

TRANSCRIPT

INTERVIEWEE: Lyubov Burlakova

INTERVIEWER: David Todd

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David Todd [00:00:03] Good morning. My name is David Todd, and I have the great privilege of being here with Dr. Luba Burlakova. And with her permission, we plan on recording this interview for research and educational work on behalf of the Conservation History Association of Texas, and for a book and a website for Texas A&M University Press, and finally for an archive at the University of Texas at Austin, in its Briscoe Center for American History.

David Todd [00:00:33] And I want to stress that she has all rights to use the recording as she sees fit.

David Todd [00:00:40] And I wanted to make sure that that's okay with you before we went any further.

Lyubov Burlakova [00:00:44] Yep.

David Todd [00:00:45] Great. Okay, well, let's get started then.

David Todd [00:00:48] It is Friday, January 26th, 2024. It's about 9:10 Central Time, or 10:10 East Coast time.

David Todd [00:00:59] My name, as I said, is David Todd. I am representing the Conservation History Association of Texas, and I am in Austin, and we are conducting a remote interview with Dr. Luba Burlakova, who is based in the Buffalo, New York area.

David Todd [00:01:16] Dr. Burlakova is a senior research scientist at the Great Lakes Center, which is a research foundation of SUNY Buffalo State College in Buffalo, New York. Previously she was an adjunct professor at Steven F. Austin State University in Nacogdoches, Texas, and also had prior positions at the State of New York Museum Field Research Lab, and the Belarusian State University and the University of Wisconsin in Madison.

David Todd [00:01:47] Dr. Burlakova is interested in the ecology and diversity of freshwater benthic communities, among other topics, and for a number of years was heavily engaged in efforts to survey, study and protect the Texas hornshell, a rare mussel native to the Rio Grande and its tributaries.

David Todd [00:02:08] So, today we'll be talking, with Dr. Burlakova about her life and career so far, to-date, and especially focus on what she can teach us about the Texas hornshell mussel.

David Todd [00:02:22] So, with that, thank you so much for joining us. I look forward to learning more.

Lyubov Burlakova [00:02:27] My pleasure.

David Todd [00:02:28] Well, good.

David Todd [00:02:29] Well, I thought we might talk first about your childhood and early years, and see if there might have been some people or experiences that introduced you to an interest in the outdoors and biology and science, maybe even in mussels in particular.

Lyubov Burlakova [00:02:50] I was born in Guryev. Now it's called Atyrau. It's a city in Kazakhstan, on the Ural River near the Caspian Sea. And by climate, it's kind of resembling south Texas, actually. Yeah. So, both my parents worked in oil exploration, which is also resembling Texas, I guess. And I had a really happy childhood with amazing friendships. I loved reading, being outdoors, travel. I loved swimming in the river, in the summer. And now I wish, oh my gosh, why didn't I check for Unionids there?

Lyubov Burlakova [00:03:30] So, and when I was 13, my family were vacationing in the Black Sea, and that's when I first was introduced to mask and snorkel. And, oh, my gosh, that was the most amazing thing. It was just fantastic, the underwater world that opened for me. So, plus I found the golden boy and the golden ring I could sign for future. So, and of course, by future finds, mussels were much more dear to me and more exciting than this goal.

Lyubov Burlakova [00:04:02] So, and then I loved biology, but I didn't have a really good memory, so I decided on a compromise. I chose biophysics. So, I went to the physics department, which was kind of easier for me. It's kind of, you need to know logic to get around, that's all.

Lyubov Burlakova [00:04:25] So, for me, when I both studied and worked at the same time, and the team of people in my lab, biophysics lab, in Belarussian State University, were really inspirational because we had really strong women scientists, the team of women scientists, and they were, all very good scientists. And at the same time, they were excellent wives, excellent mothers. And they kind of demonstrated for me how you can, basically, balance different aspects of professional life and be successful in both, which was a really good example.

Lyubov Burlakova [00:05:08] But probably the most influential for me was to meet my future husband, Alexander Karatayev. I call him Sasha, as everyone else does. He at the same time was doing research in aquatic biology, and, he took me to fieldwork, which I loved. It was a rainy cols day in October. He was like, "Come". We came back drenched, but I really loved it.

Lyubov Burlakova [00:05:36] So, he also patiently explained to me how amazing ecology is, how it is much better than any other science in the world. And I believed him. And I can sign up as of right now.

Lyubov Burlakova [00:05:49] And that really defined my future career because I was looking for a topic to do my Ph.D., and, I decided on a Ph.D. dissertation on biology, ecology and spread of zebra mussels in Belarus. So basically, we started with, I started with zebra and quagga mussels, and that's what I'm doing right now. Okay?

Lyubov Burlakova [00:06:15] Yes. So, but that part also included some Unionids as well, because we looked at the effect of Dreissenas on Unionids.

David Todd [00:06:25] Well, good. This is a really relevant topic then and now - this spread of some of these exotic bivalves. So, I'm so glad that you had an early start and long career in that.

David Todd [00:06:43] So, we talked a little bit about your childhood and about your education. One other thing that we often ask people, and it sounds like you are a reader, I think you said you enjoyed that.

Lyubov Burlakova [00:06:55] I was.

David Todd [00:06:55] Were there any books maybe in the just the common library shelves, or maybe movies or TV shows that you found to be encouraging or intriguing, inspirational. Anything like that in the public media?

Lyubov Burlakova [00:07:18] Yeah. It's, interesting because my father was a hunter and a fisherman, and when I was small, like five years old, I always was begging him, "Can you please, please take me with you to hunt?" But of course, they were going, it was serious hunting. They were going for several weeks with friends to the estuaries of Caspian Sea. They would bring like hundreds of ducks back and so on. And of course, it was no place for a five-year old to go.

