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Education

- 1997 Ph.D. in Population Biology, *University of California, Davis*
1991 M.S. in Biology, *University of California, San Diego*
1990 B.A. in Ecology, Behavior and Evolution, *University of California, San Diego*

Career employment

- 2015-Present *Research Scientist, Institute for Bird Populations*: Hierarchical modeling of point count data on bird species in western national parks
2008-Present *Research Associate, Institute for Arctic and Alpine Research, University of Colorado, Boulder*: Ecology of sub-surface habitat specialists
2014 *Research Associate, Museum Collections, University of Colorado, Boulder*: User interface development and research applications for several data archives
2008-2013 *Research Associate, Ecology and Evolutionary Biology, University of Colorado, Boulder*: Modeling metacommunity dynamics of vernal pool plants
2008 *Instructor, Ecology and Evolutionary Biology, University of Colorado, Boulder*: Graduate seminar in population biology—modeling and data analysis
2002-2007 *Research Associate, Ecology and Evolutionary Biology, University of Colorado, Boulder*: Modeling the dynamics of plague in prairie dogs and alternate hosts
2001-2005 *Independent contractor, US Fish & Wildlife Service*: Black-footed ferret endangered species recovery plan revision
1998-2003 *Research Associate, University of Nevada, Reno*: Developing predictive models of population dynamics and population genetics for species at risk

Peer-reviewed publications (mentored student authors underlined)

- Varner J, Carnes-Douglas ZJ, Dearing MD, Monk E, Benedict LM, Whipple A, Griswold L, Bhattacharyya S, **Ray C**. 2023. Sampling a pika's pantry: temporal shifts in nutritional quality and over-winter preservation of American pika food caches. *Ecosphere* e4494. <https://doi.org/10.1002/ecs2.4494>
Whipple AL, **Ray C**, Varner J, Kitchens JN, Hove AA, Wilkening JL. 2022. Stress-associated metabolites vary with both season and habitat across populations of a climate sentinel species. *Arctic, Antarctic and Alpine Research* 54:603-623. <https://doi.org/10.1080/15230430.2022.2146633>
Pandolfino ER, Douglas LA, **Ray C**. 2022. Irruptive movements of the black-chinned sparrow (*Spizella atrogularis*) in response to variations in precipitation: implications for climate change resiliency. *Western Wildlife* 9:24-37.

