SMITHSONIAN'S NATIONAL ZOO AND CONSERVATION BIOLOGY INSTITUTE
GIANT PANDA BREEDING AND CONSERVATION PROGRAM OVERVIEW

After more than 25 years on the endangered species list, the International Union for Conservation of Nature announced the giant panda was upgraded from "endangered" to "vulnerable" on the global list of species at risk of extinction. The Smithsonian's National Zoo and Conservation Biology Institute's (SNZCBI) collaborative efforts with Chinese partners to conserve giant pandas in the wild and contributions to the science of building and growing healthy populations of giant pandas in human care over the past five decades directly contributed to this momentous conservation milestone. SNZCBI remains committed to continuing its efforts to secure and safeguard a healthy future for giant pandas.

TIMELINE + BRIEF HISTORY OF GIANT PANDAS AT THE SMITHSONIAN'S NATIONAL ZOO

At dinner in Beijing, China in Feb. 1972, First Lady Patricia Nixon mentioned her fondness for giant pandas to Chinese Premier Zhou Enlai. As a gesture of goodwill following President Nixon's seminal state visit, Premier Enlai gifted two giant pandas to the American people. Nestled in the Nation's Capital and with free admission, the President and Mrs. Nixon selected the Smithsonian's National Zoo as the home for the first giant pandas at a U.S. zoo. On April 16, 1972, giant pandas Ling-Ling (a female) and Hsing-Hsing (a male) arrived at the Zoo. Mrs. Nixon welcomed them to the Zoo in ceremony held on April 20, 1972.

For a detailed timeline of SNZCBI's giant panda care and conservation program, visit History of Giant Pandas at the Zoo.

RESEARCH AND BREEDING AGREEMENTS WITH CHINA WILDLIFE CONSERVATION ASSOCIATION

SNZCBI entered into its first Giant Panda Cooperative Research and Breeding Agreement with the China Wildlife Conservation Association (CWCA) in Dec. 2000 when giant pandas Mei Xiang (female) and Tian Tian (male) arrived at the Zoo. The initial agreement between the Zoo and CWCA was a 10-year agreement and has been renewed three times since 2010. The current three-year agreement extension signed by the Zoo and CWCA is effective through Dec. 7, 2023. The terms of the current agreement are similar to the 2011 and 2015 agreements, stipulating the Zoo and Chinese partners will conduct cooperative research projects and the Zoo will pay $500,000 per year to support conservation efforts in China. The current contract allows any cubs born at the Zoo to stay up to the age of 4 before going to China to be part of the breeding program. Both parents and any offspring remain under the ownership of China.

Research and Breeding Agreement Timeline

- Dec. 2000 – Dec. 2010
- Jan. 27, 2011 – Dec. 5, 2015
- Dec. 7, 2015 – Dec. 7, 2020
- Dec. 7, 2020 – Dec. 7, 2023

FUNDING THE GIANT PANDA CONSERVATION PROGRAM

SNZCBI's 50-year giant panda breeding and research program is made possible with vital private sector support in addition to federal funding. While 70% of the Zoo's budget is federally funded and covers critical expenses including animal care needs such as food and medicine, the remaining 30% is generated from parking, concessions, gift shop sales augmented by the support of the Smithsonian National Zoo membership program, donors and corporate sponsors.

In 2020, David M. Rubenstein, co-founder and co-CEO of The Carlyle Group and former Smithsonian Board of Regent, pledged a $3 million gift to SNZCBI, funding its giant panda research and conservation

program through the end of 2023. Rubenstein has donated a total of $12 million in support of the Zoo's giant panda conservation program.

SMITHSONIAN GIANT PANDA PROGRAM RESEARCH PRIORITIES

SNZCBI's giant panda breeding and conservation program has two primary research and capacity building priorities. These areas of focus were identified as part of the Smithsonian's ongoing 50-year collaboration with Chinese partners.

1. **SAVING GIANT PANDAS IN THE WILD**
   To understand and protect giant panda ecology, habitat, and associated species in China.

2. **GENETICALLY DIVERSE GIANT PANDA POPULATION**
   Maintaining a healthy, viable giant panda population in human care to support those in nature.