Lyubov Burlakova [00:07:49] But then, I started reading, and one of the first books I read was a book called Grey Neck. It was by written by a Russian author, Dmitri Mamin-Sibiriak. It was about a little duck with a damaged wing and how it tried to go through life and survive and so on. And since that time, I was not going hunting, and always criticized my father for hunting birds. So, that book probably was also one of the first of many, many other books that formed my attitude toward animals. Yes.

David Todd [00:08:30] It sounds like it might have instilled some idea of compassion and sympathy, connection with animals. Well, so that's great. Always nice to have sort of a point of origin to fix for people.

David Todd [00:08:46] And then, movies possibly, or TV shows: was that something that was important for you?

Lyubov Burlakova [00:08:55] Yes, it was. There were several movies. But, at the same time, we were the Soviet Union. We were completely excluded from the outside world, as you know. And I don't know as much like about American movies, for example, at that time. But, there were some really nice movies about like dogs and about animals that we had - really kind and really nice. And I loved watching that. Yes.

David Todd [00:09:25] Yes. Okay.

David Todd [00:09:28] Well, let's talk a little bit about your research. And maybe a place to start would be to talk about the Texas hornshell. And it'd be great if you could give us a sort of layperson introduction to the life history and ecological niche that that hornshell fills. Could you help us get started there?

Lyubov Burlakova [00:09:55] Yep. So, Texas hornshell: the Latin name is *Popenaias popeii*. It's a species endemic to the Rio Grande watershed. And endemic means that it can be found nowhere else but in the Rio Grande watershed. It was first described in 1857 from Devils

River and the Rio Salado in Mexico. And, all freshwater mussels, including Texas hornshell, have a very complex lifestyle and life history.

Lyubov Burlakova [00:10:29] So, usually adults are sedentary. They are covered by like a pretty strong shell, depending on the species. And they can crawl around a little bit, but not much.

Lyubov Burlakova [00:10:42] Males then release sperm into the water and females, and the sperm is taken in by the female through an internal siphon. And then the eggs get fertilized and then the eggs get released into fish.

Lyubov Burlakova [00:10:57] So, from that description, you already can see several, like narrow points where the life, like the lifestyle and life history can be interrupted. For example, if there isn't enough females and enough males in the water to get the eggs fertilized and so on.

Lyubov Burlakova [00:11:25] How they can attract fish? I would suggest you guys to go to YouTube and look at different amazing mechanisms how Unionids can attract fish: say, some of them even make like a little fish on their mantle with eyes, and people are like astonished how you can make eyes if you don't have eyes? But it's so.

Lyubov Burlakova [00:11:57] So, then the glochidia are then attached to fish. They are obligate parasites for fish, and fish is needed to complete the life cycle and for development of glochidia. And then they will detach from fish and then they will get into the sediment and continue growing into adults.

Lyubov Burlakova [00:12:15] And so that's another step. Like fish: so, most of them, through centuries and centuries, adapted to a particular kind of fish. And some are really narrow specialists, for example, for Texas hornshell, we know only three fish so far that they can use.

Lyubov Burlakova [00:12:36] So, now not only are you sedentary and you depend on clean water and running water for reproduction. You also need fish, certain fish, for reproduction.

Lyubov Burlakova [00:12:52] Plus they also filter water. They filter feed by like particles in the water - algae and so on. And so the quality of water will be important as well.

Lyubov Burlakova [00:13:04] And by being sedentary, they are really prone to any kind of habitat destruction and water pollution because they are filter-feeders. And for example, *Popenaias popeii* is known exclusively from streams and rivers. And as soon as people impound and make a reservoir, they will disappear from that habitat, because they cannot withstand siltation and they cannot withstand unmoving water because it's probably not enough food and oxygen for them.

David Todd [00:13:39] That is a great summary of what I'm sure is very complicated and deep.

Lyubov Burlakova [00:13:46] We're still trying to understand it, and it's different for each different species. It's just crazy. Yeah.

David Todd [00:13:53] Well, you have a knack for making something that's complicated be intelligible for mere mortals who this is new to.

Lyubov Burlakova [00:14:03] So, I think you mentioned that the Texas hornshell is found in the Rio Grande watershed. And I was wondering when you were doing these surveys while you were in Texas, what were the sort of particular kinds of habitat within that basin where you would find Texas hornshell?

Lyubov Burlakova [00:14:27] Yeah. To start with, I will just say in the beginning that, we surveyed and tried to find all species of mussels that live in Texas. And every time we would go to a new habitat, we would tell ourselves, forget everything you know, and try to learn. Because every little river in central Texas will have a different habitat for different species.

Lyubov Burlakova [00:14:56] So, Texas hornshell, and that was part of why it was under-researched and under-surveyed, I guess, because it was pretty hard to figure out where they are, because most of the mussels, some mussels will prefer sand, some mussels will prefer silt, some mussel will prefer gravel. In the Guadalupe, you will find them in the roots of trees in the water.

Lyubov Burlakova [00:15:19] But Texas hornshell like, completely needs very different habitats. And it actually depends on the river, because, the Rio Grande is a flashy river. It means that sometimes it will be extremely slow and low, and sometimes we will have huge flooding. And to survive in the river like that, you either have to find like flow refuge, you either have to be like somewhere in gravel or in some kind of shelter.

Lyubov Burlakova [00:15:52] So, Texas hornshell found this shelter under large rocks. So, basically, you approach the rock and you try to stick your fingers under the rock and like, try to feel it. And also, these rocks were not just any rocks - like, certain type of rocks - sedimentary rocks.

