

Hi, Reddit! We're scientists at the Smithsonian's National Zoo and Conservation Biology Institute's Center for Conservation Genomics. We use genomics to save threatened species – ask us anything!

NationalZoo¹and/ScienceAMAs¹

¹Affiliation not available

April 17, 2023

Abstract

The Smithsonian's Center for Conservation Genomics <https://nationalzoo.si.edu/center-for-conservation-genomics> (CCG) uses genomics to better understand how we can care for and sustain genetically diverse animal populations in human care and in the wild. We use DNA, RNA and more to uncover information about the evolutionary history of animals and to determine the importance of genetic variation in their future survival. This information can be used to answer questions about everything from diseases to animal behavior. We collaborate with other scientists across the Smithsonian, and with institutions and agencies around the world. Here are just some of the things we do with genomics: Use non-invasive DNA collection from feces, hair, saliva and more to help conservationists find and count endangered species (link) Identify new species or use ancient DNA to determine when and if speciation reversal occurs (link) Use DNA from century-old deceased bats to analyze how white-nose syndrome impacts bats living today (link) Determine the sex of a baby animals from a small DNA sample (e.g., a baby porcupine and a quill) Map genomes to decode family trees of animals like Asian elephants to better understand health concerns and treatments (link) Determine if an invasive species is actually invasive (link) We're doing this AMA as part of the National Human Genome Research Institute's National DNA Day Reddit AMA series and are excited to answer any questions you have about genomics, DNA research or conservation biology! Ask us anything! Your hosts are: Nancy McInerney, B.S., Marquette University. I train students, researchers and visiting scientists in how genomics can be used in conservation and assist the Zoo with projects like disease detection, sex identification of newborn animals and paternity testing. I have worked on projects including sequencing mitogenomes of California sea otters, analyzing eDNA to locate endangered freshwater turtles, monitoring the impact Chytrid fungus on amphibians and sequencing the DNA of museum specimens. Jesus Maldonado, B.S. and M.S., Shippensburg University of Pennsylvania; Ph.D., University of California, Los Angeles. I have been a research geneticist at SCBI since 1998. My research applies molecular genetics tools to answer questions about conservation and evolutionary biology in mammals. I assess the genetic variation within and among populations and species to document levels of genetic diversity and determine evolutionary, taxonomic and conservation significance. While my research has many theoretical aspects, the outcomes of these studies have direct applications that help threatened and endangered animals. I am active in education programs and have mentored more than 26 undergraduate students on research projects dealing with the population genetics of mammals, birds and reptiles.

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What types of ancient DNA have you worked on? What was the most surprising or strange discovery from ancient DNA you've seen?

CORRESPONDENCE:

[genomegal](#)

DATE RECEIVED:

April 25, 2018

DOI:
10.15200/winn.152457.74257

ARCHIVED:
April 24, 2018

CITATION:
National_Zoo , r/Science , Hi,
Reddit! We're scientists at the
Smithsonian's National Zoo and
Conservation Biology Institute's
Center for Conservation
Genomics. We use genomics
to save threatened species –
ask us anything!, *The
Winnower* 5:e152457.74257 ,
2018 , DOI:
[10.15200/winn.152457.74257](https://doi.org/10.15200/winn.152457.74257)

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We have worked on a diversity of ancient DNA materials from museum specimens such as bone fragments, skin, pieces of tissue that stick to the bones. We also get DNA from bones that have been collected by anthropologists. These might be found in caves, middens, or anthropological sites.

One of my first surprising discoveries was when we looked at museum wolf bone samples back in 2004 that were collected in India in the 1800s. My Indian collaborators and I were interested in the genetic diversity of wolves worldwide, and with these India samples, we found that Indian wolves had a more ancient lineage from the rest of the wolves worldwide.

-JEM

Are there any new techniques or tools in the field of genomics that you're excited about? I studied genomics in college but it's been a few years and bio in general changes so quickly. I want to know what I've missed.

[Marzpn](#)

Great question!

You are right, the field changes so quickly. We are eager to utilize human genomics techniques for conservation. We can now sequence whole genomes in a few days, and at a fraction of the cost. A few years ago we couldn't afford to sequence a genome on a Sanger sequencer, but now we have a next-gen sequencer in our lab so the types of work and research we can do has greatly expanded.

Targeted Sequence Capture is an exciting new tool that allows us to target specific regions of the genome in good quality DNA as well as degraded samples. We can compare museum specimen DNA to modern animal DNA. This technique uses RNA probes to hybridize to our DNA, and then wash away anything that's not bound. Then we sequence these short DNA segments on our next-gen sequencer and we're able to compare samples at thousands of loci. This would have been very laborious and expensive with PCR-based technology.

