GALAPAGOS NEWS

Fall - Winter 2018

LAND IGUANAS in the Clouds

Tortoises Sowing Seeds

Skates in Hot Water

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Education for Sustainability

Rebounding in the Marine Reserve

Plastic-free Galapagos

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Galapagos Conservancy

Saving One of the World's Great Treasures

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In lieu of a photo of GC's president, we opted to print this one of a beloved but often ignored underwater marvel ... the red-lipped batfish. This animal happens to be top of Johannah's "Favorite Animal" list. For obvious reasons.

FROM THE
PRESIDENT
Johannah Barry

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© Joshua Vela Fonseca of Santa Cruz, Galapagos

Cover Image This photo of a land iguana was a finalist in our 2018 photo contest and can be found on the October page of our 2019 Galapagos calendar. See back cover for calendar details.

In this issue of *Galapagos News*, our donors are front and center as they should be! None of our work would be possible without the support and guidance of our friends and members. Here, we recognize our donors who have been with us for 25 and 30 years. Their commitment and dedication, and often their notes of support and encouragement, have meant a lot to those of us at Galapagos Conservancy, and we feel that they are truly an extension of our staff. Thank you, all.

We are pleased to share with you the important work being done by Dr. Jon Witman at Brown University on the impact of climate change in the marine environment of Galapagos. Fluctuating water temperatures are proving to have negative impacts on coral and are contributing to fish disease, as well as providing an opportunity for migration to Galapagos of species historically located in warmer waters. We have been supporting Dr. Witman's work for two years and believe that these data will be important to decision-making in the islands. You can also read about how plastics are impacting the marine environment. Not only are they a health issue for marine animals, as well as a visual nuisance, but they also are proving to be a vehicle for the introduction of invasive marine species.

Galapagos Conservancy supports a number of projects and programs in the Islands, and our project updates and blog excerpts are an excellent way to learn about the fascinating work being implemented by talented local and international scientists engaged in critical conservation efforts. This community of like-minded conservationists is a tribute to the important role the Galapagos Islands play in our understanding of the natural world.

No issue of *Galapagos News* is complete without mention of our tortoise work. We hear from Dr. James Gibbs of SUNY–ESF and Wacho Tapia, Leader of the Giant Tortoise Restoration Initiative (GTRI), on their work on Santa Fe and Santiago Islands. On Santiago, Tapia was disturbed to find few adult females, and those he found were quite old. This finding clearly has implications for any breeding and restoration efforts for this population. Dr. Gibbs' experience on Santa Fe was more promising, finding many young, healthy tortoises with plenty to eat. His full blog post, posted online, also reveals his fruitless attempts to keep the endemic rice rat out of his backpack and tent.

These are only a few of the projects and programs we are delighted to bring to your attention. As always, great work by talented and dedicated people are protecting and preserving this most special place. Your partnership has made this all possible. Our thanks and best wishes to our Galapagos Conservancy community for a wonderful new year.

Galapagos Conservancy
Saving One of the World's Great Treasures

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GALAPAGOS CONSERVANCY STANDARD MEMBERSHIP

Thanks to all of our members who make our work possible. We could not preserve, protect, and restore the Galapagos Islands without your generosity and commitment to conservation. Our annual membership levels are as follows:

Friend:	**$25**	**Advocate:**	**$250**
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With your gift of $1,000 or more (or cumulative annual giving of $1,000), we will welcome you to the Galapagos Ambassador Society. Many of our Galapagos Ambassadors are often willing to become closely and regularly involved in our programs. Ambassadors receive special updates and briefings; invitations to attend special member events; recognition in the GC Annual Report; and a special Ambassador welcome gift.

Española Society:	**$1,000 to $4,999**
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Galapagos Guardian Society members give recurring monthly contributions that are charged automatically to a credit card. These members help us reduce our fundraising costs because we do not send them annual membership renewal notices for the duration of their support. This is an easy and secure way to provide GC with ongoing funds that we can use to address the most critical conservation challenges in Galapagos.

To join, please see the mail-in form to the right or join online at **www.galapagos.org/monthly** or call **703-383-0077**.

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The tortoises thank you.

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*All gifts will be matched through 12/31/18, or until the $500,000 cap is met. Gifts received after the cap is reached will not be matched, but will support Galapagos Conservancy's vital work in the Galapagos Islands.

(B18KMATCH)

GALAPAGOS NEWS

26 TORTOISES RETURNED FROM PERU

After a lengthy stay in Peru following a wildlife trafficking attempt in April 2017, 26 young Galapagos tortoises were finally returned to the Islands in June 2018. A technical team from the Galapagos National Park Directorate (GNPD) executed the necessary procedures to enter the tortoises into quarantine at the Galapagos Air Base on Baltra Island, where they will remain in quarantine until the end of 2018. They are being kept in a specially-constructed corral, designed by GC's Giant Tortoise Restoration Initiative's (GTRI) Director Wacho Tapia, within the Air Base which has been set up to meet all of the conditions the tortoises require for optimal well-being during this period.

Specialists from the GNPD and Galapagos Conservancy reviewed the physical conditions of the tortoises and placed a subcutaneous identification device in each, upon their arrival. The tortoises are active and healthy, and feed on chopped cactus provided by Park rangers.

Jorge Carrión, Director of the GNPD, expressed his gratitude to all the Ecuadorian and Peruvian institutions and organizations that made it possible to recover this group of tortoises, part of an important endemic species.


© GNPD

FELIPE CRUZ OBITUARY

We are saddened to report that Felipe Cruz (at left with GC's Linda Cayot), who worked passionately for the conservation of Galapagos for more than four decades, passed away in Chile on August 9, 2018. He was 60 years old.

Cruz was born on Floreana Island on April 22, 1958.He was one of 12 siblings, many of whom have played important roles in Galapagos. Over the years, he held many different positions with the Charles Darwin Foundation (CDF) and the GNPD. Galapagos Conservancy staff worked most closely with him when he directed Project Isabela, from 1998 to 2006. He led this massive, multi-million-dollar project to a successful conclusion, eradicating goats and donkeys from northern Isabela and Santiago Islands, as well as eliminating the goat population on Pinta.

