Hey to all you fish enthusiasts out there. Whether you're an avid angler or just curious about fish, we'd like to welcome you to fish of the week. It's Monday, November 15 2021. We're excited to talk about all the fish. I'm Katrina Liebich with the US Fish and Wildlife Service in Alaska,

and I'm Guy Eroh, the prince of pup fish.

we are talking about Devil's Hole pupfish. Our guests are Jenny gum, Jenny's with the US Fish and Wildlife Service, and she's the facility manager at Ash Meadows Fish Conservation Facility. We have Kevin Wilson and Kevin's an aquatic ecologist at Death Valley National Park. So welcome you two.

It's great to be here.

Thanks.

Okay, so Devil's Hole. If we were to be transported there right now where exactly on the map would we be and what specifically is Devil's Hole from like a geological and hydrological perspective.

So Devil's Hole is located on the boundary of Ash Meadows National Wildlife Refuge. And that's about, you know, 75 miles west of Las Vegas. In context of Death Valley National Park, it's about 245-250 miles from the park headquarters in California. So, Death Valley actually has this 40 acre part that is Devil's Hole in Nevada. It's located in a limestone cavern. So it used to be this full cave and about 60,000 years ago, this cave system collapsed, and exposed the groundwater or the window into the aquifer to the atmosphere. So when this happened, the whole ecological community started to grow. And we believe that the pup fish had been present in Devil's Hole for about at least 10 to 15,000 years.

It looks kind of like a little oasis. From what I've seen, it's like a really beautiful color. And it's I mean, it's not a big hole, but this opens up correct into a pretty big underwater cave.

It is. It's about 10 feet wide and about 60 foot in length, and the fish uses about the top 15 feet. It's considered probably the smallest known habitat for a vertebrate species in the world, because the small opening, and that they only use the top portion of Devil's Hole because that's where the food is in the best spawning habitat. We do see him when we go into count the fish in scuba gear down at 70-80 feet though.

Let's talk a little bit about the fish themselves. This genus these pup fishes, they're unlike anything that we've talked about before on this show. So if you could talk about what specifically just sets these Devil's Hole pupfish apart?

Yeah, so pup fishes are in the genus Cyprinodon and they're small bodied. They typically live in pretty limited habitats, and many of them live in extreme habitats that are very hot, and very salty. So there are somewhere around about 50 species, I believe, that are described currently. And they range from along the eastern seaboard coast down all along the coastline, where they're found in salt marshes and

brackish waters. And then in addition to that widespread species, there are a number of species that are found in more localized endemic habitats in the southwest.

What is the mechanism responsible for creating all this endemism and keeping these fish from being able to interact with each other?

Well, a lot of the species that are distributed through the Death Valley region, there used to be a very large lake called Lake Manly, and when Lake Manly dried up, they were isolated in these different areas. So they're often found in spring systems, where they have sort of naturally occurring water feeding their habitats.

Yes, Death Valley is a perfect example about how the pupfishes become endemic to their specific water source. For example, in Death Valley, there's a species that lives in a place called Salt Creek and the water can be saltier than the ocean. It's still considered a freshwater fish.

For folks that haven't seen these fish, they're really beautiful. Could one of you describe what they look like? Like if you were to have one in your hand, like how big and what color?

So we cannot handle the wild population that much we don't use typical population estimates like mark and recapture. But when you look at the fish the male's staring when they're spawning up colors are this beautiful blue iridescent color, the females are typically more drab and olive green. And one thing I like to add about their morphology, the Devil's Hole pupfish, lack a pelvic fan. And so it makes it unique amongst the pupfishes in the southwest, we use a certain technique, a stereo video system to actually measure the pupfish underwater. And it gives us highly accurate, precise, total lengths. And the record book for using this system is 42 millimeters. And so that's the largest pupfish, so I think that's just under two inches. So they're very small.

You could have a whole bunch of them in your one hand.

There you go [laughs]. And did they look different in the captive rearing environment, Jenny?

