IMPACT REPORT

2022 – 2024

Center for Chelonian Conservation

Saint Louis Zoo
Institute for Conservation Medicine™
Healthy Animals. Healthy People.™

Saint Louis Zoo
WildCare Institute®

How it started and how it is going

The Saint Louis Zoo WildCare Institute Center for Chelonian Conservation (WCI CCC) was launched in 2019, and thus we have entered our 5th year as a Center. The core work of this Center, and our work for turtle and tortoise (chelonians!) health and conservation, began in 2012. This was the year we started the St. Louis Box Turtle Project (SLBTP). The following year we became a collaborating partner of the Galapagos Tortoise Movement Ecology Programme (GTMEP). Based on this foundation, the WCI CCC in 2020 became a major player working with the Turtle Survival Alliance and others for the conservation of radiated tortoises in Madagascar.

Why a Center for the conservation of turtles and tortoises?

Chelonians are the most endangered vertebrate group on the planet with more than 60% of their species endangered or already extinct. Chelonians are threatened by habitat loss and fragmentation, human use as pets and for food, climate change, and infectious diseases. Turtles and tortoises are essential to ecosystems, with many species, including Galapagos tortoises, serving as "ecosystem engineers". Unfortunately, the health status of most species remains poorly understood. The WCI CCC supports the SLBTP (including box turtles and snapping turtles) in Missouri, the GTMEP in Ecuador, and the radiated tortoise health program in southern Madagascar. We incorporate applied science, local capacity building, and an inspirational turtle-based outreach and education program to inform management decisions and local stakeholders to effectively conserve turtles and tortoises.

What the Center works to achieve

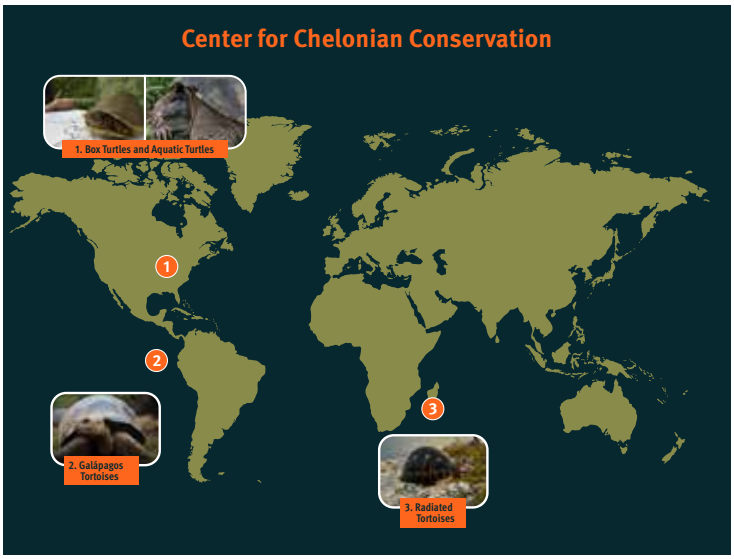
The Center for Chelonian Conservation is structured around three major objectives. These include:

1. Scientific research to provide evidence-based data on the ecology and health of turtles and tortoises.
2. Application of scientific discoveries to ensure appropriate conservation actions that support turtle and tortoise survival.
3. A vibrant outreach program to teach students and the general public on the plight of turtles and tortoises, what they can do to save them, and simply the joy of these iconic creatures.

With these three major objectives, our overarching goal is to minimize threats to the long-term survival of turtle and tortoise species globally.

Where we work

The Center for Chelonian Conservation has boots on the ground in three locations: Missouri, the Galapagos Islands, and Madagascar. In Missouri, our primary sites are Forest Park and Tyson Research Center. In the Galapagos, we work mainly on three islands: Santa Cruz, Isabela, and Española. In Madagascar we work in the dry southern spiny forests that are home to the endangered radiated tortoise.



Theory of change

We use an iterative process to assess whether, and how, our efforts in research and outreach are leading to our overarching goal to minimize threats to the long-term survival of turtle and tortoise species globally. To do this, we take a number of steps.