GC's Giant Tortoise Restoration Initiative personnel — Linda Cayot and Wacho Tapia — worked closely with Cruz on many past projects at both the CDF and the GNPD. Upon his death, Linda said, "I cannot imagine this world without Felipe Cruz in it. His passion for and dedication to Galapagos were contagious. He was a close friend and will be missed."

VOLCANIC ERUPTIONS


© GNPD

There have been two major volcanic eruptions in Galapagos so far in 2018. Starting on June 16, La Cumbre Volcano on Fernandina began to erupt. Just 11 days later, following two large earthquakes, Sierra Negra Volcano on Isabela also erupted. While Fernandina is uninhabited, a small number of residents on Isabela were evacuated and visitors were banned from going to the popular tourist area for several days.

Fernandina is the youngest and most volcanically active island in the Archipelago (see pp. 8-9). The last time La Cumbre erupted was in September 2017. Sierra Negra is one of the most active volcanoes on Isabela, last erupting in 2005, though Wolf Volcano, also on Isabela, erupted more recently in 2015. Work being undertaken by the University of Cambridge and the University of Leeds is improving the ability to anticipate these eruptions. While they are currently unable to predict eruptions with certainty, they knew that both these volcanoes were showing signs of unrest.

40 YEARS AS A WORLD HERITAGE SITE

September 2018 marked the 40th anniversary of the Galapagos Islands being declared the very first UNESCO World Heritage site. In 1978, this title was awarded to the Archipelago for its collection of unique flora and fauna — many of which are endemic. Management of the Islands is governed under a special regime that safeguards their long-term conservation.

In honor of the occasion, the GNPD held a public event showcasing their work and that of their partners. Members of GC's GTRI Team, including Director Wacho Tapia (second-from-right, below), enjoyed explaining the tortoise nesting and incubation process along with various other components of the tortoise breeding programs to those in attendance.

Ecuador's Ministry of the Environment wrote on Twitter that Galapagos was "the first site in the world to be included in the prestigious list of natural heritage sites, of which there are currently 222." We remain grateful to play an important role in the conservation of this remarkable chain of islands.


Park rangers and GTRI staff at the UNESCO celebration. © Ros Cameron

GALAPAGOS MARTIN AFFECTED BY *PHILORNIS*

More than a dozen pupae of the parasitic fly *Philornis downsi* have been found in a nest of a Galapagos martin on Isabela Island, report ornithologists from the Charles Darwin Foundation (CDF). The discovery adds another species to the long list of endemic landbirds that are attacked by this invasive species.

These endangered martins are found in low numbers and little is known about their biology or natural history, which makes it hard to protect them against potential threats. They nest in cliffs next to the sea, making them hard to find and then monitor. CDF and the GNPD now plan to inspect more nests to evaluate the impact of *Philornis downsi* on the population. This work was funded by Galapagos Conservancy as part of the Blue-footed Booby census completed in 2017.

DETERMINING SEX IN PENGUINS

There is a new, non-invasive and reliable way to sex a Galapagos penguin, according to scientists from the University of Washington. Like all penguin species, Galapagos penguins lack external genitalia, the two sexes look similar, and both sexes incubate eggs and rear offspring. Until recently, the only way to distinguish males and females was to take a blood sample. It turns out, however, that a ruler is all that's needed, as males consistently have thicker beaks than females, report scientists in the journal *Endangered Species Research*. This new technique will speed up data collection during field work. It will also be important for studies looking at how the two sexes are affected by threats such as shifting climatic conditions. This research was funded, in part, by Galapagos Conservancy.

LAND IGUANA RELOCATION

Galapagos National Park rangers recently transferred six land iguanas of the species *Conolophus subcristatus* from the island of Venecia, located to the northwest of Santa Cruz Island, to the nearby visitor site Cerro Dragón. The shortage of rain, little food, and high population number of land iguanas on the island motivated the transfer as a management measure to ensure the survival of these individuals. Park rangers placed tracking devices on the six iguanas relocated in order to track and monitor their health status and survival in their new home.

Venecia did not originally have land iguanas, but in the mid-1970s, part of the iguana population of Cerro Dragón was taken to the islet to protect them from the presence of feral dogs that threatened their existence. That initiative also included the transfer of tons of soil from Santa Cruz to create a suitable nesting area for the iguanas.

The efforts to control introduced species carried out by the GNPD in Cerro Dragón eliminated the wild dogs and made it a safer place so that land iguanas could survive in their natural habitat. The relocation began in 1990. Since then, the GNPD has carried out more than 100 transfers — especially during times of drought or lack of food — while at the same time working at Cerro Dragón to control introduced predators such as donkeys and wild cats.

Land iguanas, or yellow iguanas, serve the ecological function of natural herbivores in the islands in which they inhabit. They can measure more than three feet long and weigh up to 28 pounds. They eat mainly the fruit of cactus plants.


© GNPD

LAND IGUANAS
IN THE CLOUDS


© Luis Ortiz-Catedral

by **Luis Ortiz-Catedral**, *Conservation Biologist for Massey University*

A bite from a land iguana can be a very painful matter. They munch through cactus pads, spines and all; they can pierce through each other's skin during a fight, and they could easily take off a finger.

The reptile, however, is being skilfully handled by "iguanero" Johannes Ramirez, a Galapagos National Park (GNP) ranger with special expertise working with iguanas. We work quickly to avoid causing the animal undue stress. We determine its sex and approximate age, record its length and weight, and insert a tiny electronic identity tag under the skin on the left thigh. We must also examine its overall condition, noting any bite marks, missing claws and coloration, and take three mugshots, all in a matter of minutes.

Johannes has just released the 109th iguana caught during this two-day fieldtrip. This is a new record. It is not that we are becoming faster at processing them, it's that we are in the right place at the right time. We are on the rim of La Cumbre Volcano, a massive volcanic crater on the island of Fernandina, one of the most active volcanoes in the Archipelago (see p. 4), and female land iguanas have come here in search of soft soil in which to lay their eggs.

