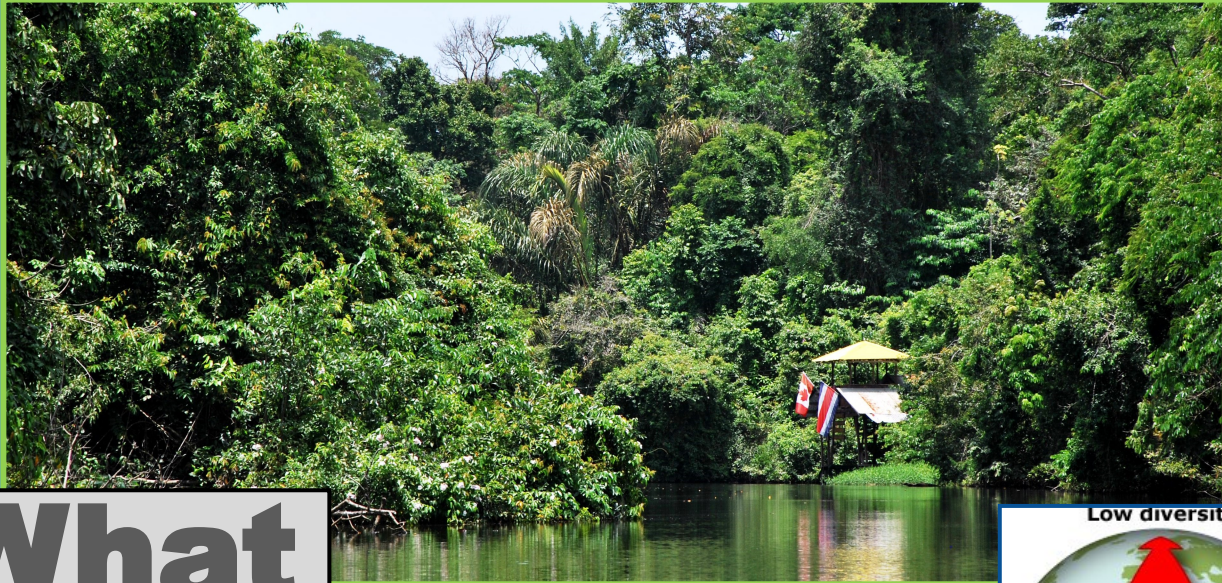


RAPHIA

Newsletter of Caño Palma Biological Station

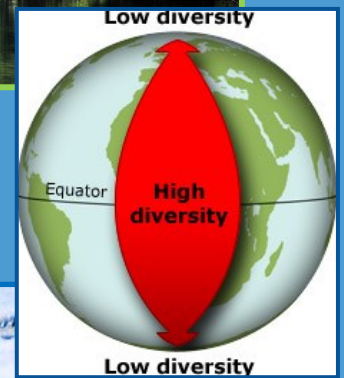


What Is LDG?

From Tropics ↑

Hint ⇒

To Tundra ↓



Canadian Organization for Tropical Education & Rainforest Conservation

In This Issue of Raphia

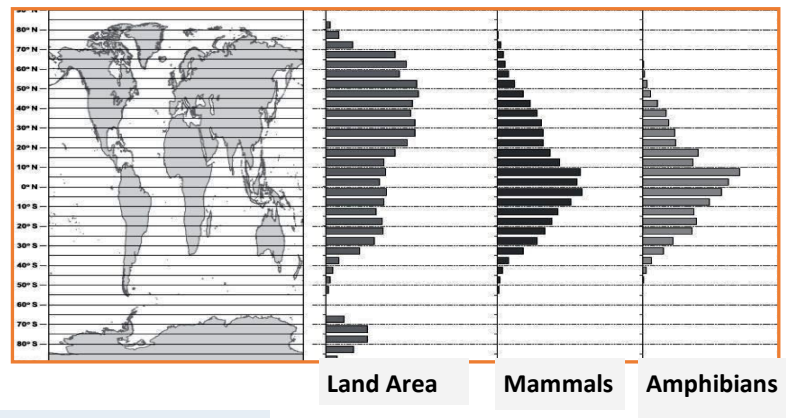
3	R.I.P. Ozzie Teichner • A look back at one of the founders of Caño Palma Biological Station.
4	Introduction to the LDG
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Until a few months ago, I'd never heard of the Latitudinal Diversity Gradient (LDG), the cover story of this issue of Raphia. I'd just assumed that biodiversity was greater in the tropics and let it go at that. No thought was given as to why that might be.

On the other hand, we all think a lot about how we humans are lessening biodiversity around the planet. We destroy habitats, poison the earth, pollute the air and water, accelerate climate change, etc. As well, we might also note non-human-related events that have caused losses in biodiversity such as the five major mass extinctions and other smaller extinctions all the way back to the Great Oxygenation Event 2.4 billion years ago. (Interesting story, the GOE. Article in next Raphia?)

But, for this issue, I thought it might be fun to look at biodiversity in a different way – by considering the factors that go into producing the pattern labeled the Latitudinal Diversity Gradient. What is the pattern? It's simply, as seen below for mammals and amphibians, that species richness for almost all animals and plants decreases as you move from the tropics towards the poles. Trying to explain why is not so simple. In fact, researching this topic was not a lot of fun. Hundreds of papers have been written on this quite complex topic, and each has its own spin on some particular factor or combination of them.

So, many questions remain. The article (on Page 4) isn't meant to answer those questions, but only to lay out some of the main hypotheses on what determines patterns of biodiversity. Give it a go.



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Ozzie Teichner, the co-founder of Caño Palma Biological Station, sadly passed away June 8, 2019. Ozzie and his then-wife Marilyn Cole purchased the property from a fellow named Marcos in 1990. Marcos was from Nicaragua and squatted on the property, eventually gaining legal title (land ownership in Costa Rica is complicated!). Ozzie worked at the Toronto Zoo with Marilyn and then left the Zoo when he and Marilyn purchased the land that was to become CPBS.

Interestingly, Ozzie hired Marcos to stay on, take care of the property, and build a small dorm. However, Marcos continued to manage the land as it was customarily done at the time. He continued to use the land resources, cutting the trees and selling them.

That prompted Ozzie to go to the station in the spring of 1991 to try and get things moving forward towards the original goal of managing the land for conservation purposes. Ozzie enlisted the help of the local farmers on Caño Palma (Juan, Fermin and Jonnie) to build the original four-room dormitory. It was then decided that a Canadian station manager was needed, which is when Greg Mayne was hired as the first station manager. Ozzie's big personality enabled him to meet with locals and many of the lodge owners with whom he left a great impression. This helped the station get off to a good start with support from locals.

In the early 90s, Marilyn and Ozzie separated. After that, Ozzie backed off from COTERC and left it in Marilyn's hands.

As noted by Tom Mason, Ozzie worked at the Reptile Breeding Foundation in 1991 and later worked in a number of jobs. He was a great chef, a restaurant manager, and worked as a technician at the ROM. Ozzie was very gifted and a quick learner. Whatever he did, he did well.

