

**Sensory Ecology (light interactions with other sensory modalities) and PhotoDiversity**  
Grant Application

*The effects of anthropogenic light, noise, and landscape on the American Robin bird song, behavior, and reproductive output.*

**Karina Sanchez, University of Northern Colorado**

**BACKGROUND:** As humans continue to modify habitats, we are placing unique selective pressures on animals, such as light pollution and noise pollution. For organisms that rely heavily on acoustic and visual communication, it is important to understand the effects of anthropogenic environmental changes on signaling behavior. In urban habitats, avian species have been observed to alter song behaviors, which are critical to individual fitness<sup>1</sup>. Studies show that birds alter the temporal timing, frequency, and duration of their songs to avoid being masked by anthropogenic noise,<sup>2,3,4,5</sup> while others show shifted dawn choruses in areas with anthropogenic light<sup>5,6</sup>. Despite the rise in urban studies, scientists have yet to define “urban” environments. Many studies define “urban” by assigning study sites to a habitat classification based on landscape, and then infer noise and light. Few directly measure the acoustic dynamics and the light regimes in combination with landscape. I intend to tackle this gap in the literature by directly measuring these variables in urban environments and pairing them with data on individual behavior and success. This study investigates the effects of anthropogenic light, noise, and landscape on bird song characteristics, song function, and reproductive output of American Robins in Weld County, CO (Figure 1).

**Research Questions:**

**Q1:** Is land development altering light and noise regimes?

**Hypothesis:** Urban development will alter light and noise regimes with more light and noise being associated with more land development.

**Q2:** Do light, noise, and landscape alter bird song characteristics?

**Hypothesis:** Light, noise, and landscape alter bird song characteristics. Increased light, noise, and urban landscape (development) will be associated with earlier and later day singing, increased song audio frequency, and increased song bandwidths.

**Q3:** Do song changes in urban habitats have fitness consequences?

**Hypothesis:** Changes in songs will have individual fitness consequences. Individuals with adjusted songs for urban habitat will have higher pairing, hatching, and fledging success in urban environments.

**Study Species:** The American Robin (*Turdus migratorius*) is one of the most common and proliferate bird species of North America. This species offers an excellent test system due to its apparent success in varied environments and presence at all sites from my preliminary study.

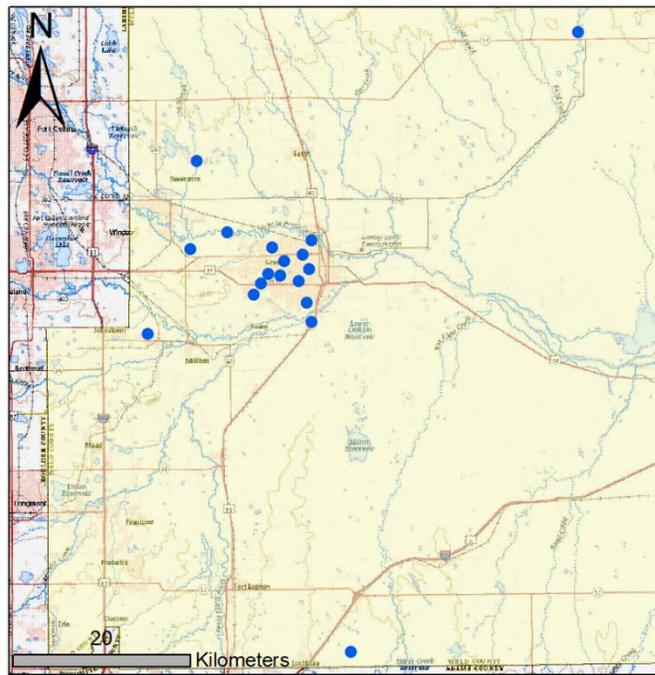
**METHODS:**

I will use Wildlife Acoustic song meters and Unihedron sky quality meters to measure light (ground reflectiveness) and noise in areas of high singing occurrences and at nesting sites<sup>7,8</sup>. I will use a custom R code to understand the lightscape, to create acoustic indices, and to determine times of day when singing occurs for each location. NLCD land cover data will be used to evaluate landscapes. Zonal statistics will be used to determine a percent developed land and percent impervious surface. Light, noise, and landscape measures will be used to test **Q1**.