This is my fourth visit to Fernandina since 2012, when I began a joint project with the GNP to study the population dynamics, habitat use, and movements of land iguanas on the island, which is one of the most pristine in the Archipelago. Our project seeks to identify the factors that influence the numbers of these long-lived herbivores that can survive on an island like this. The vegetation cover is constantly shifting due to variable rainfall, seed dispersal by native and introduced species, and the ever-present volcanic eruptions. If we can understand how Fernandina's iguana population changes in response to the vegetation, we will be able to predict their distribution in coming years and will be better able to assist in the conservation of these impressive reptiles.

In the clouds, at 1,300 m above sea level, La Cumbre is an important place for these iguanas. Males hold territories near the summit, which is where mating occurs. However, there is also soft soil in which to lay eggs. When the nesting season comes around, it is the females that compete for space. As soon as all nesting sites are taken, any late-coming females have no choice but to descend almost 500m into the crater to lay their eggs.

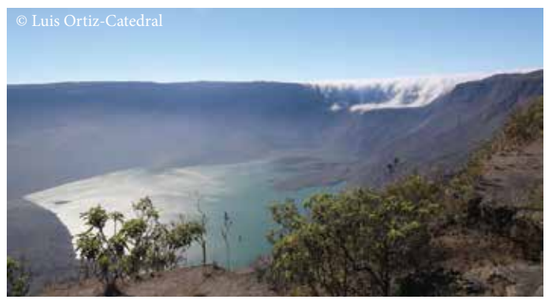
After an incubation period of almost three months, the emerging hatchlings rush for cover in an effort to avoid a suite of predators that lie in wait, including Galapagos hawks, racer snakes, short-eared owls, and barn owls. The 109 iguanas we have surveyed so far are true survivors.

> "The 109 iguanas we have surveyed so far are true survivors."

These are the largest herbivores on Fernandina, acting just as Galapagos giant tortoises do on other islands, dispersing seeds of many plants and grazing the vegetation. They can even reshape the landscape, digging intricate burrows many meters long in which to shelter from the blistering sun.

Like many other Galapagos species, land iguanas are highly susceptible to introduced predators. When Charles Darwin visited Santiago Island in 1835, he struggled to find a spot to pitch his tent due to the high density of land iguana burrows. Yet within 100 years, this species had vanished from Santiago because of predation by feral pigs and dogs.

On Fernandina, there are no introduced vertebrates (other than the odd smooth-billed ani), making this the perfect place to study the natural ecology of land iguanas.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This research will help the GNP manage land iguanas on Fernandina, but it could also inform efforts to reintroduce the species to Santiago in the not-too-distant future.

For now, the sun is setting on this iguana kingdom. "Should we catch one more?" asks Johannes. He has his eye on a large iguana under a *Scalesia* tree. We have just one microchip left, I tell him. He smiles and we prepare to collect one last set of data. ■

AUTHOR SPOTLIGHT

Luis Ortiz-Catedral is a Lecturer in Environmental Science and Ecology at Massey University in New Zealand. Since 2010 he has worked with the Galapagos National Park monitoring and researching threatened native species in Galapagos, including the critically-endangered Floreana mockingbirds and Galapagos racers (snakes — a study supported by a grant from Galapagos Conservancy). Since 2012, he has also turned his attention to land iguanas, as his conservation efforts continue to span many species and islands in Galapagos.

English name: Land iguana
Latin name: *Conolophus subcristatus*
Size: 75 – 111 cm
Weight (adults): 4 – 8.5 kg
Lifespan: up to 50 years
Conservation status: Vulnerable


© Luis Ortiz-Catedral

Opposite page: Land iguanas near La Cumbre Volcano on Fernandina Island.

Top, this page: The crater of La Cumbre Volcano on Fernandina Island has steep sides and is dangerous for any females that have to descend into it to lay their eggs.

Above, info box: Land iguanas often appear to have the slight curve of a smile. Photos by GC members, Mike Cornish and Karen Sitnick.

Left: Land iguanas have adapated to feed on cactus pads, ingesting spines and all.

SKATES IN HOT WATER

A black-smoker hydrothermal vent chimney in the deep waters near the Galapagos Islands.

© Ocean Exploration Trust

by **Leigh Marsh**, *Deep-sea Ecologist and Research Fellow at the University of Southampton*

Hercules landed on a ridge on the seafloor, just north of a hydrothermal vent on the Galapagos Rift. As we maneuvered the remotely operated vehicle through a plume of black smoke being emitted by the vent, we were stunned to see images of a number of large, green egg cases commonly known as mermaid's purses.

Examining the egg cases more closely, we could see that there were not just a few, but layer upon layer. Some of them were greenish, an indication that they had been laid more recently. Others appeared to be darker, so the embryos inside were likely more developed. Some looked as though they had hatched out completely. Whatever was laying these egg cases had been doing so year after year, and it was probably not just one individual.

This was one of many discoveries made during a 2015 expedition carried out by the Charles Darwin Foundation, the Ocean Exploration Trust, and an international team of researchers. Our goal was to use the Hercules remotely operated vehicle (ROV) to get close to the high-temperature "black-smokers" in and around an active hydrothermal field inside the Galapagos Marine Reserve approximately 45 km north of Darwin Island. We wanted to explore and sample the highly-evolved animal communities living in this other-worldly environment, but it's fair to say that nobody had been expecting to find these egg cases.

From high-definition video footage, we were able to identify 157 egg cases and collected four specimens with the ROV's robotic arm. These were sent for DNA analysis, which revealed that they belonged to the Pacific white skate (*Bathyraja spinosissima*), one of the deepest-dwelling skate species and one previously not known to occur near vents.

Using the positional and temperature data obtained from the ROV's sensors, we were able to map the locality of each of the egg cases in relation to the hydrothermal vent. We found that the majority of the egg cases observed were found within 20 m of the chimney-like black smokers, the hottest area of a hydrothermal vent field, and almost 90% had been laid in places where the water was significantly warmer than background water temperature at this depth. This led us to believe that the skates may be using the warmer temperatures in the area to speed up the incubation of their eggs.

> "It's fair to say that nobody had been expecting to find egg cases."

