CONSERVATION & RESEARCH UPDATES FROM THE NATIONAL AVIARY

flightpaths

SPRING 2019

RECENT PUBLICATIONS

Brian Trevelline conducts DNA analysis of waterthrush gut microbiome.

Gut Microbiome Affects Bird Health

by Steven Latta

A recent surge in research has revealed that the microbiota found inside organisms can profoundly influence the health of animals. At the forefront of new research into these communities of bacteria, fungi, and viruses is National Aviary Research Associate, Dr. Brian Trevelline.

His interest in genetic analyses of gut contents led directly to a new field of study analyzing the microbiome present in the gut of Louisiana Waterthrushes. Among the first biologists to explore the microbiome of birds, Trevelline is interested in how intestinal microbial communities are altered by human changes to the environment, and how changes in the gut microbiome within waterthrushes impact

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NOTES FROM THE FIELD

Focal Species Research Yields Conservation Tools

by Steven Latta and Robert Mulvihill

Productive science depends on knowledge, creativity, determination, collaboration, and, often times, a perfect focal species! The authors have invested almost 25 years on one such species — the Louisiana Waterthrush (a.k.a., LOWA).

A dweller along forested streams, this migratory bird promises to fulfill a much sought-after mission of ornithologists — some would say the "Holy Grail" of migratory bird ecology and conservation — a full life cycle model capable of expressing which events in the complex annual cycle are the most significant determinants of population size. Along the way, the waterthrush has also allowed us to address provocative issues like the value of birds as indicator species showing impacts from hydraulic fracturing and acid pollution.

The genesis of our study of LOWA was in 1995, when Mulvihill settled on the species as a model Neotropical migratory bird for studying nesting success and survival in an undisturbed ecological reserve in Western Pennsylvania. It was a good choice because waterthrush population ecology had not been studied well for decades, its reliance on headwater riparian habitat made it comparatively easy to find and follow within the 2,000-acre reserve, and it was a common breeding resident.

Although the study was originally intended to be a long-term population assessment, it fortuitously became much more. In fact, because the original two study sites just happened to have drastically different water quality, with one being significantly impaired by highly acidic mine drainage, it laid the groundwork for establishing LOWA as an important regional bioindicator of stream health.

In just two years, with collaborators from Penn State and East Stroudsburg universities, the study secured major funding from the U.S. Environmental Protection Agency. The three-year project (1998-200) addressed several major stressors on waterthrushes resulting from human population, including stream acidification, forest fragmentation, second home development, and loss of hemlock trees due to an introduced and invasive insect pest. The final report, entitled ***Using bioindicators to develop a calibrated index of regional ecological integrity for forested headwater ecosystems***, led to the LOWA being chosen as an indicator of

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Robert Mulvihill bands a Louisiana Waterthrush.

NATIONAL AVIARY

The National Aviary inspires respect for nature through an appreciation of birds.

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FROM THE EDITOR

Effective Conservation Requires Sound Science

At the National Aviary we pursue conservation-oriented scientific research and integrate science into our avian management efforts and educational programming. In this issue of *Flightpaths*, we highlight the critical role of science in guiding the National Aviary towards fulfilling its mission.

Major efforts in our field research program have centered on the migratory Louisiana Waterthrush. This bird promises to fulfill the "Holy Grail" of migratory bird conservation by enabling us to determine which factors in its complex life cycle have the greater impact on its overall population size.

As part of these efforts we describe Research Associate Brian Trevelline's breakthrough study revealing that the microbiota living inside waterthrushes is profoundly affected by habitat quality, which, in turn, influences the birds' health.

Our research efforts also extend to three of the longest running long-term monitoring programs in the Americas all of which address the need for high quality, reliable data to determine population trends and inform conservation actions.

We also use science to inform avian management right here at the National Aviary. Behind the scenes, our propagation team draws on science to help some of the world's rarest birds reproduce successfully. Through their work, breeding programs for endangered species are designed so many of these species can continue to thrive in our care and, in some cases, in their native habitats, too.

Finally, in this issue of *Flightpaths* we highlight ways that we bring science to life for every student. When schools visit us, gasps of wonder and excitement fill our hallways as kids encounter our birds for the first time. For college students and young professionals, we offer field courses that create unique learning environments and get students out of the classroom to work side by side with a practicing conservation biologist.