Adults will be trapped using mist nets and given a unique color-band combination. Each bird will have morphological measurements taken. Songs of identified adults will be recorded. Recordings will be analyzed using Raven Pro 1.3 Sound Analysis Software. These variables will be tested against indicators of “urbanness,” including light regimes to test **Q2**.

Time of pairing, nest initiation, and nest success will be estimated by observations and monitoring<sup>9</sup>. These data, in combination with song measurements will be used to test **Q3**.



**FIGURE 1:**  
**Study Location:**  
**Weld County, CO**

● 2018 Field Sites  
■ Weld County



**ANTICIPATED FINDINGS:** In 2018 I measured anthropogenic noise, light, landscape, and avian presence in Weld County. I confirmed that noise and light are positively correlated with developed land which is negatively associated with avian diversity. With confirmed feasibility of my methods, I will now investigate behavioral change as a mechanism for how American Robins persist in urban landscapes. I anticipate encountering variation in urban characteristics across sites. I believe these characteristics and the severity of each will have a unique interaction with behavior of American Robins, revealing the complexity of these systems and the importance of independently measuring these characteristics.

Federal (#23741), State (#19TRb3273) and IACUC (UNCO1807B-LB-Birds-21) permits have been approved for this study. Precautions concerning the safety, welfare, handling, and preservation of wildlife, and collections will be followed.

**BROADER IMPACTS:** I am a first-generation Latina student. I have overcome many obstacles on my journey to becoming a woman in STEM that have provided me with a unique view on the world. I intend to use the resilience my experiences have given me to provide opportunities to students of underrepresented groups in STEM. **Collaboration:** I have partnered with five cities, private land owners, the US Forest Service and the NPS Natural Sounds and Night Skies Division to conduct this project. These cities are all within Weld County, CO where over 30% of the population is Hispanic. Since my work takes place in urban locations, I have the opportunity to start a dialogue with the community, including those who only speak Spanish, about noise, light, and wildlife. As I continue my research, I intend to share my findings with these cities. **Outreach:** In my first year as a PhD student, I have founded an on-campus organization named **Women In Graduate STEM** to create a safe space for women in STEM to build community. I currently mentor six undergraduate students on my research team. Each student gets a first-hand research experience by designing their own research question and using existing data or



collecting their own. I am proud to have a diverse research team with five women, two of which are first-generation students of Mexican descent, one non-traditional student and mother of two, and another a member of the LGBTQ community. I am dedicated to mentoring and providing opportunities for people from underrepresented groups and I intend to continue to recruit undergraduates. I believe that creating opportunities for equity and inclusion in the sciences will make our community outstanding and will allow us to push our science in ways that have never been done before.

### **REFERENCES:**

- 1:** Kroodsma, D. E., & Byers, B. E. (1991). The function (s) of bird song. *American Zoologist*, 31(2), 318-328.
- 2:** Nemeth, E., & Brumm, H. (2009). Blackbirds sing higher-pitched songs in cities: adaptation to habitat acoustics or side-effect of urbanization. *Animal behaviour*, 78(3), 637-641.
- 3:** Nemeth, E., & Brumm, H. (2010). Birds and anthropogenic noise: are urban songs adaptive?. *The American Naturalist*, 176(4), 465-475.
- 4:** Slabbekoorn, H., & Peet, M. (2003). Ecology: birds sing at a higher pitch in urban noise. *Nature*, 424(6946), 267-267.
- 5:** Slabbekoorn, H., & den Boer-Visser, A. (2006). Cities change the songs of birds. *Current biology*, 16(23), 2326-2331.
- 6:** Kempenaers, B., Borgström, P., Loës, P., Schlicht, E., & Valcu, M. (2010). Artificial night lighting affects dawn song, extra-pair siring success, and lay date in songbirds. *Current Biology*, 20(19), 1735-1739.
- 7:** Kolláth, Zoltán. "Measuring and modelling light pollution at the Zselic Starry Sky Park." *Journal of Physics: Conference Series*. Vol. 218. No. 1. IOP Publishing, 2010.
- 8:** McKenna, Megan F., Graeme Shannon, and Kurt Fristrup. "Characterizing anthropogenic noise to improve understanding and management of impacts to wildlife." *Endangered Species Research* 31 (2016): 279-291.
- 9:** Bayne, Erin M., and Keith A. Hobson. "Effects of habitat fragmentation on pairing Success of Ovenbirds: importance of male age and floater behavior." *The Auk* 118.2 (2001): 380-388.