Lyubov Burlakova [00:16:18] But as soon as we, started looking and we figure out where they live, then we surveyed about 150 kilometers of river stretch in the Rio Grande around Laredo, and we identified fifteen suitable habitats. So, basically as soon as you know where to look at, because you look at the shore, the shore will have some kind of like, falling rocks. You go into that area, you put your hand under the rock and you find the mussel.

Lyubov Burlakova [00:16:54] So, but it was typical for the Rio Grande, for example, in the city of Laredo, where we found mussel in completely different habitats: we found them in gravel. And we also found them on the rocks as well.

Lyubov Burlakova [00:17:08] So, but it wasn't easy kind to find these mussels that were so cryptic and were trying to hide so well. But they needed these rocks to be protected from this flooding.

David Todd [00:17:24] That's fascinating. It sounds like a real hunt.

Lyubov Burlakova [00:17:28] Exactly. It's a hunt for treasures.

David Todd [00:17:30] Yeah, yeah. Exactly!

David Todd [00:17:32] Well, and I think that you had said that another factor for the life cycle of one of these Texas hornshell is the Glochidia phase where they're sort of parasitizing on host fish. And so, what sort of host fish were involved in their life cycle?

Lyubov Burlakova [00:17:58] So, when we started working with Texas hornshell, not much was known about that in Texas. Most data we had from New Mexico where, Brian Lang worked a lot on the Black River studying its population. So, we knew that there are three types of fish - carpsucker, gray red horse, and red shiner that were identified as the primary fish hosts. And in the Black River, they were carrying over 99% of all Glochidia.

Lyubov Burlakova [00:18:30] And most of them are very small fish. And that makes sense, because if you're sitting in a little niche under the rock, you have to have a small fish coming to you and probably trying to explore this little area. So, it totally makes sense.

Lyubov Burlakova [00:18:48] And I know that, right now, we are still stuck with these fish. I don't think we found more fish in the Rio Grande as well.

Lyubov Burlakova [00:18:58] So, and of course, fish are also affected by water quantity and water quality. And if the fish disappear, the mussels will survive for some time, but they will disappear as well.

David Todd [00:19:11] This is great to know that it's not just that particular mussel, but that it relies on these other creatures in its local habitat.

Lyubov Burlakova [00:19:21] Yes.

David Todd [00:19:21] So speaking of the habitat, of course, the Rio Grande touches lots of areas, from New Mexico to Texas, but then across the border into Mexico, Old Mexico. And I was wondering how you factored that into the surveys. Were you able to go into Mexico or did you rely on partners there? What can you tell us about that?

Lyubov Burlakova [00:19:43] We, really, that was our dream for, like, ten years to get to Mexico and to start searching there. Unfortunately, we were not able to do that. We were trying to find partners, but we were not lucky with that.

Lyubov Burlakova [00:19:56] But I know that now people are trying to go to Mexico and discover new species. And, recently, there was an additional hornshell population found in Rio San Diego, which is a Mexican tributary to the Rio Grande. And, hopefully we will have more research going in Mexico: we will know more about that.

Lyubov Burlakova [00:20:24] Yeah, I would expect that they will be, for example, in the Rio Conchos, because we surveyed the Rio Grande starting from Eagle Pass - not from Eagle Pass - starting from where it crossed the Texas border and coming from New Mexico. And it's just a very small river and like, it's almost like a little channel basically there.

Lyubov Burlakova [00:20:55] And only after the Rio Concho joins the Rio Grande in Big Bend do we start seeing that mussel. So, I would expect they may be in the Rio Concho, or may have been in the Rio Concho, but it also depends on how polluted the city were, how modified the city was, how much agriculture or development is on the shores. So yeah.

David Todd [00:21:14] I see: lots of factors and maybe limits on where you could find them.

David Todd [00:21:20] So, you know, one thing I thought was, was really interesting is that, I think you mentioned that the Texas hornshell was first described almost 170 years ago. And

yet it sounds like it was a real question mark, you know, its life cycle, its, you know, habitat and so on, until you and others got involved in relatively recent times. And I was wondering why you think the understanding of this mussel was so late in coming.

Lyubov Burlakova [00:21:57] I think it was a combination of several factors.

Lyubov Burlakova [00:22:00] First of all, there was a lack of funding, specifically for invertebrates, and a lack of interest, I would say, to invertebrates, because in, Texas, like, the most important species are deer, of course, and other small pets.

Lyubov Burlakova [00:22:15] So, but, then State and Wildlife Service money, funding, became available and that really moved things along.

Lyubov Burlakova [00:22:27] So, and also there was a feel that everything is already lost. We don't have many rare species. For example, there were very extensive surveys done by Texas Parks and Wildlife Department in 1998 to 2001. And unfortunately, they failed to recover any live endemic species in the Rio Grande.

Lyubov Burlakova [00:22:50] And I wanted just to mention that it's not only Texas hornshell. It's also a little tiny mussel which called *Truncilla cognata*, or Mexican fawnfoot. It's also Salina mucket, *Potamilus metnecktayi* ... larger species. They only can be found in the Rio Grande watershed.

Lyubov Burlakova [00:23:10] And if you have this news that nothing's survived, why would you spend money and look more?

Lyubov Burlakova [00:23:20] But we were lucky because, first of all, we had these funds, independent, like, state funding (I mean, it's federal funding going through the state).

Lyubov Burlakova [00:23:30] And we also met Tom Miller. He was in Laredo Community College and he was collecting mussels. And from 2001 to 2008, he collected about 52 live hornshells. So, that was a good indication that they are still there.

Lyubov Burlakova [00:23:50] So, in 2005, this federal funding that I just mentioned, Texas, it's called State Wildlife Grants, became available for Unionids, freshwater mussels, for statewide surveys in Texas. And we were really lucky to get this funding with the help of Robert Howells, who is a really good Unionid expert in Texas. He worked in Texas Parks and Wildlife.