Informing conservation and management options to protect birds and training the next generation of conservationists are critical responsibilities. At the National Aviary, science helps guide us in our efforts to meet these challenges every day.

Steven Latta, Ph.D.
Director, Conservation and Field Research

Long-term Monitoring Critical for Bird Conservation

by Steven Latta

In Ecuador, horses are sometimes used to transport supplies for long-term monitoring activities to remote, high elevation sites.

Imagine managing bird populations based on a hunch. Best guess estimates of bird population size, personal judgments of whether a species is declining, or a sense that a bird just doesn't seem so common anymore, do not leave wildlife managers or the public feeling very confident about conservation directions.

Because conservation dollars are scarce and must be spent with the utmost confidence in achieving desired results, it's important to demonstrate assurance that specific conservation actions are the best available given the facts provided. Financial considerations are also important because monitoring might help us detect population trends so that declining species can be rescued while they are still relatively abundant and conservation measures are far less expensive to implement.

Long-term monitoring programs address the need for high quality and reliable data. Using standardized methods to monitor bird populations, data on population size and demographic make-up (numbers of adults and young, males and females) are collected in a similar manner and on a regular basis so that comparisons can be made across space and time. When combined with habitat data, climate variables, or changes in human population impacts, these monitoring data can be extremely valuable resources for conservation.

At the National Aviary, I have worked hand-in-hand with locally based collaborators to coordinate three of the longest running monitoring programs in the Americas. Using constant effort mist-netting, a technique that uses the same number of nets placed in the same place at the same time(s) each year — we are able to make within-site (across years) and between site (within years) comparisons in the number of birds captured, banded, and recaptured to similar data from that site or other sites.

These long-term monitoring programs in the Dominican Republic, the tropical forests of Costa Rica, and the high Andes of Ecuador have generated information on thousands of birds and dozens of species for more than 12 years.

Although researchers and institutions often are hesitant to invest in such long-term efforts, results of these studies inevitably reveal their own importance. For example, we have seen how all bird species experience "good" years and "bad" years. If we only looked at a few years of data, as is typical with a short-term study, we might report on one population trend without knowing that it was reversed by natural fluctuations the next year. Another pattern we have seen that we would never detect with a short-term study is a slow yet sustained population change, because such change would not be evident or significant without many years of data.

Communities of birds (populations of multiple co-occurring species) also change over time. For example, we have seen how large-scale habitat changes (good and bad) can affect patterns of avian diversity and species richness even within seemingly well protected reserves. In Ecuador, human population growth and associated land use pressures outside our study area have had an adverse effect on bird communities within our study areas; but, in Costa Rica, the regeneration of previously cleared forests has allowed the return of primary forest bird species to remnant forest fragments that we have been studying.

Last but not least, long-term monitoring programs can serve as a vehicle to train new biologists and volunteers, a centerpiece for developing community-based environmental education programs, and a catalyst for local and regional conservation initiatives. And, when monitoring programs incorporate mist netting, they can be an especially effective public education tool. The beauty of a bird in the hand is an irresistible lure for school children and adults alike that can hook them on the idea that healthy bird populations and healthy ecosystems are in their best interests, too. ■

EDUCATION

Science Classes at the National Aviary are Hands-on and Fun!

by Jennifer Torpie, Education Manager

During a hands-on science class, National Aviary summer campers dissect owl pellets.

Science class is _____ (fill in the blank). Unfortunately, many students might answer, "boring."

A 2016 study reported that 81% of students nationally found science interesting, but only 37% actually *liked* their science classes. With STEM (science, technology, engineering, and math) education increasingly emphasized by state and federal education standards, how can we create programs that excite kids about science?

Children of all ages bring an unbridled enthusiasm and curiosity to the National Aviary. When schools visit us, our halls come alive with laughter, squeals of delight, and gasps of wonder as kids encounter birds in a new way. As an educator, my goal is to help children transform this enthusiasm into an enduring love and respect of the natural world through hands-on learning. We draw inspiration from our birds and the work of our staff to create standards-aligned, age-appropriate education programs that bring science to life for every student.