There are only two known examples of animals using volcanically heated soils to incubate their eggs: the modern-day Polynesian megapode, a rare bird native to Tonga; and a group of nest-building dinosaurs from the Cretaceous Period. As far as we know, this is the first time incubating behavior using a volcanic heat source has been recorded in the marine environment. Hydrothermal vents are extreme environments, with high-temperature fluids and low oxygen levels that are likely to challenge species that have not evolved to live in these conditions. This observation is one of very few that demonstrates a link between the hydrothermal vent environment and animals that live most of their life elsewhere in the oceans.

As a result of their long lifespan and the slow rate of development at ambient deepwater temperatures, these skates may be particularly sensitive to threats to their environment. With seafloor mining at some hydrothermal vents about to start, this is especially pertinent. It is imperative that we improve our knowledge and understanding of the development and habitat use of such species, which will be vital for developing effective conservation strategies. More broadly, it is clear that we still have a lot to learn about this deep-sea ecosystem.

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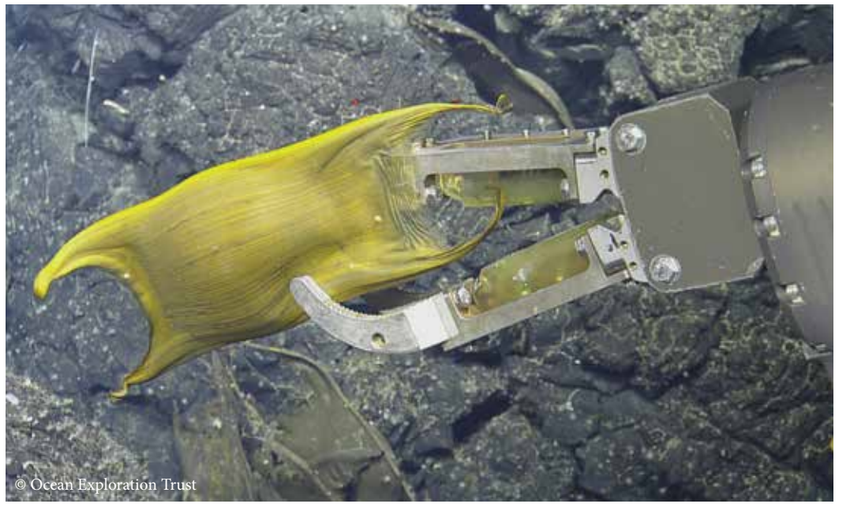

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Left: More than 150 white skate egg cases were discovered near the black smoker, and all appeared to be different ages depending on the color of the cases.

Below, left: Using the ROV's robotic arm, the team collected four egg cases for DNA analysis.

HYDROTHERMAL VENTS

In 1977, scientists demonstrated the existence of deep-sea hydrothermal vents at the Galapagos Rift, some 600 km northeast of the Archipelago and more than 1 km below the surface. As if this discovery wasn't exciting enough, the photos revealed a strange habitat teeming with otherworldly life: clams, giant tube worms, anemones, and much more.

Scientists already knew about the existence of mid-ocean ridges before the discovery of hydrothermal vents. In the 40 years since their original discovery, we now know that many sections of the global mid-ocean ridges host hydrothermal vents. The Galapagos Rift is part of the global oceanic spreading ridge system, a series of faults and fractures on the deep ocean floor where molten mantle material emerges to create new oceanic crust. The water that emanates from these vents is mostly seawater drawn through faults in the seafloor, super-heated by a magma chamber and released back into the ocean. When the scalding, sulphide-rich water drifts from chimney-like vents, it resembles black smoke, which is why these structures are commonly referred to as "black smokers."

AUTHOR

Leigh Marsh is a deep-sea ecologist and visiting research fellow at the University of Southampton. Leigh's work uses submarine robots to explore and map our deep oceans. She is currently the acting scientific lead for the Seamount and Deepsea Ecosystems Project at the Charles Darwin Foundation.

This research was conducted under the Galapagos National Park research permit PC-45-15 and was possible thanks to grants from the Helmsley Charitable Trust, NOAA Office for Exploration and Research (E/V Nautilus Exploration Program NA15OAR0110220), and the Save Our Seas Foundation. The full research article, published in the journal *Nature Scientific Reports*, can be freely accessed here: **go.nature.com/2vYcLBY**

© Kara Bohne

SOWING SEEDS IN GALAPAGOS

by **Steve Blake and Diego Ellis Soto** *of the Giant Tortoise Movement Ecology Program*

A single pile of tortoise scat may contain more than five thousand seeds. Owing to the huge amount of fruit a tortoise consumes, its slow pace of digestion, and the large distances it covers, a seed that has passed through the gut of a giant tortoise may find itself many kilometers from its parent plant.

Before the arrival of humans in Galapagos almost 500 years ago, the seed dispersal provided by Galapagos giant tortoises surely played a significant role in shaping the distribution of plants across the Islands. More recently, tortoises have probably also assisted the spread of introduced species. Most of these recent arrivals are benign and do not have a significant impact on endemic and native species. What if, however, tortoises are unwittingly helping spread invasive plant species that are capable of transforming the composition and function of a local ecosystem?

One of the most aggressive invasive tree species in Galapagos, and on other Pacific islands like Hawaii, is guava (*Psidium guajava*), known throughout the world as a particularly difficult species to control. Guava grows well in moist soil and is most abundant in the humid highlands of Galapagos' four main human-inhabited islands. On Santa Cruz, guava occurs from the humid highlands down to about 100 m above sea level. Any lower and the conditions appear to be too dry for germination — though that may not always be the case.

In previous work, we have shown that giant tortoises often prefer to eat invasive plants over endemic and native species, and guava appears to be a particular favorite. In the inhospitable lowlands, we frequently find piles of tortoise scat full of guava seeds. Although these do not appear to be viable at present, the climate in Galapagos is constantly changing and most models predict warmer and wetter conditions in decades to come, with increased rainfall in the lowlands.

Are tortoises sowing the seeds for a massive spread of guava in coming decades, as a wetter climate creeps further and further down the island toward the sea?

In order to address this question, we began by counting the number of guava seeds in tortoise scat found from sea level up to 400 m elevation. We mapped the distribution of guava trees along the same elevation gradient. Finally, with an understanding of the conditions under which guava thrives and how the climate will change, we were able to build a model to predict how the area suitable for guava is likely to increase from now until 2070.