Yeah, so our captive rearing environment that we have, we have a facility that has a feature that we call the refuge tank. And so this is a very large habitat re-creation of Devils Hole. It's a little bit different than what you might be thinking of in terms of a refuge for fishes. It really is a habitat re-creation, and it's got all the same algae and invertebrates. And they hopefully feel just like at home, as they would if they were out in the wild. But they do live a little bit longer in captivity, and they do grow a bit bigger in captivity as well. We actually collect eggs from the wild population and raise them in a lab-like environment. And those ones don't get that same kind of blueish, beautiful iridescent blue color. But when we move them out to the refuge tank, they do take on that blue color as well. That blue color is one of the things that makes the Devils Hole pupfish special and different from the other species of pupfishes. Usually most of the other species have much more pronounced sexual dimorphism between the species with the males being quite a bit larger and having some blue and sometimes some yellow coloration, as well as some differences in their behavior as well.

And how hot are you keeping in your tank, and is it the same as what they experience out in the Death Valley area?

Our facility is just a mile from Devils Hole. And we do have the same water source. But we do keep it a little bit cooler. The management goals are sometimes in conflict with the goals of trying to have something that really mimics the ecosystem. Because they live at such high temperatures, their reproduction can be limited by the temperature itself. And so when the refuge tank was getting set up, it was kept at a little bit lower temperature, which research has shown increases reproductive output. But as populations become a little more robust and has grown, we've slowly increased the temperature. So right now it's about between 32 and 32 and a half degrees Celsius, which still is a little bit cooler than the wild,

we got a lot of American listeners and Celsius doesn't mean a lot to them. What does that mean in terms of Fahrenheit?

Just under 90 degrees?

Wow.

Perfect.

So I can give you the perspective of living in Devil's Hole proper. So that was all is you know, considered an extreme environment in that it's always 93 degrees Fahrenheit all the time. But on this shallow shelf, when sunlight reaches the water surface, which is only through early spring in early fall in for a maximum about four and a half hours, we can have higher temperatures, or in the winter, lower temperature. So it's more dynamic on the shallow shelf. But at the deep pool, it's a constant source of 93 degree water. So it's extreme environment with temperature, it's like limited. And the dissolved oxygen or the amount of oxygen in the water is really low compared to other aquatic systems that have fishes in them. For example, the background in Devils Hole is to 2.5 milligrams per liter. What does that mean? The other springs in Ash Meadows would be eight, nine, 10 milligrams per liter. So this puts a stress on the fish. And then the sunlight not reaching the water surface in the winter it becomes food limited. The algal communities reduce, the invertebrate communities reduce so they get hungry and we typically lose a certain percentage of the population through the winter.

So they're eating algae and invertebrates. And if if so what are the invertebrates they're eating?

are omnivorous, the most dominant species of invertebrates we have a springs snail which is typical in desert springs. It's one of the most common and dominant species. We have our typical dipterans. So your flies, a few species of those. We found about 16 different types of invertebrates, a few insects and a few types of worms. But it's depauperate compared to other spring systems.

Was this an underwater cave system that collapsed or did this happen after the lake had already receded, and if it was after, how did the puffer fish then get in there?

So that's the big question: where the fish come from? Devils Hole is right in Ash Meadows where there's a lot of other spring systems. So the geology in areas created groundwater to come to the surface and create all these springs, but Devils Hole is the highest elevation wise. So there is an evidence that it was actually connected to the wetter lake down in the Amargosa Valley. And so this system kind of evolved separately and first from the other species that are found in Ash Meadows. So there isn't geological evidence that shows an outflow into Ash Meadows. That can be because there would never was, or it's been eroded away. limestone rock is very fractured. So at some point, these cracks connected to the wetter portion of the Amargosa Valley, and fish were able to move in and out and then finally became isolated when the water did connect.

In Ash Meadows, we have seen fish move underground. So a couple of times, in the last couple of years, there's been areas where new water sources basically appear. And so the water bubbles up in a new area and starts an extension of a stream system where all of a sudden there are fish. So we do know that they the fish can travel subterraneanly, and move into new areas. But it's thought that the connections between Devils Hole and these other regions haven't been open for quite a while.

So this is an extremely isolated fish. And I know the numbers are small, just given the size of its habitat. What kind of numbers are we talking through time? And could you guys talk a little bit about their status?