Research has increasingly indicated that young children learn best through play, so we structure our programs to encourage playful exploration of birds and their habitats. Recently I had the pleasure to watch Janet, one of our veteran volunteer educators, act as Mother Nature in "*Mother Nature's Diner*" at a local preschool. Through an interactive puppet show, Mother Nature encouraged children to wonder what birds would eat at her diner, serving up plates of flowers, seeds, fish, and even worms *("Ewwww!")* for her bird friends. The children sat enthralled as they sang songs, asked questions, and helped Janet match bird puppets with their dinners. I won't soon forget the children's excitement and joy when Gonzo, one of our Yellow-naped Amazons, greeted them with a cheerful "Hello!"

And play doesn't stop after pre-school. We create fun hands-on activities that put middle and high school students in the shoes of our veterinarians, our researchers, and our animal care staff. In our *Science and Animal Behavior* class, teens explore tools that our ornithologists use, including drones, camera traps, and a parabolic microphone. Then they go out into the Aviary to conduct their own observations of bird behavior. During our *I want to be a Vet* program, students at a local nature club mimicked how our veterinarians conduct an animal wellness exam by using stethoscopes and examining x-rays to discover what might be ailing their "plush" animal patients. And during a recent necropsy lab, our educators led a group of high school students through a quail dissection. There were many squeals of disgust, but every student was glued to her seat waiting to see what she would discover next. These types of experiences inspire students to explore and solve problems like those that scientists investigate daily.

At the National Aviary, science class is surprising, messy, hands-on, and fun — all in the hope that an interest in science will take flight in the lives the students who visit us. ■

ANIMAL PROGRAMS

Science Guides Our Breeding Programs

by Jennifer Haverty, Senior Aviculturist

Behind the scenes at the National Aviary, our propagation team draws on the science of avian ecology to help some of the world's rarest birds reproduce successfully.

Our Breeding Center is home to five endangered species, including extinct-in-the-wild Guam Kingfishers and critically endangered Golden White-eyes. Using science-based techniques, the propagation team is able to provide birds with customized breeding conditions tailored to meet all of their reproductive requirements.

Proper pairing is the first step in designing a breeding program; it ensures healthy reproduction and successful chick rearing. Each breeding pair is established based on recommendations from their respective Species Survival Plan® (SSP), a cooperative national program that recommends mated pairs based on their genealogy, with the goal of maximizing genetic diversity across the entire zoo population of the species.

After pairs are established, habitats are designed to match conditions that the birds would naturally encounter during breeding. The propagation team has detailed data on the photoperiod and temperature experienced by each species, and is able to reproduce the light cycle, temperature, and humidity in the Breeding Center to match the birds' native habitat year round. The team can even simulate a "rainy" season using misters and create natural forest sounds with audio players.

Each species housed in the Breeding Center has unique requirements when it

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Gut Microbiota

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their health, reproductive success, and survival. Specifically, he asked whether a dietary deficiency of the waterthrush's preferred aquatic prey, mayflies, due to stream acidification affects the health of birds occupying those polluted habitats.

Looking through this new "lens" at our long term study of the Louisiana Waterthrush, Trevelline is analyzing how decreased pH associated with acid precipitation affects not only the macroinvertebrate prey of the waterthrush, but also the microbial community in the guts of the birds. And because particular microbes are associated, for example, with fat deposition and other essential physiological processes, changes in the gut microbiome could have cascading effects on the overall health and performance of the bird. In an important paper just published by the British Royal Society, Trevelline and colleagues have called on conservation practitioners to consider disruption of host-associated microbial diversity as another serious threat to some wildlife populations. ■

Trevelline, B. K., S. S. Fontaine, B. K. Hartup, and K. D. Kohl. 2019. Conservation biology needs a microbial renaissance: a call for the consideration of host-associated microbiota in wildlife management practices. Proc. R. Soc. B 286: 20182448.

