetics of the greater sage-grouse (*Centrocercus urophasianus*) in greater Montana. June 2010–August 2011. Supervisor: Michael Schwartz

  This research laid the groundwork for my dissertation research. I extracted DNA from over 500 feather and blood samples from across Montana and into North Dakota, South Dakota, and southern Canada. I researched, selected, and optimized multi-primer amplification protocols for over 20 microsatellite loci. I created and maintained GIS spatial databases, which I used to develop a sampling protocol and to analyze population and landscape genetics. This project

was in close collaboration with and the Montana and Dakotas Bureau of Land Management, Montana Fish Wildlife and Parks, National Resources Conservation Service, The Nature Conservancy, The University of Montana, and The Wildlife Federation.

- Laboratory DNA Extraction, Genotyping, and Analysis. May 2010–June 2010. Supervisor: Kristine Pilgrim.

  This research involved creating and maintaining databases of genetic data for multiple federal and state agency projects comprised of mammalian, avian, fish, and insect species. I isolated trace amounts of DNA from feather, hair, fecal, blood, and tissue samples. With the resultant DNA, I performed restriction digests to identify species, amplified mitochondrial DNA for sequencing, and amplified nuclear DNA for microsatellite genotyping. I was also responsible for composing summary reports of analysis findings for dissemination to project leads.

Research Associate. The Martin Lab, Department of Ecology and Evolutionary Biology, University of Colorado, Boulder. Boulder, Colorado. January 2010–May 2010.

- Connectivity of prairie dog colonies in an altered landscape: inferences from analysis of microsatellite DNA variation. Advisor: Dr. Andrew Martin.

  In Boulder County, Colorado, the humans and black tailed prairie dogs (*Cynomys ludovicianus*)—a known vector of the plague (*Yersinia pestis*)—exist in very close proximity. This landscape is increasingly human-altered. I focused on conducting landscape genetics analyses to identify landscape features correlated with patterns genetic divergence among prairie dog populations to better understand how the species moves about the landscape. I was responsible for extraction and amplification of nuclear and mitochondrial DNA from animal tissue to quantify genetic divergence. Resistance surfaces were generated from land-cover variables, and analyzed using Circuitscape, a program that draws on electronic circuit theory and incorporates random walk algorithms, to model animal movement, gene flow, and genetic differentiation across these heterogeneous landscapes.

Research Associate. Museum of Natural History, University of Colorado, Boulder. Boulder, Colorado. August 2009–May 2010.

- Morphological shifts and plasticity of *Xanthippus corallipes* and *Camnula pellucida* in response to climate change along an elevational gradient. Advisor: Dr. César Nufio.

  Grasshoppers behaviorally regulate internal temperature. Ambient temperatures

and opportunities for thermal regulation via insolation vary across elevations and with changes in climate. I assessed wing melanization and grasshopper body size (means of absorbing and retaining solar radiation) across multiple elevational gradients and over 50 years of climate change on the front range of Colorado. As part of this research, I designed a novel approach to quantify wing melanization using digital image capture and software analysis.

Biological Science Technician. USDA Forest Service, White River National Forest, Eagle/Holy Cross Ranger District. Minturn, Colorado. July 2007–August 2008.

- Biological Science Technician – Threatened Amphibians. July 2007–August 2008.

  The distribution and abundance of Colorado amphibian species is not well documented, many species are in decline, and some species are imperiled. I collected occupancy and abundance data for the Colorado state endangered boreal toad (*Bufo boreas boreas*), species of greatest conservation need northern leopard frog (*Rana pipiens*), western chorus frog (*Pseudacris triseriata*), and tiger salamander (*Ambystoma tigrinum*) by field surveying habitat previously identified as suitable. This included sampling for the presence of chytrid fungus on the particularly susceptible boreal toad. I also restored degraded riparian habitat by introducing large woody debris for in-stream habitat by planting willows for erosion control and amphibian and macroinvertebrate habitat.

- GIS and Data Technician – Aquatic Invasive Species and Threatened Amphibians. December 2007–May 2008.