SAVING PANDAS IN THE WILD: SMITHSONIAN IMPACT OVERVIEW

BY THE NUMBERS

- Collaborated with **150+** Chinese partners.
- Trained **1,500+** Chinese wildlife professionals and students, many of whom now lead major giant panda research and habitat protection programs in China.
- Produced **115+** books, book chapters, scientific articles and technical manuals on wild giant pandas, associated wildlife and native habitat, as well as husbandry, veterinary care and reproductive research on giant pandas in human care.
- Conducted **60**+ different training courses for Chinese professionals and students representing 55 giant panda reserves, 14 universities and 20 forest departments.
- Worked with Chinese students and protected area rangers to collect infrared camera data on giant pandas and associated wildlife for **31K** camera nights at **953** locations within giant panda protected areas.

RESEARCH IMPACT AREAS

Restoring Giant Panda Habitat Connectivity
SNZCBI scientists and Chinese colleagues work to increase giant panda habitat through bamboo restoration and by designing "corridors" of bamboo forests to link isolated habitats. Corridors help strengthen giant panda populations by enhancing movement and increasing options for mate selection and can support reintroduction of captive-born pandas into the wild and other wildlife that share the same habitat. Research milestones include:

- Mapped and assessed wild pandas' highly fragmented habitat, a leading threat to survival in the wild.
- Examined the creation and impact of corridors to link fragmented habitats to benefit giant pandas and other wildlife species.
- Developed and implemented strategies for restoring bamboo to logged protected areas and detected successful return of giant pandas to replanted areas in the Qinling Mountains.

Climate Change and Bamboo Growth
Scientists are modeling the potential impacts of climate change on giant panda habitat and making recommendations for mitigation strategies. Research milestones include:

- Used giant panda data to advance selection of species distribution models, allowing for improved predictions of where species potentially could survive as climate changes.

- Conducted experimental study on risks of warming temperatures to bamboo survival, providing results to inform adaptive management of habitat to mitigate negative effects of climate change.

Preserving Biodiversity: Vegetation and Wildlife Monitoring
Smithsonian ecology research focuses on how managing protected areas for the benefit of giant pandas impacts other species that share the same bamboo forest. Research milestones include:

- Published ecology research assessing how reserves established for one endangered species can be effective in conserving other endangered species.
- Biodiversity surveys and published research showed how giant panda reserves have been very successful at conserving giant pandas but not large carnivores, which have continued their decline over the same period giant panda populations have increased.
- Conducted climate and wildlife monitoring with an infrared camera on established vegetation plots.
    - 31K camera nights at 953 locations; detected 30+ species including many giant pandas.

Wildlife Disease Study
Smithsonian researchers study diseases that threaten giant pandas. Research milestones include:

- Collaborating with Chinese colleagues at the Wildlife Disease Control Center in Sichuan Province to study parasitic and other infections as well as disease in aging giant pandas—all of which will help inform future studies on the species.
- Evaluating threats of disease transfer from dogs to pandas including examining dogs for disease exposure, evaluating the range of dogs via tracking collars and analyzing spatiotemporal overlap between dogs and wildlife.

CAPACITY BUILDING AND TRAINING
In addition to one-on-one mentoring exchange programs, a core component of how SNZCBI supports the conservation of wild pandas is through hands-on field and lab training in collaboration with Chinese colleagues.

Geographic Information Systems (GIS) and Remote Sensing Training for Wildlife Managers

- Annual sessions focus on GIS remote sensing/landcover change; radio telemetry, GPS, mapping; how to store and access biological info; open-source GIS and R ecological software.
- Trained 500+ wildlife professionals and students and 20 Chinese instructors from 55 reserves, 15 universities and 20 forestry departments.

Behavioral Enrichment Workshops

- Trained 130 students on the use of enrichment in animal exhibits to stimulate natural behavior and collection of pre-and post- enrichment behavioral data.
- Helped create two new permanent workshop facilities for animal enrichment creation at Beijing and Shanghai Zoos and supported six exhibit makeovers.

Environmental Education

- Trained 22 reserve staff and teachers in areas surrounding giant panda reserves on ways to use environmental education as a tool for conservation.

Biodiversity Survey Techniques
Giant panda's native habitat is a biodiversity hotspot. SNZCBI ecologists share best practices on conducting censuses and surveys of large mammals in the wild using GIS and other high-tech tools for tracking wildlife.