Engaging College Students Ensures the Future of Conservation

by Steven Latta

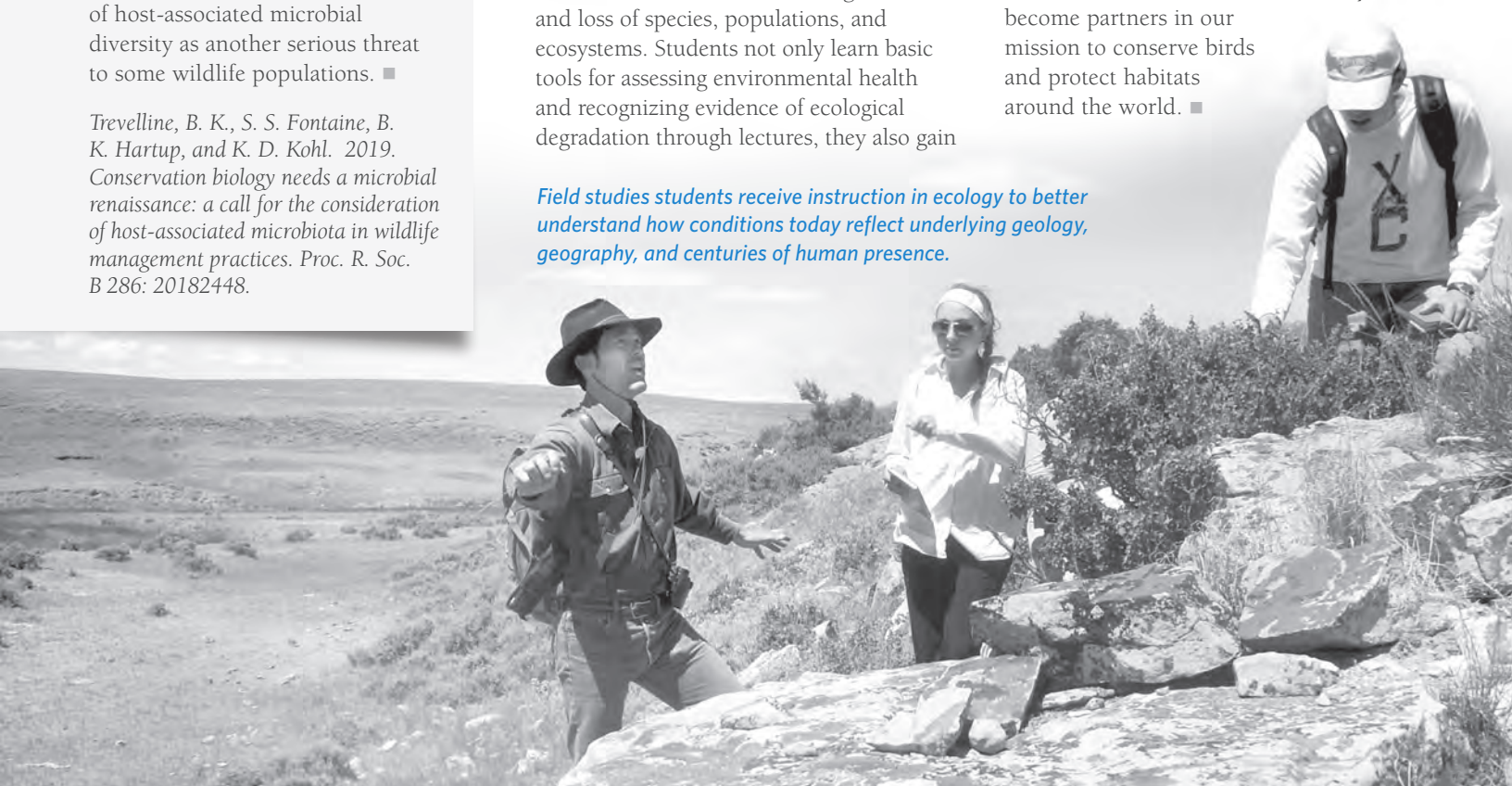
Training the next generation of conservationists is a critical responsibility. Not only does the National Aviary train interns in a variety of professional fields, we also develop and teach field studies classes for college students.

Teaching college students through field studies is an enriching experience that allows students the opportunity to get out of the classroom and get their hands dirty, while also working side by side with practicing conservation biologists. As a professor, I find it rewarding to see students learn and grow, developing a sense of environmental responsibility, and accepting that they have an important role in the earth's future.

One of these classes is held at the Pymatuning Laboratory of Ecology, a field station for the University of Pittsburgh located in northwestern PA. A field course in conservation biology, it focuses primarily on applied aspects of conservation biology — i.e., examining how human activities have resulted in the degradation and loss of species, populations, and ecosystems. Students not only learn basic tools for assessing environmental health and recognizing evidence of ecological degradation through lectures, they also gain an understanding of the complexity of many conservation issues. They learn that resolving environmental problems often involves not just biology and ecology, but also economics, sociology, politics, and more.