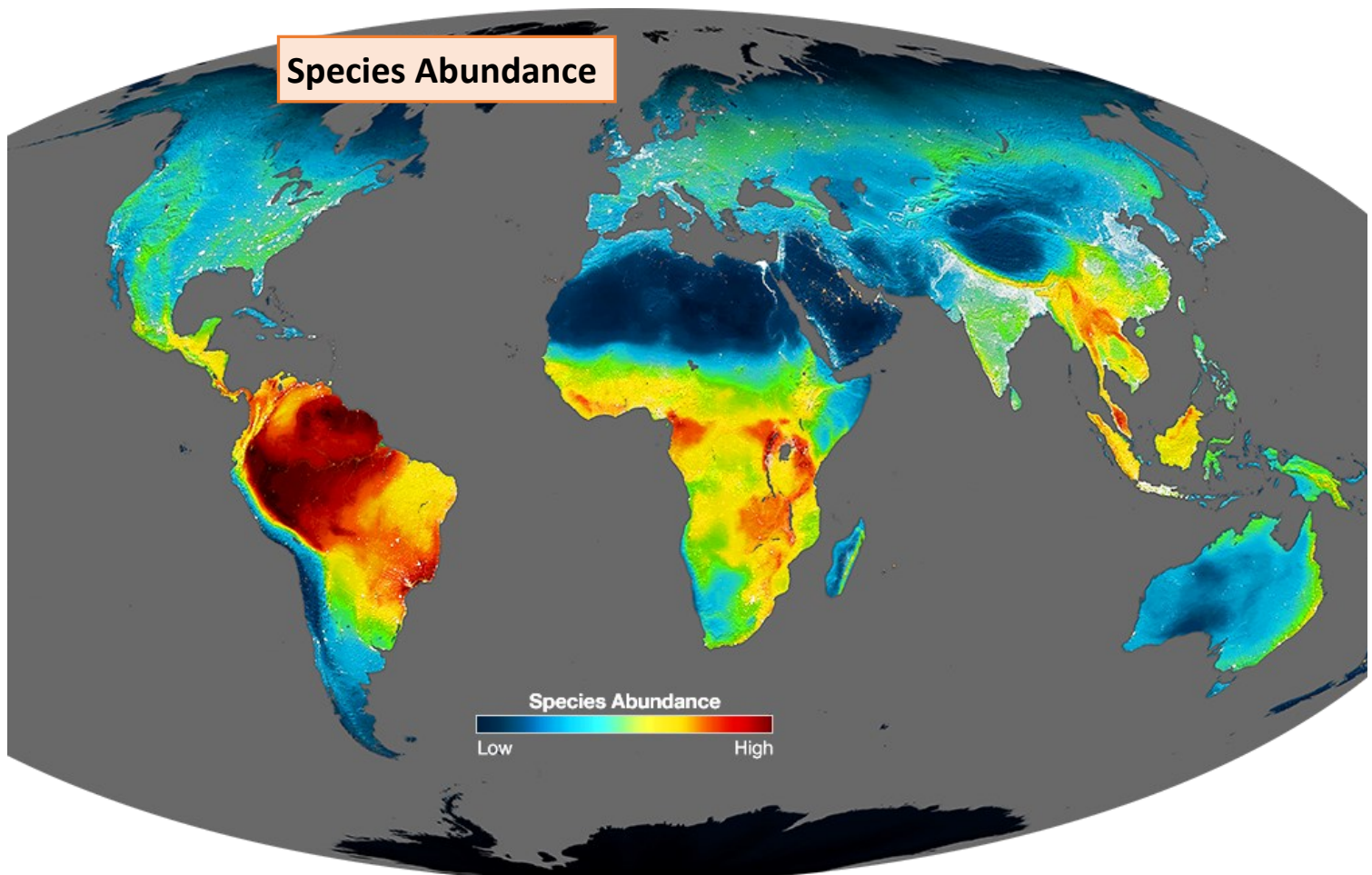
(Information supplied by Tom Mason, former long-term Board Member, and Greg Mayne, the first station manager and former Board member.)

Latitudinal Diversity Gradient (LDG)

A pattern of species richness, or biodiversity, that decreases from the tropics towards the poles for most terrestrial and marine organisms.

The Latitudinal Diversity Gradient is one of the most widely recognized patterns in ecology. The question "What determines patterns of species diversity?" was among the 25 key research themes for the future identified in 125th Anniversary issue of *Science* magazine (July 2005). And damn, do scientists love to research it. Go online, and the articles and papers are endless.

Still, among ecologists, there's a lack of consensus about the mechanisms underlying the pattern. Most hypotheses focus on evolutionary, ecological, dispersal and climatic factors. But why does it matter, you ask? Well, understanding is essential for such issues of major concern as the spread of invasive species, the control of diseases and their vectors, and the likely effects of global climate change on the maintenance of biodiversity. By studying why the LDG pattern exists, researchers may gain a better understanding of what our planet needs for life to thrive and survive. Tropical areas play prominent roles in the understanding of the distribution of biodiversity as their rates of habitat degradation and biodiversity loss are exceptionally high.



In reviewing the literature, regardless of what the main factor may be, it's now basically accepted that several have worked together to produce the present Latitudinal Diversity Gradient. All should be further studied. Here's a look at some of the main hypotheses:

Cradle-Museum-Engine hypotheses – The species-rich tropics are sometimes referred to as the 'cradle' because speciation rates are higher. On the other hand, there's the 'tropics as museum' model: the tropics can accumulate more species because extinction rates are lower. And then there's the 'out of tropics' engine model describing a situation where species originate in the tropics and migrate (disperse) to extratropical areas when the opportunity arises.

Species-energy hypothesis – Here scientists postulate that the amount of energy available sets a limit on the number of species that an ecosystem can support. Thus, higher amounts of energy in the tropics from higher solar radiation translate into higher primary productivity (photosynthesis), which is thought to increase biodiversity. Conversely, lesser amounts of sunlight and heat in higher latitudes can only support lesser amounts of biodiversity.

Climate harshness – Simply, fewer species can tolerate the colder and often drier conditions at higher latitudes.

Climate stability – It's hypothesized that a stable environment (low seasonality) in the tropics allows species to specialize on resources that are reliably available. This promotes speciation as well as allowing species to have narrower niches, producing higher diversity. But it could also result in tropical species being produced with highly restricted environmental tolerances and limited dispersal ability across environmental barriers. The tropics then, with high solar radiation and warm temperatures year-round, should be more species rich than cooler climates. In the cooler climates, frequent environmental changes like the Pleistocene glaciations cause extinctions and low rates of adaptive niche evolution. At least one study has supported this hypothesis for tetrapods (living and extinct amphibians, mammals, and reptiles including dinosaurs and therefore birds).

A similar hypothesis suggests that the LDG pattern is related to the **Eocene-Oligocene extinction event** about 34 million years ago, our planet's last significant mass extinction. Global cooling meant that ice sheets extended a great ways outward from the poles. As tropical conditions were squeezed closer to the equator, many animals and plants became extinct. So less temperate ecosystems haven't been around long enough to accumulate as many species as the tropics.

One study found **clade longevity** to be the most important factor, i.e. older groups will have had more time for diversity to accumulate than younger groups.

More individuals = more mutations – Higher resource availability in the tropics supports higher population density so that more mutations should be produced. More mutations should mean more opportunities to adapt to changes and niches.

The greater solar radiation in the tropics generally produces higher temperatures. **Metabolic rates** and mutation rates are increased while generation time decreases.

The evolutionary rate and microevolution – The evolutionary rate, meaning the speed of the evolutionary process, is hypothesized to affect speciation rates. It has been shown that faster rates of microevolution occur in the lower latitudes for plants, mammals and amphibians. Over time, this can lead to greater speciation. The higher evolutionary rates in the tropics have been attributed to higher temperatures, higher mutation rates, higher energy availability, shorter generation time, faster physiological processes, and increased selection pressure from other species that are themselves evolving.

