



Bird Genoscape Project's Annual Newsletter

Issue 2, Fall 2022



Message from the Directors

Welcome to the Bird Genoscape Project's 2022 newsletter!

2022 has been a very busy year for the Bird Genoscape Project and we're excited to share our latest news with you! Our team members worked hard to build genoscapes with our partners from across the Western Hemisphere, including researchers in Columbia, Trinidad & Tobago, Puerto Rico, Mexico, and the United States. This work resulted in the completion of genoscapes for several migratory bird species including Common Loon, Common Yellowthroat, and Hermit Thrush. The results of these collaborative efforts were featured in several new manuscripts (see page 5) and popular media outlets including 'Audubon Magazine' and 'BBC Sounds'.



2022 also brought migration into and out of our flock, including graduate student Taylor Bobowski who migrated out after successfully completing his MS degree on the Common Yellowthroat, while Dr. Jacob Job migrated in as our new Associate Director. Please read on to learn more of the feathery details from this past year!



What is inside this issue?

- **Page 2 - Breeding Ground Research Highlight:** Genomics and Burrowing Owl: A BGP solution for captive breeding by Christen Bossu
- **Page 3 – Wintering Ground Research Highlight:** Living in a changing world: climate vulnerability in Yellow Warblers of the Yucatán Peninsula by Whitney Nakashima
- **Pages 4-7:** News, publications, and updates

Happy reading!

Sincerely,

Kristen & Tom

Kristen Ruegg *Tom B Smith*



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From the breeding grounds....

During a time of unprecedented avian population declines, captive breeding programs have become an essential tool in conservation. BGP scientist Christen Bossu and collaborators and field researchers for the Santa Clara Valley Habitat Agency (SCVHA) have teamed up to incorporate genomics (i.e., an organism's complete set of DNA) with field data to inform a captive breeding of a resident Burrowing Owl population in the San Francisco Bay area. Burrowing Owls are the only raptor in North America to nest exclusively underground and have been declining steadily in part due to loss of habitat, drought, and elimination of ground squirrels, which the owls rely on for burrows. Recent surveys reveal a >90% decline in the San Francisco Bay area population since the 1980s. Even more concerning is that research from UCLA PhD candidate Kelly Barr hints that inbreeding, or mating between relatives, may be contributing to these declines. Kelly Barr and his colleagues (paper in review) demonstrated that resident Burrowing Owls are more inbred than migratory populations and that the residential San Francisco Bay area population had some of the most inbred individuals of all the birds tested in the western U.S.

What is inbreeding? Inbreeding is the mating between closely related individuals that results in offspring. Inbred offspring may suffer from what is called reduced biological fitness, with individuals being less healthy, producing fewer young, and/or are smaller than most non-inbred individuals. Inbreeding can also result in the reduction of genetic diversity which prevent organisms from adapting to and surviving changes in the environment over time. Not only are Burrowing Owls losing critical habitat, but inbreeding appears to be working to further reduce their population size.

Captive breeding programs help wild populations recover while maximizing genetic diversity. Typically, this is done by pairing unrelated individuals using carefully researched pedigrees that contain long-term information about each individual's family, such as breeding pairs and parentage. However, in wild populations, where pedigrees do not exist or are incomplete, we can rely on genomics. Genetic markers are used to identify related individuals and thus breeding pairings that should be avoided. With advances in genomic methods, we can identify inbred individuals, regions of the genome that are most inbred, and the timing of the inbreeding events; information use to identify the most ideal breeding pairs.

For the past four years, Burrowing Owl researchers with the SCVHA have implemented a Juvenile Burrowing Owl Overwintering Project. Here, young birds are captured during the breeding season and transferred to a facility where they spend the winter. Meanwhile, their genomes are analyzed and combining this information with field data on pedigrees, optimal pairs are chosen. The pairs are put into specially designed aviaries in the wild and released the following spring. Thus far, each of our pairing decisions has resulted in successful pairs, in other words, Burrowing Owl pairs that produce offspring. In addition, the offspring of these optimal pairs show greater genetic diversity than their parents—all very good news for the owls. This critical work is giving the northern California Burrowing Owls the best chance at continued survival.