  This position involved compiling amphibian breeding site data from multiple sources into a single database. From this data, I identified suitable habitat for threatened amphibians and created digital site maps for future sampling efforts. I also researched, designed, and produced an interpretive poster and pamphlets regarding the presence and prevention of aquatic invasive and nuisance species for display and dissemination.

- Biological Science Technician – Fisheries, Lotic, and Riparian Ecosystems. July 2007–November 2007.

  Historical surface mining and interstate sediment runoff have impacted contemporary fisheries by altering lotic and riparian habitats and aquatic macroinvertebrate abundance and assemblages. I compared control and impact sites by: quantifying differences in lotic and riparian habitat characteristics and quality (stream composition, substrate, flow); sampling aquatic macroinvertebrate populations; quantifying fish abundance, species composition, and size distributions; and collecting fin clips for genetic subspecies identification of greenback (*Oncorhynchus clarkia stomias*) and Colorado River cutthroat trout (*Oncorhynchus clarkia pleuriticus*). I also trained field crew and

maintained field equipment. This project involved close collaboration with EPA, CO Division of Wildlife, and CO Division of Reclamation Mining and Safety.

TEACHING EXPERIENCE

Guest Lecturer. Conservation Genetics, Molecular Ecology and Applied Management, BIOL 480/580. Division of Biological Sciences, College of Arts and Sciences, University of Montana. Winter Session 2014.

Guest Lecturer. Wildlife Habitat Conservation and Management, WILD 370. Department of Wildlife Biology, College of Forestry and Conservation, University of Montana. Spring 2013.

Instructor. Wildlife Interest Group, WILD 170. Department of Wildlife Biology, College of Forestry and Conservation, University of Montana. Fall 2011.

Teaching Assistant. Careers in Natural Resources, NRSM 180 (WBIO/FOR 180). Department of Wildlife Biology, College of Forestry and Conservation, University of Montana. Fall 2011.

GRANT ACTIVITY & AWARDS

Funded Grants and Agreements

- **Range-wide analysis of greater sage-grouse genetic population structure.** $30,000. United States Geological Survey. 2018.
- **Greater sage-grouse genetic connectivity.** $20,000. Bureau of Land Management. With DE Naugle & MK Schwartz. 2016.
- **Greater sage-grouse DNA analysis.** $15,000. United States Geological Survey. With MK Schwartz. 2016.
- **Greater sage-grouse DNA analysis.** $25,000. United States Geological Survey. With MK Schwartz. 2015.
- **Greater sage-grouse genetic connectivity.** $75,000. Bureau of Land Management. With DE Naugle & MK Schwartz. 2014.
- **Greater sage-grouse DNA extraction.** $2,500. United States Geological Survey. 2012.
- **Genomics and range-wide connectivity of greater sage-grouse populations – the northern tier.** $243,690. Intermountain West Joint Venture & Natural Resources Conservation Service – Sage Grouse Initiative. With MK Schwartz. 2012.

- **Providing high-resolution connectivity maps for greater sage-grouse in the Great Northern Landscape using state of the art genomics.** $90,000. Great Northern Landscape Conservation Cooperative. With MK Schwartz & JL Sanderlin. 2012.

- **Filling the gaps: targeted sage grouse genetic sampling in Montana.** $11,436. Natural Resources Conservation Service – Sage Grouse Initiative & Montana Fish, Wildlife, and Parks. With DE Naugle & R Northrup. 2012.

- **Greater sage-grouse genetic connectivity across the species' Eastern Range.** $175,000. Bureau of Land Management. With DE Naugle & MK Schwartz. 2011-2016.

Awards & Fellowships prior to arrival at the University of Montana

- **Dean's List.** University of Colorado at Boulder. Fall 2009 & Spring 2010.
- **Undergraduate Research Opportunities Program.** $742.50. University of Colorado at Boulder. 2009.
- **Wheaton Grant.** $461. Wheaton College. 2005.
- **Emery Scholarship.** $2,146. Wheaton College. 2003.
- **Wheaton Grant.** $3,143. Wheaton College. 2003.
- **Bailey Scholarship.** $250. 2002.
- **Frank & Olive Gilman Foundation Scholarship.** $2,250. 2002.