Several thousand guava seeds can be found in a single pile of tortoise scat. Since tortoises feeding on guava in the humid highlands poo every day as they migrate to the lowlands, it was of little surprise to find guava seeds in tortoise scats at all elevations. So if, as climate models predict, the front of moisture creeps down each island towards the sea over time, it looks like there will be guava seeds ready and waiting in nutrient-rich "grow bags" of tortoise excrement. Other species, such as lizards and finches, also disperse guava seeds, but in far fewer numbers and over far smaller distances. It is the giant tortoises then that appear to be facilitating the invasion of one of the more disruptive alien invasive species in Galapagos.

Ecosystem engineers like Galapagos giant tortoises have a profound ecological role. Their activities have likely shaped the distribution of plants, the animals that depend on them, the balance of light and shade, and other important resources that help an ecosystem to function effectively. However, these same ecosystem services that the tortoises provide can be exploited by invasive species like guava, whose trees are using giant tortoises to ferry their seeds far beyond their current range. At present, we do not know how this ecological battle will play out. However, the pace of climate change is sufficiently rapid that within the next decade we should have a clearer idea whether our predictions are becoming reality.

Left: Galapagos tortoises may deposit several thousand seeds from up to nine plant species in a single scat pile.

Below: This immature guava tree was almost certainly brought here by a tortoise. Without intensive and costly management, this area could soon be converted into a dense guava forest.

GC CONNECTION

As part of Galapagos Conservancy's Giant Tortoise Restoration Initiative, carried out in collaboration with the Galapagos National Park, GC's Jonathan Cueva sorts through tortoise scat collected during the recent population census of the critically endangered Eastern Santa Cruz giant tortoise (new species identified in 2015). The GTRI field team regularly collects tortoise scat during field trips to the various islands to gain a better understanding of seasonal changes in tortoise diets. Examining which plant species are found in the scat, especially their seeds, can also indicate potential for dispersal of invasive plants throughout the tortoises' range.

AUTHOR SPOTLIGHT

Having worked in Central Africa for over 15 years on a variety of conservation issues, **Steve Blake** moved to Galapagos in 2008. He established the Giant Tortoise Movement Ecology Program (GTMEP) to conduct research on the movements of Galapagos tortoises. **Diego Ellis Soto** works at the Max Planck Institute for Ornithology researching bioinformatics, biologging, spatial ecology, and macroecology. Previously he worked with Steve Blake on the GTMEP in Galapagos, and became hooked on the study of animal movement.

Young *Opuntia* cacti abound on Santiago, a positive result of the removal of donkeys more than a decade ago. © Wacho Tapia/GTRI

◆ GC PROJECT UPDATE ◆

Giant Tortoise Restoration Initiative

by **James Gibbs and Wacho Tapia,** *Leaders of GC's Giant Tortoise Restoration Initiative*

Excerpted from James Gibbs' July 2018 Blog

Mating tortoises! Well, sort of. As we arrived at our study area in the middle of Santa Fe Island to check on the status of the 396 tortoises released since 2015, the very first tortoises I spotted were an ambitious pair of 7- or 8-year-old juveniles perched on a flat rock in that most awkward of tortoise postures.

The small male teetered on the back of the small female; they reminded me of two tiny cars that just had a fender-bender. But these young juveniles are still way too small to "make this work." In fact, they have another 8+ years before they arrive at the 20-year threshold when we know that Española tortoises, and probably all of the saddleback species, can start producing eggs. Although not yet ready for the real thing, their shell margins are starting to flare out and their saddles starting to peak — like the shells of their Española tortoise parents.

During our week on the island, we saw lots of tortoises out and about. This was a bit of a surprise, as Santa Fe Island had been very dry for many months. We expected to find the tortoises hunkered down, waiting out the drought. It was so dry that the Galapagos National Park Directorate (GNPD) even postponed the long-scheduled release of the next cohort of tortoises to repopulate Santa Fe Island until rains arrive and the island "greens up." Despite the lack of rain, there seemed to be plenty to eat, at least for young tortoises adapted to life on an arid island. Their most important food source during this dry period: the quarter million massive cactus trees that call Santa Fe home. Cactus pads were scattered about — green and plump, some with tortoise bites but many without a scratch. Even the many land iguanas lying about seemed to have had their fill. Although very dry, with all that juicy cactus, their situation was by no means desperate.

We also found the remains of two expired tortoises. These were the first "muertos" we've encountered among the nearly 400 released over the last three years. The two we found dead were small and their condition (missing limbs and heads) suggested that hungry hawks, many of which patrol Santa Fe Island, were the perpetrators. Most of the tortoises released are large enough to be "hawk-proof," but apparently not all. Nonetheless, we expected a much higher mortality of released tortoises based on what has transpired in releases on other dry islands, so the program remains overwhelmingly successful.

Young tortoises huddled on Santa Fe. © James Gibbs/GTRI

Excerpted from Wacho Tapia's July 2018 Blog

Santiago Island is one of the largest and most fascinating islands of the Galapagos Archipelago. In addition to an extensive arid zone, it has a very dense humid region, which at the lower altitudes is dominated by the native shrub glorybower (*Clerodendrum molle*). This shrub forms thickets that are impossible to pass through without an army of men skilled at wielding machetes — unless, of course, you are a giant tortoise and can bulldoze a tunnel straight through using your extraordinary strength.

Perhaps that's why Santiago is little-studied. Although we launched the Giant Tortoise Restoration Initiative (GTRI) in 2014, and planned to begin work on Santiago in 2016, we didn't make it until 2018. The trips were delayed for various reasons (including the extremely dense thickets of vegetation). In June, we finally completed our first trip focused exclusively on Santiago tortoises (*Chelonoidis darwini*).

This trip had a dual mission: 1) to open the access trail to Zone D — the closest giant tortoise nesting area to the coast, and 2) to evaluate the reproductive activity of Santiago giant tortoises there. We collected data that will help us, along with GNPD personnel, design a new strategy to accelerate the repopulation of Santiago with thousands of its giant tortoises. This tortoise species managed to survive for centuries, despite hundreds or thousands being removed by whalers and other sailors in centuries past as a source of fresh meat, followed by at least a century of negative impacts due to an immense population of introduced competitors (feral goats and donkeys) and predators (pigs that preyed on tortoise nests).