Burrowing owl family captured by SCVHA cameras.



...to the wintering grounds 

Down on the wintering grounds BGP researchers are investigating how climate change might be impacting populations of Yellow Warblers. Leading this work on the Yucatán Peninsula in southeastern Mexico is Whitney Tsai Nakashima (UCLA). Whitney is exploring interactions between migratory Yellow Warblers that overwinter throughout the peninsula and resident Yellow Warblers that inhabit the Yucatán's mangroves year-round. Previous observations by BGP scientists, Dr. Richard Feldman and Ingrid Tello-López, indicate that migratory and resident individuals utilize different habitats. However, it is unclear if any migratory individuals remain on these grounds during the breeding season or the extent to which resident individuals relocate each year. These events could lead to interbreeding between populations. Whether or not they interbreed may have implications in the capacity for Yellow Warblers to adapt to climate change.



Whitney holding a Yellow Warbler on Isla Cozumel, Mexico.

Previous work on the migratory populations of Yellow Warblers by BGP scientist, Dr. Rachael Bay, suggests that genes linked to exploratory or migratory behavior were identified as important for successful adaptation to climate (Bay et. al 2018). The study also indicates that the inability to adapt to climate change might already be playing a role in the declines of certain migratory populations. In general, resident birds live in areas with more consistent climate throughout the year and have experienced less climatic fluctuations historically. They also have low dispersal capacity, which could make resident Yellow Warblers even less equipped to persist in the face of rapid environmental change than their

migratory counterparts. For her research, Whitney is collecting genomic data to address the question: ***Is there gene flow between migratory and resident populations of Yellow Warblers and how does life history affect their response to climate change?***

In January 2022, Whitney traveled to the Yucatán Peninsula with BGP scientists, Luz Zamudio Beltrán and Genaro Rodríguez Otero. The trio met with BGP collaborators from the Moore Laboratory of Zoology (MLZ) and spent two weeks collecting blood and feather samples. Despite challenges presented by the pandemic, they successfully collected samples from migratory and resident Yellow Warblers across the peninsula. These samples, along with samples collected by Ingrid during previous field seasons, will increase our understanding of how well these understudied resident Yellow Warbler populations are adapting to climate change. The team plans to return to the Yucatán in the fall to complete sample collection for this project. In addition to this work, the team has collected samples from other BGP species on their wintering grounds, including **American Redstart (*Setophaga ruticilla*)**, **Black-and-White Warbler (*Mniotilta varia*)**, and **Common Yellowthroat (*Geothlypis trichas*)**. These samples will help the BGP continue to build an understanding of where populations of birds live throughout the entire year and their movements across the hemisphere.



Field crew working on Isla Cozumel, Mexico during the winter of 2022.



What have we been up to?

Dr. Jacob Job joined the Bird Genoscape Project in March as the new Associate Director. Jacob comes from the Sound and Light Ecology Team at Colorado State University and brings with him nearly 8 years of project management, communications, and supervisory experience. Although he doesn't have a genetics background, he is a big believer of the BGP's mission and will work tirelessly to advance it!

Dr. Kristen Ruegg received a National Science Foundation ORCC award of \$485k to study ecological and evolutionary responses to climate change in a high-altitude alpine songbird. This work is in collaboration with researchers at UT Austin and UC Santa Cruz. Kristen was also a plenary speaker at this year's AOS meeting in Puerto Rico where she was able to talk about the Bird Genoscape Project.

Matt DeSaix received scholarships from UW Summer Institute of Statistical Genetics and CSU College of Natural Science, presented his dissertation work at four different conferences, published one manuscript about his work with American Redstarts, has currently has two other manuscripts in review, and was selected to be a Sustainability Leadership fellow in the School of Global Environmental Sustainability. Way to go Matt!

Whitney Tsai Nakashima passed her qualifying exams and is now a PhD candidate at UCLA. She was awarded funding from the Society of Systematic Biologists to continue her genomics work with Yellow Warblers and from the K. Patricia Cross Future Leaders for exemplary commitment to equity, community engagement, teaching, and learning. Congratulations Whitney!