Is speciation in fact greater in tropical areas? – In an attempt to answer this question, one paper (from the Okinawa Institute of Science and Technology and summarized by Andrew Scott) focused on ants because they're found all over Earth, they're ecologically dominant, and they're well studied. Still, there are nearly 15,000 ant species and the researchers had to record each one's distribution as well as their evolutionary relationships (phylogeny). It was a demanding task. And it wasn't made any easier that they decided to check out an additional 500 ant species that are now extinct. Their conclusion: The rate that new species arise is not higher in the tropics. In fact, they found that new species arise at highly variable rates at various latitudes. Scott's paper concludes with: "...tropical areas have had a much longer time to accumulate the diversity we see today, and given enough time, we could expect to see the same happen in other parts of the world." (References on next page)

Microevolution is sometimes defined as the change in allele frequencies that occurs over time within a population. This change is due to 4 different processes: mutation, selection (natural and artificial), gene flow and genetic drift. It happens over a relatively short (in evolutionary terms) amount of time compared to macroevolutionary changes, which is where greater differences in the population occur. Microevolution is also known as change at or below the species level.

An observable example of such evolution that is also an example of microevolution is bacterial strains that develop antibiotic resistance.

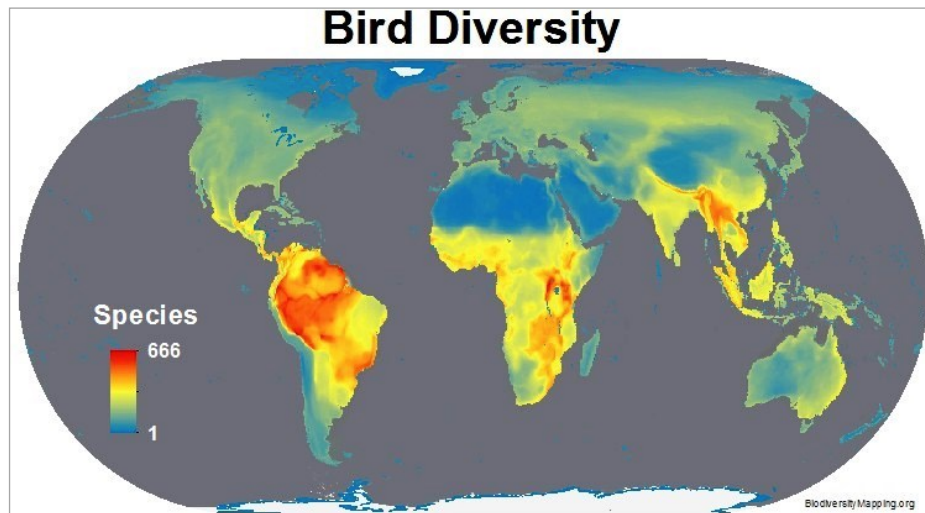
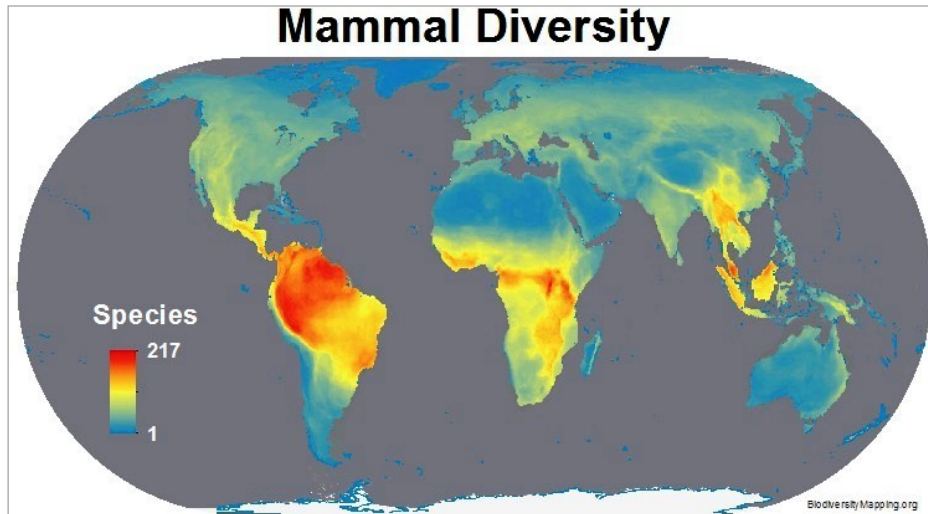
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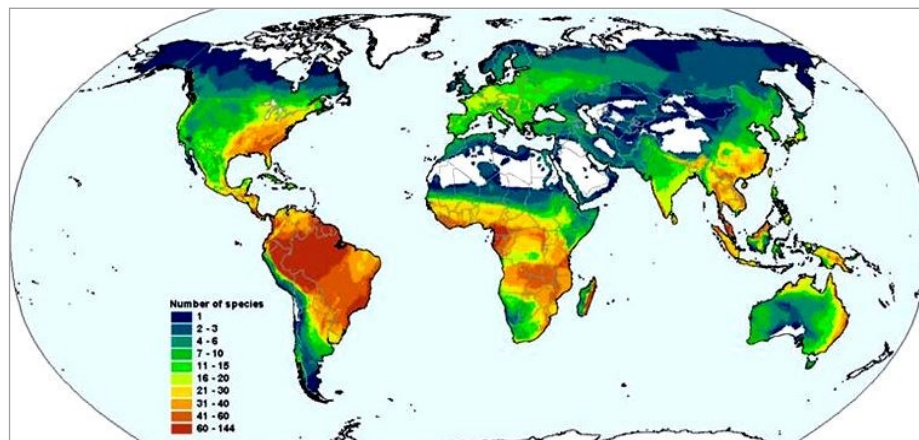
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Amphibian Diversity



Though her family is from Zimbabwe, Sable grew up in the small southern Californian town of Idyllwild. There, surrounded by the San Bernardino National Forest, Sable was instilled with her love of nature and earned her handle of Sable the Nature Girl. She has been studying environmental conservation at Santa Barbara College and is planning to transfer to UCLA to further her geography and environmental studies.

At Caño Palma, I experienced more wildlife than I could have imagined, including: green and hawksbill turtles, their hatchlings, diverse wildlife, turtles nesting in the moonlight while phosphorescence waved through beached kelp in an electrifying blue color. All that and I helped rescue a green sea turtle painfully bound by poachers [a story which will be featured in the next *Raphia*].

With that said, let me tell you about the night our team dealt with three green turtles. At 8:45 in the evening, we canoed over the channel and walked to the beach. I was so excited to see what the night was holding in store for us. We turned off our headlight so we wouldn't deter turtles coming ashore to nest or let poachers know we were there. We saw our first turtle really quickly. She trampled through the sticks on the beach like a rock on wheels. But, after an hour, she decided that she didn't find the spot suitable. To ensure she didn't get poached, we waited with her until she reached the safety of the ocean.

Continuing down the beach with the waves rolling over our feet, we soon came upon a second turtle. She was using her back flippers to dig a deep egg chamber. When the time was right, I crawled up behind her and, lying in the sand, stuck my gloved hand into the nest to count the eggs as they dropped. It was amazing to sprawl there with such a huge creature hissing in laborious contractions. After counting 83 eggs, I stood up and watched her flick sand in the air to cover over the egg chamber. We took her measurements, did a body check, tagged her to monitor her future nesting habits, triangulated the nest, and

recorded the GPS coordinates.