1. Scientific Data: All of our research projects involve data collection, leading to scientific and layperson-friendly presentations and much of our work is shared in peer-reviewed scientific publications.
2. Passion/Enthusiasm/Caring: Through outreach programs in Missouri and the Galapagos, and capacity building workshops in Madagascar, we have introduced turtle and tortoises to thousands of people while also training the next-generation of care providers for chelonians.
3. Training next-generation turtle conservationists: We lead classes at local K-12 schools in Missouri and Galapagos. We take students on turtle safaris to meet small box turtles in Missouri or giant tortoises in Galapagos, and have held training exercises in Madagascar as well as training of Malagasy veterinary students in field and laboratory techniques.
4. Conservation Action: Combined together, the science we perform and the outreach we lead are synergistic for instilling appropriate conservation actions. Understanding the problems and having a passion to tackle these challenges are key to conservation success.

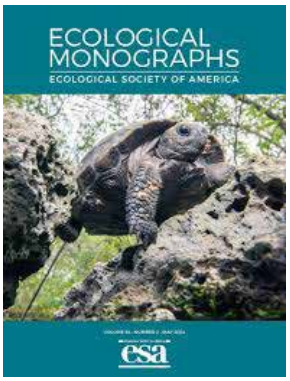
Galapagos map with insert of the three giant tortoise field sites within the archipelago.

Scientific Data + Passion/Enthusiasm/ Caring = Conservation Action

Major accomplishments 2022 – 2024 (to date)

Scientific Publications = 14

Two of our publications in 2024 had the pleasure to have one of our study animals as the cover of the journal: a three-toed box turtle and a baby giant Galapagos tortoise!



Apakupakul, K, Duncan, M, Subramaniam, K, Brenn-White, M, Palmer, JL, Viadanna, PHO, Vann, JA, Adamovicz, L, Waltzek, TB, Deem, SL. 2024. Ranavirus (Frog Virus 3) Infection in Free-living Three-toed Box Turtles (Terrapene mexicana triunguis) in Missouri, USA. Journal of Wildlife Diseases. 60: 151-163.

Blake, S., Cabrera, F., Cruz, S., Ellis-Soto, D., Yackulic, C.B., Bastille-Rousseau, G., Gibbs, J.P., and Deem, S.L. 2024. Environmental Variation Structures Reproduction and Recruitment in Long-Lived Mega-Herbivores: Galapagos Giant Tortoises. Ecological Monographs, e1599. https://doi.org/10.1002/ecm.1599

Blake, S., Cabrera, F., Rivas-Torres, G., Deem, S. L., Nieto-Claudin, A., Zahawi, R. A., & BastilleRousseau, G. 2024. Invasion by Cedrela odorata threatens long distance migration of Galapagos tortoises. Ecology and Evolution, 14, e10994. https://doi.org/10.1002/ece3.10994

Blake, S., Palmer, J., Brenn-White, M., and Deem, S.L. 2023. Home ranges of box turtles in a rural woodland and an urban park in Saint Louis, MO; implications for turtle conservation. Urban Ecosystems. https://doi.org/10.1007/s11252-023-01354-8.

Brenn-White, M., Raphael, B., Rakotoarisoa, N.A.T., and Deem, S.L. 2022. Hematology and biochemistry of critically endangered radiated tortoises (Astrochelys radiata): Reference intervals in previously confiscated subadults and variability based on common techniques. PLos ONE 17(3); e0264111. https://doi.org/10.1371/journal.pone.0264111

Brugal, M.P., Moscoso, M.B., Nieto-Claudin, A., Deem, S.L., Siddons, D.C., Cáceres, R.C. 2024. The fungus Aphanoascella galapagosensis affects bacterial diversity of Galapagos giant tortoise carapaces. Journal of Applied Microbiology. DOI: HYPERLINK "https://doi.org/10.1093/jambio/lxae202"10.1093/jambio/lxae202

Deem, S.L. 2023. Temperature along an elevation gradient determines Galapagos tortoise sex ratios; a summary. Testudo. 9(5): 11-15.

Deem, S.L., Rivera, S., Nieto-Claudin, A., Emmel, E., Cabrera, F., and Blake, S. 2023. Temperature along an elevation gradient determines Galapagos tortoise sex ratios. Journal of Ecology and Evolution. https://doi.org/10.1002/ece3.10008.

Lamczyk, BA, Palmer, JL, Kozlowski, CP, Blake, S, Deem, SL. 2022. No difference in corticosterone concentrations between Missouri three-toed box turtles living in an urban and a rural site. Human-Wildlife Interactions 16(1).