Lyubov Burlakova [00:24:18] And, we got the first funding together with him, and then we continue getting this funding, because at that time there were very few people who actually were doing research on freshwater mussels. You know, we have a very strong research in marine sciences in Texas. But, and there was a generation of people who were doing freshwater mussel research. But somehow we came in between the generations.

Lyubov Burlakova [00:24:44] So, we got this funding and in 2008 we contacted Tom Miller, who did the surveys on the Rio Grande, and we asked him if he wants to join us. And he took us to several places. One was below the Big Bend in like a private ranch where we found like two of these endemic species live - Texas, hornshell and the Salina mucket.

Lyubov Burlakova [00:25:18] And then he took us to Laredo. And in Laredo, he showed us places where we started finding Texas hornshell as well, in the Rio Grande.

Lyubov Burlakova [00:25:29] So, we published a report saying that we found several live specimens of all these three endemic species. And that was exactly the time when Texas hornshell was finally considered for listing, because only one population was known in New Mexico, in Black River.

Lyubov Burlakova [00:25:54] So it was, of course, a big problem for Brian Lang, who describes this population, who was instrumental in submitting this petition and so on and so on. So, he contacted us and said, "Guys, we almost got it listed. And you found a few more. What can we do?".

Lyubov Burlakova [00:26:16] Okay. So, he offered to submit a joint proposal. It was a joint Section 6 proposal, between New Mexico and Texas. We got some money and we started intensive surveys in Texas.

Lyubov Burlakova [00:26:34] And as I already mentioned, when we started to go around Laredo, we actually hired an airboat that was like really fantastic because you can do only as much using kayaks. You can't really cover a lot. And, but an airboat is really fast. And Steve Barclay and his brother, Don Barclay. They really helped us a lot in that. They brought their own airboat, and we were surveying, and all the Border Patrol were coming to us and like, "Oh my gosh, you have such a wonderful airboat!".

Lyubov Burlakova [00:27:18] Yeah. And the airboat could actually go through ... we tried to sample in very low water season and airboats sometimes could just fly over gravel areas and so on and so on.

Lyubov Burlakova [00:27:29] But here's the problem. Now we are working on Rio Grande and we're finding big populations. So, how do we justify that? Because that species shouldn't be listed, if we just found three more populations.

Lyubov Burlakova [00:27:45] So, then what we did next, we wrote a paper and we published it in 2018. We, in this paper, we tried to reconstruct the former area and we've been able like, we've been sitting like accountants trying to calculate how many mussels in this little patch and that little patch. And then we took the whole Rio Grande, and all these other tributaries where we knew that mussels were there.

Lyubov Burlakova [00:28:14] And we were able to show that most of the populations are gone. They were declining. Like the length of the river, which was populated with Texas hornshell declined by 75%. And the total population size declined by 72%. Only 12% of the population is left.

Lyubov Burlakova [00:28:35] So, that was really helpful for us in getting this species enlisted, because there are certain criteria where you can enlist a species. And if you, for example, if you have a very small population, that's easier to enlist. But if you have a large population, how do you enlist? It's only when you show that it's still large, but it's really a remnant of what it was before.

Lyubov Burlakova [00:29:00] So, in addition, in 2011, together with Brian Lang and also David Berg and Ken Inoue from Miami University, we started mark / recapture in a small, like

about 1000 square meters in the La Bota area in Laredo. And we did this mark / recapture for three full years. And over this time, we in this small batch we marked about 2000 mussels.

Lyubov Burlakova [00:29:31] And then, interestingly enough, our son, who was in high school, in middle school and in elementary school in Texas, and he was helping us with surveys in Texas. At that time, he was a student in Cornell University. And I told him, "I don't have anyone to work with mark/recapture data, why don't you try it for your class?"

Lyubov Burlakova [00:29:52] And eventually we published a paper, and he was able to show that there is some kind of advective dispersion. So, with floods, part of the mussels will be washed away from this population with high flow. And that actually present another danger. Because when you are flushing this, when the mussels are kind of flushed out and they find themselves below. But this area below is not hospitable for them. They cannot survive there.

Lyubov Burlakova [00:30:31] That's where you have a huge population loss. And that's what we've been able to find, because in Laredo, we checked pretty well, Rio Grande in Laredo, like almost every 500 meters. And sometimes there was a lot of trash in the river, and so on. But there were some really nice patches where you could still see mussels.

Lyubov Burlakova [00:30:54] But as soon as we got to Laredo's sewage plant, just before that, there was a big stone, and we found about 50 mussels under the stone. Just after the Laredo place, and 40 kilometers below, no more Texas hornshell.

Lyubov Burlakova [00:31:14] And when we were like disturbing sediments and trying to find mussels all these 40 kilometers below Laredo, and actually Nuevo Laredo sewage plant on the other side, in Mexico. That's when our captain was sitting on the airboat and said, "Stop doing that. I can't breathe here. It's like it smells like sewage."

Lyubov Burlakova [00:31:41] And after, like, in the last, like, maybe kilometers, we start finding other mussels, but not Texas hornshells. So, they're probably very, very sensitive to ammonia or other waste components of wastewater.

David Todd [00:32:01] This is such an interesting story about, you know, both your surveys and how you did them, but also what you were finding along the way. It's a wonderful whodunit. And I love the clues that you were teasing out from what you're witnessing.

David Todd [00:32:21] So, you know, I think that your studies found really dramatic declines in the range and the population of Texas hornshell, from what I understand. And I was wondering if you could sort of factor out what were some of the major causes, perhaps. I think you've touched on a few of them, but maybe you can kind of review those for us.