The little literature available on Santiago tortoises indicates a small population of 500 individuals, dominated by males. Although we did not do an island-wide census during our short and limited visit, we were disturbed to find that the few adult females we encountered were very old. More than ever, it is urgent that we develop integral research and management actions to restore this population toward its historical number, similar to the restoration efforts for other populations, such as the Española tortoise, which was even closer to extinction.

During this intense and interesting trip, several things caught my attention. One of the most striking was that almost all the *Opuntia* cactus we observed were sub-adults or juveniles of about 10–12 years old, which coincides with the eradication of the feral donkeys. That made me wonder: If the donkeys had not been eradicated, would we be looking at an eventual extinction of the cactus?

In a few months we will return to Santiago to search for nests, collect eggs, and transfer them to the Tortoise Center on Santa Cruz. We can go knowing that we will find an accessible trail and even more importantly, we can rely on water collected during this *garúa* (heavy mist) season in a tank we left for that purpose in Zone D. This will circumvent the need to transport all our drinking water from Santa Cruz and then carry it on our backs along with food and equipment. I look forward to the day when this island is covered with these giant reptiles that I have come to love and will continue to work to save. ■

Water collection tanks © Wacho Tapia/GTRI

◆ GC PROJECT UPDATE ◆

by Richard Knab, GC's Education for Sustainability Leader

Now in its third year of implementation, the Education for Sustainability in Galapagos Program is firing on all cylinders and we are beginning to see significant, positive changes in classrooms throughout the islands.

Over the past year, we conducted the 5th and 6th week-long Teacher Institutes — the most visible and complex component of the program, where we mobilize 45 specialists to work with all 400 pre-K through 12th grade teachers in Galapagos. Our team has fine-tuned these events, which are broken up into two-hour blocks during which trainers model proven, student-centered teaching strategies and activities that integrate local examples and sustainability issues in every subject and grade level.

By themselves, these events would not be enough. That's why our full-time instructional coaches continue to observe and provide feedback to all teachers and facilitate professional learning circles in each school. During 2019, a team of 40 Galapagos coaches-in-training and 30 school leaders — participants in a parallel educational leadership track — will begin to complement the work of our program coaches.

We are also working with curriculum specialists at Ecuador's Ministry of Education and international specialists in Education for Sustainability (EfS) to develop EfS Teacher Guides and supporting materials that, once validated in Galapagos, will be used by teachers in mainland Ecuador. According to Miriam Chacón, program coordinator in Galapagos and our lead instructional coach, "When we visit classrooms, we see that more and more teachers are embracing effective teaching strategies. Teachers are thinking about their profession differently and are engaging their students in new and exciting ways that help them to better understand the special place in which they live."

As we pass the halfway mark in the program, Galapagos Conservancy would like to thank the dozens of education specialists collaborating in this effort and the generous donors who make this work possible. ■

GC PROJECT UPDATE

Rebounding in the Marine Reserve

by **Jon Whitman,** *Brown University Professor & Collaborating Scientist at the Charles Darwin Research Station*

Whether the Galapagos marine ecosystem can rebound from the stress caused by El Niño is a key question that our research team is aiming to answer, with the support of Galapagos Conservancy, by monitoring bottom-dwelling communities of marine invertebrates and reef fish at 12 sites in the Galapagos Islands and by conducting underwater experiments. After a productive summer of dive-based research, our team, consisting of myself, PhD Candidate Robert Lamb, and undergraduates Maya Greenhill and Calvin Munson, returned to Brown University, while our colleagues Franz Smith and Alejandro Perez-Matus returned to New Zealand and Chile, respectively. We all brought back hard drives filled with pictures, videos, and data on the state of the subtidal marine ecosystem.

We're adding this most recent survey data to our 19-year baseline to test our roller coaster conceptualization of how the spectacular marine life of Galapagos rises and falls as it is impacted by El Niño – La Niña cycles (El Niño Southern Oscillation, or ENSO). With its unusually high temperatures and scarce planktonic food, El Niño represents the downhill phase of the roller coaster — a period of high stress potentially decreasing population numbers and the diversity of bottom-dwelling (benthic) organisms. The change in temperature causes corals to bleach and eventually starve and die as they expel the brownish-green photosynthesizing algae in their tissues. Many Galapagos marine animals die or cannot reproduce successfully due to the lack of food.

The ecosystem appears to bounce back to a certain degree when cool, nutrient-rich waters of La Niña return, pushing the system back uphill on the rollercoaster, demonstrating resilience to a reoccurring climatic shock. The big question is: will the subtidal benthic and reef fish communities be degraded after the intense sequence of three recent ENSOs (and counting — there is a 70–75% chance of another El Niño occurring in Galapagos in January–April 2019), or will unexpectedly high levels of resilience during La Niña enable the ecosystem to once again recover to its original, biodiverse state?

The jury is still out since resilience, which depends on the intrinsic capacities of organisms to reproduce, recolonize habitats, grow, and recover from stress, takes time to measure. By surveying permanent coral plots in January and in August this year, we found that more finger corals bleached and died during the strong 2014–2017 ENSO cycle than the massive coral species, *Porites lobata*, that resembles Chinese pagodas or flattened shingles. The overall rate of coral bleaching was lower than during previous ENSOs since 1999, which is curious, as the most recent El Niño was the strongest in this period. Some of the massive *P. lobata* corals bleached and recovered in 8 months (see photo below), demonstrating unusually high resilience.

The "barnacle booms" of the 2017 La Niña continued into 2018. As of early 2018, 83% of our monitored sites were in a barnacle reef state where most of the rocky bottom down to a 15m depth was covered with big *Megabalanus sp.* barnacles. We think that these barnacle booms occur during La Niñas due to high reproduction when the phytoplankton that the barnacles eat becomes super-abundant. Since these barnacles are an important food source for lobsters and many fish species, La Niña barnacle booms may also boost upper levels of the Galapagos marine food webs, helping them to rebound following El Niño food shortages.