Another field course, also offered through the University of Pittsburgh, is "Reading the Earth: Wyoming Field Studies in Ecology and Paleontology." Listed by Pittsburgh Magazine (Sept 2014) as one of eight "Can't Miss College Courses," the course was described as "one of the most innovative and memorable classes that reflect the wide spectrum of higher education in Pittsburgh." This class integrates ecology, paleontology, geology, and archaeology in order to convey to students a deep "sense of place" — the interactions among the landscape itself, its habitats, and its flora, fauna, and human communities, both past and present.

A number of students from field courses I've taught have continued their career development right here at the National Aviary as interns, field assistants, and research associates. From here, many will become partners in our mission to conserve birds and protect habitats around the world. ■



Field studies students receive instruction in ecology to better understand how conditions today reflect underlying geology, geography, and centuries of human presence.

VETERINARY PROGRAMS

Helping Others Help Birds

by Pilar Fish, DVM, Director of Veterinary Medicine

The field of avian medicine is continually growing to meet the needs of numerous bird species and their medical conditions. Because of our highly specialized focus on birds, and the large number and diversity of species in our care, the National Aviary contributes significantly to that growth. Our dedicated veterinarians regularly develop new treatments customized for birds. This scientific information is then rapidly distributed to our students and colleagues, veterinarians, and wildlife rescue centers through conferences, publications, consultations, and on-site training.

Veterinary students and professionals frequently spend weeks to months training at our teaching hospital, where the primary focus is hands-on instruction with generalized patient care and the provisioning of specialized treatments. We also provide consultations for veterinarians, both in the U.S. and internationally. Challenging cases are discussed following careful review of x-rays, test results, and even videos of patients. Online video conferences are sometimes arranged in order for our staff to perform virtual physical exams and discuss treatment options.

National Aviary veterinarians also travel internationally to teach. Recently, we traveled to Ecuador to help our colleagues at Bioparque Amaru, a wildlife center dedicated to helping injured and ill animals and birds such as toucans, macaws, and Andean Condors. We have worked with Bioparque Amaru for years sharing new treatment protocols and even donating the medical supplies needed for procedures. Recently, three Andean Condors in Ecuador were poisoned and in need of immediate medical attention. We had previously developed a novel protocol specific to testing and treating poisoned Andean Condors. We were able to share this publication and additional treatment advice with the Ecuadorian veterinarians, and this helped their condors to recover.

Another recent example of the National Aviary's commitment to innovative approaches to veterinary care comes from our collaboration with SANCCOB, a penguin and seabird rehabilitation center in South Africa. In the past, consultations and medical donations were primarily focused on the endangered African Penguin, but recently, SANCCOB admitted hundreds of orphaned Lesser Flamingo chicks into their facility. The National Aviary sent one of its most experienced aviculturists, along with important medical supplies, to help with this unprecedentedly large rescue effort in South Africa.

Each and every bird that recovers from an injury or illness is important to its species. The expertise of our staff and other flamingo specialists from zoos around the world has given the rescued chicks the best possible chance for recovery and survival. ■

LEFT: Dr. Pilar Fish teaches Latin American veterinarians techniques for performing medical exams on an Andean Condor.

ABOVE: Teri Grendzinski, National Aviary supervisor of animal collections, feeds an orphaned Lesser Flamingo chick in South Africa.

RECENT PUBLICATIONS

What Nesting Success Tells Us About Bird Populations

by Steven Latta

Have you ever wondered how scientists determine whether a bird population is increasing or decreasing?

One way to do this is to calculate the overall nesting success, or the average number of offspring a pair of birds can produce. Although this is very labor intensive, involving finding many nests and monitoring them for survival of the young, its advantage is that you can relatively quickly determine whether a population is growing, stable, or declining.

This approach also allows us to determine basic life history characteristics of the birds, such as clutch size, length of incubation and brooding periods, and details of nest site selection and nest construction. These and other basic breeding ecology data are needed to inform conservation of resident birds.

In a recently published paper, we provided the first assessment of daily survival and overall nesting success for resident and endemic birds on the island of Hispaniola. Hispaniola supports one of the Caribbean's most diverse avifaunas and harbors more endemic species than any other island in the group. And many of the endemic species are of high conservation concern.