Lyubov Burlakova [00:32:50] Yes. So, basically, as we know, for the Rio Grande, it's habitat modification. There were no artificial reservoirs or lakes on the Rio Grande, and now we have several very large reservoirs - so, Amistad, Falcon reservoirs and smaller dams as well. So, habitat modification probably will be number one.

Lyubov Burlakova [00:33:17] Then water over-extraction: for example, in the upper and lower reaches of the Rio Grande, if we're talking about New Mexico, if we're talking about, like when the Rio Grande comes to Texas, it's not a river. It's like a really canal. It's a small little channel. You know, when we found it, we were, like, astonished because that's the Rio Grande,

where during the blockade, big barges were bringing cotton and so on. Where is this Rio Grande? It wasn't there! So, water extraction, it's a huge part as well.

Lyubov Burlakova [00:33:52] Wastewater discharges as we've seen in Laredo and Nuevo Laredo, wastewater treatment facilities.

Lyubov Burlakova [00:33:58] And salinity: salinity is another factor which really hurts the mussels because, for example, in Pecos River, our colleagues from New Mexico, they sometimes would, like, find salinities up to seven parts per million, ppm. And 7 ppm is like the concentration of salts, which is where mussels, like, have physiological stress and die. At 4 ppm, you already have much smaller survival. There was a recent study done showing that. And, in the Rio Grande sometimes we have salinities up to 4 ppm.

Lyubov Burlakova [00:34:52] So, and it's especially bad like when the Rio Grande gets into the Gulf of Mexico and so on. So, salinities are even higher. Because mussels were found in Brownsville before, but they're not there anymore.

David Todd [00:35:15] So, this is a little bit afield, but I think it may help set the stage for understanding not just the situation for Texas hornshell, but for freshwater mussels in general. And I was hoping that you could sort of take us back in time and talk to us a little about the commercial harvest of freshwater mussels in the Mississippi watershed back in the 1890s, because I think that there's a really fascinating story that I knew nothing about. And I bet some of our listeners would be interested to know about why they were being harvested. You know, what the industry was about.

Lyubov Burlakova [00:35:56] Yes, yes. So, it was mostly a harvest for shells and for the button industry. If you look at the old clothes, if they are well-preserved, you can see that most buttons were done from freshwater mussel shells. And there were tons of mussels harvested, especially in the Mississippi River.

Lyubov Burlakova [00:36:17] I know that there was some harvest later in Texas in the '80s, but it was connected not to the button industry, but to the freshwater pearl industry.

Lyubov Burlakova [00:36:29] And the button industry, actually, fortunately, when plastics came, that ceased to exist because it was much less, of course, stress and problems to do it from plastics than to do it from freshwater mussels.

Lyubov Burlakova [00:36:44] But that was a time when a lot of freshwater mussels were harvested. And, some areas on the Mississippi River, especially in the shallow areas, sometimes there are places where we have lots of mussels in the same area. We call it a mussel bed. And some of these mussel beds at low water could be really reachable. And they were completely devastated.

Lyubov Burlakova [00:37:09] But in the '60s and '90s actually, the Japanese figured out how to do artificial pearls in the beginning of last century. And then there was a war and people come back and were making pearls. The United States, and then, people get introduced to the pearl industry. And then, the Japanese they also found that when you embed, when you use oysters and you use a piece of freshwater shell, mussel shell, you get much better results. And that's when in the '60s and '80s, still in the '80s and late '80s, there was a harvest of freshwater mussels in North America for the Japanese pearl industry.

Lyubov Burlakova [00:38:00] And I know that some areas, and especially it was also biased, because only shells of several species were the best shells. So, several species were like really hit by that harvest because they would be collecting lots of mussels from one place. I know it was going on, some in Texas, but not a lot.

Lyubov Burlakova [00:38:25] And now, fortunately, most states prohibited taking mussel shells.

David Todd [00:38:33] That's a fascinating story. Thank you very much for walking us through that.

Lyubov Burlakova [00:38:38] Yeah, but I don't think that ... we never heard about Texas hornshell being exploited this way because first of all, try to find it! You'd need to know where to. And second, yeah, it was hard to find that. I think that was the major thing.

David Todd [00:38:55] Yes. Okay. So, there's something else that I thought would be interesting to kind of understand the world of freshwater mussels in general, not just Texas hornshell, but others, is the impact of exotic invasives, which I think you've been studying and thinking about for a long time, since early days, 20th century.

Lyubov Burlakova [00:39:23] Yes.

David Todd [00:39:23] And so, I thought you might talk to us a little bit about the research that you did on some of these invasive exotics, such as the zebra mussel and the quagga mussel, Asian gold clam, apple snail - any of those. It would be really interesting to find out about the pressures that those may have played in problems for native mussels.

Lyubov Burlakova [00:39:45] So, as you know, zebra and quagga mussels are now present in Texas. When we came to Texas, because we had a long history of working with zebra mussels, we started with writing a proposal to Texas Sea Grant, predicting where zebra and quagga mussels will be in Texas waterbodies. The proposal was in review and was returned from review with a sign on the top saying that zebra mussels will never be in Texas.

Lyubov Burlakova [00:40:15] We're like, okay. So, we switched to other exotic species in Texas. And then we moved to the Great Lakes, we were working with zebra and quagga mussels again. And in 2007, when we moved from Texas, the first mussels were found: Dreissenas were found in Texas.

Lyubov Burlakova [00:40:36] So, when I started working on my Ph.D. dissertation, we had a lot of problems with newly invaded lakes. So, when zebra mussel will just come to the lakes, first, the most attractive substrate for them and sometimes in rivers too, but less in rivers because they don't form big populations in rivers. So, they will attach to freshwater mussels, because freshwater mussels are hard substrate, because both zebra and quagga mussel are bivalves. So, they have to attach themselves to something and mussels can move. Mussels can sometimes even escape, like low oxygen or something like that, moving a little bit. So, it was a great substrate.