With marine invertebrates and fish rebounding during La Niña, we think we're seeing a rare type of resilience across the broad spectrum of the animal kingdom — possibly by the same mechanism. Thankfully, we found that two surprising signs of ecosystem stress that we discovered during the January 2016 El Niño — an ulcerating skin disease affecting 18 species of reef fish, and a proliferation of rubbery mats of brown cyanobacteria across one third of the bottom at Cousins Rock — were short-lived and had virtually disappeared by our latest surveys in August 2018.

GC PROJECT UPDATE

Heading Towards a Plastic-free Galapagos

by **Henry Nicholls, *Galapagos News Editor*, and Galapagos Conservancy Staff**

Plastics pose a serious threat to the wildlife of Galapagos. So it was great news when, on April 22nd as part of Earth Day celebrations on the Islands this year, the Galapagos Governing Council (GGC) passed a new resolution to restrict single-use plastics in the Islands, taking a lead in the fight against plastic pollution in our oceans.

Styrofoam containers (like those used for take-out food) and shopping bags were prohibited in 2015, and since then more single use products have been gradually added to the list to eliminate. In 2018, plastic straws were banned and restaurants now offer alternatives; sugar cane, paper, metal, or no straws at all. By early 2019 single-use plastic and non-returnable bottles (especially for carbonated drinks) will be gone as providers phase in alternatives such as beer in kegs and water refill stations in schools.

These developments form part of the GGC's ultimate goal to make Galapagos plastic-pollution-free once again. GGC will be working with a range of partners including the Ecuadorian Government Ministries, Galapagos National Park Directorate, local agencies, scientists, NGOs (including Galapagos Conservancy) and the local community to ensure that the plan is successful across the four human-inhabited islands.

The GGC's recent phase-out ban on single-use plastics in the Islands is a critical step towards a plastic-free Galapagos, but we must also ensure that local Galapagos communities and tourists recognize how their actions can contribute to solving the problem, and that sustainable and alternative solutions are readily available.

Together with our valued travel partner, Celebrity Cruises, we are supporting this effort by raising funds and awareness in the US and with Celebrity's guests that visit the Islands. Our local partners, Grupo Eco Cultural Organizado (GECO) and Verde Milenio Foundation, undertake sustainable initiatives to reduce the amount of plastic being used across the four inhabited islands. GECO's goal is for shoppers to adopt reusable bags made by local artisans. They give shop owners, who currently provide plastic bags, free, sturdy paper bags made from recycled materials, as long as they invest in and promote the locally-made reusable bags in their store. By charging $0.50 for each re-usable paper bag, shoppers can make a one-off purchase to use each time they shop. This initiative is currently being tested in 250 stores across the Islands.

Verde Milenio Foundation is implementing a simple way to reduce disposable cups for hot and cold drinks. "Iguana Cups" are reusable and made of 100% recycled materials and were designed to promote a zero-waste model to locals and tourists through a deposit-return scheme. Customers pay $2 for the cup, which is then refunded to them if they give the cup back to any participating restaurant; easily identifiable by the initiative's pink iguana posters. In addition to spreading the message to be proactive in protecting the Islands, with time, more and more individuals will lead by example and encourage community-wide behavioral changes.

The Galapagos people are taking a stand against plastics generated within the Islands, but the problem often originates from further away. Across the planet we can all take action in our homes and communities to eliminate single use plastics that can end up as trash on Galapagos shores.

Galapagos Conservancy and Celebrity Cruises have been jointly supporting local sustainability initiatives in the Islands since 2006.

Student members of GECO perform an educational skit to raise awarness about the need for plastic-use reduction. © GECO

From the GC BLOG

Our Galapagos Conservancy blog is full of engaging conservation stories about the projects and initiatives we support. Here, we share with you a few excerpts from recent posts. The full stories can be found online at **www.galapagos.org**

Conservation of the Vermilion Flycatcher: Studying the Causes of its Decline

posted May 25, 2018

"This year, I began data collection for my master's thesis on the vermilion flycatcher, an endemic bird of the Galapagos Islands, which has gone extinct on Floreana and San Cristóbal Islands and is rapidly declining on Santa Cruz. I spent most of my field time in the highlands of Isabela Island, within the Galapagos National Park, directly in the middle of nature — one of the reasons why I loved this experience...

We rose each morning with the birds, beginning our fieldwork at about 6 am. Our main activities included searching for new nests by walking through the study area and observing the behavior of the birds, checking the status of nests already located, and collecting nests once they were empty. We treated some of the nests with an insecticide to kill the larvae of the parasitic fly (the larvae suck the blood of the nestlings and cause high mortality), and observed the birds foraging to determine their main food items."

Author: **Célina Leuba** is currently doing her master's degree in "Conservation and Biodiversity Management" at the University of Vienna, under the direction of Dr. Sabine Tebbich.

Promoting Healthy Pets and Responsible Pet Ownership in Galapagos

posted June 29, 2018

"On an island famous for sea lions that fill the beaches, lounge on benches, and nap on the front porches of waterfront buildings, one can begin to understand how species in the Galapagos Islands can peacefully coexist. San Cristóbal, like the other islands in the Galapagos Archipelago, is home to a vast array of wildlife that live harmoniously — seemingly unaware that this is a remarkable feat in today's crowded world.

This scene provided an ideal backdrop for the recent Animal Balance campaign on San Cristóbal. It was our second trip to the island in the last 12 months, and a continuation of our 15 years of partnerships in Galapagos, working to provide sustainable, humane population management solutions for domestic cats and dogs ... The goal of the campaign, and the continuing work that Animal Balance is doing with our partners in Galapagos, is to provide a humane way to control the cat and dog populations while allowing these animals to live out their lives alongside the many native species that call the island home.

Above: A male Vermilion flycatcher. © Paul Patterson

Left: Eileen Heyer and Célina Leuba film a nest in order to check its status. © Quentin Jost

Author: **Elsa Kohlbus** has been with Animal Balance for six years, as a volunteer veterinary technician and, for the past year as a staff member, serving as Communications Director and now as Program Director.

An Explosive Trip to Isabela: New Potential Nesting Sites for Galapagos Penguins

posted September 18, 2018

"Our research team visited Elizabeth Bay on Isabela Island in July 2018 to see if the Galapagos penguins were breeding and to look for individuals we had web-tagged on previous visits. As if leaping from our boat to the shore to catch a penguin, crawling through tight lava tunnels to looks for chicks, and seeing a penguin carefully brood its new egg aren't thrilling enough, we had an additional source of excitement this trip: Sierra Negra, one of the colossal volcanoes of Isabela, was erupting.