- Conducting research on other native wildlife such as takin, golden monkey, Asiatic black bear and goral; tactics include sign surveys, infrared cameras, data collection and maintenance.
- Trained 150 staff from 32 nature reserves.

Endocrinology Training

- Trained 28 professionals on non-invasive methods to enhance reproductive management.
- Designed hormonal tests/assay systems for application to China's giant panda health and reproduction program and provided advanced training in panda hormonal monitoring.
- Helped establish endocrinology laboratories at the Chengdu Research Base for Giant Panda Breeding and the China Conservation and Research Center for the Giant Panda to improve long-term reproductive management of species in human care.

Biomedical Training and Capacity Building

- Determine factors limiting reproductive success in the ex-situ population and share knowledge and experience needed to maintain a healthy population.
- Trained 30+ professionals in China and the United the States.

Preventative and Diagnostic Medical Training

- Held workshops and trained 22 staff on diagnosing diseases and monitoring health to include:
    - Identifying and treating giant panda medical problems, advanced anesthesia techniques, ultrasounds, health monitoring, physical exams and caring for aging giant pandas.

Genetic Management Workshops

- To support a self-sustaining captive population and maximize genetic diversity, facilitated workshops to review the status of the population in human care and make breeding recommendations for all female pandas based on a mean kinship algorithm developed by Smithsonian scientists.

GENETICALLY DIVERSE GIANT PANDA POPULATION: SMITHSONIAN IMPACT OVERVIEW

Since April 1972, giant pandas at the Smithsonian's National Zoo have been part of long-term studies on husbandry, nutrition, behavior, genetics, veterinary medicine and reproduction. Over decades of joint efforts with Chinese partners and other zoos, knowledge about the reproductive biology of the giant panda has increased exponentially. SNZCBI's breeding and veterinary research on giant pandas has provided critical data for the management of this species in human care and valuable insights for the conservation of wild populations.

BIOMEDICAL SURVEY: 1998-2000

This multi-disciplinary study conducted by SNZCBI and Chinese partners was instrumental in advancing our understanding of giant panda biology and management.

- The survey examined many aspects of reproductive physiology, endocrinology, veterinary medicine, nutrition, behavior, genetics and pathology and included 63 of China's 104 giant pandas at Chinese breeding centers. Findings and impact include:
    - Identified secondary nutritional hyperparathyroidism in select giant pandas which can cause several maladies including abnormal calcium and phosphorous levels and decreased reproductive rates; worked with Chinese counterparts to correct the diet and imbalance, leading to a giant panda cub boom.
    - Stunted growth syndrome was thought to be due to intestinal parasites which can cause a host of problems. Working with Chinese counterparts, bowel biopsies showed hypereosinophilia, a type of blood disorder, which was resolved by regular dewormings.

REPRODUCTIVE SCIENCE

Smithsonian scientists have made important advances in improving reproductive success in giant pandas, which has served as a model for the management of other rare and endangered species under human care.

Endocrinology and Artificial Insemination

Smithsonian's work to understand reproduction increased the likelihood of pregnancies in giant pandas under human care.

- Advances in noninvasively tracking metabolites of hormones and sex steroids in fecal and urine samples helped Smithsonian scientists better detect estrous periods, determine optimal timing for natural mating or artificial insemination and monitor pregnancies. Similar approaches are now being applied to the reproductive management of a variety of other species.
- Pinpointing the best time to perform artificial inseminations has led to more pregnancy success and surviving giant panda cubs at the Zoo. All four of the female giant panda Mei Xiang's surviving cubs were the result of artificial inseminations following close tracking and monitoring of hormones via urine analyses.
- Techniques in monitoring hormones in feces were developed at SNZCBI to provide another noninvasive approach to monitoring both reproduction and welfare in giant pandas both *in situ* and *ex situ*.
- To facilitate monitoring, techniques were streamlined, and a mobile Endocrine Laboratory was created to allow hormone analyses to be conducted onsite at the Zoo during the breeding season, which also increased success in producing successful pregnancies.
- With estrus windows being just 72-hours long during the breeding season and natural breeding efforts being unsuccessful for many pairs, including Mei Xiang and Tian Tian, artificial insemination has been critical to giant panda reproductive success in human care. Artificial insemination techniques advanced by the Smithsonian include the use of transcervical catheters used in human reproductive medicine.