Lyubov Burlakova [00:41:21] And my impression was as soon zebra and quagga mussels come to a lake, the mussel population will be devastated. And then, when I revisited a lake in Belarus, which was invaded by zebra mussels 200 years ago, and we found, the first thing we

found, we found quite a number of mussels in the shore - live mussels - which had one or two zebra mussels sometimes on them.

Lyubov Burlakova [00:41:47] But that was like eye-opening for me because most of the people when zebra and quagga mussel invade, they see the first stage of invasion. Then we worked also on Great Lakes and, we published a paper. We did a really huge survey on Lake Erie and Lake Ontario. And I have to say that when zebra and quagga mussel came to Great Lakes, they devastated the mussel population, the freshwater mussel populations. Needless to say, actually these populations were already on very steep decline before zebra mussels came.

Lyubov Burlakova [00:42:29] But anyways, they devastated this population. You still hardly can find any mussels in Lake Ontario and Lake Erie - freshwater mussels. But, they were found in small refuges.

Lyubov Burlakova [00:42:41] So, we've worked on Lake Erie. We've made a predictive model where to look for freshwater mussels in Lake Ontario. And it really worked well.

Lyubov Burlakova [00:42:50] And another thing we've found, a very important thing we've found, is that in these refuges, the number of mussels, Dreissenas attached to freshwater mussels, was very low. I think it was on average like one or three mussels per freshwater mussel.

Lyubov Burlakova [00:43:07] So, we think that later in invasions, especially with replacement of zebra by quagga mussel that doesn't attach as well, maybe the pressure on freshwater mussels will be less.

Lyubov Burlakova [00:43:23] But, with all of this, I have to say that, in Texas reservoirs, we don't really have a huge diversity of freshwater mussels. It's mostly very common mussels that can be found everywhere else and so on.

Lyubov Burlakova [00:43:38] So, even if there will be a large effect of zebra mussels on these populations, our most treasured places where we have freshwater mussels are rivers, so, rivers that are going through these reservoirs. So, as soon as our rivers are intact and functioning, the reservoirs can be repopulated with mussels as well.

Lyubov Burlakova [00:44:04] And the good news here is zebra and quagga mussels don't really form big population in rivers because it's not a really good environment for them because rivers can fluctuate, they can change their currents. Sometimes, they're extremely muddy and they hurt the filtration apparatus of mussels, and so on and so on.

Lyubov Burlakova [00:44:26] So, I think, I think our major diversity is in rivers. And because zebra and quagga mussels are not really prolific, will never be prolific in rivers, our most important parts will be saved.

Lyubov Burlakova [00:44:45] With regards to Corbicula, Asian clam, Corbicula fluminea, we've been seeing them quite a bit during our surveys, but mostly in areas which were recently disturbed by people, like sediment changed or something else, or a river was streamlined or channelized or something like that.

Lyubov Burlakova [00:45:09] But, we also saw them in places where we had lots of freshwater mussels and we wrote a review about invasive species, invasive freshwater

mussels in Texas. And we actually checked a lot of literature, and there were no really reliable cases where we have evidence that *Corbicula*, for example, will affect freshwater mussels.

Lyubov Burlakova [00:45:39] We worked a lot with apple snails. We studied the first populations of apple snails in the Houston area. We've been working with farmers. We've been monitoring population dynamics on golf courses and so on and so on. And, we've been able to find that actually apple snail probably will not be so devastating for the rice industry as in the Philippines, for example, because our rice farmers are using different technology.

Lyubov Burlakova [00:46:14] But apple snails, I don't think there will be any effect on freshwater mussels because, first of all, they really require different habitats, say, like, areas with saltwater, with some macrophytes where they can put the eggs on and so on and so on, but not the big flashy rivers. You may see them sometimes on their shores, but not in huge densities. So, I don't think there will be ... and unfortunately they tell us that the most problems for the species survival are human-related: it's our human activities that hurts more than invasive species.

David Todd [00:46:58] Okay. So, I was intrigued that we're sort of in the era of a shrinking globe, of extensive globalization. And, some 15 years ago, I think you wrote that that the worries about exotic freshwater bivalves are very much linked to global trade. And can you talk about that sort of the commerce / mollusk connection. That's really interesting.

Lyubov Burlakova [00:47:34] It's actually an interesting story because when we were working in Belarus we were looking, we did a huge survey (and we have about a thousand lakes in Belarus) trying to find zebra mussels. We still don't have quagga mussels in Belarus by the way. Also, Ukraine, where quagga mussel came from - our next neighbor.

Lyubov Burlakova [00:47:55] So, we've been doing a lot of surveys on lakes, trying to understand the distribution of species. And what we found is that the major factors that were moving mussels from one lake to another were freshwater fishery. So, the fishermen will collect fish, and then in the wet nets, zebra mussels could live up to two weeks. So, they will go to another lake, they will fish there, and they will bring all the mussels to a new lake.

Lyubov Burlakova [00:48:38] And also another thing was that we looked at the distribution of mussels before there were borders within Belarus and there was no big trade, exchange, with western and eastern Belarus. And then when the borders were opened, the trade increased a lot, and with infestation and mussels.

Lyubov Burlakova [00:49:04] Also Belarus had three channels from which zebra mussels came to Europe. So, it was a really interesting place to start seeing this.

Lyubov Burlakova [00:49:15] And then we just summarized lots of other literature things, and we showed how construction of reservoirs, for example, were helping quagga mussel to move through rivers in the Ukraine and so on and so on.

