Tracey: Hello, and welcome to NC State's Audio Abstract. I'm your host, Tracey Peake. Providing veterinary care to aquatic animals like turtles and fish can be challenging, even when you have a vet school's resources at your disposal. We're speaking today with Greg Lewbart, a professor of aquatic medicine here at NC State's College of Veterinary Medicine, who knows that when treating turtles and fish, innovative solutions are part of the process. Welcome, Greg.

Greg Lewbart: Hey, thanks, Tracey.

Tracey: I'm glad you could be here. Let's start by talking about what makes treating fish and turtles and reptiles different from your so-called standard pets, mammals like dogs and cats?

Greg Lewbart: Yeah. Well, it's a great question. And it probably all starts out with basic anatomy and physiology. So I think we'll divide those groups up into two. So we'll start with fish. Most fish swim around in the water most of the time, and they have gills. So they get their oxygen from the water and so they respire in the water, whereas terrestrial animals, mammals and also reptiles, breathe air. So that's a big challenge, but not insurmountable and actually quite manageable is when we're working with fish to make sure their life support needs are met, and that involves some innovation, creativity, but mostly it's just about pumping clean water over their gills whenever we're doing things with them.

Moving on to the reptiles, let's talk about turtles. Probably my favorite group to work on. They've got that big shell, right? It's bone. They're the only animals in the world where the shoulders and the hips are inside of the ribs. So they've got some odd anatomical challenges compared with mammals and birds, but again not insurmountable.

So sometimes that makes our jobs easier and sometimes it makes it harder. So all in all, I think the key to being successful or at least to learning is being willing to accept the challenges that these different animals present and then try to use a cliche to MacGyver your way through the cases.

Tracey: Right. That's what I was thinking. Or maybe a MedGyver, in this case.

Greg Lewbart: MedGyver, I like it.

Tracey: Well, you helped found the turtle rescue team which is a pretty popular group here, and you regularly do help treat injured sea turtles. If a human breaks a bone, we're going to put a plaster cast on it and just immobilize it. But you can't really do that with turtles. What are some of the other strategies your team has found useful treating them?

Greg Lewbart: Sometimes it will take a yogurt cup and stick the turtle on top of that and then we can go and have a snack or prepare something and that turtle is just sort of suspended in mid-air and it can't get away. So we use plumber's putty, clothing hooks from ladies dresses. We use those to secure fractured shells with super glue or sometimes the medical formulation of it. But a lot of times as we've talked, Tracey, we're going to Home Depot or Lowe's to find some things we need and because these animals present some challenges. If they're pretty severely injured or the stabilization process is going to be involved, they're anesthetized. So the yogurt cup is out of play. But the yogurt cup or whatever other cottage cheese cups are actually quite good too, where that comes into play is usually wound management, dressing wounds, examining turtles.

But let's take it a step back because it's a great question. So I graduated veterinary school 32 years ago. So I've been at this for a while and even when I was a student back in the mid '80s, I remember watching and learning to fix turtles with fiberglass and Bondo. Like you might fix a car or maybe a hole in a boat. I understand where that comes from, but it's sort of skipping over the part where the shell is made of vascular bone, it's alive.

I mean, that works great if you break a vase or something, but there's an animal under that. So when I got to NC State, I officially started in January of 1993. We're talking before there was any kind of active internet and certainly social media, and there was no turtle team, but still people put two and two together. I found a turtle on the road. My dog chewed up a turtle. There's a college of veterinary medicine in town. Let me go see if they can help.

So I think that first year in 1993, I saw about 10 turtles. These were Good Samaritans, bringing the turtle and in those days they would page me, "Hey, Lewbart, there's a turtle. You're a turtle guy." I'd come look at it and I'd start patching it up the way I was taught. And the turtles were dying. So that next year, I think we saw 30 turtles and then I connected with a local wildlife rehabilitator named, Linda Henis and then we formed a team. She would triage turtles and if she thought they needed a veterinarian, then she would bring them to me.

It's not just me. I did start the turtle team, but my colleague, Dr. Stoskov said, "We really need to get the orthopedic surgeons involved. Let's raise the bar." So we brought over Dr. Rowe and Dr. Marcellin and we said, "Look, we got these broken turtles and there must be a better way to fix them."