Freezing for the Future: Genome Resource Banking

Collecting and freezing biological materials from threatened species helps scientists and animal breeding experts ensure the genetic diversity of future animal populations. The Pan-Smithsonian Cryo-Initiative is a leader in preserving genetic material including gametes, DNA, blood and tissue samples.

- SNZCBI's pioneering first attempts to cryopreserve giant panda semen showed it is resilient to cold storage at subzero temperatures. The potential loss of valuable genes from non-breeding pairs is a major concern for the survival of the species. Developing advanced methods for the successful cryopreservation of giant panda sperm was a major conservation milestone.
    - This advance made it possible to fulfill breeding recommendations for giant pandas thousands of miles apart by shipping frozen samples from genetically valuable male pandas between breeding institutions across the globe.
    - Effective sperm cryopreservation makes it possible for males that have died to still be part of genetic management plans.
- Semen from the Zoo's male giant panda Tian Tian has been systematically cryopreserved since 2005 to check fertility and for use at the Zoo and in other centers breeding giant pandas. It is the largest collection of cryopreserved gametes from a single male giant panda in the world. This unique set of samples could be used to measure variations and evolution over time of giant panda male fertility.
- Giant panda cub Xiao Qi Ji's birth is the first outside of China from artificial insemination with frozen-thawed semen only and demonstrates the value and key role of systematic biobanking in species conservation.
    - The semen used on March 22, 2020, to inseminate Mei Xiang was collected from Tian Tian and frozen in February 2015. Until Xiao Qi Ji's birth, all successful giant panda artificial inseminations outside of China used exclusively fresh or a combination of fresh and frozen semen samples.

CONSERVATION GENETICS

Smithsonian scientist emeritus John Ballou's pioneering work in conservation genetics has played an instrumental role in saving species.

- Ballou's theoretical basis for the mean kinship-based method for genetic management is the standard used worldwide for breeding recommendations for the global population of pandas in human care as well as all Association of Zoos and Aquariums Species Survival Plan managed animals.
- This algorithm has helped scientists and zoos maximize genetic diversity and create self-sustaining captive populations of animals once extinct in the wild, including the California condor, black-footed ferrets, golden lion tamarin and the scimitar-horned oryx.

ANIMAL CARE

Husbandry Training and Veterinary Care

Over the past five decades, SNZCBI's animal care team, including keepers, curators, nutritionists and veterinarians, have become globally recognized experts on the training and care of giant pandas. The Zoo is one of three U.S. zoos with giant pandas; there are a total of 26 zoos outside of mainland China with giant pandas.

- The successful use and expert application of operative training and positive reinforcement have transformed the preventative and diagnostic veterinary care of SNZCBI animals.
- Building trust and relationships with each of the Zoo's giant pandas using these techniques has resulted in Mei Xiang, Tian Tian and Xiao Qi Ji voluntarily participating in their own medical care. This is critical as routine anesthesia, which has inherent risks, would be required for health management.
- The Zoos' giant pandas have been trained to voluntarily present their body parts for examination, place their arm through a sleeve for a blood draw or blood pressure reading, present their belly for an ultrasound, climb upon a scale, sit still for laser therapy arthritis treatment, open their mouth for a dental exam, and the list goes on.
- Participation in husbandry training sessions is completely voluntary, and the pandas are free to walk away at any time. If they do the behavior asked of them, they receive verbal praise and a treat—usually a piece of sweet potato, apple, or honey water from a squeeze bottle.

Caring for Aging Giant Pandas

- In addition to commonly used pharmaceuticals and treatments, SNZCBI's veterinary team is exploring new approaches to address Mei Xiang and Tian Tian's health and maintain a high quality of life as they age, including therapeutic laser treatment for arthritis, acupuncture and medicines to address high blood pressure, a chronic condition in older pandas.

Nutrition Science

SNZCBI's Department of Nutrition Science (DNS) uses best-practices and conducts scientific research to provide the best diets to the animals in the Zoo's care, including giant pandas.

