



On the Importance of Scientific Collections

A Series by Natural Science Collections Alliance

Informing Wildlife Management: Genetics Research Uses Natural History Collections

By Christina Slover

Natural resource managers are faced with the difficult challenge of conserving and restoring populations of animals and plants, as well as natural ecosystems.

One important scientific tool they use is knowledge of the species' genetic material. Recent advances in genetics research provide scientists with an understanding of a species' DNA. This information can be used to identify members of a species or even shed light on the causes of a population's decline.

Natural history collections play an important role in such research. Although many specimens were collected and preserved before DNA was discovered, natural history collections are repositories of genetic material for plants, animals, fungi, and microbes from around the world. Biological samples such as tissues, bones, feathers, or entire organisms contain a wealth of information about the natural world.

Scientists are using scientific collections in cutting-edge research to improve management of wildlife. Natural history collections are being used to prevent bird strikes with aircraft, better understand population genetics, and potentially revive extinct species.

Preventing Airplane Collisions with Wildlife

On January 15, 2009 US Airways flight 1549 was forced to land in the Hudson River after taking off from LaGuardia Airport. Fortunately, none of the 155 passengers onboard was killed. The plane stalled after it flew through a flock of birds, which resulted in the failure of both engines.

Unfortunately, this was not an isolated incident. Annually, bird strikes cause about \$1.1 billion in damages to commercial airlines.¹ The threat to passenger safety and the high cost of bird strikes is an incentive to prevent future collisions.



Researchers at Smithsonian Institution use specimens to identify birds that are involved in bird strikes with airplanes. Credit: James Di Loreto, Smithsonian.

Bird collections in natural history museums are often used to identify which birds have struck a plane. Once this is known, information about the birds' behavior and habitat can be used to relocate nesting grounds or redirect flight paths.

After the crash of flight 1549, scientists from the Smithsonian Institution and the U.S. Department of Agriculture extracted DNA from feather and tissue samples found in the plane's engines. These samples were compared to museum specimens using a technique called DNA barcoding to identify the species of bird involved in the accident. Scientists have collected around 3,800 DNA barcodes for individual bird species, often using museum specimens. This genetic library makes it possible to identify species using only small samples of tissue or feathers. The results of the DNA barcoding comparison identified Canada Geese as the likely culprit in the accident.

Researchers then compared amounts of stable hydrogen in the engine feather samples and museum feather samples to determine whether the Canada Geese involved in the accident were from the New York City area or had migrated from elsewhere. Ratios of stable hydrogen within animal or plant tissue differ from location to location due to differences in global weather patterns and local topography. The analysis determined that a flock of migratory Canada Geese from the Labrador region of Canada were involved in the crash.

Using this knowledge, LaGuardia Airport developed a management plan to reduce the risk of future bird strikes.

Informing Management of Rare Species

Scientific collections are a valuable source of information concerning management of genetic diversity of species. A population that lacks sufficient variation in DNA is less able to adapt to new conditions, such as a disease outbreak, and is more likely to go extinct than a population with greater genetic diversity.



Courtesy Illinois State Museum.

Scientists use museum specimens to glance into the past of a species. One area of interest to scientists and wildlife managers is changes in genetic diversity of rare species like the Greater Prairie Chicken. Scientists at the University of Illinois have determined that a sharp reduction in population numbers, referred to as a population bottleneck, occurred in the Illinois Greater Prairie Chicken population. When the scientists compared genetic material from museum specimens collected decades ago to more recent specimens, they found less genetic variation in contemporary populations.²

This reduction in genetic diversity in the Prairie Chicken population could be due to fragmentation of the species' habitat. Loss of the tall grass prairie that this bird uses for breeding is one of the greatest threats to the population. Today, the Greater Prairie Chicken is listed as an endangered species, but the bird is already extinct in much of its original range.

Understanding the changes in DNA in a wildlife population over time allows scientists and natural resource managers to identify problems in that population and improve management plans. Natural history collections are a valuable tool in these assessments.

Bringing Species Back to Life

Natural history collections are not only used to improve management of species; researchers are also using tissues from natural history specimens to try to ‘bring back’ species that have gone extinct.

Recently, Spanish scientists attempted to revive an extinct species of wild goat, the Pyrenean Ibex. They extracted DNA from the tissue of a museum specimen, which was then implanted into a cell with no genetic material.³ This process results in the genetic information from the extinct species being present in the cell and the resulting embryo. Scientists hope that this method will be successful in bringing back species from extinction and eventually allowing the species to be reintroduced in nature.

This method of de-extinction does not come without problems, however. In Spain only one out of hundreds of Pyrenean Ibex fetuses fully developed. After birth, the Ibex only survived for a few minutes. The method is also limited in its potential implementation by virtue of requiring a complete genome. In practice, this means only species that went extinct very recently would be candidates for this method of de-extinction. Regardless, as science technologies advance, museum specimens allow the possibility of reviving extinct species. This opportunity would not be possible without specimens preserved in scientific collections.

Conclusion

Managing the planet’s wildlife populations would be more difficult without the extensive natural history collections in the care of museums, government agencies, and universities across the U.S. and around the world.

Maria Wheeler, a graduate student at Duquesne University in Pittsburgh, Pennsylvania, studies the population genetics of Bald and Golden Eagles in North America. Wheeler summarizes the value of natural history specimens to her research: “The kind of questions I’m asking wouldn’t be possible to answer without museum specimens. The beauty of it, though, is that a hundred years ago when most of my samples were being preserved, no one would even have been able to ask about heredity or population genetics. Thus, invaluable genetic information was locked safely away long before curators even knew it was there. Just imagine the questions that can be asked in another hundred years.”

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2. Bouzat, J.L, Lewin, H.A. & Paige, K.N. 1998. The Ghost of Genetic Diversity Past: Historical DNA Analysis of the Greater Prairie Chicken, *The American Naturalist* 152:1-6.
3. Wandeler, P., Hoeck, P.E.A., & Keller, L.F. 2007. Back to the Future: Museum Specimens in Population Genetics. *Trends in Ecology and Evolution* 22: 634-642.

About NSCA

The NSC Alliance is a nonprofit association that supports natural science collections, their human resources, the institutions that house them, and their research activities for the benefit of science and society. Our 100 institutional members are part of an international community of institutions that house natural science collections and utilize them in research, exhibitions, academic and informal science education, and outreach activities.