- Johnson EC, Hastings A, **Ray C.** 2022. An explanation for unexpected population crashes in a constant environment. *Ecology Letters*. <https://doi.org/10.1111/ele.14110>
- Monk EM, Ray C.** 2022. Revisiting talus and free-air temperatures after 50 years of change at an American pika study site in the Southern Rockies. *PLOS Climate* 1(7): e0000049. <https://doi.org/10.1371/journal.pclm.0000049>
- Kaschube, D.R., J.F. Saracco, **C. Ray**, C.M. Godwin, K.R. Foster, and P. Pyle. 2022. Minimum capture-recapture rates and years of banding station operations to obtain reliable adult annual survival estimates. *Journal of Field Ornithology* 93:7.
- Whipple AL, Ray C, Wasser M, Kitchens JN, Hove AA, Varner J, Wilkening JL.** 2021. Temporal vs. spatial variation in stress-associated metabolites within a population of climate-sensitive small mammals. *Conservation Physiology* 9(1): coab024; doi:10.1093/conphys/coab024.
- Klingler KB, Jahner JP, Parchman TL, Ray C, Peacock MM.** 2021. Genomic variation in the American pika: signatures of geographic isolation and implications for conservation. *BMC Evolutionary Ecology* 21, 2. <https://doi.org/10.1186/s12862-020-01739-9>.
- Brinkerhoff RJ, **Rinsland HS**, Sato S, Maruyama S, **Ray C.** 2020. Vector-borne pathogens in ectoparasites collected from high-elevation pika populations. *EcoHealth* 1-12. <https://doi.org/10.1007/s10393-020-01495-8>.
- Pandolfino ER, **Ray C.** 2020. Comparison of the songs of Cassin's and Plumbeous vireos. *Western Birds* 51:293-306. <https://doi.org/10.21199/WB51.4.2>.
- Ray, C.,** R.M. Rochefort, J.I. Ransom, J.C.B. Nesmith, S.A. Haultain, T.D. Schaming, J.R. Boetsch, M.L. Holmgren, R.L. Wilkerson, R.B. Siegel. 2020. Assessing trends and vulnerabilities in the mutualism between whitebark pine (*Pinus albicaulis*) and Clark's nutcracker (*Nucifraga columbiana*) in national parks of the Sierra-Cascade region. *PLoS ONE* 15(10): e0227161. <https://doi.org/10.1371/journal.pone.0227161>.
- Benedict LM, Wiebe M, Plichta M, Batts H, Johnson J, Monk E, Ray C.** 2020. Microclimate and summer surface activity in the American pika (*Ochotona princeps*). *Western North American Naturalist* 80:316-329.
- Smith AB, Beever EA, Kessler AE, Johnston AN, **Ray C** et al. 2019. Alternatives to genetic affinity as a context for within-species response to climate. *Nature Climate Change* 9:787-794. <https://www.nature.com/articles/s41558-019-0584-8>.
- Ray C, DR Cluck, RL Wilkerson, RB Siegel, AM White, GL Tarbill, SC Sawyer, CA Howell.** 2019. Patterns of woodboring beetle activity following fires and bark beetle outbreaks in montane forests of California, USA. *Fire Ecology* 15:21. <https://doi.org/10.1186/s42408-019-0040-1>
- Ray, C., M. L. Holmgren, R. L. Wilkerson, R. B. Siegel, and J. I. Ransom.** 2019. Trends in landbird density at two national parks in fragmented, mixed-use landscapes of the Pacific Northwest. *The Northwestern Naturalist* 100(1):1-25; <https://doi.org/10.1898/NWN18-11>.
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- Koju, N.P., K. He, M.K. Chalise, **C. Ray**, Z. Chen, B. Zhang, T. Wan, S. Chen and X. Jiang. 2016. Multilocus approaches reveal underestimated species diversity and inter-specific gene flow in pikas (*Ochotona*) from southwestern China. *Molecular Phylogenetics and Evolution* 107:239–245. <https://doi.org/10.1016/j.ympev.2016.11.005>
- Wilkening, J. L., and **C. Ray**. 2016. Characterizing predictors of survival in the American pika (*Ochotona princeps*). *Journal of Mammalogy* 97(5):1366–1375. <https://doi.org/10.1093/jmammal/gyw097>
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- Schwalm, D., C. W. Epps, T. J. Rodhouse, W. B. Monahan, J. A. Castillo, **C. Ray** and M. R. Jeffress. 2016. Habitat availability and gene flow influence diverging local population trajectories under scenarios of climate change: a place-based approach. *Global Change Biology* 22(4):1572–1584. <http://dx.doi.org/10.1111/gcb.13189>
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Professional reports

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- Peralta, A. **C. Ray** and M. Mueller. 2021. Establishing capacity for long-term monitoring of the American pika, a sentinel species, by citizen scientists in Rocky Mountain National Park. University of Colorado-Boulder, CO.
- Ray, C.**, S. Albert, L. Schofield and J. Schillaci. 2021. Fort Bragg landbird monitoring program: report for the 2020 field season. The Institute for Bird Populations, Petaluma, CA.
- Kaschube, D. R., **C. Ray**, R. Taylor, S. Albert, R. Keith, B. Keith and J. Brenneman. 2021. An analysis of point count and demographic monitoring data from Fort Custer Training Center and the Kalamazoo Nature Center 1990-2019. The Institute for Bird Populations, Petaluma, CA.
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- Varner, J., **C. Ray**, and D. Dearing. 2022. Sampling a pika's pantry: Temporal shifts in nutritional quality and over-winter preservation of American pika food caches ver 1. Environmental Data Initiative. <https://doi.org/10.6073/pasta/91798dccc14852d8d3db5cfca8c3a127> (Accessed 2022-12-28).
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- Craighead, A. and **C. Ray**. 2021. Talus Subsurface and Surface Temperature Data from Southwestern Montana, USA, 2010-2020 ver 1. Environmental Data Initiative. Accessed 2021-08-18. <https://doi.org/10.6073/pasta/6f19d3e6e6bc609ad1aa57b853395f30>.
- Ray, C.** and Niwot Ridge LTER. 2021. Pika demography data for west knoll and Indian Peaks wilderness, 2008 - ongoing ver 4. Environmental Data Initiative. Accessed 2021-05-19. <https://doi.org/10.6073/pasta/0a786c99fe3d4e1dfb8c57424ce79091>.
- Ray, C.** 2020. Pika habitat occupancy survey data for Niwot Ridge and Green Lakes Valley, 2016 - ongoing ver 2. Environmental Data Initiative. Accessed 2021-05-19. <https://doi.org/10.6073/pasta/e6b0d005a2a8e655be4cfda8d6b59329>.