So historically, say pre mid 1990s, the population ranged between say 200-250 in the spring, and 450 and 500 fish in the fall. But in the mid 1990s, we saw this decline in the fall population, we hit an all time low of 35 observable pupfish in the spring of 2013. Previously, in the spring of 2006, and 2007, it was 38. But our most recent count that we had just a few weeks ago, we had 174 observable pupfish, which is still below historic levels, but it's been slowly increasing, we're kind of in a stable situation, the last time you're able to get in the water and count the fish was in the fall of 2019 then COVID hit. Well we were unable to dive. And so people ask how do you count the fish? We don't use your typical mark recapture ways to count fish, we actually count the whole population. We have divers, two teams of two: a science pupfish counter and a safety diver that descend about 110 feet. And as they go to the surface, there's a certain pathway, the divers take and count the fish. And we've been doing this same method, relatively same method, since 1972. And so while the scuba divers are counting fish, there's a team of three that are counting fish on that shallow shelf. And then we add those two numbers together to the first diver. And that gives us somewhat estimate a population size.

That's pretty unique. There's not a lot of populations where you can get the full census every year. It's super cool. So these fish are listed as endangered. What are some of the other threats that they're facing?

There are concerns about the levels of inbreeding and possible mutational meltdowns, genetic meltdowns and so called all different things. But the fact that the population did go through, at least we know of two bottlenecks where the adult population size was in the 30s is very, very small - amongst some of the smallest bottlenecks for wild, wild species or species in the wild, and very limiting in terms of the genetic variability that might be left in the population after that bottleneck event.

So normally, when we think of an endangered species being on the list, the goal is to eventually get that species off the list and self sustaining however, with a population that has such an small natural size This species has gonna have to kind of always be on life support to so to speak, or is there a long term goal to maybe get this delisted?

Right, so delisting is probably not an option because this is the only place that it's found. Now, one of the older management plans from 1990 did call for the captive population to have at least two additional captive populations off site and Jenny is the facility manager at one that's really doing well. The likelihood of it being delisted is not a, you know, my lifetime maybe down listing to threatened but small population size, one habitat in the wild where it's found, it's unlikely from my point of view.

According to the recovery plan, there is not an option for delisting at this point. So it can be downlisted if a number of recovery criteria are met. And that does include multiple captive populations that are self sustaining, as well as the Devils Hole pupfish is part of the Ash Meadows recovery plan. So it does include a number of recovery goals for the greater area as well. So there are some things that are going on in some of the other springs that would also need to be met for that to be down listed. But in that most recent recovery plan, there is no option for it to be delisted.

Okay, so I live a couple 1000 miles away from Devil's Hole. I live in Anchorage, Alaska. But I learned that the pupfish and myself have a shared experience. And that's the 2018 earthquake that happened here, just north of Anchorage. And so while I was kind of like running around, cursing, taking my kids into the doorway to hide from like all the shaking going on, I heard that the pupfish also experienced that same earthquake, and I heard that it caused them to spawn and I just wanted to hear from you guys what exactly happened? I think that's so amazing.

That's a great question. That is one of the really cool fun facts about Devils Hole in that earthquakes around the world can cause waves. They're called a seiche - earthquake induced waves. And that 2018 earthquake created waves in Devils Hole. And also, the more recent earthquake just at the end of July of this year, really shocked Devils Hole. And what that does, it redistributes sediment on the shelf kind of resets the ecosystem. So there's short term negative impacts, because the eggs and those little fish that can't swim that well most likely perish. But there's long term benefits in that if there is a period in which we don't have earthquakes to clean off the shelf, that can be a buildup of material that's decaying and creating anoxic are areas in which it's not conducive to egg hatching and larval success with really low or lower oxygen levels. But yes, that you know, we do feel those around the world. Typically, the Ring of Fire is where the earthquakes will impact Devils Hole. And it's typically based on the magnitude 6.0 and greater.

Yeah, that was a seven.

Yep. And of course, location.

I thought that was so cool. Thank you.

I'd like to talk about non natural disasters a little bit. So this is a seemingly controversial species, especially when you start talking about water rights out west. I can imagine I mean, it went all the way to the Supreme Court. It's a big issue. Have you ever experienced any issues with people trying to breach the perimeter who don't like the pupfish?