Nieto-Claudin, A., Esperón, F., Apakupakul, K., Peña, I., & Deem, S. L. 2022. Health assessments uncover novel viral sequences in five species of Galapagos tortoises. Transboundary and emerging diseases, 69(4), e1079-e1089. https://doi.org/10.1111/tbed.14391

Nieto-Claudin, A., Palmer, J.L., Brenn-White, M., Esperón, F., and Deem, S.L. 2024. Hematology and plasma biochemistry reference intervals of Española, San Cristobal, and Eastern Santa Cruz Galapagos tortoise species. Conservation Physiology. 12: coae055; doi:10.1093/conphys/coae055.

Pike, K. N., Blake, S., Gordon, I. J., Cabrera, F., Nieto-Claudin, A., Deem, S.L., Guezou, A., Schwarzkopf, L. 2022. Sharing land with giants: habitat preferences of Galapagos tortoises on farms. Global Ecology and Conservation. 37: e02171. Winter, JM, Wellehan, JFX, Apakupakul, K, Palmer, J, Brenn-White, M, Standorf, K, Berry, KH, Childress, AL, Koplos, P, Garner, MM, Deem SL. 2022. A novel herpesvirus detected in 3 species of chelonians. Journal of veterinary Diagnostic Investigation. 34(4). https://doi.org/10.1177/10406387221092048

Ramon-Gomez, K., Ron, S.R., Deem, S.L., Pike, K.N., Stevens, C., Izurieta, J.C., and Nieto-Claudin, A. 2023. Plastic ingestion in giant tortoises: An example of a novel anthropogenic impact for Galapagos Wildlife. Environmental Pollution. 340: 122780.

Presentations = too many to count!

We delivered more than 50 talks with presentations given from elementary school-level to international One Health, wildlife health, and turtle conferences. Some highlights of these presentations include scientific presentations to the American Association of Zoo Veterinarians and Turtle Survival Alliance conferences. Each year, we also present at the One Health Fair Day in April on the Zoo campus, reaching thousands of Zoo guests with turtle messaging. A highlight of these presentations is the number of turtle lovers we reach with stories from the field. Additionally, in the Galapagos, we were busy sharing our giant tortoise work with tourists, park guides, and Galapagos National Park personnel.

Training next-generation conservationists

During the period 2022 – 2024 (to date), we have trained students in three regions: USA, Galapagos, and Madagascar. These students range from undergraduate to veterinary and graduate students. Training of the next-generation turtle caretakers is one part of our Center of which we are very proud. Here are the students who have benefited from this program and who we know will continue to do great things for turtle and tortoise conservation.

USA

Carly Etter, Rimsha Malik, Nathaniel Phillips, Brianna Hawkins, Erin Sedlacek, Victoria Christianson Galina, Emily Donovan, Michelle Weaver, Saima Parikh, Cathy Taylor, Grace Witsken, Addison Brannon, Sandy Kelly Souza Marques da Silva, Alison Cash, Emily Lesniak, Katherine Handler, Aiden Percer, Sarah Look.

Galapagos

Karina Ramón, Miguel Perea, Manuela Burbano, Paz Guillen, Samara Zeas, Gislayne Mendoza, Emma Vaasjo, Emily Donovan

Madagascar

Mamy Navalona Andriaihajarivo, Hoby Ambinintsoa Rasoanaivo, Liantsoa S.A.F. Rasoanarivo, Tony Nambinina Natacha Rasolozaka, Elodi Rambeloson, Tsiky Ny Ando Andréa Rahagalala, Santatriniaina Randrianarisoa, Stephan Andrianarivo, Razanamahenina Tahina

In addition to these students that participated in internships, externships and workshops, we held two separate workshops. In August 2022, we held the Galapagos Tortoise Movement Ecology Programme meeting in Santa Cruz, Galapagos. We then ran a two-day workshop in March 2024 with our partners working on radiated tortoise conservation in Madagascar. Hosting eight individuals from other institutions, including five from the Zoo, we were able to develop health assessment protocols for use to aid with tortoise confiscations in Madagascar.

Media attention for turtles and tortoises = too many to count!