I'm not saying we invented this. People all over the world have been coming up with different techniques, but they said, "Well, why don't we treat this a broken bone and a dog?" And you mentioned stabilization. That's the key. However you can do it, however you can reduce the fracture so put the ends together, clean, healthy vascular with blood supply ends together and then stabilize it so it doesn't move. That is the goal, whether that's with duct tape or clothing hooks. But the technique, the orthopedic surgeons helped us with were surgical screws and wires.

You basically drill holes in the shell, thick screws in there. Not real long screws, maybe just a few millimeters and then you do a figure eight wire to cinch the bone edges together. We published on that and we did that for, oh, I don't know, maybe 15 years. Maybe almost 20 years. And it was working, but it does add more trauma to a turtle. Sometimes we were drilling eight, 10 a dozen holes into a shell and it was really veterinary students that said, "Can we do this without drilling more holes in the turtle?" And there was a paper published in 2008 with the clothing hook method. So these were colleagues in Boston that did this work. Then we switched over to a less invasive method most of the time. Now sea turtles, it doesn't work as well with sea turtles. First of all, they're in sea water. That's a challenge and their shell is actually a little more spongy than let's say a box turtle.

So sometimes, we're still putting in screws or plates, actually stainless steel plates because they're such big animals in many cases. We're always evolving and changing and frequently that's driven by students.

Tracey: Right. I think it's interesting that we've moved from treating a turtle shell like a car with like Bondo to realizing that these are bone injuries just like people have, just like dogs have and then moving to even less and less invasive ways to treat it. It's a neat evolution to watch even though it's hilarious to see when you come in and there's a little turtle with ladies dress hooks glued to the back and wire woven in among it.

Greg Lewbart: In fact most of the top shell what we call the carapace is a combination of fused ribs, fused backbone, and something we call dermal bone. It's a bone that comes from skin cells.

Tracey: That's amazing.

Greg Lewbart: And then the other thing about turtles and amphibians, other reptiles is that they don't have a diaphragm. So they have no chest.

So this is another thing that's different than the standard mammalian medicine whether it's human medicine or veterinary medicine is they just have a bag of guts, right? I know that's really taking it to the basic level, but when you're dealing with a human or a dog, the pressure is different in the chest cavity than it is in the abdomen, so that we can breathe and exchange gases. And then there's that diaphragm, when you get the hiccups or you get the breath knocked out of you, that's what happens. But reptiles, everything is all together. So it makes it simpler in a lot of ways actually, but the liver and the stomach, and the intestines actually touch the lungs.

Tracey: Oh, wow.

Greg Lewbart: Yeah. Other quirky things about reptiles is they're generally what we call very hypoxia tolerant. They can hold their breath a long time.

A sea turtle probably... It's so funny. We'll have them under in... If it's someone who hasn't anesthetized a turtle before, especially a sea turtle, and we'll have them under anesthesia for an hour and then someone will say, "Hey, what's the heart rate?" And we'll say, "Oh, it's two." They'll say, "Two? Two what?" We'll say, "Two beats per minute." For us, that's fine, but that would not be a very healthy mammal.

Tracey: Not at all, not at all. That's amazing. Two beats per minute.

Greg Lewbart: I mean, their swim around rate is probably dependent on the species and temperature and size, because that's the other thing about these cold-blooded animals. Their physiology is very much determined by their environment. Well, we're 98.6 where mammals and birds have what we call homeostasis. Everything is pretty much the same most of the time. We do a lot of things to regulate that. We wear clothes and we heat up the house and we move blood around a little bit.

But these animals, they can change a lot. Sea turtle probably in the wild can hold it routinely hold its breath for an hour. In a pinch, probably three hours. Think about turtles, let's say in Canada like a snapping turtle or a painted turtle. They live under ice for four or five, maybe six months a year. They don't breathe at all. They have some different tricks like they can turn their mouth and their rear end, the opening of their vent into a little gill.

It's very vascular, what we call a mucous membrane and they turn parts of themselves into gills so they can survive. And they slow everything down. They don't need much.

Tracey: Does that have an effect on how long it takes a turtle to heal from an injury as well?

Greg Lewbart: Yeah. Great question. We'll throw out some numbers. Let's say your dog gets surgery and it has sutures put in. Most veterinarians are taking those sutures out in 10 days, maybe 14 days. Reptiles, I like to leave sutures in for six weeks. Very minimum four weeks. A couple more weeks just because they heal slowly.

Now, fish, it's interesting. Even though fish are cold-blooded, they heal pretty fast and I think that's because they have to... If you're a fish and you've got somebody took a bite out of you, you really need to close that thing up pretty quickly or you're going to be vulnerable to other predators and parasites.