After disguising the nest and waiting for her to get safely to the ocean, we rushed over to another mom nearby. She was an older turtle, and laid 138 eggs. We went through all the steps that we'd just completed for the last turtle. By this time, it was 3:30 in the morning. So we started to head back. On our way, we found a third turtle nesting. We repeated the steps once more. While we waited for her to make her way to the ocean, the sun was coming up, a sunrise I'll never forget. Distant lightning, which had been illuminating the heavens all night, was still piercing the distant horizon.

We got back to the station at 6 am after 10 hours of work, smelling of turtle, sand and kelp.

Caño Palma is not the place to go if all you want to do is see animals and have a vacation. It's a place where, amongst other roles, you work really darn hard to monitor turtles that need protection.

I recommend it to anyone who's physically fit and loves nature because I had life-changing experiences I'll never forget. It's hard, meaningful, rewarding, beautiful, and one-of-a-kind work. Get out there and do it.

Check out Sable's YouTube channel - Sable the Nature Girl - as well as her Instagram page @sablethenaturegirl



With a hectic turtle season still in progress, Caño Palma has been a little crazier than normal. The end of summer sees young biologists heading back to university, and the turtles have little respect for their schedule. While traditionally the turtle season peaked late July to mid-August, we've seen a shift in the past few years to a nesting peak in September. So, as interns and volunteers head back to studies and work, our beach gets crazy, and our need for patrols increases.

Not a great time to start rebuilding!

The first major project was planned, with the timing dictated by the availability of the builder. So we got to work on a much needed extension of the dining room. Fortunately, it was just far enough from the dorms so that the noise wasn't too disruptive to those sleeping after night patrols. And it has definitely made mealtimes a more comfortable affair as well as giving us a more functional space to host the university groups that come through. Replacing the entirety of the exterior wall with breeze blocks has extended the life of the building. And with all windows now able to be opened, we have a perfect view of the wildlife in the trees around us.

The new structure was soon flood-tested with people kayaking in the kitchen within days of completion!

This year's floods prompted our next overhaul as



there's been major damage to the staff housing and the rancho. The rancho was a project that couldn't wait as we observed significant damage to the bases that elevate the building. While Manuel was able to make provisional repairs, the replacement of the bases became an urgent issue

As we started to remove the wooden flooring to replace the bases, the extent of the damage to the entire



lower floor quickly became obvious. The project rapidly grew in scope and cost. While we still have some work to do to finish it off, as the project has moved forward, we've become increasingly excited about the potentials for this new and improved space. We've long wanted a more functional area for lab work, such as the sand and scat analyses undertaken by recent students. As well, for many years we've needed better storage options for the research equipment we have on base. This additional space looks to offer us both of these as well as a much more resilient structure. (See photos on next page).

The staff building will have to wait, but we are really happy with these recent improvements. If this year's turtle season ever ends (!!), we'll be spending some time finishing these projects off, but want to thank everyone here for their patience during construction, and all COTERC supporters for their help in getting these vital projects done.

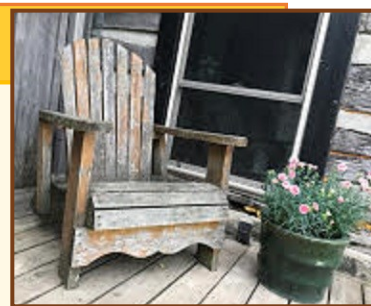


New entrance to bottom floor of Rancho. Note squared corners.



Notes from the Chair by Kym Snarr

Here we are into the fall of 2019 in Canada and into the drier season at Caño Palma Biological Station!



While summer was flying by here, news from the station has highlighted its continuing efforts to monitor biodiversity, educate young researchers, and deliver evidence-based information to locals, the general public, the Ministry of Education, and the scientific community at large. COTERC has been doing this for nearly 30 years. With this edition of *Raphia* discussing latitudinal diversity gradients, it should be a reminder to us of the responsibility we have to continue studying and passing on this knowledge of a remarkably diverse piece of land. And, though Canada is at a latitude where we don't have the same level of biodiversity, we should recall the interlocking nature of nature as we do share some of that diversity up here in Canada through migratory birds and marine animals.

But what's been happening with COTERC over the summer. As with all organizations, there are ups and downs. I want to pass along some of them that we've experienced recently.

First, one of the downs. This summer saw the passing of the co-founder of CPBS, Ozzie Teichner (June 8th 2019). We were informed by his son of his death. Ozzie was a major driver in the original formation of the station and then, with the parting of Ozzie and Marilyn, Marilyn took over the reins, putting into place a Canadian station manager to ensure the station was secure and moving forward in a stable manner.

Another piece of negative news is that, with the passing of Marilyn, we have been naive in the paperwork needed by the Canadian tax authorities (CRA) to maintain our charitable status. We are currently working towards having our charitable status re-established. Our organization failed to put in all of the paperwork required by the CRA over the past 3 years since Marilyn's passing. I had thought we were past the frustrating times, such as in the aftermath of Marilyn's death when we lost control over our Google suite, and ultimately our website and email accounts. We have certainly grown in our ability to seamlessly maintain emails, website access, and communications overall. We are learning and overcoming these administrative barriers!

Now onto some of the better news to share. We have a new board member, Barbara Arn, who is taking on the position of Director of Special Events. After experiencing life at the station and motivated by other Board members, she has undertaken this role with an open heart. We are hoping to pull together a small fundraiser in the fall and a larger event in the new year. If any former Board members, volunteers in Canada or station volunteers wish to help out with this portfolio or any other portfolio, we welcome the volunteer opportunity! Knowing that you are assisting in supporting the nearly 30 years of continuous conservation efforts and the high diversity in the southern tip of Barra del Colorado Wildlife Refuge leaves you feeling like you're an important piece in the legacy of this organization.

The station has seen some upgrades over the past few months. Since we lie basically at sea level in lowland wet forests, we experience annual flooding. Staff is excited to report that the new dock has held up solidly. Other Improvements involve the rebuilding of the footings of the Rancho, upgrades to the office area, and expansion of the kitchen area. As the main transportation in and out of the station is via the canal, continued use of our boats has resulted in the need to either have extensive repairs to the Suzuki boat motor or to replace it. The Board wishes to continue to see the station move towards self-sustainability. And with this movement, we continue to work on improving programs and the experience of interns and all volunteers coming to the station. Keeping up with our 10 main regular monitoring programs has kept all interns and staff hopping at the station. Recently we've moved away from having a Head Intern for the turtle program and another single Research Coordinator for the other 9 programs. We've added one more position so that we'll now have 3 Head Scholarship Portfolios who will have expenses covered, receive a small stipend, and have access to select data for publication and/or setting up independent research projects. This will mean the various long-term monitoring programs will be led by more specialized leaders who can focus on areas of interest and continue to supply evidence-based material from which to report to our wide audience. (cont'd on next page)

Finally, while we have operated under the same Mission statement put in place by the first Board, the current Board has been grappling with a new Mission and Vision statement. We have been evaluating what is different with the station since its inception and its original Mission, plus trying to establish what our final 'future' goals are. We've been fleshing out these things at retreat sessions to finalize these ideas. Stay tuned!

I often wonder what Marilyn Cole, our founder, would think about the current station and its programs as it nears its 30th year of operation. Marilyn's vision was to provide experience for those who wished to learn about the Neotropics and the rich diversity in our region. While the station itself was secondary forest at the time of its inception, it has flourished and changed over the past 30 years in response to the lack of harvesting from its land and from changes in the surrounding area. Board members continue to operate in good faith towards these goals while leading the organization and the station in the next phases of their work!