**Karina Sanchez**

•Email: [karina.sanchez@unco.edu](mailto:karina.sanchez@unco.edu) • Phone: 801-631-5634 • Greeley, Colorado  
[Urbanbirdnerd.com](http://Urbanbirdnerd.com)

## EDUCATION

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2017-Present	Ph.D.	<i>University of Northern Colorado, Greeley, CO</i> Biological Education PhD Program
2014	B.S.	<i>Westminster College, Salt Lake City, UT</i> B.S. in Biological Sciences.

## RESEARCH INTERESTS

I use behavioral ecology and field studies to gain a better understanding of how altered habitats change behaviors and the repercussions of these behaviors on spatial and regional population patterns. My research has an ultimate goal of preserving biodiversity and providing information for conservation efforts.

- Urban ecology • Behavioral ecology • Population ecology • Light Ecology • Sound Ecology • STEM education
- Diversity and Inclusion in STEM • Inquiry-based learning

## PRESENTATIONS

**Sanchez, K.,** Kennedy, C., Salo, J., Benedict, L., (2019) The effects of urban landscape characteristics on avian diversity and abundance in Weld County, Colorado, US-International Association for Landscape Ecology Annual Meeting, Fort Collins, CO.

**Sanchez, K.,** Benedict, L., Cicero, C., Fialko, K., (2018) Spotted Towhee (*Pipilo maculatus*) song characteristics at two time points across an urban gradient, American Ornithology Meeting, Tucson, AZ.

**Sanchez, K.,** Benedict, L (2018) The effects of urban noise and light on songbird abundance, richness, and song characteristics in a rapidly urbanizing area, Front Range Student Ecology Symposium, Fort Collins, CO

**Sanchez, K.,** Neville, A., (2015) Predator Control on Utah's managed wetlands, Utah Wetlands Foundation Annual Meeting, Salt Lake City, UT.

**Sanchez, K.,** Hawkins, D., Stracey, C., (2013) Singing on the nest: the occurrence of a paradoxical behavior, poster presentation:

- 98th Annual Ecological Society of America Meeting, Minneapolis, MN
- 2013 Utah Conference on Undergraduate Research, Logan, UT
- Utah Audubon Society Meetings, Salt Lake City, UT

## CURRENT RESEARCH

### University of Northern Colorado

*The Effects of anthropogenic noise, light, and landscape on American Robin (*Turdus migratorius*) song, behavior and reproductive success.*

I will investigate the behavior of a songbird that has persisted across all landscape types in Weld County, CO. I intend to quantify noise, light, and landscape in this county as well as document bird behavior. This data will be used to identify relationships of these urban characteristics with bird song characteristics, parental behavior, and reproductive success.

### University of Northern Colorado

*The Effects of anthropogenic noise, light, and landscape on avian diversity and abundance in Weld County, CO.*

Urban environments are a combination of conditions including, excess noise, light, and novel structures. I used sky quality monitors and song meters provided by the National Parks Service to measure noise and light in Weld County, CO. I conducted avian surveys and used GIS National Land Cover Database layers to quantify developed land. Preliminary results show that increased developed land and impervious surface are associated with decreased avian diversity.