Package and software development

- Chamberlain, S., **C. Ray** and Vijay Barve. c 2015. rvertnet: an R interface for the VertNet database. <https://github.com/ropensci/rvertnet> and <https://cran.r-project.org/web/packages/rvertnet/rvertnet.pdf>
- Ray, C.**, c 2000. POPNET: model of structured population dynamics, based on movement and survival patterns implied from demographic census data.

- Ray, C.** and G. Hoelzer, c 1999. VISCOUS: cellular automata model of genetic viscosity in spatially structured populations.
- Ray, C.**, c 1996. BRYOGROW: spatially realistic (non-cellular) modeling of clonal growth, competition and integration (developed for study of bryozoans or lichens).
- Ray, C.**, P. Sjogren-Gulve and M. Gilpin, c 1994. METAPO2: general software for modeling patch dynamics in heterogeneous and spatially explicit metapopulations.
- Gilpin, M., **C. Ray** and C. Biehl, c 1989*. LESSON: self-instruction software for learning the True BASIC programming language. (*New version released by M. Gilpin, c 1990.)

Invited presentations (* indicates presenter)

- Peralta A***, Ray C. 2023. Exploring the potential for plains-to-peak spillover of Rabbit Hemorrhagic Disease in a diverse lagomorph community. Symposium on Conservation and management of North American lagomorphs. 30th Annual Conference of The Wildlife Society, Louisville, Kentucky, November 6-9.
- Ray, C.***, R.M. Rochefort, J.I. Ransom, J.C.B. Nesmith, S.A. Haultain, T.D. Schaming, J.R. Boetsch, M.L. Holmgren, R.L. Wilkerson, R.B. Siegel. 2022. Will the mutualism fail? Modeling nutcracker response to whitebark decline. White Pine Ecosystem Foundation High-elevation Five-needle White Pines: Science and Management Webinars, W. A. Franke College of Forestry & Conservation, Univ of Montana, Virtual, April 19.
- Ray, C.***, R.M. Rochefort, J.I. Ransom, J.C.B. Nesmith, S.A. Haultain, T.D. Schaming, J.R. Boetsch, M.L. Holmgren, R.L. Wilkerson, R.B. Siegel. 2021. Assessing trends and vulnerabilities in the mutualism between whitebark pine and Clark's nutcracker in Sierra-Cascade national parks. Second Conference on the Research and Management of High Elevation Five Needle Pines in Western North America, Virtual, October 5-7.
- Ray, C.*** 2021. A long-term study by Chris Ray: fieldwork as my life. Betty Ford Alpine Gardens seminar series inspired by Hope Jahrens' book Lab Girl, Virtual, March 17.
- Ray, C.*** 2020. American pika: climatic influences on distribution throughout western North America. Betty Ford Alpine Gardens seminar series, Virtual, September 24.
- Ray, C.***, A. Smith, J. Stewart, A. Whipple, et al., 2020. The little pika who could: lessons in biogeography of a model species. Southern Illinois University, Carbondale, Illinois. Departmental seminar, January 23.

(Invited presentations prior to 2020 omitted.)

Contributed Presentations (* indicates presenter; students underlined)

- Ray C***, Vidrio J. 2023. Long-term data reveal a severe decline in recruitment of the American pika on Niwot Ridge. North American Pika Consortium V, Online, May 24, Oral presentation.
- Peralta A*, **Ray C.** 2023. Occupancy surveys reveal a healthy pika population in a region hit by rabbit hemorrhagic disease. North American Pika Consortium V, Online, May 24, Oral presentation.
- Billings R*, **Ray C.** 2023. First steps in audio classification of pika vocalizations using deep learning. North American Pika Consortium V, Online, May 24, Oral presentation.
- Perkins E*, **Ray C.** 2023. Identifying predictors of ectoparasite abundance on American pikas in Colorado. North American Pika Consortium V, Online, May 24, Oral presentation.
- Whipple A*, **Ray C.**, Kitchens J, Hove A, Castillo Vardaro J, Wilkening J. 2023. Stress-associated metabolites vary with season and habitat across populations of the American pika. North American Pika Consortium V, Online, May 24, Oral presentation.
- Monk E*, **Ray C.** 2023. An increase in American pika habitat temperature over 50 years on Niwot Ridge. North American Pika Consortium V, Online, May 24, Oral presentation.