When we heard that Sierra Negra was erupting just before our July trip, and that there had been two 5.3-magnitude earthquakes associated with the eruption, we were concerned about the penguins that nest in Elizabeth Bay. How many of their nests would collapse due to the earthquakes? Would the constructed nests that we built for them in 2010 be strong enough to withstand the tremors?"

Author: **Caroline Cappello, Godfrey Merlen, and Dee Boersma** make up the dedicated research team that has traveled to Galapagos penguin breeding areas twice a year since 2010 to check both natural and constructed nests and study the penguins.

Learning More About the Mysterious Galapagos Martin

posted November 5, 2018

"As an ornithologist and a lover of all things Galapagos, my focus is to conserve and protect the unique birds of these Islands. My current goals include getting to know one of the most mysterious and elusive birds of the Archipelago, the Galapagos martin. This bird, endemic to Galapagos, is closely related to the purple martin. The Galapagos martin has never been studied. We don't know how many individuals exist in the Archipelago and if they are threatened. It's a difficult species to study as it is rarely seen and, when it is, it is usually found on hard-to-reach sea cliffs and hilltops.

In July 2017, with the support of Galapagos Conservancy, I was able to search for and count Galapagos martins on the shore and sea cliffs throughout much of the Archipelago during the blue-footed booby census. We only managed to see about 30 individuals and identify three potential breeding sites. I could not estimate population size with this technique, but the discovery of the breeding sites was vital to furthering our understanding of these elusive birds."

Author: **David Anchundia**, a native Ecuadorian, has been working as a researcher on the Landbird Conservation Project at the Charles Darwin Foundation since 2015. He completed his Master's degree with Dr. Dave Anderson of Wake Forest University on blue-footed boobies. David first started working in Galapagos in 2008 and is passionate about finding ways to ensure the long-term protection of the unique birds of Galapagos.

Above, left: Dr. Fernando Villa, the new vet on San Cristóbal, with a canine patient in Galapagos. © Animal Balance

Above, right: The population size and health status of the Galapagos martin is currently unknown. © David Anchundia, CDF

Just above: A male Galapagos penguin protects its eggs in one of Dee Boersma's team's constructed nests in July 2018. © Dee Boersma

GALAPAGOS NEWS & CONSERVANCY VIEWS

Galapagos Conservancy
Saving One of the World's Great Treasures

DECADES of SUPPORT for GC

The Galapagos Conservancy donors listed below comprise a very special group of people. Through their impressive donation history, these donors have proven their amazing dedication and loyalty to the cause of conserving the Galapagos Islands. They know how the issues in Galapagos have changed over the years, and they have witnessed Galapagos Conservancy evolve and grow to adapt to those changes. They have stuck with us, and we humbly thank and recognize our 30-year and 25-year donors for their decades of support. We are grateful!

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** Denotes our Ambassador-level members who currently donate $1,000 or more annually.*

2018 YEAR-END $500,000 MATCHING GIFT CHALLENGE

Dear Friends of Galapagos,

One of our most generous long-time supporters has offered to match every gift we receive from dedicated partners like you before December 31st — **up to a total of $500,000**.

If you are considering making a year-end contribution to Galapagos Conservancy, I hope you will respond soon. This is an amazing opportunity to make your gift go twice as far for the Galapagos Islands and their rare and remarkable wildlife.

When combined with these critical matching funds, your tax-deductible gift will have double the impact on Galapagos Conservancy's ongoing efforts to return giant tortoises to their historic numbers and distribution … continue the recovery of the Galapagos penguins … reduce the impact of harmful invasive species … educate the future leaders of Galapagos … and provide needed resources to make up for ongoing funding shortfalls at the Galapagos National Park Directorate.

I urge you to return your gift to Galapagos Conservancy today. We must receive it before December 31st for it to be matched 100% and to be eligible for a 2018 tax deduction. Thank you, in advance, for your continued support!

— Johannah Barry and the GC Staff

See the donation form on page 3 for instructions on how to make a year-end gift to GC and have it matched 1:1.

GALAPAGOS CONSERVANCY 2018 PHOTO COMPETITION

THANK YOU to all of the talented photographers who submitted their stunning images to our annual photo contest! The GC team had a difficult task choosing the winners among ***more than 2,000 photos.*** Here is a sampling of some of the best, which you can find in our 2019 calendar. See details at right.

Great Frigatebird Male on Genovesa by Bill Yetz of Saugus, MA
Marine Iguana by Gaston Bonaudi Pez of Shanghai, China
Black-tipped Reef Shark at Darwin by Gregory Asner of Stanford, CA
Great Blue Heron with Sea Turtle Hatchling by Harris Nguyen of Lagrange, OH
Sea lion Pup by Dianne Logan of Monrovia, CA

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Symbolic Animal Adoption Kits

Ranging from $30 up to $100, we offer symbolic adoptions for tortoises, blue-footed boobies, sea lions, and marine iguanas. A great gift for a budding conservationist!

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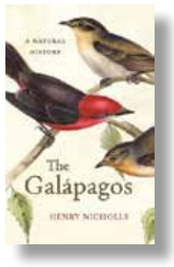
Honor your loved ones by supporting the important conservation efforts in Galapagos! Gift levels start at $25. Recipients will receive a beautiful card informing them of your gift, which you can personalize with a special message.

Books

Ranging from $15 up to $50, we offer a limited selection of Galapagos books for all ages, while supplies last.



2019 Galapagos Calendars, $15

Featuring stunning photos from the winners of our 2018 photo competition.

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Our 2018 Year-end $500,000 Matching Gift challenge is happening now! Deadline for matching is December 31, 2018.

Congratulations to our 2018 Photo Contest winner, Jem Dodia!

Hailing from Santa Cruz, Galapagos, Jem won for this shot of young marine iguanas on Isabela Island. This photo, chosen from nearly 2,000 entries, dons the cover of our 2019 calendar.

2019 calendars can be ordered online at: www.galapagos.org/shop/