Tracey: Well, that brings me to the next question I had, which is fish nowadays, we've come a long way from you win the goldfish in a bag at the state fair and it maybe survives a week kind of thing. They're very precious now both in terms of value. You have people raising koi, for example and spending thousands of dollars, and an emotional attachment. They're even surgical candidates. How has this evolved? How has this changed? How is the treatment of fish basically evolved since you started your career?

Greg Lewbart: Yeah. I love that question. That's a really good question. It's interesting. I have worked on fish, looked at fish worth more than race horses, worth more than some people's houses. It's hard for people to process that. I looked at a fish in 2001, I was in Japan giving some lectures and I visited the largest koi farm and largest fish farm in the world outside of Hiroshima and the owner's son asked me if I would look at this one particular fish that was behaving abnormally. This fish in 2001, the owner turned down $200,000 for it.

Tracey: Good grief.

Greg Lewbart: Since then, the record koi fish, and you can look this up, is $1.6 million for a fish. Fish that weighs about... I mean, this isn't your average fish. I mean, this is a fish that's a meter long so over three feet long probably weighs about 40 pounds. Now, that's the Van Gogh. That's the Picasso of the fish world. There's plenty of other regular old fish and it goes all the way down. But I certainly have seen my share of six figure fish and plenty of five figure fish yet, and I think some of my best clients, I won't even say I think, my best clients are fish clients and in particular goldfish clients. People that own goldfish and love their goldfish, I'm telling you I could go through a long list of dedicated goldfish owners including some that come from a fair that managed to survive whatever the obstacles are. The oldest goldfish patient I had died at 29 years old.

Tracey: 29?

Greg Lewbart: 29. This is a regular old goldfish. I've seen plenty in teenagers. I had a koi patient that now is in its 40s, if it's still alive. It actually survived its owner.

Tracey: Oh, wow.

Greg Lewbart: Its owner passed away. But your question was, how are things changed? How I got into this whole game is I graduated in 1988, the University of Pennsylvania and I wanted to be an aquatic animal veterinarian.

Look, there have been people doing fish medicine for many decades, but very few were veterinarians. They were fisheries biologists, aquaculturists, researchers, that sort of thing. Veterinarians got into the game a little late. Let's bring it back to the when I started here. I saw a fish in 1993 named Zeus. Zeus is a Midas Cichlid. This is a fish like an Oscar. Most people kind of know what an Oscar is or a Jack Dempsey. The size of like a big sunfish. People loved it. It had a swim bladder problem. I spoke to the Raleigh Aquarium Society and these people said, "Hey, we've got this fish named Zeus. We really love him. He's standing on his head. He's been like that a couple years. Can you help?" I said, "I don't know, but we can work him up."

Really for me, the way I've been able to succeed is in the vet community or the vet environment is with all the specialists there. I rely on a team approach. Hey, let's get X-rays and let's get a surgeon involved. Then that case, we operated on that fish. It was a 70-minute procedure. We took out part of the swim bladder, sutured him up. He recovered.

We published it in the Journal of the American Journal of Veterinary Medicine. I'm fairly sure that's the first published surgery case of a pet fish. Now, it's routine. now we see about one pet fish a week at NC State.

Tracey: You're talking about Zeus. He's a pretty sizable fish comparatively. What about these little tiny gold pet store gold fish?

Greg Lewbart: The Chinese fighting fish, the betta fish?

Tracey: Yeah, or the betta fish.

Greg Lewbart: This year we've seen maybe four or five.

Tracey: A fish that size, what exactly can you do for them?

Greg Lewbart: We're limited. I'll give you a success story recently. So there was a betta fish. It's actually owned by someone at the vet school. I think it's three years old. It just looked bad. Its color didn't look good. Its fins didn't look good. Its water quality was apparently okay. It lives by itself. So that's a big help. When a fish is only living by itself and other fish aren't coming in contact with it, that bodes well for the diagnosis because it probably doesn't have something infectious that was introduced. A lot of people don't properly quarantine fish.

What do you think? I'll put you on the spot. So you've got this fish, it lives by itself. The environment looks good to me. The tank looks good. The water looks good, but the fish just doesn't look good. If this was a dog or a person, I mean, what kind of thing might you think to ask about?

Tracey: Is the fish eating? Is the fish going to the bathroom? Basic stuff.