- Monk E, **Ray C***. 2022. Fifty years of warming at an American pika study site on Niwot Ridge. Long Term Ecological Research (LTER) All Scientists' Meeting, September 19-23, Pacific Grove, California. Poster.
- Rinsland, H*, **Ray C**. 2022. Investigating occupancy drivers across the two American pika subspecies in ROMO. 101st Annual Meeting of the American Society of Mammalogists, June 17-21, Tucson Arizona. Oral presentation plus poster.
- Monk, E*, **Ray C**. 2022. Fifty years of warming at an American pika study site. 101st Annual Meeting of the American Society of Mammalogists, June 17-21, Tucson Arizona. Oral presentation plus poster.
- Kaschube, D.* , **C. Ray**, R. Taylor, R. Keith, B. Keith, J. Brenneman, and S. Albert. 2022. Combining point count and demographic data for comprehensive bird population trend assessment at the Fort Custer Training Center and the Kalamazoo Nature Center. 87th North American Wildlife and Natural Resources Conference, March 9-18, Spokane, Washington.
- Varner J*, Carnes-Douglas ZJ, Dearing MD, **Ray C**. 2021. Nutritional quality and overwinter preservation of pika winter diet over three decades of climate change. Oral presentation. American Society of Mammalogists. Virtual Conference.
- Whipple A*, **Ray C**. 2021. Keeping their cool: do pikas have lower stress-associated hormone levels in habitats with subsurface ice? Oral presentation. American Society of Mammalogists. Virtual Conference.
- Hill PJ*, Wasser M, **Ray C**. 2021. Range retraction in paradise: microclimatic controls on occupancy of core habitat for the American pika. Oral presentation. American Society of Mammalogists. Virtual Conference.
- Ray C**, Vidrio J. 2021. Long-term data reveal a severe decline in recruitment of the American pika on Niwot Ridge. Oral presentation. American Society of Mammalogists. Virtual Conference.
- Holtz S*, **Ray C**. 2020. Same pika, different story: how new genetic analyses offer a different perspective on populations as they respond to climate change. Poster, Annual Meeting of the Ecological Society of America, Virtual, August 3-6.
- Ray C***, Vidrio J. 2020. Trending pikas: what one population might say about its neighbors. Rocky Mountain National Park 2020 Biennial Research Conference, Estes Park, CO, March 10-11.
- Whipple A*, **Ray C**. 2020. Assessing habitat quality using stress measurements in American pika populations. Rocky Mountain National Park 2020 Biennial Research Conference, Estes Park, CO, March 10-11.
- Ray C***, Rochefort R, Ransom JI, Nesmith JCB, Haultain SA, Schaming TD, Boetsch J, Holmgren ML, Wilkerson R, Siegel R. 2020. Assessing vulnerabilities in the mutualism between whitebark pine and Clark's nutcracker in national parks of the Sierra-Cascade region. North American Congress for Conservation Biology, Virtual, July 26-31.
- Holtz S*, **Ray C**. 2020. Using RADseq to illuminate pika metapopulation structure. Poster, Rocky Mountain National Park 2020 Biennial Research Conference, Estes Park, CO, March 10-11.
- Ray C***, Rochefort R, Ransom JI, Nesmith JCB, Haultain SA, Schaming TD, Boetsch J, Holmgren ML, Wilkerson R, Siegel R. 2020. Assessing vulnerabilities in the mutualism between whitebark pine and Clark's nutcracker in national parks of the Sierra-Cascade region. 68th Annual Meeting of The Western Section of The Wildlife Society, Virtual, February 1-5.
- Ray C***, Cluck DR, Wilkerson RL, Siegel RB, White AM, Tarbill GL, Sawyer SC, Howell CA. 2020. Woodboring beetle colonization of conifers killed by bark beetles vs wildfire. USDA Forest Service Forest Health Monitoring Workshop, Raleigh, NC, February 24-27.