We are pleased with the amount of press covering our work with turtles and tortoises during the recent years. Four studies in the Center for Chelonian Conservation have received the most attention via video, TV, newspaper and social media. These studies include:

- The impact of roads on box turtle movement and survival, featured by HEC TV: youtube.com/watch?v=V419m-4i-2I
- The finding of plastics in free-living Galapagos tortoises, featured in the Guardian and other outlets: theguardian.com/environment/2024/apr/23/currents-bring-life-and-plastics-animals-of-galapagos-live-amid-mounds-of-waste
- The possible impacts of climate change of sex ratios of Galapagos tortoise populations, featured in Science Direct and other outlets: advancedsciencenews.com/galapagos-tortoises-are-being-threatened-by-a-lack-of-males/
- The impacts of the invasive Cedrela tree in the Galapagos and giant tortoise movements featured in Science News and other outlets: sciencenews.org/article/tortoise-migration-galapagos-invasive-trees

Budget and Staff Time Allocation

The Institute for Conservation Medicine (ICM) team is committed to turtle and tortoise conservation as reflected in the percentage of staff time we dedicate to this work. (Note salaries are not included in budget calculations in this impact report except funds included in WildCare Institute budget line with salary for Kathleen Apakupakul and ½ salary for Ainoa Nieto Claudin.) The team members spend the estimated following percentage of their time working for chelonian science, conservation and outreach.

Staff Member (* = Part Time Employee)	Percent of time
Kathleen Apakupakul*	70%
Laura Budd	20%
Michael Dawson	5%
Sharon Deem	30%
Jamie Palmer	60%
Ainoa Nieto Claudin*	90%
Stella Uiterwaal	10%

The average annual budget of the Center for Chelonian Conservation is $262,134 (without including staff salaries except for Wildlife Chelonian Part Time Veterinarian Ainoa Nieto Claudin). We have six major funding streams to cover costs of our work. The WildCare Institute contributions have increased during this period, from $40,000 to $81,000 / year. The ICM also budgets approximately $45,000 / year in chelonian research and travel lines. Additionally, we secured four grants totaling $79,041. The Center budget streams are presented here:

Proposals include:

Washington University St. Louis – Here and Next

$49,996 awarded to Ling, F., Deem, S.L, and Losos, J. "Expanding the toolset for conservation: Understanding the diversity, distribution and dynamics of Galapagos Giant Tortoise microbiomes." 05/01/2024-05/31/2026.

Saint Louis Zoo – The Field Conservation Program

$9,050 awarded to Mendoza Alcivar, G., Nieto Claudin, A, Palmer, J.L., Deem, S.L., Apakupakul, K. Building local capacities in Galapagos: advanced training in molecular biology techniques for One Health projects. 11/01/2023-10/31/2024.

Saint Louis Zoo – The Field Research for Conservation Program

$10,000 awarded to Nieto Claudin, A, Mantilla, D., Deem, S.L., Apakupakul, K., and Ling, F. Seasonal dynamics of the gut microbiome of Chelonoidis donfaustoi and correlation with health of migratory and non-migratory individuals. 05/20/2023-05/19/2024.

Saint Louis Zoo – The Field Conservation Program

$9,995 awarded to Donovan, E., Deem, S.L., Russello, M., Blake, S., and Bastille-Rousseau, G. "International capacity building of next-generation conservationists as part of the paternity and male reproductive success of Galápagos giant tortoises project." 10/05/2022-10/04/2023.

Institution	2022	2023	2024	Total
WildCare Institute	$40,000	$45,000	$81,000	$166,000
Institute for Conservation Medicine	$45,000	$45,000	$45,000	$135,000
Houston Zoo	$50,000	$50,000	$50,000	$150,000
Galapagos Conservation Trust	$20,000	$20,000	$20,000	$60,000
Charles Darwin Foundation	$30,000	$30,000	$30,000	$90,000
WildCare Institute Donor (one-time anonymous donation)	N/A	$50,000	N/A	$50,000
Philanthropy endowed harvest for the CCC	$9,100	$9,100	$9,100	$27,300
Proposals	$9,995	$19,050	$49,996	$79,041
Total	$204,095	$268,105	$285,096	$757,296