Based on more than 600 nests of 14 species, including endemics like the Vervain Hummingbird, we describe the nesting ecology and nesting success of birds occurring in four major habitat types in the Dominican Republic. We calculated that the mean cumulative survival probability (i.e., the likelihood that at least one young bird will survive to fledging) for these birds was 33.6%, which is comparable to other species in the Neotropics.

But an important finding was the critical role of introduced mammalian predators in depressing survival rates. Nest predation was the leading cause of nest failure in our study sites; depending on the bird species, 73% to 100% of all nest failures were attributed to predation. Predation was primarily attributable to non-native mammals introduced via European colonization, such as black rats, Norway rats, domestic cats, and Indian mongoose.

We expect that these data on nest success will be used as a baseline to evaluate bird population changes, but we also highlight new ways to better understand species' breeding ecology and to improve the outlook for Hispaniolan birds. ■

Townsend, J. M., C. C. Rimmer, S. C. Latta, D. Mejia, E. G. Garrido, and K. P. McFarland. 2018. Nesting ecology and nesting success of resident and endemic tropical birds in the Dominican Republic. Wilson J. Ornithol. 130: 849-858.

Studies in the Dominican Republic focused on survival rates of young birds such as this Vervain Hummingbird nestling.

Focal Species Research Yields Conservation Tools

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stream water quality by state and federal resource agencies.

In 2006, Mulvihill invited Latta to take over his long-term LOWA study. Latta, who had been working for years on the wintering grounds ecology of many migratory species, quickly extended the study to the Caribbean in order to understand how stream conditions and changes in the surrounding landscape affect the birds' winter health and survival.

With help from new graduate students, Latta introduced new technologies to better track waterthrush. This included radio transmitters to document the survival and death of young birds after leaving the nest, and also laboratory analyses using stable isotopes and hormones in blood, nails, and feathers to assess how environmental differences affected the physiological condition of LOWA and their reproductive success and survival. Novel "DNA fingerprinting" techniques documented shifts in diet related to pollution impacts, and also enabled a detailed assessment of how changes in food resources affects microbial communities in the bird's gut (the so-called gut microbiome).

Combining many different approaches, our field studies have documented the bioaccumulation of heavy metals associated with hydraulic fracturing, revealed patterns of latitudinal variation in waterthrush life history parameters, and have detected significant between-season "carry-over" effects, where conditions faced by waterthrushes in one season affect their reproductive success or survival in a subsequent season.

Our LOWA research program began as a modest effort to understand long-term reproductive success in a Neotropical migrant species; today it has blossomed into an international effort providing diverse tools for conservation and management of migratory birds. And, we are getting close to that "Holy Grail," too! ■

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Science Guides Breeding

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comes to courtship, nest building, egg laying, incubation, and rearing. Once breeding season conditions for a species are established, the team provides the birds with appropriate nesting materials, nesting sites, and diets. For example, Guam Kingfishers are excavators, requiring nest cavities that the birds can carve away using their long beaks; Golden White-eyes need fine fibrous materials, such as dog fur and coconut fiber, to build their cup-shaped nests. Whatever is needed, the propagation team works tirelessly to provide it to the birds in order to elicit the desired breeding behaviors and achieve reproductive success!

After the habitats are properly designed and breeding season conditions are met, the team takes a hands-off approach, allowing breeding to occur naturally without interference. The team is able to gather data through the use of cameras positioned near nests or other areas of interest. These cause no disturbance to the birds and allow the team to collect data on incubation times, feeding habits, and chick rearing while the birds express their natural behaviors.

There are other uses for cameras, too. Cameras also help the team to determine how well breeding is progressing and if there is a need to supplement care. We can establish exactly when eggs are laid, when they hatch, and how well they are being cared for. Cameras enable the team to quickly determine if there are any problems and to intervene if necessary to ensure egg hatchability and chick survival.

The National Aviary's Breeding Center is home to some of the rarest birds in the world and is an amazing example of how the National Aviary works to save birds and protect habitats. Through the work of the propagation team and breeding programs for endangered species, we are making sure these species continue to thrive, both in human care, and in their native habitats. ■

Nest photos are taken at regular intervals so that the propagation team can closely follow nesting behavior and activity.

BELOW: A successful Guam Kingfisher with chick.