-NCM

Can genomic mapping help bring back extinct species in the future if their DNA is still retrievable?

[SpeedyDoc](#)

Understanding the architecture of a genome is an important first step. The exact location of the DNA in the genome is imperative for the function of a living animal.

We do not want to set up an extinct species for failure. We all need to address the reasons a species went extinct in the first place.

-JEM, NCM

When dealing with a threatened or endangered species in a captive breeding program, how do you make decisions on which individuals to mate? Do you know whether certain mutations will prove to be advantageous, are there certain mutations you aim to cull from the herd, or is it a case of trying to conserve as much variability as possible?

[Grain-Fed](#)

We provide the genomic information about a species in question to the Species Survival Plan (SSP).

They will take this information, such as age, etc to make breeding decisions.

The SSP is trying to build genetic diversity into a captive breeding population. Yes, trying to conserve variability.

We are currently undertaking some projects that are looking at genes that confer protection against disease. We published the first MHC (Major Histocompatibility Complex) variability paper in wild elephants. This region would be helpful to research for captive breeding programs in all animals.

-JEM + NCM

Does the research you conduct get repurposed for other scientific studies e.g. for CDC NCEZID disease control or USDA APHIS wildlife services? What sort of interactions do you have with their staff and scientists?

[grandpa_faust](#)

Our major role is to conduct research and publish our work in scientific journals. Any scientist or agency can then use our data and our findings. We have worked with APHIS, USFWS, USGS and various NGOs.

-JEM

Can you say a little more about how DNA from animal poop helps you understand genomic variation in different species?

[genomegal](#)

Animal poop is one of our best materials for understanding genomic variation in species. It is not very easy to go out and collect a blood or tissue sample from an endangered species (whether that's because of the habitat or how rare they are). Poop contains DNA from the species, as well as it's diet and parasites and microbiome.

To determine the genetic diversity of a population, we need as many samples of the population as we can get. We go into the field and collect many samples by walking transects and picking up whatever we see, or poop-detecting dogs specially trained to identify the poop we're looking for!

We have a long term project with the conservation of endangered kit fox in the San Joaquin Valley in California. The poop-sniffing dogs are trained to detect kit fox poop by scent. The dog then sits down by it, and the handler picks it up and ships it to us in baggies filled with silica gel to dry it out and prevent degradation. We then extract the DNA, and we sequence it to identify the species, sex, and number of individuals in the area. It is a great tool for monitoring the population over time.

-JEM

How do you stay optimistic about conservation efforts in light of a lot of negative messaging about global climate change? What makes you hopeful?

[genomegal](#)

The students I work with make me optimistic. We train the next generation of conservation scientists, and we're so proud to help them accomplish their goals. I want to be part of the solution!

-NCM

The data that shows how humans are impacting the earth is troubling. This is what motivates me, and keeps me wanting to do my work of monitoring the genetic diversity of animals in a fast changing world.

-JEM

Why and how did you find and follow your career path(s)?

[LaTraLaTrill](#)

I have always been interested in Biology, but could never decide on one topic. I studied Biology in undergrad and then STILL couldn't decide what to do, but I knew I liked working in a laboratory. I got a job out of college doing DNA sequencing in a Human Genomics laboratory in Milwaukee, WI, where I learned how to PCR and sequence DNA using robots. I WAS HOOKED. Then I wanted to move to Boston, so I was lucky enough to snag a lab manager job at Harvard's Ornithology laboratory that happened to have the same equipment. I segued to studying birds and found that the research and stories around studying animals was more interesting than humans (ha!). I wanted to move to DC, and got a job at Smithsonian in the Bird Strike Laboratory at the Natural History Museum with Carly Dove. I sequenced the CO1 gene in any sort of debris the pilots/mechanics could wipe off the planes, and we could identify the birds for them. Definitely google that. And now I'm back to lab managing at SCBI and am lucky to help all the students and scientists sequence DNA of animals from all over the world, as well as the animals in the Zoo. I get to sequence the baby pandas when they're born to figure out male/female, as a perk!

-NCM

I grew up in the suburbs of Mexico City in the 1960s. My house faced the mountains and fields and loved to go outside and explore as a child. In the 70s my house was in the middle of Mexico City and all the wildlife and habitat was destroyed and replaced by condos and roads. This really motivated me to pursue biology and conservation biology. My path was lucky because my father was stationed at the War College in PA, and the closest college was Shippensburg State University. There, I was mentored by the mammal curator of the vertebrate museum and participated in many internships and field trips to the surrounding areas, which greatly increased my interest in studying mammals. That led to a masters degree looking at morphometric variation of skunks parasitized by a nematode. This involved measuring hundreds of skulls in museum collections with and without evidence of parasites. I then got a job as a curatorial assistant at LA County Museum of Natural History, because of this museum experience during my masters. At the museum I learned about how little we knew about some mammal species in California, and in my case, shrews. Shrews are difficult to find and study, and the morphology was very consistent across species, so I needed to use the new genetic tools available then to study these animals. That led me to enroll at UCLA in one of the first conservation genetics labs. I then came to DC to join the Smithsonian and continue studying the genomics of animals.