Greg Lewbart: Yeah. Right off the bat, is it eating? Yes. But what is it eating? So here's the thing. And this is really what exotic animal medicine boils down to is what... We have a dog and the cow, and even the horse. And most domestic, even chickens, pretty figured out. We know how to take them from a little baby and grow them into whatever purpose we want, pretty efficiently and relatively safely or without disease. Not completely and there are issues, but many, many decades of research and experience have gone into it.

There are 30,000 species of fish. There's one species of dog. Different breeds, but they're all the same dog. 30,000 species. Now, I don't know in my career. I could probably figure it out. Maybe I've worked with 300, right? What is that? That's 1%, and that's that's probably being a little generous. When I say work, like I've netted them, treated them. Then if you think about, well, what do we really know about those animals? What do they eat in the wild? Who are their friends? Who are their enemies?

I mean, it's just very complicated. Then we try to replicate that in a 10 gallon tank. It's a big ask. A lot of people say, "Well, why isn't my chameleon doing well? Or why isn't my discus fish doing well? Or why aren't these corals thriving?" My answer is it's a high bar to get over to figure out how to replicate nature. Okay. So let's get back to our betta fish. Kind of have them figured out. These are raised in captivity. They're raised in in Thailand where they're native.

But one of the problems fish food off the shelf, and we've made good strides with nutrition, but that stuff has a shelf life and one little betta fish like a jar of even a small container of betta fish is probably going to last years. But the vitamins are only good for maybe six months. So going back to our fish friend. I said, "Well, what's..." Eating okay. What you thought of. How about the food? I checked the food. They had three containers. One expired in 2014. This is this year. One expired in 2014, one in 2015 and the newest, freshest 2016 expired.

Tracey: Oh, wow.

Greg Lewbart: So it's four years old. I showed the owner that can. She was pretty alarmed. She bought some new fish food the fish looks dynamite now, looks great. Miracle cure.

Tracey: Excellent. Just fresh fish food.

Greg Lewbart: That's it.

Tracey: What about fish that size if they have a swim bladder problem? I've had the betta fish or the goldfish that suddenly one day couldn't dive. They just did this little thing where they were kind of up toward the...

Greg Lewbart: Yeah, tell me about.

Tracey: Sideways.

Greg Lewbart: If I had a magic bullet and it could fix one fish problem, like if somebody said, "Greg, you get to pick it," I would pick buoyancy challenged goldfish. Upside down goldfish, sideways goldfish, goldfish laying on the bottom. It's really not a disease, it's a manifestation of probably a number of diseases. If you think about it, if your dog is sick or you're sick, you're not going to be as mobile. You may lay down. What if you have gas? And I'm not saying that every fish or maybe any fish that floats has that problem, but they are a fine-tuned little animal machine that's neutrally buoyant. And if there's gas anywhere where it shouldn't be in the GI tract, or if there's a swim bladder problem, they can end up floating upside down or on their side. And there are other contributing factors. You know about bulldogs and some of these breeds that we've selected for certain traits that make it harder for them to breathe or run or walk.

Well, goldfish have been selected sometimes to be very round and plump with a big mass on their head or big bags under their eyes and these things all contribute to their tendency to have buoyancy problems. So let's just say we have a goldfish that's five years old and is like that. First, we like to identify the problem. So if the owners are up for it, we'll take an X-ray. Sometimes we do ultrasound. Sometimes we take air out of the swim bladder and make them neutrally buoyant. But I'll tell you that's really just palliative. It's just like a temporary fix. Usually, they fill back up.

I've got a fish patient right now named Teddy. This owner loves this fish. And this is usually the end game for a lot of these fish is they end up being negatively buoyant on the bottom, but pretty happy. They're facing the right way. They can swim and sometimes we have taken part of swim bladders out of fish. Sometimes the swim bladder contracts and gets diseased. Sometimes, if it's a betta fish, there may be very little we can do.

A betta fish weighs about two to three grams, which means you could put 10 in an envelope and mail it with a first-class stamp. An ounce is about 28 grams. That just to put in perspective. They can be a challenge, but we've had a couple betas in the last couple years with cancer. It's like a melanoma in a human, because they have a lot of colorful cells in their skin. I don't know if it's genetic, but we're seeing an increase in cancer in betta fish.

Tracey: That's wild.

Greg Lewbart: A lot of times, they're too small probably to irradiate. You can imagine, it would just be like poof. So we're just limited in what we can do. Mostly we're just trying to debulk the tumor, make it smaller, maybe give the fish pain meds or antibiotics. Size does matter. I mean, you can be limited.