REFEREED PUBLICATIONS

Cross TB, McKelvey KS, Schwartz MK. Submitted. Detection of hierarchical genetic population structure: method validation via a modeling approach? *Molecular Ecology Resources*.

Cross TB, Naugle DE, Oyler-McCance SJ, Row JR, Fedy BC, Schwartz MK. In Press. The genetic network of greater sage-grouse: range-wide identification of keystone hubs of connectivity. *Ecology and Evolution*.

Row JR, Doherty KE, **Cross TB**, Schwartz MK, Oyler-McCance SJ, Naugle DE, Knick ST, Fedy BC. In Press. Quantifying functional connectivity: the role of breeding habitat, abundance, and landscape features on range-wide gene flow in sage-grouse. *Evolutionary Applications*.

Cross TB, Naugle DE, Carlson JC, Schwartz MK. 2017. Genetic recapture identifies long-distance breeding dispersal in Greater Sage-Grouse (*Centrocercus urophasianus*). *The Condor: Ornithological Applications* 119:155-166.

Cross TB, Naugle DE, Carlson JC, Schwartz MK. 2016. Hierarchical population structure in greater sage-grouse provides insight into management boundary delineation. *Conservation Genetics* 17:1417–1433.

Hanks EM, Hooten MB, Knick ST, Oyler-McCance SJ, Fike JA, **Cross TB**, Schwartz MK. 2016. Latent spatial models and sampling design for landscape genetics. *Annals of*

Applied Statistics 10:1041–1062.

Sackett LC, **Cross TB**, Jones RT, Johnson W, Ballare K, Ray C, Collinge SK, Martin AP. 2012. Connectivity of prairie dog colonies in an altered landscape: inferences from analysis of microsatellite DNA variation. *Conservation Genetics* 13: 407–418.

WORKSHOPS, MEETINGS & WEBINARS

Invited Speaker

- **Great Northern Landscape Conservation Cooperative:** Live Webinar (recording: http://greatnorthernlcc.org/event/873). December 2016.
  Cross TB, Naugle DE, Carlson JC, and Schwartz MK. *Hierarchical population structure in greater sage-grouse provides insight into management boundary delineation*.

- **NRCS – Sage Grouse Initiative Workshop:** Lewistown, Montana. June 2016.
  Cross TB, Naugle DE, Carlson JC, and Schwartz MK. *Hierarchical population structure in greater sage-grouse provides insight into management boundary delineation*.

- **The Bureau of Land Management, Montana/Dakotas:** Annual Biologist Meeting. Lewistown, Montana. July 2014.
  Cross TB. *Greater sage-grouse conservation & network theory: using population networks to identify the relative importance of leks for maintaining population connectivity and persistence.*

- **The Wildlife Society:** Colorado Chapter, Landscape Genetics Workshop. Fort Collins, Colorado. February 2014.
  Cross TB and Schwartz MK. *Wildlife conservation & network theory: using population networks to identify the relative importance of leks for maintaining population connectivity and persistence.*

- **NRCS – Sage Grouse Initiative:** Montana NRCS Sage Grouse Partner Meeting. Billings, Montana. April 2012.
  Cross TB. *Linking genetics to habitat to identify conservation priorities.*

- **Montana Audubon:** Adopt-A-Lek Annual Meeting. Missoula, Montana. March 2012.
  Cross TB. *Sage-grouse connectivity among core breeding areas in Montana.*

- **Western Association of Fish and Wildlife Agencies - Range-wide Interagency Sage-grouse Conservation Team:** Sage-grouse Connectivity Scoping Meeting. Denver, Colorado. January 2012.
  Cross TB and Fedy B. *Linking genetics to habitat to identify conservation priorities.*

Presenter

- **Society for Conservation Biology:** Montana Chapter, 8th Annual Research Symposium. University of Montana, Missoula, Montana. November 2017.
  Cross, TB, Naugle DE, Carlson JC, and Schwartz MK. *Genetic recapture identifies long-distance breeding dispersal in Greater Sage-Grouse (Centrocercus urophasianus).*

- **30th Western Agencies Sage and Columbian Sharp-Tailed Grouse Workshop.** Lander, Wyoming. June 2016.
  Cross TB, Naugle DE, Carlson JC, and Schwartz MK. *Hierarchical population structure in greater sage-grouse provides insight into management boundary delineation*.