Oh, yeah. So in the 70s, there were two bumper stickers that you'd see on cars around in the area, one that said, "Save the Pupfish!", and then another that "Kill the Pupfish!" So those sentiments are still alive and well in the community because as you say, the Supreme Court decision in 1976 regulates water use in the Amargosa Valley in some times farther out to Pahrump Valley, where the largest community is in my county. So most recently, I believe it's 2016. We had a few individuals that had been drinking, they were on their OHV or ATV, they broke a fence, they shot up some locks, they jumped in, they went down to the water surface, they puked the wind for a swam, they left their boxers in the water. So they ended up killing a pupfish and one of them spent a year and a day in prison. So people do stupid things. And it's unfortunate. That's why we have the fence up with some barbed wire but it doesn't limit or stop people from breaking in.

We do hope that those sentiments are changing and then we do a lot of outreach and work in the community and the Ash Meadows National Wildlife Refuge also does a lot of work in local schools and in the community. And I think that we start to see some of those attitudes changing with younger people and with the younger generation as they learn about the Devils Hole pupfish and the unique ecosystems that are found in their backyards.

Is the public able to come view the refuge tank and if so, how do they go about that?

The refuge tank is a The Fish Conservation Facility is not open to the public. But you can visit the Ash Meadows National Wildlife Refuge. We're working on getting some video and we do have video of both Devil's Hole and the fish conservation facility in the visitor center there. And there are other springs where you can get a bit more up close and personal with other species of pet fish that live in Ash Meadows. There's two different boardwalks where you can go out and walk and see some of these springs and very easily spot the pupfish. Pretty close.

We've covered a lot of species so far that are like, yeah, people eat them for food, they're fishing for them. So I guess, finding that intrinsic value? I mean, what would you say to folks that maybe fall kind of in between those two extremes? or to you know, I guess on either end of that spectrum?

Or how would you convince the people who are putting "kill the pupfish" bumper stickers on their car that this fish that seemingly to them, all it's doing is keeping them from being able to use water that they see is theirs? Why use all this taxpayer dollars to keep it going?

That's a great question. And I get that question a lot. Who cares about the pupfish? You can't eat them. You can't fish for them. And so I have several responses. And it depends what hat I have on. A famous conservationist/ichthyologist/geologist/biologist Bill Pistor, his response would be: "Who cares about you?" You know, I don't like to say that. But I like to say, you know, one avenue I take this, like, you know, pupfish is live in extreme environments, specifically, the Devils Hole pupfish that you're looking at

here. What type of medications do you take, you know, these are developed from animals, typically from species that live in extreme environments. And I also put on the society hat that says, we need to preserve and protect these special places for future generations. Society needs to make those decisions. And it does, in many ways of what is important. Is it cute and fuzzy? Well, no, it's blue and iridescent, and beautiful. And so we try to convey the ecosystem services, the water and how important these special species are just to humankind.

I think in terms of the responsibility that we have to protect the fish, it's to a certain extent, we don't know what their population size would be, we don't know how they would be doing if their water level had never gone down after the pumping in the late 1960s. And while the water level did come back up, it didn't come all the way up to historic levels. And so I've heard Kevin say this before, so I'm stealing one of his answers. But part of the responsibility that we have is to take care of the species because they're imperiled or endangered to a certain extent because of the actions of humans in the first place. So while they still would only live in one place and one habitat that's still very small, the population size could be quite a bit bigger if there hadn't been human impacts in the first place.

Kevin and Jenny, were super happy to have you on the show. Thank you so much for joining us.

Really appreciate it.

Thanks for having us.

It was a pleasure. Thank you.

I hope everybody gets out there and enjoys all the fish and appreciates the pupfish. Thanks for listening to fish of the week. My name is Katrina Liebich. And my co host is Guy Eroh. Our production partner for the series of Citizen Racecar. Produced and story edited by Charlotte Moore. Production management by Gabriela Montequin. Post production by Alex Brower. Fish of the Week is a production of the US Fish and Wildlife Service, Alaska Region Office of External Affairs. As the Service reflects on 150 years of fisheries conservation, we honor thing and celebrate the whole community individual's tribes, the state of Alaska, our sister agencies, fish enthusiasts, scientists and others who have elevated our understanding and love as people and professionals of all the fish