Josee Soars at Ara Manzanillo

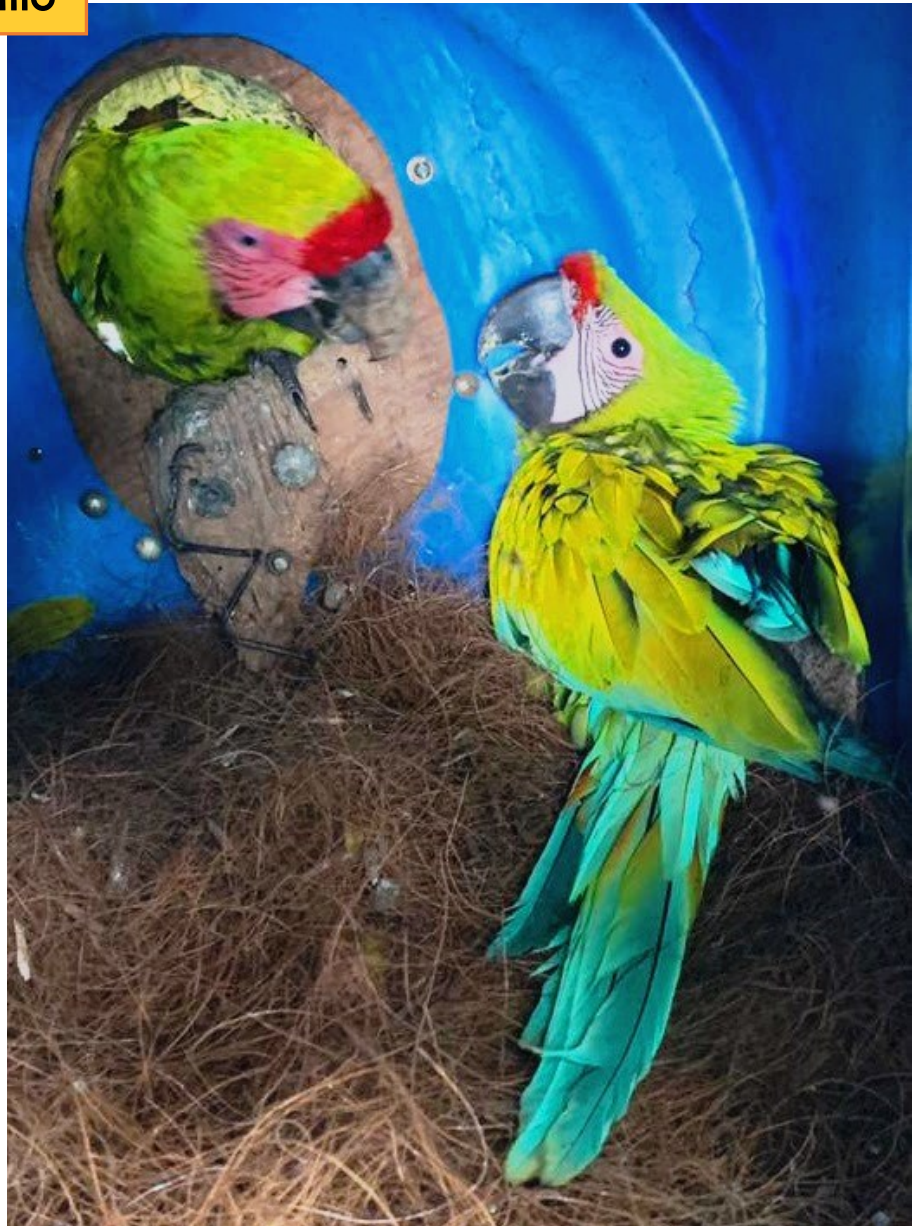
Josee, pictured to the right inside its artificial nest, became the sixth great green macaw fledgling to flutter off into the forest this year at Ara Manzanillo. Staff there will now start repairing used nest boxes and constructing new ones in preparation for the next reproduction cycle that begins in November. Macaws will be courting and hopefully trying out the artificial nests high up in their favored mountain-almond trees.

That's mom looking in on Josee.

Ara Manzanillo is just down the coast from us, southeast of Cahuita. If you're in the area, drop in for a visit. Go to their website to find out how to make a reservation and get directions.

<https://aramanzanillo.org/visit-us/>

Ara Manzanillo has successfully introduced 45 of this endangered species into the wild.



Greg Davies and Alexander Skutch have something in common besides being ornithologists. Both have published a field guide for the identification of birds. Mr. Skutch is of course renowned for his book "A Guide to the Birds of Costa Rica" (co-authored with Gary Stiles). Greg co-authored the 2nd edition of the popular "Roberts Bird Guide" to the birds of southern Africa.

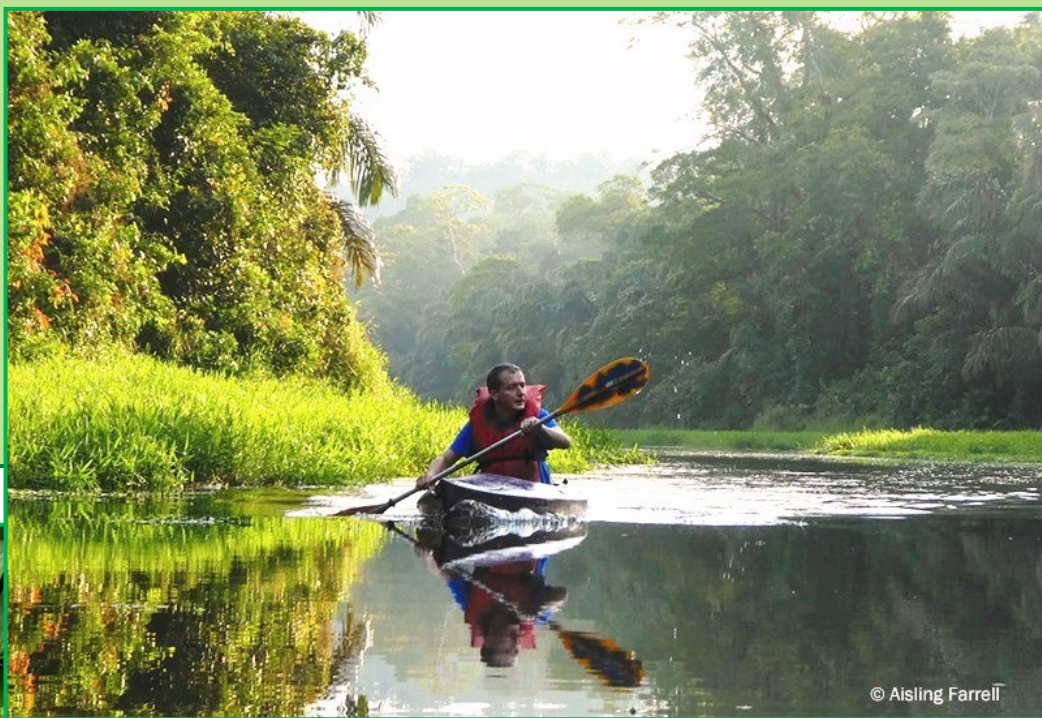
Why mention that though? Well, Greg was recently named recipient of the Pamela & Alexander F. Skutch Research Award.

How will he use that funding? Well, Greg has an interest in sungrebes and was recently at Caño Palma scouting out the possibility of doing research in the wetlands around the station. This survey was quite productive as he found sungrebes nearly every day. So Greg will apparently be carrying out his research with us. Here's Greg's bio, slightly edited from the Association of Field Ornithologists' acknowledgement of his award.