Lyubov Burlakova [00:49:31] So, and of course, now with commercial trade, actually first zebra mussels were predicted to come to North America in the beginning of the last century and also with commercial trade. But that didn't happen until ships started going into Welland Canal. And there was one ship from Ukraine that actually brought both quagga and zebra mussel veligers with them. Yeah, so that was obviously the trade and globalization of the economy.

Lyubov Burlakova [00:50:08] Ornamental trade is still a huge factor because this ornamental trade - I remember when I was working with apple snails, every time before I would go to a conference and make a presentation, I would check what is available on the web, and there will be all these apple snails available for sale.

Lyubov Burlakova [00:50:29] So, it's ... yeah, it's just amazing. And the first site, when we started looking at the distribution of apple snails in South Texas, the first site we came to had an empty aquarium sitting on the shore of the river. So, someone just dumped everything which was in the aquarium into the river. So that pet trade is a big part of it as well. Yeah.

David Todd [00:50:55] Gosh. What we do to ourselves.

Lyubov Burlakova [00:50:57] Yes.

David Todd [00:50:58] So, another thing that I think you've investigated and I'm sure could teach us a lot about are these invasive macrophytes, I guess, hydrilla and other kinds of aquatic plants.

Lyubov Burlakova [00:51:09] Yeah.

David Todd [00:51:10] What role do they play? And, you know what are some of the big factors from their invasion?

Lyubov Burlakova [00:51:17] Yeah, we studied certain small ponds in Texas army camps in North Texas. And we've seen like when sometimes these ponds will be choked by macrophytes. First of all, it, of course, increases the amount of sediment that mussels have to use to like, for example, dig in or something like that. Then another important thing: macrophytes really affect oxygen changes in the water, because in the daytime when they can photosynthesize they increase the amount of oxygen a lot. But then at night, when they can't photosynthesize, they decrease the amount of oxygen a lot.

Lyubov Burlakova [00:52:05] We did a really interesting study over several nights to kind of register that (and it's well known also). So, basically, they can compete with some mussels. But again, that will be in certain areas. That will be in lakes. That will be in some small, slowly running rivers and so on. But there's no concern about that in the Rio Grande fortunately, because they won't be really able to survive in the flashy flow river like we have sometimes in Rio Grande.

Lyubov Burlakova [00:52:42] If you come to Laredo, you'll see very high bridges above you, and you see huge trunks of trees stacked under these bridges. So, it tells you how crazy it can be at times. So, I don't think they can survive this.

Lyubov Burlakova [00:52:57] So, for Texas hornshell particularly I don't think there will be any problem from that. But for other mussels in other areas, it may be.

David Todd [00:53:06] Okay. All right. Gosh. So many effects and factors, influences. Thank you for helping us piece this together.

David Todd [00:53:17] So, you know, we've talked a little bit about macrophytes and some of these invasive mussels. I was hoping that you could talk about hydrology, which it sounds like

that's a kind of problem in the background for a lot of freshwater mussels, including the Texas hornshell. I think you've written about drawdowns and droughts in streams and reservoirs ...

Lyubov Burlakova [00:53:46] Right.

David Todd [00:53:46] And how that can expose freshwater mussels, maybe including the Texas hornshell to predation maybe, you know, the temperature swings. I don't know. I'm rambling here, but maybe some of these factors connected with the hydrology would be good to talk about.

Lyubov Burlakova [00:54:06] Absolutely. And it's a really good question. And especially in Texas, because, for example, in East Texas, it's less of a concern because it's much more, we have more water and we have more trees, and we have much higher, much higher moisture there. But in central Texas especially it's a huge problem because lots of central Texas endemic species live in these smaller rivers which are, which are fed by spring water. So, they usually, these rivers, have a very different history. They're not that flashy and flooding rivers like Rio Grande. They are pretty much steady. They are extremely clean. And that's where lots of central endemic mussels live.

Lyubov Burlakova [00:55:04] And when we, visited Central Texas, first time, I think it was in 2005 or 2006, and then through the years, what we've been seeing, it was just horrible because you look at the historical data from '30s and '40s and see where there were huge amounts of mussels, endemic mussels, in these rivers. You come now to these rivers, one river may have three or four reservoirs on it, built on it, three or four dams built on it, not reservoirs, dams built on it. And when you have dams, you really interrupt the natural flow of a river.

Lyubov Burlakova [00:55:43] And I remember being on rivers where a kilometer or two of the river is completely empty. And you can see all the shells of all these rare endemic species that we were trying to find alive. And they are just lying there in the sun. And, that really, that really is one of the worst things that happened to central Texas rivers - the impoundments and water over-extraction as well, because, like, we'd been on the San Saba River, which is like hardly surviving. And here is a dairy farm just moved from Colorado to San Saba River.

Lyubov Burlakova [00:56:27] But, you know, there are lots of people who are concerned about that who are trying to protect the rivers. But, that's one of the two biggest problems.

Lyubov Burlakova [00:56:40] And when on top of that, we have climate change, with much higher temperatures, as we have every year, more and more higher temperatures. So, this reduced water flow during drought is exacerbated by ever increased air temperatures. And, yeah, while Texas hornshell may be a little bit better acclimated to this particularly because through the millions of years they survived in the Rio Grande, there were, of course, periods of flood and drought and so on and so on.

Lyubov Burlakova [00:57:16] It's less true for central Texas rivers. And so that's where we have, I think, the largest amount of problems. Yeah.

David Todd [00:57:23] I see. Okay.

David Todd [00:57:26] So, I think that I understood that, and you mentioned this earlier that, there are these host fish that are really important for maintaining and spreading the population of Texas hornshell, but their movement may be interrupted by dams.

Lyubov Burlakova [00:57:49] Absolutely. Yes.

David Todd [00:57:49] Can you sort of help us understand the mechanics of that?