- **Society for Conservation Biology:** Montana Chapter, 7th Annual Research Symposium. University of Montana, Missoula, Montana. November 2015.
  Cross, TB, Naugle DE, Carlson JC, and Schwartz MK. *Greater Sage-grouse Hierarchical Genetic Population Structure: Ecoregions, Contemporary Landscape Features, and Management.*

- **Society for Conservation Biology:** Montana Chapter, 3rd Annual Research Symposium. University of Montana, Missoula, Montana. October 2010.
  Cross TB, Schwartz MK, Pilgrim K, Tack J, and Naugle DE. *Sage-grouse connectivity among core breeding areas in Montana.*

Attendee

- **Society for Conservation Biology:** 2nd North America Congress for Conservation Biology. University of Montana, Missoula, Montana. July 2014.

- **The Wildlife Society:** Landscape Conversations. Great Falls, Montana. 2012.

- **Society for Conservation Biology:** Montana Chapter, 4th Annual Research Symposium. University of Montana, Missoula, Montana. October 2011.

- **Defenders of Wildlife:** Carnivores 2009: Carnivore Conservation in a Changing World. Denver, Colorado. 2009.

PROFESSIONAL MEMBERSHIPS *(activity within last five years)*

- Backcountry Hunters and Anglers
- Big Sky Upland Bird Association
- Ducks Unlimited
- National Wild Turkey Federation
- Rocky Mountain Elk Foundation
- Ruffed Grouse Society
- Society for Conservation Biology
- Theodore Roosevelt Conservation Partnership

COURSEWORK

Wildlife Habitat Modeling, Spatial Statistics, Applied Sampling, Introduction to Geographic Information Science, Programming for Bioinformatics, Biometry, Landscape Conservation, Advanced Topics in Evolution, Conservation Genetics, Evaluating Landscape Connectivity of Plants and Animals, Genomics, Population Genetics Data Analysis, Population Genetics Seminar, Wildlife Graduate Seminar

SERVICE

- **Board Member.** Big Sky Upland Bird Association. Missoula, Montana. 2016 – Present.
- **Article Reviewer.** *Journal of Avian Biology*, reviewed article on genetic structure, December 2017.
- **Article Reviewer.** *Journal of Fish and Wildlife Management*, reviewed article on ancestry and genetic population structure, October 2017.
- **Search Committee Member.** Assistant/Associate Professor of Fisheries and Conservation Genomics, College of Forestry and Conservation, University of Montana, October 2014 – March 2015.
- **Article Reviewer.** *Landscape Ecology*, reviewed article on network models of genetic connectivity and landscape resistance, February 2014.
- **Article Reviewer.** *Landscape Ecology*, reviewed article on network models of genetic connectivity and landscape resistance, December 2013.
- **Article Reviewer.** *Conservation Genetics*, reviewed article on spatial analysis of landscape genetic data, March 2012.

ADDITIONAL INFORMATION

- Proficient in programming in R
- Proficient in ESRI ArcGIS
- Competent in programming in MS-DOS, PYTHON, Linux/Unix

- Cross-cultural experience from humanitarian aid trips to Senegal (2005), Romania (2003), and travel throughout Europe (Austria, Denmark, Germany, Hungary, Spain) and Central America (Belize).
- NCAA Division III Varsity Football, Wheaton College, 2002–2006.
- Collegiate Lacrosse Team, Wheaton College, 2006.
- Activities: Alpine and Nordic Skiing, Camping, Backpacking, Bicycle Racing, Fishing, Hunting, Rock Climbing, Trail Running, Weightlifting.

CERTIFICATIONS

- Adult CPR, AED and First Aid – 2/5/2016