Stories from the field

Radiated tortoises in Madagascar

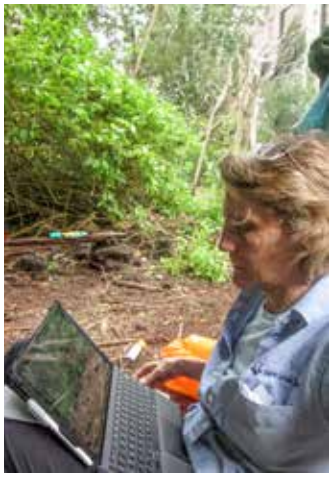
Jamie L. Palmer

Radiated tortoises are one of the most beautiful, but also one of the most trafficked tortoise species in the world. With thousands of individuals illegally removed from their natural habitats every year, helping to protect them is key for their survival. In collaboration with Malagasy and international institutions, we are supporting in-country tortoise conservation through reintroduction of confiscated animals back into the wild. In the last three years, we have traveled to Madagascar to provide tortoise health care and conduct disease assessments in 5,000 tortoises rescued from the illegal trade. We have helped to ensure that healthy animals are back in their homes while also supporting local capacity building. Students from Madagascar have joined us on each expedition in a collaborative effort to share life and professional experiences that have helped us all learn from each other, as we share our collective love for one of the most biodiverse countries on the planet.

Giant tortoises in Galapagos

Dr. Sharon L. Deem

Giant tortoise females make their nests along an elevational gradient from sea level to 160 m on Santa Cruz. Through our field work we have a window into the secret lives of tiny juveniles-soon to be giant--tortoises. Camping and working at our makeshift field surgical suite was a once in a lifetime opportunity to combining adventure with science to advance conservation. Through this work, we show that where eggs are incubated along the elevational gradient determines what sex you will be as a giant tortoise. Nests in the cooler, higher elevation produce more males, and those in the warmer lower elevations, more females. Our study provided necessary data to make projections of how climate change may impact future tortoise sex ratios in the Islands.



Box turtles in Missouri

Kathleen Apakupakul

Supporting wildlife conservation requires implementing innovative strategies and collaborations. A focus on wildlife microbiomes has been emerging in recent years, and given the attention that the human microbiome (mostly the microbes that make our guts their home) has received, it's not a far stretch to believe that animal microbiomes are also key to their health. The ICM has teamed up with Dr. Fangqiong Ling, a scientist in the Department of Energy, Environmental and Chemical Engineering at Washington University, to study the microbiomes of box turtles in Forest Park and Tyson Research Center. We swabbed turtle mouth, cloaca, and feet, and collected temperature data throughout the summer of 2022. These turtle swabs were then processed in Dr. Ling's lab to determine the baseline of microbial populations in free-living individuals, which is crucial in understanding how microbiomes might change in response to environmental shifts. Knowing which microbes make up the microbiomes of healthy animals gives us a picture not only of a turtle's health, but of ecosystem health as well, adding another tool in our suite of conservation strategies.

Lessons learned

We learned many lessons during the past years. We continue to appreciate how having a funding portfolio is key for success in conservation. The CCC has multiple funding streams, which allows us to continue our turtle and tortoise research and outreach through a portfolio of internal and external organization funds, successful grant funding, and philanthropy.

One growing lesson we are all learning is the extent of the negative impact that is placed on chelonians from the illegal trade of wildlife globally. Working for radiated tortoise health and conservation and providing health assessments for thousands of tortoises as we work to reintroduce them to Madagascar has brought to light the scale of the wildlife trafficking issue.

Although not a new lesson, we remain fully dedicated to the science that drives conservation. That is why all of our projects and programs are based on research at the core. However, we are also strong believers in that science does not matter if you can't communicate findings that are relevant to people's lives. Turtles are amazing ambassadors to connect people to the conservation of species in both their backyard and across the world. These charismatic creatures are perfect for getting people of all ages engaged in conservation efforts.

Plan for the future

In the short-term, the Center for Chelonian Conservation will:

1. Continue leading our on-going programs in Missouri, the Galapagos Islands, and Madagascar.
2. Continue our global outreach messaging on turtles and tortoises.
3. Continue high-quality, cutting-edge research that includes bringing Galapagueñan Gislayne Mendoza to the Zoo for a 3 month internship with the Institute for Conservation Medicine.
4. Continue our local Missouri turtle conservation work within the larger Forest Park Living Lab (forestparklivinglab.org) which grew from the St Louis Box Turtle Project.

Partners Of The Wildcare Institute Center For Chelonian Conservation

- Animal Health Research Center (CISA), INIA-CSIC, Madrid, Spain
- AZA SAFE Radiated Tortoise
- Charles Darwin Foundation
- Forest Park Forever
- Galapagos Conservation Trust
- Galapagos National Park Directorate
- Houston Zoo
- Mahaliana Lab
- Mississippi Aquarium
- Saint Louis University Blake Lab
- Turtle Survival Alliance
- WCS- Bronx Zoo
- Washington University Tyson Research Center
- Zoo Knoxville
- Zoo Atlanta