"Greg Davies is a naturalist and ornithologist from South Africa and currently a Research Associate of the Ornithology Dep't of the Natural History Museum of Los Angeles County. Previous ornithological work in Africa included studies on the breeding biology of termitaria-nesting kingfishers, the taxonomy of Afrotropical pipits, the status and biology of a Critically Endangered rallid, and the occurrence of fossil ibises in the Pliocene of Africa.

"The Sungrebe (*Heliornis fulica*) is an elusive, poorly known aquatic bird inhabiting the Neotropics. The only New World member of the Heliornithidae (finfoots), it is thought that Sungrebes have one of the shortest incubation periods of any non-passerine (10.5–11 days), is the only species in the Gruiformes to hatch altricial young, and is the only bird in the world to have 'pockets' (marsupia) underneath the wings to carry newly-hatched young. These conclusions, though, are based on an incomplete field study of a single nest from 50 years ago. It is Greg's intention to use the Skutch Award to confirm these extraordinary details and extend those pioneering observations by comprehensively studying the breeding biology and spatial deployment of the Sungrebe at a lowland-forest site in Costa Rica. The eventual aim of the project is to determine the ecological factors that drove the evolution of these life-history attributes.

"Fieldwork is intended to cover two seasons beginning in 2020 in the Tortuguero region of Costa Rica. A reconnaissance visit to Tortuguero in March 2019, based out of the Caño Palma Field Station, located a suitable population of Sungrebes for study along the Rio Penitencia, Caño Palma and La Suerte rivers."



© Aisling Farrell



Photos by Aisling Farrell

As Amy Cocksedge noted in the Summer issue of *Raphia*, white-lipped and collared peccaries are regularly recorded on our mammal surveys around the station as well as in Tortuguero National Park. Elsewhere the white-lipped isn't doing so well. In almost all of their range, they are declining in numbers if not outright extirpated as in El Salvador and Uruguay.

Historically, great numbers of white-lipped peccaries ranged far and wide in Central America from Belize down through the Caribbean lowlands to Panama. A 2016 study claims that now the white-lipped only exists on 13% of its former range. At this rate, it's predicted that in 50 years, the white-lipped peccaries of Central America will only survive in select areas like Costa Rica's Corcovado NP and isolated areas like ours. In South America, most of its territories have been greatly reduced in size.

In the Winter 2019 issue featuring jaguars, we learned that peccaries are high on the list of a jaguar's preferred menu items. (Here's a video of a confrontation between a jaguar and a collared peccary: <https://www.youtube.com/watch?v=dGLGY5zeLSM> Too squeamish to watch? You might be surprised.)

Ungainly and slower peccaries should be easy pickings for jaguars. As the video shows though, they can defend themselves – they're noted for their fearlessness. But that was one collared peccary that had wandered off and maybe got lucky. After all, jaguars usually ambush their prey. A herd of white-lipped peccaries however, when threatened, will form a defensive wall that makes it easier to fend off predators. Regrettably, this bunching behavior also makes it easier for the ultimate enemy – human hunters – to shoot them in greater numbers.

Why do we shoot them? They're good eatin' and provide protein in remote areas where this valuable nutrient might otherwise be hard to find. As well, poachers can sell the tasty meat back in the city.

And we help the poachers, summed up in these immortal words: "If you build it, they will come". So, when we extend road networks into forests, the unintended result is: Hello hunters, goodbye sanctuary. In Central America, peccaries as well as jaguars, tapirs and brocket deer are now at the mercy of hunters who have been handed better access to formerly remote areas. (cont'd on next page)

Why is there so much pressure on land in Central America?

In the 65 years since 1955, Central America's population has quadrupled from 44 million to 181 million. Most of that growth has been in cities as urban population has increased by 7 times. Though rural population only doubled, that still amounts to 21 million additional people. Many of them would be working on more recently established farms, and, as the article states, more farms mean less space for the peccaries and other animals.



RAPHIA

FALL

But we don't have to shoot them to put a herd's survival under pressure. White-lipped peccaries need large ranges to keep their large herds of 20 to 300 fed. Such territories have to supply a diversity of fruits, nuts, seeds, tubers and roots as well as habitats. When we move in with large-scale farming or herds of cattle, well there goes their neighborhood. White-lipped herds either find another territory or they eventually die off.

With most remaining populations being small, genetically isolated and threatened, the future doesn't look bright for the white-lipped peccary. So the IUCN lists it as Vulnerable.

And now you know the rest of the story.

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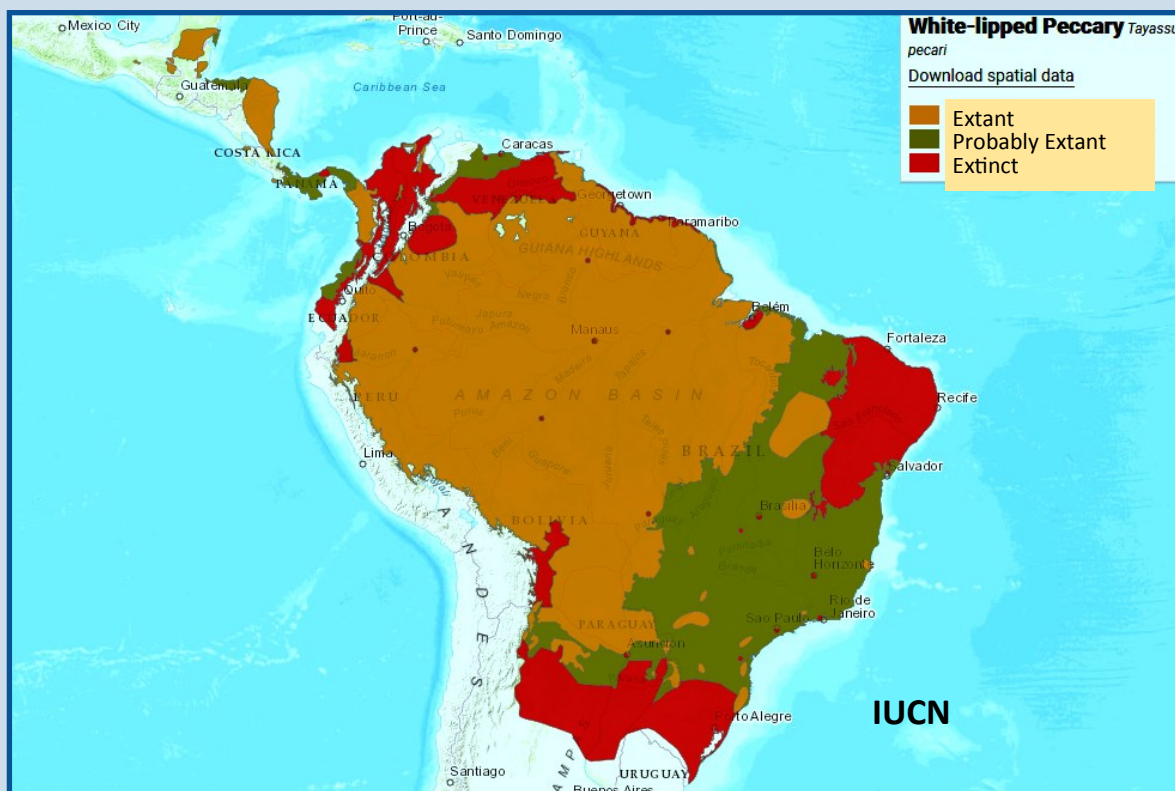
<https://phys.org/news/2016-10-peccaries-mesoamerica-highly-threatened-experts.html>

Note – Research has shown that the size of a peccary herd depends on these factors:

1. How close it is to a **human settlement**. People disturb habitats. If food is not easily obtainable, herds will be smaller and may even lead to their extirpation from an area. It's been found that white-lipped peccaries are among the first species to disappear when people move into their territories.