- The Zoo's giant pandas eat approximately 200 lbs. of bamboo a day. DNS staff cut bamboo all year round; the supply comes from locations at the Zoo and from 20 stands across Washington, D.C., Maryland and Virginia. Throughout the year, pandas transition from eating mainly leaves to mainly culm (the stalk) and back. In summer, bamboo leaves make up the majority of the pandas' diet and in the spring bamboo shoots are a treat. In addition to bamboo, giant pandas receive apples, pears sweet potatoes and high-fiber biscuits.
- The Zoo houses the most extensive collection of exotic animal milks in the world, including samples of giant panda Mei Xiang's breast milk. Physical samples are used to collect invaluable data as scientists continue to discover the secrets of lactation. Practically, this information assists researchers and colleagues in their efforts to raise neonatal mammals that may need hand-rearing.

DISEASE STUDY AND PREVENTION

Giant pandas have long been threatened by infectious diseases and SNZCBI's Wildlife Health Sciences veterinary team and Global Health Program have been leaders in investigating potential impact of transmissible diseases at the Zoo and in China.

Antibiotics

- SNZCBI piloted the use of long-acting antibiotics in the treatment of giant pandas with the Zoo's adult male giant panda Tian Tian; an upcoming study with Chinese colleagues will look at a population conservation model.
    - SNZCBI developed a long-acting antibiotic pharmacokinetic profile and conducted a study of how the drug was absorbed, metabolized and excreted over the course of Tian Tian's treatment; in the first profile the antibiotic maintained high levels for more than 12 days, which is close to the duration of 14 days reported in the domestic dog and cat.
- Testing long-acting antibiotics has direct implications for giant pandas in human care as well as pandas being prepared for reintroduction. Chinese colleagues can safely administer long-acting antibiotics to giant pandas ahead of release to the wild when there is no opportunity for follow up treatment. This is also a critical tool for vets who treat injured wild pandas in the field.

Canine Distemper

- Giant pandas are particularly susceptible to canine distemper, a viral disease most domestic dogs are vaccinated against. Following the death of several giant pandas in China from canine distemper, a new type of vaccine initially developed for the domestic ferret was employed to stimulate immunity but not cause illness in giant pandas. Due to the potential enormous contribution to conservation efforts, the Zoo agreed to test the vaccine on giant pandas Mei Xiang and Tian Tian. This involved administering the vaccine and monitoring titers in the blood. Based on data known from domestic carnivores, the vaccine is considered to provide protection to giant pandas against disease caused by the canine distemper virus. The published 2007 study on testing the distemper vaccine is now the foundation of vaccine protocols utilized worldwide for giant pandas.

Cardiac Disease

- One of the leading causes of death in giant pandas is cardiac disease. SNZCBI's Global Health team is currently researching the use of implantable loop recorders in giant pandas to monitor cardiac disease and provide early warning signs so treatment can be initiated.

Hepatozoan

- Hepatozoan, a parasite transmitted by ticks, was found in the Zoo's giant pandas in 2005. Working with Chinese colleagues, SNZCBI scientists determined it was a novel parasite brought to the United States from China. This parasite has not had any negative impact on the Zoo's pandas. SNZCBI published research in 2019 and is working towards a clinical study to investigate more thoroughly in China.

Pathology

- Smithsonian veterinarians and pathologists collaborated with Chinese colleagues to publish a groundbreaking paper on neonatal giant panda necropsy and physiology. Findings include identifying a dysmaturity syndrome in giant panda cubs that did not survive and discovering that alveoli in their lungs was too thick, a condition similar to what occurs in premature human infants.

CONSERVATION PARTNERS

The following government and non-governmental organizations have collaborated with the Smithsonian to help study and save the giant panda and its native habitat.

Government and Non-Governmental Organizations

- 20 Chinese provincial forestry departments
- China Conservation & Research Center for the Giant Panda
- Chengdu Research Base
- China Wildlife Conservation Association
- Chinese Academy of Forestry

- Chinese Academy of Botany
- Chinese Academy of Sciences
- Conservation International
- State Forestry & Grassland Administration (China)
- Wildlife Conservation Society
- World Wildlife Fund

Chinese Universities

- Beijing Forestry
- China West Normal
- Fudan
- Peking
- Sichuan Agricultural
- Tsinghua