Tracey: Right. And that kind of leads into the follow-up question, which I know that you had a hand in developing one way to perform surgical procedures on fish. So these are obviously not going to be betta fish size necessarily or maybe you have like a little tiny table.

Greg Lewbart: We did once. You've probably heard a zebrafish.

Tracey: Yeah.

Greg Lewbart: They're very important lab animals. Really have probably in some ways surpassed the lab rat for utility in research. Some of these fish are quite valuable genetically, and they're small. They're betta fish size. We did do surgery on one. That had a swollen abdomen. This is probably 10 years ago. One of the technicians, rigged up a system using a fluids bag like if you're going to give somebody IV fluids and put the anesthetic water in the bag, and then it had the tube that ran into the fish's mouth and just drip, drip.

The guy that did the surgeon, his name is Tres Clarke. He's now the head vet at SeaWorld in San Diego. And that fish did survive the surgery. That would have been out of my league. That fish weighed a couple grams. But generally, we call it the FADS, the fish anesthesia delivery system that Dr. Harms and I published on back in 1999. That's really meant for fish that are hand size and above.

Tracey: And you guys developed this one. Was this one of those, "Hey, run to Home Depot and let's see if we can figure out how to do surgery on a fish kind of deals?"

Greg Lewbart: It was seeing how we could teach surgery to a bunch of zoo vets in Omaha kind of deal. So this was 1998 and we had been doing some fish surgeries. We had a student named Robert Bacal who actually developed quite an involved anesthesia machine with lots of bells. I mean, I would say bells and whistles, like valves and different things. It worked great but it was on a big cart. It wasn't shippable. We could wheel it around, but it really wasn't modular.

Craig Harms and I were asked to go out to the zoo vet meeting and teach zoo vets fish surgery. So we made this machine with a pump and some tubing, and an aquarium. We went and bought some mattress material and electric knife and put this thing together.

We figured out we could do them for about $25, and then we shipped 10 or 12 of these to Omaha. We just took a lot of components and put it together. We didn't invent the pump. We use an aquarium pump, some tubing from Home Depot, some mattress material from a mattress shop and we had a plexiglass company make us the tops.

Then really if you can imagine, it's nothing more than a fountain like you might have in your bird bath. And the water just recirculates and then you put anesthetic in the water and then the tube instead of coming out of a frog's mouth on your fountain, the tube goes into the mouth of a fish and irrigates the gills with water. You can keep a fish under for hours.

Greg Lewbart: People are doing some creative stuff in the decade since. Some people make a trough like a V and they may line that with some surgical towels or some kind of soft material. So we still use the foam sometimes, but we've actually further modified that fads. One of our technicians, Kent Passingham, we call it the KADS now after Kent's anesthesia delivery system. Instead of an aquarium and Plexiglass which are somewhat expensive, he uses a like a Rubbermaid sweater box and a cutting board. And then that sits neatly on top.

These things are stackable, very easy to clean. Let's say your fish is three feet long. You're going to have to MacGyver it, right? But there are all kinds of ways to do it. You can use a bigger Rubbermaid container, a bigger pump, bigger tube. So it's always frequently a challenge, but always fun.

Tracey: Yeah, I like it doesn't have to be high cost to be high enough tech to get the job done, so that's good to know.

Greg Lewbart: Yeah.

Tracey: That brings me to my final question, which is what is your favorite success story in working with aquatic animals?

Greg Lewbart: That's a great question. So I find a lot of times a little bit like the betta fish in the food, sometimes the most rewarding cases are the simplest ones. I'm not sure it's anything I did or didn't do, but it's a really rewarding case. It probably goes back to about... Let's see, about six or seven years ago. I got an email from a potential client that their koi just wasn't doing well and they had been nursing it along for a couple weeks.

It was laying on its side and it was curled up, usually a bad sign. In other words, the tail was curved up like a C. So that's usually not good when that's happening. And it was laying on its side and floating a little bit. I think it was the left side that was up. The only thing it had going for it... Well, I had two things going for it. It was still eating when the owners hand-fed it. So when an animal is still taking nutrition, that's one thing that's in your favor as a clinician.

The first thing I think of when I see a koi that has a curved spine or can't swim, but the other fish in the pond are okay, which they were because I think about trauma. And in particular, this is going to sound pretty crazy if you haven't heard it before is lightning strike. It's documented that a lightning storm, a thunderstorm, with lightning that strikes in or near a pond can break the backs of fish.