### University of Northern Colorado • University of California, Berkeley

*Spotted Towhee (*Pipilo maculatus*) song characteristics at two time points across an urban gradient*

I am analyzing how bird song has changed in Spotted Towhees of Berkeley, California between 1970 and 2015. I use song characteristic analysis in combination with GIS landcover layers to assess the relationship of time and landcover change with birdsong. Preliminary results show that songs from 2015 are longer in time, have slower trill rates, and higher trill frequencies.

## SELECTED WORK AND PRIOR RESEARCH EXPERIENCE

- 2017-present **Graduate Teaching Assistant**, University of Northern Colorado  
Lab instructor for introductory biology, organismal biology, and museum studies.
- 2016- 2017 **Outreach Educator**, Loveland Living Planet Aquarium  
Developed and delivered engaging, educational presentations and workshops for both elementary & secondary students and teachers using Utah State Core standards. Assisted in the care of a variety of animals (tarantulas, amphibians, reptiles, insects) on a daily basis.
- 2016- 2017 **Youth educator**, Red Butte Garden  
Developed, prepared, and delivered educational lesson plans on a variety of science-based topics for ages 5-13 years.
- 2016 **Wildlife Technician**, Utah Division of Wildlife  
Conducted population surveys on brine shrimp, waterfowl, and shorebirds. Assisted on brine shrimp behavior studies, nutrient tests, water quality tests, bird banding, waterfowl management plans, outreach and presentations.  
Research Conducted:  
*Monitoring and management of nesting American White Pelicans on Gunnison Island, UT.*  
*Brine shrimp cyst buoyancy and behavior in the water column of Great Salt Lake.*
- 2014-2015 **Intern and research associate**, Rio Tinto Kennecott  
Assistant land manager of the Inland Sea Shorebird Reserve (ISSR) and Kennecott property. Conducted wildlife population surveys, and vegetation surveys. Managed field data, developed databases, and performed water flow analysis. Initiated research to understand outcomes and improve effectiveness of monitoring and habitat management. Engaged the public through outreach and presentations and prepared educational content for field trips.  
Research Conducted:  
*Predation of shorebirds on the Inland Sea Shorebird Reserve*  
*Heavy metal contamination in macro-invertebrates of the Rio Tinto Kennecott Copper Mine tailings dike*
- 2012-2014 **Research student and research assistant**, Westminster College  
Developed and carried out research projects addressing ecological questions and assisted in ecological field work of several research projects. Engaged the public by presentations and poster sessions at both local and national meetings.  
Research Conducted:  
*Singing on the nest: a paradoxical behavior of Northern Mockingbirds*  
*Bioaccumulation of methyl-mercury in terrestrial environments on Antelope Island*  
*Investigating urban house finch songs in and around Salt Lake City, UT*

## GRANT SUPPORT AND AWARDS

2019	-	NSF Graduate Research Fellowship Program Honorable Mention
2019	\$1500	Colorado Field Ornithologists
2019	\$300	UNCO NHS Student Award Fund
2019	\$600	UNCO Graduate Student Association Travel Award
2018	\$300	UNCO Graduate Student Association Travel Award
2018	\$150	UNCO Graduate Student Association Research Award
2018	\$3200	UNCO School of Biology Summer Funding Grant
2018	\$3500	Colorado Graduate Grant
2013-14	\$3000	Great Salt Lake Institute B.R.I.N.E. Research Grant
2012-14	\$7500	Westminster College Summer Undergraduate Research Stipend

## OUTREACH AND PUBLIC SERVICE

2018-Present	President of University of Northern Colorado Women In Graduate STEM (WIGS)
2018-Present	Biology Graduate Student Representative
2016	Great Salt Lake Audubon Education Committee Member

## RELEVANT COURSES TAKEN

Behavioral Ecology, Teaching College Biology, Community Statistical Analysis, Molecular Ecology, Applications in GIS, Species and Speciation, Foundations of Research, Coevolution, Applied Statistics, Biological statistics, Calculus for biological sciences, Physics, Organic Chemistry, Advanced Ecology & Lab, Field Ornithology, Field Botany, Great Salt Lake field study,