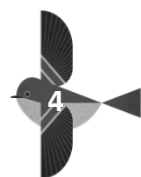
Genaro Rodríguez Otero spent the year moving across the hemisphere. He traveled to Holbox and Cozumel, Mexico to help with Yellow Warbler genomics fieldwork, visited Fort Collins to take part in a documentary about the BGP's work and impact, and collected Wilson's Warbler data at the Museum of Natural History in New York for his master's work. Way to get those frequent flyer miles!

Caitlin Miller received a research grant from the Graduate Degree Program in Ecology at CSU and was a given honorable mention for her grant submission to the National Science Foundation's Graduate Research Fellowship program. She presented her work with Canada Warblers at the Front Range Student Ecology Symposium at CSU and at the American Genetics Association President's Symposia.

Taylor Bobowski has flown the coop! He successfully defended his Master's thesis. He presented this work at the American Ornithological Society meeting in Puerto Rico and won the Nellie Johnson Baroody Award for best oral presentation in any topic in ornithology. What a successful year!

Dr. Luz Zamudio received a second-year renewal for her postdoctoral fellowship with UNAM and CSU. She also spent time in Fort Collins filming with Genaro Rodríguez Otero, Marina Rodríguez, and Kristen Ruegg for an upcoming educational film about the BGP's work and its impact.

Marina Rodríguez passed her qualifying exams and is now a PhD candidate at CSU. She also presented her dissertation work with Yellow Warblers at the American Ornithological Society meeting in Puerto Rico and at the Front Range Student Ecology Symposium at CSU.



BGP in the news....

Audubon published an article featuring the Bird Genoscape Project's main work creating avian genoscapes entitled, "The Bird Genoscape Project Aims to Unlock the Secrets in Birds' Feathers" (<https://www.audubon.org/magazine/spring-2022/the-bird-genoscape-project-aims-unlock-secrets>)

Audubon published an article where Dr. Kristen Ruegg discusses the genetic basis for migratory behavior entitled, "How and Why Did Bird Migration Evolve?" (<https://www.audubon.org/news/how-and-why-did-bird-migration-evolve>).

Audubon featured the Bird Genoscape Project in their article entitled, "A Brief History of How Scientists Have Learned about Bird Migration". The Bird Genoscape Project's founding is highlighted in their historical timeline. (<https://www.audubon.org/magazine/spring-2022/a-brief-history-how-scientists-have-learned-about>)

Audubon mentioned the Bird Genoscape Project in their article about their Migratory Bird Initiative and uncovering the phenomenon of migration, entitled "This Pioneering Collaboration Will Open a New Window into Bird Migration". (<https://www.audubon.org/magazine/spring-2022/this-pioneering-collaboration-will-open-new>)

BBC Sounds interviewed Dr. Kristen Ruegg in their animal migration podcast entitled, "Why do animals migrate? Part 1" (<https://www.bbc.co.uk/sounds/play/w3ct1pry>)

The Source from Colorado State University wrote a feature article about the collaboration between the Bird Genoscape Project and Day's Edge Production, who produced a short film about our work entitled "Feathers in Flight. (<https://natsci.source.colostate.edu/national-geographic-film-reveals-how-csu-researchers-track-bird-migration-through-feathers/>)

Publications

1. CM Bossu, JA Heath, GS Kaltnecker, B Helm, and KC Ruegg. 2022. Clock-linked genes underlie seasonal migratory timing in a diurnal raptor. *Proceedings of the Royal Society B* 289: 20212507. https://www.birdgenoscape.org/wp-content/uploads/2022/05/procB_2022.pdf
2. KC Ruegg, EC Anderson, RA Bay, M Whitfield, EH Paxton, and TB Smith. 2021. Linking climate niches across seasons to assess population vulnerability in a migratory bird. *Global Change Biology* 27: 3519-3531. https://www.birdgenoscape.org/wp-content/uploads/2022/05/globalchangebiology_2021.pdf
3. B Larison, AR Lindsay, C Bossu, MD Sorenson, JD Kaplan, DC Evers, J Paruk, JM DaCosta, and TB Smith. 2021. Leveraging genomics to understand threats in a migratory waterfowl. *Evolutionary Applications* 14: 1646-1658. https://www.birdgenoscape.org/wp-content/uploads/2022/05/evolutionaryapplications_2021.pdf