They think it's the electric surge, the acute electric surge that causes a rapid contraction of the muscles. I've seen this. It doesn't affect all the fish in a pond. So the first thing I asked the owners is, "Since this happened, have there been any thunderstorms?" "No, and the other fish were okay." So I thought well maybe it's not that.

So then we X-ray'd it and the spine looked good. But it was curved upwards as I mentioned, but it wasn't what we call scoliosis, which is a curvature of the spine like a sigmoid. It looked okay. The swim bladder looked big on the left side, abnormally big. So we anesthetized the fish. We had ultrasound on. We put a needle in the swim bladder and pulled out air until the fish was neutrally buoyant in the middle of the water.

But in my experience as I mentioned earlier, there's usually some problem that causes that air to return and there's some anatomical peculiarities. Koi fish and goldfish are real closely related and those fish actually gulp air. They can take in air and it goes into their swim bladder and they can burp air out. But if there's a problem in that anatomy, then they could end up having buoyancy problems.

So this fish was a bit of a conundrum, right? It was very skinny. It had the swim bladder issue and the curved tail. Typically, what we'll do is treat the treatable. The water quality was good. I don't think it had any parasites. We put it on antibiotics because sometimes they can get a swim bladder infection. They might even aspirate water from the environment into the swim bladder. It's possible. So we put it on antibiotics. We added salt to the water. Freshwater fish can tolerate a fair amount of salt and sometimes it probably helps them with their fluid regulation and also replaces some electrolytes like sodium and chloride.

So we did that we made sure the owners kept feeding it. In the back of my mind, I thought best case scenario is the fish spends the rest of its life on the bottom, but more or less happy, eating just not swimming normally. That was I thought would be a good outcome. I have all this documented and I have all the emails from the owner. The fish's name is Flash.

Tracey: Flash?

Greg Lewbart: Flash. So a week goes by and the owner is pretty upset. It's around Easter time. He said, "Flash, really looks pitiful. We're giving it the antibiotics. It's eating." Then a week later it's like, "Wow, we've noticed quite a change in Flash. He seems a lot perkier and he's actually getting up off..." I think after we took the air out, he sunk for a while and they said, "Oh, he's getting up off the bottom." Then a week later they said, "We can't..." I don't think they used the word miracle, but they said, "This is amazing. Flash is swimming." Then a week later, he was out in his pond.

To this day, I don't know how that fish recovered. That's the only koi fish with a problem like that that I have seen recover, what I would say is 100%. That's my favorite outcome. I wish I could repeat that. I think you can't underestimate the power of good nursing care, what those owners are willing to do, hand feed it and treat it and baby it. They send me a picture every year.

Tracey: What's the average lifespan for a koi fish? We've talked about the seriously old ones.

Greg Lewbart: They're very sensitive. You've got to really stay on top of the water quality. I can tell you horror stories about koi in North Carolina, hurricanes, power outages, ice storms, predators, blue herons, all those things take their toll. But your question is a good one. I would say, hurricanes, blue herons, other disasters aside, probably 15 to 20 years old.

Tracey: So well worth the investment, surgery and medical treatment and all that.

Greg Lewbart: Well, worth it. And these animals, they do respond to their owners. If you talk to koi people, they say, "My koi knows my shadow, my cadence, the way I walk.” They really do respond to certain people. I had a client, she brought her goldfish in for us to treat. We were going to work it up and it was in a white five-gallon bucket and then she left. These were in the days when owners came into the vet school and I hope they're going to return soon. And then she came running back in. She said, "Oh my goodness, I forgot to kiss Bubbles goodbye." She reached in, picked up the goldfish, kissed it on the lips and put it back. There are seriously people that kiss their fish.

Tracey: That's amazing.

Greg Lewbart: The human-animal bond can go to a lot of different species. It's pretty cool.

Tracey: That is indeed. Well, thank you so much for being here and sharing these great stories today. I was amazed at the stuff that people will do for their pets and the way that treatment has evolved as pet ownership has expanded in different and interesting ways.

Greg Lewbart: It's very enlightening and enriching, and I really appreciate the opportunity, Tracey.

Tracey: We've been speaking today with Greg Lewbart, professor of aquatic medicine, here at NC State's College of Veterinary Medicine. This has been Audio Abstract. I'm your host, Tracey Peake. Thank you so much for listening.