2. **Rainfall** has to be reliable so that the fruits that are a large part of the peccary diet can be produced.

https://www.academia.edu/23179819/What_Ecological_and_Anthropogenic_Factors_Affect_Group_Size_in_White-lipped_Peccaries_Tayassu_pecari_13_PUBLICATIONS_78_CITATIONS_SEE_PROFILE



Why strange? Well, until 1930, the Chacoan peccary was unknown to scientists. That year they unearthed its fossilized remains, and assumed they'd uncovered an extinct animal. It took another 40 years, till 1970, before this third species of peccary was discovered alive and well in northernmost Argentina.

Eventually, Chacoans were also found in western Paraguay and southeastern Bolivia. This area is part of the Gran Chaco, aka the Dry Chaco. In this semi-arid habitat dominated by thorny scrub vegetation, the Chacoan peccary has a much different habitat than the white-lipped and collared peccaries.

And what's the derivation of the word 'chaco'? Well, it comes from the Quechuan *chaqu*, which means 'hunting land'. That's one good reason why the Chacoan peccary has been hard to find. In their range, they're an important source of bushmeat, providing a tasty source of protein for local hunters and their families in this isolated region.

Protein. Protein. Protein. It's not just locals who want it. In faraway cities, there's a huge demand. So farmers are moving into the Gran Chaco and planting large acreages with soybeans. Ranchers are opening up huge cattle haciendas. This takes place right on prime peccary territory. And, since peccaries require large territories to roam, herds can easily be wiped out when their habitat is destroyed or fragmented.

So, the Chacoan peccary is listed as endangered with an estimated population of only 3000. Recently, two new populations were detected south of its known range. With other suitable habitat in the area, it may be that other populations exist there. Even if true, this may be faint hope as the region suffers from some of the heaviest deforestation in Latin America.

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Typical habitats of the Gran Chaco



June **Sea turtles**— Night patrol was carried out every night this month. Numbers were basically in line with June 2018 except for greens, which increased from 5 to 10 emergences.

Community coordinator— Camila Rojas (Mexico) is a recent graduate of St. Edwards in Austin, Texas. Her studies focused on conservation strategies in coastal communities, making her a great fit for our community program.

Sam Orpin— This Brit has departed the station after completing a nine-month internship assessing the aging of otter scat under different weather conditions. We are eager to read his final report so we can better assess the age of the scat we find on monitoring patrols.

Snakes — Due to high water levels, snake surveys were unable to be done this month. Still, six snakes were found incidentally and processed. Highlights were two fer-de-lance, a boa and a Halloween snake.

Caimans— High water levels reduced caiman surveys to just three. One survey had no sightings because of the flooding, which pushes caimans further back into the forest, making them less visible.

July **Sea turtles**— Hawksbill sightings were greatly reduced from 2018: 20 down to 3. On the other hand, on the last three days of July, green turtles started emerging in high numbers: 158 vs 37 last July.

Poaching— High number of incidents this month. Three deceased greens washed ashore, perhaps from a capsized boat. Two triangulated nests were poached along Playa Norte. In addition, there were two unsuccessful attempts.

Brent Kaboor— This Dutchman departed after his one-month stint gaining experience in handling snakes.

Turtle Interns— Also departing this month were Elijah Dewoski (USA), Rachel Green (USA) and Jasmine Joy (Canada) who all made patrol leader and offered leadership in the field as well as levity on base.

U of Toronto Scarborough— Michelle Sone and Tristan Williams left after two and a half months, gaining valuable field experience.

August **Sea turtles**— Sightings increased greatly this month. Hawksbill emergence numbers went from 14 to 23 though just one nest was recorded. The big move was in the number of greens, Numbers swelled from 162 last year to 613. Of those 613, 83 were nesting events.

Poaching— Fifteen attempts occurred along Playa Norte this month. As well, a green was found washed ashore entangled in a fishing net. A deceased turtle was found in vegetation. Finally, a flipped turtle was also found in vegetation. However it was spotted and our morning census team safely returned it to the sea.

Frank van Schie— This long-term intern departed after great work on morning census.

Fernando Lopez— After serving as research assistant, Fernando left us this month.

Sea turtles— September is usually the peak for green activity and this year was no exception. There were 784 emergence events versus 393 last year. Of the 784, 176 nested.

September **Poaching**— Unfortunately, poaching numbers were again high. Many were successful. All attempts are reported to MINAE the day they occur.

Tygo de Munck arrived this month from HAS University in the Netherlands to focus on river otters.

Mary Maximiadi— From Greece, Mary's area of concentration will be tent-making bats during her two-month stay.

Sea turtles are surviving -- despite us by Craig Welch (in National Geographic)

This excerpt, taken from the October 2019 issue of National Geographic, features Helen Pheasey, a former turtle project coordinator at Caño Palma. Helen still visits the station to carry out various research projects. To read the whole article, go to <https://www.nationalgeographic.com/animals/2019/09/sea-turtles-are-surviving-despite-threats-from-humans-feature/?fbclid=IwAR06Mmh07ZFzql7ZhNB2SCNctuRi3ohTgSqBbg29fMFF1eaUuc18e-30MJA#.XYJeZw0mZLY.facebook>

The rain is just starting on a dark Costa Rican night when Helen Pheasey and I cut across a beach with a red flashlight. Pheasey, a Ph.D. candidate who studies the black market in reptiles, is working with a US-based conservation outfit called Paso Pacífico. In her pocket, she carries a fake turtle egg implanted with a GPS transmitter, and we're



looking for its potential mom. She gestures toward an olive ridley, alone and kicking up sand in the dark. As the pregnant turtle drops her eggs, Pheasey crawls toward the turtle's tail, reaches into the mound of Ping-Pong ball-size eggs, and places the decoy in the middle of the pile. She's hoping hurried egg poachers will nab her fake along with their intended loot.

Turtle eggs are hot commodities in parts of Asia and Latin America. They may be boiled in soup, cooked into omelets, or dropped raw into a shot glass with lemon, tomato juice and pepper. Eggs don't bring huge dollars, but because most turtles lay 50 to 100 or more at once and leave long sandy tracks from sea to nest, they're easy to find and steal in volume.

In most countries, selling turtle eggs has been illegal for years. Yet in 2018, police seized a pickup in Oaxaca, Mexico loaded with garbage bags stuffed with 22,000 turtle eggs. Malaysian authorities two years earlier intercepted four Filipinos in wooden boats carrying 19,000 eggs. The \$7400 those sailors stood to make was nearly three times the yearly average wage in their community. Egg theft is often linked with poverty or drug or alcohol abuse, Pheasey says. But the hope is that fake eggs could help stop organized traffickers.

On a recent Saturday near Guanacaste, Costa Rica, thieves raided 28 nests — a haul that included one of Pheasey's fake eggs.

At 7 a.m. Monday, Pheasey watched on smartphone apps as her egg traveled from the peninsula to the back of a building on the mainland. After a delay, the egg moved again, to a neighborhood in San Ramón, 85 miles from the beach. Pheasey traced the route in her car. The egg had stopped at a supermarket loading dock. There it probably changed hands before being ferried to someone's house.