Publications continued

4. AH Alvarado, CM Bossu, RJ Harrigan, RA Bay, ARP Nelson, TB Smith, and KC Ruegg. 2022. Genotype-environment associations across spatial scales reveal the importance of putative adaptive genetic variation in divergence. *Evolutionary Applications*; <https://www.birdgenoscape.org/wp-content/uploads/2022/08/Evolutionary-Applications-2022-Alvarado-Genotype-environment-associations-across-spatial-scales-reveal-the-importance.pdf>
5. MG DeSaix, T George, A Seglund, G Spellman, E Zavaleta, and K Ruegg. Forecasting climate change response in an alpine specialist songbird reveals the importance of considering novel climate. *Diversity and Distributions*. <https://www.birdgenoscape.org/wp-content/uploads/2022/08/diversitydistributions2022.pdf>

Website upgrade

With the help of new Associate Director Dr. Jacob Job, the Bird Genoscape Project molted its old plumage and is sporting a fresh new look! We've built off the great information from its predecessor to bring you all the information you need to stay up-to-date with our work and to help guide your contributions so we can continue our march towards creating genoscapes for 100 migratory bird species. You can see the new website and all the beautiful photos and artwork at <http://www.birdgenoscape.org/>. Let us know what you think!

Completed genoscapes

Our flock of species with completed genoscapes has grown to 14 species! This includes:

American Kestrel
Burrowing Owl
Hermit Thrush
Swainson's Thrush
Wilson's Warbler

Anna's Hummingbird
Common Loon
Northern Fulmar
Tricolored Blackbird
Yellow Warbler

Brown-capped Rosy Finch
Common Yellowthroat
Painted Bunting
Willow Flycatcher

We are currently working with numerous collaborators to produce genoscapes for the following species:

American Redstart
Black-throated Blue Warbler
Prothonotary Warbler

American Robin
Grasshopper Sparrow
Western Grebe

Canada Warbler
Loggerhead Shrike

We are also working with the Winger Lab at UM to construct genoscapes for the following boreal species:

Yellow-bellied Sapsucker
Alder Flycatcher
Red-eyed Vireo
Ruby-crowned Kinglet
Dark-eyed Junco
Continued below...

Hairy Woodpecker
Least Flycatcher
Black-capped Chickadee
Brown Creeper
White-throated Sparrow

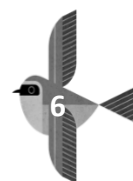
Yellow-bellied Flycatcher
Blue-headed Vireo
Golden-crowned Kinglet
Veery
Lincoln's Sparrow



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Updates cont.



Tennessee Warbler
Cape May Warbler
Blackburnian Warbler
Yellow-rumped Warbler

Nashville Warbler
Magnolia Warbler
Chestnut-sided Warbler
Black-throated Green Warbler

Mourning Warbler
Bay-breasted Warbler
Palm Warbler

[Visit our website to learn more!](#)



Sampling update

In 2021, we received ~**6,029** blood and feather samples. We're still working through 2022 samples, but it looks like we are off to a great start. Thank you so much to all our amazing collaborators and contributors!!



Thank you to our amazing contributors!

Alex Jahn
Annie Lindsay
Chuck Hathcock
Dan Wenny
Jeff Kozma
Madeline Alberg
Rafa Rueda
Sarah Milligan
Steve Albert

Alice Boyle
Brenda Keith
Claire Stuyck
Darlene Woodbury
Jodi Isaacs
Mary Whitfield
Richard Bailey
Scott Rush
Tim Kita

Allen Chartier
Callie Gesmundo
Clifford Berek
Eric Soehren
Lori Walewski
Nick Bayly
Richard Lewis
Shannon Mendia
Vanna Boccadori

Allison Nelson
Cathy Nowak
Colin Woolley
Gordon Howard
Lynn Trulio
Paul Fehringer
Robert Snowden
Stacey Hayden

Thank you for reading! Visit the '[How to help](#)' section of our website If you or someone you know want to support us. See you next year!



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