-JEM

I just want to share how deeply I respect your work. I have been a supporter of the Smithsonian for all of my 52 years. I know I was a smart baby ;)

Our species on Earth are disappearing rapidly. Are there in place now genome Banks that Preserve DNA of at-risk species with the goal of one day restoring them to our planet?

[TheUncommonShaman](#)

Thank you! We very much appreciate it!

We do indeed have DNA bank at SCBI, and the Smithsonian Institution has a extensive cry-preservation initiative that includes samples ranging from soil to plants to DNA of everything in-between! These samples are used for research not to put back into the wild. One exception is coral. We are freezing sperm and eggs and larvae of coral with the hope of re-introducing one day.

-NCM + JEM

How likely is it that captive animals will be reintroduced (once threats facing them in the wild have dissipated)? Particularly since many will have over generations adapted to captivity (whether this is behavioural or through changes to their immune responses/microbiome etc) and, given technologies such as AI, which if further developed over the next few years could be used for embryo/gamete transfer if suitable populations still exist in more natural habitats?

[queenofthesea123](#)

Captive animals are reintroduced to the wild. SCBI has helped reintroduce black-footed ferrets, scimitar-horned oryx, guam rails, golden lion tamarins, to name a few.

Those reintroductions are going well and what we see from those animals is that they can survive in the wild even if they were born in captivity. We use AI as a tool to help increase genetic diversity, and black-footed ferrets is a specific example of that because there were only 18 individuals left when we started the breeding and reintroduction program in 1988.

To clarify, animals in reintroduction programs are not kept in captivity for generations. They are introduced relatively quickly. The black-footed ferrets are reintroduced at about 1yr of age. We use genomics to help us see the affects of captivity on these animals.

-NCM

What do you think are the most important factors in mentoring students and trainees? Especially those from groups historically underrepresented in the sciences?

[genomegal](#)

I think that exposure to the actual work is an important factor in mentoring students and trainees. Our students come into the lab and are responsible for a portion of a project and learn all the techniques needed to accomplish the work, as well as becoming co-authors on the published papers. Immersing students in the lab which includes interactions with the other grad students, post-docs, and research staff scientists in the laboratory and in scientific discussions is a great way to encourage and prepare them for a career in conservation science.

Recruiting and providing those opportunities to underrepresented groups is particularly important. I mentor minority interns through a Smithsonian USCB ERES program which provides funding to expose students to SCBI science.

Smithsonian Mason School of Conservation (SMSC) was started in 2008 to provide training for students and conservationists. Through SMSC students get to learn and work directly with SCBI scientists.

-JEM

On a scale of 1 to 10 with 10 being the highest, how much do you guys love giant pandas?

Also, did your work help get giants pandas off the endangered species list?

I love the National Zoo! One of my favorite spots in DC.

[TinyRandomLady](#)

I love panda DNA. 10+

The vets swab the baby panda's cheek during the first neonate exam, which then I take and extract the DNA. There is always plenty of DNA to extract and sequence the X and Y chromosome to determine sex.

Preserving panda habitat in the wild is the major reason for the reclassification to threatened.

Thanks for visiting!

-NCM

I don't know whether it is appropriate to ask here. I have heard multiple times that machine learning and deep learning is used in genomic research. Can you give a brief idea on how these are used and how it improves your work?

[abinmn619](#)

Machine learning is fascinating, and very helpful for analyzing genomic data! Our colleagues at National Museum of Natural History are studying machine learning as it relates to genomics, and actually a former graduate student is doing her post doc with this group.

-NCM

What do you all think about using genome editing technologies to either increase genomic diversity in endangered species (e.g. cheetahs) or using genome editing to try to combat infectious diseases that threaten endangered critters (e.g. white-nose syndrome in bats)?

[genomegal](#)

We think it's cool and has potential, but we're personally not using CRISPR in conservation genomics yet. We need to know a lot more about infectious diseases in wildlife before we tackle CRISPR.

There might be ways to protect bats using their microbiome. For example, SCBI scientists are studying Chytrid in amphibians, and seeing what is happening with disease-resistant individuals and how the microbiome can influence the health of the animal.

-JEM + NCM