Pheasey and Paso Pacífico are still working out kinks in their tactics, but even if the decoy eggs show promise in fighting smugglers, that's just one of the many problems turtles face. We're chewing up nesting beaches by erecting oceanfront skyscrapers, hotels and subdivisions. We've illuminated coastlines with disorienting streetlights. When turtles manage to find sand in which to lay eggs, bright lights often send them wandering. Some get hit by cars. Pollution, from oily toxics to plastics, spills into coastal waters. Straws and plastic forks get sucked up turtles' noses. Hungry leatherbacks mistake plastic bags for jellyfish.

The Kingfishers -- Adaptations For Life in Two Very Different Elements

by Doug Durno

**** Featuring the American Pygmy Kingfisher**

**** With special appearance by Tony the physics guy**

You'll find these little guys, the pygmy kingfishers, on the channels and rivers around Caño Palma. Well, you won't actually find one unless you're lucky. They perch just above the water, hidden behind branches, patiently waiting for a fish to come into range. Often your best chance of seeing one is that fleeting flash of a bird streaking past just inches above the water.

And they're small, only 13 cm long, weighing about half an ounce (10 to 16 g).

To satisfy its high energy needs, the pygmy kingfisher has to eat around 60% of its body weight every day. This keeps them on the prowl for prey almost all day long. When a small fish or tadpole comes within range, the pygmy dives head-first to nab its prey in its comparatively big beak. Back on its perch, it swallows its catch whole. It also hawks insects. And it's not big on sharing. It will fight off other pygmy kingfishers that intrude on its domain.

But diving for your dinner has a few problems for kingfishers based on the fact that they're living in one element: air - and feeding in another: water.

1. **Glare** – We humans use polarized sunglasses to reduce glare. But apparently birds can't wear glasses. So, pygmy kingfishers have adapted with polarizing filters built right into the cone cells (photoreceptors) of their eyes.

2. **Refraction** – Diving kingfishers have an intuitive understanding of the physics principles of light refraction caused by water. Subsequently, they have a fairly high success rate of nabbing their underwater prey. Watch **Tony** explain the physics of it: <https://www.youtube.com/watch?v=CWqJA4dxEDg>

3. But, if they're diving head-first, how are their eyes protected? Well, they have a third eyelid, the **nictitating membrane**, which closes on impact. Being translucent, it allows them to see their prey when submerged.

4. Underwater, kingfishers have a remarkable adaptation that allows them to switch to binocular vision from the monocular vision they employ above the water. This relates to the **dual-fovea** setup kingfishers have in each eye. Humans have only one fovea. The kingfisher's main fovea is a small pit in the center of the retina at the back of the eyeball. It has a high density of color-sensitive cones, and provides sharp central vision. But, as stated, it only allows monocular vision. But, a second fovea at the periphery of its oval eyeball enables kingfishers to have 3-D (binocular) vision in a single eye – even underwater. Quite a trick. Though this temporal fovea doesn't provide vision that is as sharp, that's not the point of the second fovea. Rather it's the ability to have binocular vision, which allows the kingfisher to better judge distance, important when you're trying to catch a moving fish.

Bank deposits - Pygmy kingfishers are known to make deposits in banks. Well, they deposit eggs in a tunnel that they've dug into a river bank. Keep your eye out for one entering or departing as Caño Palma has the ideal habitat for this species: dense forest and swamp along streams, rivers or canals with heavily vegetated banks.



American Pygmy Kingfisher. Female above with breast band. Male below.





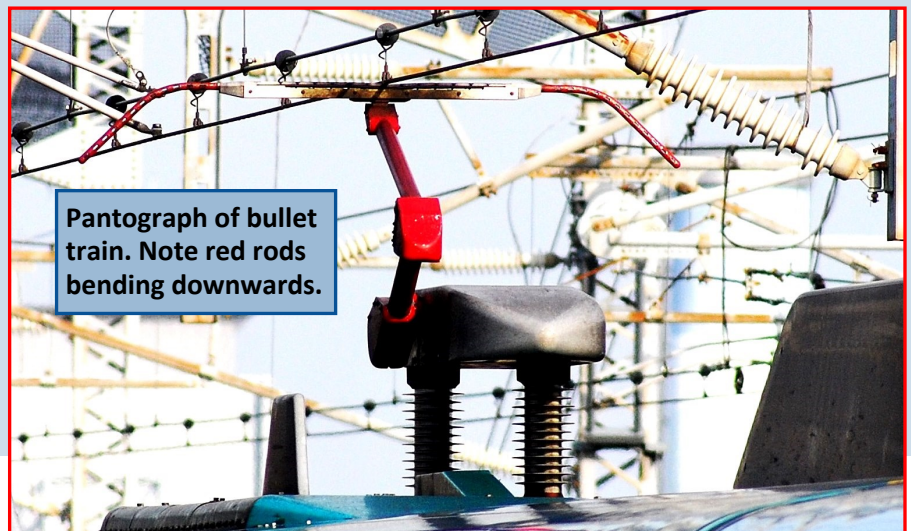
Japanese engineers developing the Shinkansen bullet trains had a problem. Trains exiting tunnels at high speed produce an intense "tunnel boom" as well as aerodynamic vibration. This can be a headache for anyone within three to four hundred meters. In response, government regulations were amended to lower the allowable decibel level to 70. That's not very high as a normal conversation has a level of 60 dB and a telephone ring reaches 80 dB.

In an enclosed tunnel, the boom is created by fast-moving trains pushing air out ahead of them, compressing it. Since the air has no escape, pressure waves are created that grow in size as the train continues forward. The waves reach the tunnel's exit at the speed of sound, and explode out because of the dramatic difference in pressure there, creating the boom and vibration.

Eiji Nakatsu was the engineer responsible for solving the problem. He recognized that it involved a sudden change in air resistance when trains entered a tunnel. Being a birdwatcher, he realized that kingfishers can dive for prey into the water without making a splash. At high speed, the kingfisher is leaving a low-resistance medium, air, and entering water, a high-resistance medium (800 times denser). He understood that it was the shape of the kingfisher's bill that enabled this. The long, pointed bill is so streamlined that water flows past the beak rather than being pushed out ahead.

Nakatsu's team set about testing various shapes, and the kingfisher bill turned out to be the best by a wide margin. It reduced air resistance by 30%. As well, it allowed faster speeds – up to 300 kph – while staying within the allowable noise level of 70dB. As a side benefit, energy consumption was reduced by 15%.

Nakatsu wasn't finished with biomimicry. Pantographs, which sit atop the trains, link to the overhead electrical wires that provide power. At a bullet train's speed, air rushing over the pantographs produces excess noise levels. How to dampen it? Nakatsu thought of owls. They're more successful hunters if they can avoid warning prey of an oncoming attack. To approach prey quietly, they evolved a comb-like array of serrations on the leading edge of their wings. This breaks the turbulence a normal wing would create into micro-turbulences, and its prey becomes a sitting target, now hearing nothing. It took Nakatsu's team quite a while, but they eventually contrived an array of serrations on the pantograph's 'wing' that broke up the air turbulence that created the noise. Eventually, this idea was applied to aircraft wings too.



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COTERC would like to thank the following individuals for their generous donations over the years. Such contributions greatly assist in furthering the research we do at Caño Palma.

Pennie Mason	Fran & Tom Mason
Jim Taylor	Michelle Hunwicks
Lillian & Larry Hall	Rob Hamilton
Susan Kunanec	Lauren Stewart
Vanessa Phelan	Durham Region Aquarium Society

We would also like to thank Microsoft for the donation of MS Publisher software.