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MONITORING BONEFISH HEALTH: DISEASE DETECTIVE

Collecting bonefish in a seine net along the Mexico-Belize border. Photo: Patrick Williams

Question: What do lowland gorillas, Tasmanian devils, little brown bats and golden toads have in common?

Answer: All of these species have been decimated by infectious disease. Ebola caused massive mortality in gorillas in Central Africa in the early 2000s, a strange transmissible cancer reduced Tasmanian devils to a fraction of their original population in the 1990s, and white nose syndrome has put the once-common little brown bat at risk of extinction across North America. And chytridiomycosis, a fungal disease that swept through Central America in the late 1980s, sounded the death knell for the golden toad of Costa Rica's cloud forest, which is now extinct.

So, what does this have to do with bonefish? That's what we're trying to find out. Infectious diseases (diseases caused by microbes) in wildlife were once thought to be like bad weather or a dip in the food supply—disease would come, do some damage, then disappear and populations would bounce back. But today, there's a new view. It's kind of like Godzilla—disease can seem to come out of nowhere to cause mayhem all by itself. Emerging infectious diseases don't come from nowhere, of course—they come from other species, other places, or from mutated versions of familiar germs. But they can cause permanent population declines or even extinctions if left unchecked.

Could disease be impacting bonefish in places where their populations have crashed, like in the Florida Keys? To be sure, there are many possible causes—habitat loss, climate change, over-exploitation—that are likely contributors. But there's a problem with these explanations by themselves: These are ecosystem-level issues that should impact all species to some extent. But other flats species, such as permit and tarpon, haven't suffered the large-scale decline like bonefish, and non-gamefish species that share the flats with bonefish, such as mullet, mojarra, and checkered puffers, are doing fine. This points to a disease as a possible culprit since a disease can affect one species and not others.

Extracting a blood sample from a bonefish. Photo: Omar Arceo

So, it's not just a matter of understanding bonefish germs—it's actionable science that will aid conservation and help us understand the challenges facing the Florida Keys bonefish population.

Infections can be very specific with respect to the hosts they attack. For example, if you have the common cold, your dog is not at risk. Many microbes, and especially viruses, have learned to exploit particular hosts over the course of their evolution.

Right now, we know basically nothing about bonefish health and disease. In part that's because, if a bonefish population got sick, we wouldn't expect to find a pile of dead fish—sharks, barracudas, and other predators would take advantage of weakened bonefish in short order. We'd just notice one day that the fish aren't there anymore, or at least not like they used to be. Or disease could reduce the ability of bonefish to reproduce, which would result in a declining population over time as fewer juveniles were produced to replace older adults.

In the case of bonefish, we need to begin by measuring the health of normal, healthy populations so we can use that information as a baseline for examining populations that are not what they used to be. We also need to consider how disease works in tandem with the usual suspects of habitat loss, climate change, water quality reduction, and other ecological drivers.

A few years ago, we were able to take a first look. We focused on the gills (a common place for nasty bacteria to attach in fish) and the blood (where viruses often lurk). With a small pilot grant and the dedicated help of BTT's network of scientists and anglers, we sampled fish in the Florida Keys and in the Bahamas. Back in the lab, we conducted "microbiome" analyses of gill samples (that's a way to get a picture of the entire community of bacteria) and "metagenomics" on bonefish blood (a way to "hunt" for unknown viruses). Both methods are yielding fruit. Bacteria on the gills of bonefish in the Keys are strikingly different from those in the Bahamas, and some bacteria in Keys fish are associated with disease.

We've also found at least one previously unknown virus in bonefish and we're trying to understand more about it.

We're now in Phase 2 of the study to expand our sampling to new areas throughout the Caribbean, increase the number of samples from the Florida Keys, and deepen our analyses in the lab. Our objective is to generate the first description of bacteria and viruses in bonefish across the Caribbean so we can begin to understand what's normal, what's abnormal, and what to look for as telltale signs of ill health in bonefish populations.

Importantly, this work will help us conserve and manage the species. For example, if we find diseases in certain bonefish populations but not others, we'd better consider how to keep those diseases contained. This is familiar to those of us who fish for trout and know how important it is to clean our gear between rivers, but have you ever seen similar precautions at a bonefish lodge? If populations are sick, we'd better think about minimizing pressure on them until they recover. If we find a "smoking gun" disease, there are even some new and promising technologies available for controlling it—vaccination or probiotics, for example. So, it's not just a matter of understanding bonefish germs—it's actionable science that will aid conservation and help us understand the challenges facing the Florida Keys bonefish population.

It won't be easy—it's hard enough to understand human disease even with all the resources of the National Institutes of Health and other funding behemoths that support human health research. We're working at the edges of scientific knowledge on a species about which very little is known, sometimes in remote locations. But we need to know. Baselines of bonefish health may be shifting right under our feet, and if we ignore that possibility we do so at our peril.

Taking a fin clip sample from a bonefish. Photo: Omar Arceo