(Contributed presentations prior to 2020 omitted.)

Awards

2020 Rocky Mountain National Park Stewardship Award
 2018 Denver Zoological Conservation Award (\$5K)

Chris Ray

Honors

Graduated *Summa Cum Laude*, UC San Diego (1990)

Phi Beta Kappa and Caledonian honor society memberships (1990)

Judson Memorial and Sprague Memorial awards for excellence in journalism (1985)

Professional service and society memberships

IUCN Lagomorph Specialist Group

Ecological Society of America

Society for Conservation Biology

500 Women Scientists

The Wildlife Society

American Society of Mammalogists

NSF Population and Community Ecology Panel (2010, 2011)

Student mentoring

Post-doctoral students (co-advisor)

Tord Snäll, Swedish University of Agricultural Sciences, 2005

Graduate students (co-advisor)

Airy González Peralta, Ph.D. X2025

Ashley Whipple, Masters 2019

Isabel Corona, Masters 2018

Jennifer Wilkening, Ph.D. 2014

Liesl Peterson Erb, Ph.D. 2013

Fulbright students (co-advisor)

Sabuj Bhattacharyya, Fulbright 2010

Undergraduate honors students (advisor)

Jane Hill, ENVS Honors 2021

Hilary Rinsland, Univ. of Richmond VA 2018

Emily Monk, EBIO Honors 2018

Max Wasser, EBIO Honors 2018

Lauren Benedict, Whitman College Honors 2017

Spencer Holtz, EBIO Honors 2016

Maxwell Plichta, EBIO Honors 2016

Meghan Wiebe, EBIO Honors 2015

James Howe Jr., ENVS Honors 2014

Undergraduate student research (supervisor or co-supervisor)

Crystal Gonzalez, RECCS Summer 2021

Patricia Jane Hill, BSI Scholar Winter/Spring 2020/2021

Patricia Jane Hill, BSI Scholar Summer 2020

Daniel D'Souza, RECCS Summer 2020
Claire Atkins, NSF RECCS Summer 2019
Airy González Peralta, Front Range Community College Spring 2019
Caitlin Stiltner, ENVS Spring 2019
Minyue Hu, ENVS Spring 2019
Haley Weaver, NSF REU Summer 2017
Emily Monk, UROP Summer 2017
Max Wasser, NSF REU Summer 2017
Hilary Rinsland, U Richmond Virginia Fellow Summer 2017
Lauren Benedict, NSF REU Summer 2016
Max Wasser, BURST Summer 2016
Jeremy Bonnell, ENVS Summer 2016
Spencer Holtz, UROP Summer 2015
Maxwell Plichta, NSF REU Summer 2015
Jasmine Vidrio, NSF REU Summer 2015
Hilary Brumberg, Wesleyan Fellowship Summer 2015
Max Wasser, UROP Summer 2015
Christian Prince, ENVS Internship Fall 2014, UROP Spring 2015
Maxwell Plichta, UROP Fall 2014
Meghan Wiebe, NSF REU Summer 2013, UROP Spring 2013
Taylor Stratton, NSF REU Summer 2013
James Howe Jr., BURST Summer 2013
Kacey Fitzgerald, UROP Summer 2013
Kayla Barton, EBIO Independent Study Spring 2013
Riley Stuckey, BURST Fall 2012
Sarah McLaughlin, NSF REU Summer 2012
Jessica Johnson, UROP Summer 2012
Brooke Regan, UROP Fall 2011
Gerardo Dillehay, NSF REU Summer 2011
Lindsey Nietmann, NSF REU Summer 2008
Phillip Wasz, NSF REU Summer 2008

Advisors

(Ph.D.) Alan Hastings, University of California, Davis
(M.A.) Michael Gilpin, University of California, San Diego (Retired)

Recent supervisors

Rodney Siegel (rsiegel@birdpop.org)
Director, Institute for Bird Populations, Petaluma, CA

Katharine Suding (Katharine.Suding@colorado.edu)
Professor of EE Biology, INSTAAR Associate and Lead Investigator for the Niwot Ridge LTER, University of Colorado, Boulder, CO