Lyubov Burlakova [00:57:53] Yes. And I would think also that this particular species could have the same habitat requirements as mussels. So, if mussels cannot survive in impoundments, nor will the species. Plus, instead of continuous rivers that we had before, where you will have free movement of fish between different parts of the river, plus you have this advancing movement of mussels when mussels are washed out from one place to another place.

Lyubov Burlakova [00:58:28] So, now what we have is just like pieces of former river, which are like, completely, like which are interrupted by building large reservoirs. Now, fish cannot even if they go into the reservoirs, they cannot survive there. And then at the end of the reservoir, sometimes some reservoirs will actually, will actually out of the reservoirs, there will not be just like surface water that will be flowing, but it will be profundal water, which is much colder water, that will be flowing from the reservoirs. That's what we've seen. That's it.

Lyubov Burlakova [00:59:13] So, it all really changes the whole ecosystem. And it really interrupts this natural flow of the river and of course affects mussels.

Lyubov Burlakova [00:59:24] And plus huge amount of siltation in the reservoirs. There are a lot of reservoirs that now work like a trap for all kinds of particles, silt, and not only silt because of lots of phytoplankton still growing in the reservoir. And then, when they die, they form silts. But also, in the upper reaches of Amistad Reservoir when the Rio Grande flows in there, goes into this upper reaches of Amistad, we saw like it was kilometers and kilometers choked by silt.

Lyubov Burlakova [01:00:05] I would go to the shore to sample, and I will be up to my, like, middle in the silt, in the mud. It's not like even silt. It's like silt and clay. It's actually the same clays that you can see where mussels are sitting under the stones. But when you have that clay in this amount, like they are completely choked by clay, then what kind of mussels can you expect there?

Lyubov Burlakova [01:00:30] So, it's like profound in a lot of different effects. And mussels can't really survive in reservoirs. First of all, they need running water for food and for feeding, and for the life cycle. And then they also are very intolerant to low oxygen in the reservoirs, oxygen because water is much more shallow. It loses oxygen much quicker, especially in the summer. And there will be much less oxygen, of course, going into the mussel.

David Todd [01:01:05] You know, we talked a little bit about the Amistad Reservoir here, which is, of course, a gigantic impoundment.

Lyubov Burlakova [01:01:14] Yes.

David Todd [01:01:14] I understand that there are considerations, discussions, of having a weir near Laredo, which would be, I guess, not as major a dam, but still maybe significant. Do you see that being an issue for the Texas hornshell that are found in the Laredo area?

Lyubov Burlakova [01:01:35] Actually, yes. And actually, that was exactly why we were, like, hurrying up writing this paper, because we were trying to show that, yes, we found this big population, but they're going to build a dam. If the weir were to be built, the total like normal flow of the river will be completely disturbed. And then I don't think we will, we will save this, we will be able to save this population.

Lyubov Burlakova [01:02:04] And then, and the purpose itself: the reservoir that they're planning to build there would be very shallow. It will be extremely prone to evaporation in hot summers. It will be, of course, in the beginning it will be large, but then it will shrink like all other Texas reservoirs. You probably know about this problem, when people will buy very expensive property on the shore and then in a few years, instead of beautiful shore, all they see is dying algae, really bad smelling and water will be like 100 meters from them. So.

Lyubov Burlakova [01:02:41] And, yeah, that, you know, that's why basically we wrote this paper because we really wanted, we first wrote some letters, a lot of letters, to different agency trying to stop the weir. And then we also wrote the paper because it's, yeah, it's more visible.

David Todd [01:03:01] Oh boy! So, let's move to another part of the Rio Grande watershed and talk a little bit about the Pecos. I think that you and other researchers have discovered that female and young Texas hornshell appear to be largely gone from that part of the basin. And I was wondering if you can help us understand some of the history and maybe the process of what's going on there.

Lyubov Burlakova [01:03:33] Yeah. First of all, we checked the Pecos River in several locations when we did our survey, not exhaustively, but in several locations. And we, during our survey, we didn't find any live mussels - just like lots of shells of *Popenaias popeii* and other species. And salinity that we actually registered in some of the parts of Pecos River was just like our meter could not measure the salinity.

Lyubov Burlakova [01:04:02] So, when these few live specimens were found, it really reminds me of other populations in Texas which I've seen where you may have still some population, but that population consists of older mussels, large mussels. There are no younger mussels, which means that ... You know that freshwater mussels, I forgot to mention that when I introduced them, they can live up to decades. And some of them, Margaritifera, they can live up to 100 years. So, they have very slow growth. They don't live in Texas, but they live mostly in the northern parts of Europe and North America.

Lyubov Burlakova [01:04:51] But anyway, so they live for decades. And what, you don't see young mussels that tells you that there is no reproduction. And what you see is just the leftover population from previous years. So, these mussels will be able to survive until they can't and then the population will die out.

Lyubov Burlakova [01:05:14] Yeah. So, it's kind of a, we call it a "remnant population". So, it's kind of just because they live so long, that's what we see is left. Yeah.

Lyubov Burlakova [01:05:23] And until something will be done with salinity in the Pecos River, I don't think we can use this river to, for example, reintroduce mussels. And salinity is like a much larger problem. It's like in agriculture irrigational land, it's water table, it's water over-extraction. It's like lots of, it's like a compound question, complex question, that we have to approach before we will be able to restore the conditions there.

David Todd [01:05:58] So, I guess the issue in the Pecos is maybe more agriculturally related. But, I think that there was also concern about toxic spills.

Lyubov Burlakova [01:06:15] Yes.

David Todd [01:06:15] And if I read and understood this right, in 2017, there was an oil line that ruptured up in the Delaware. How would that affect Texas hornshell or other freshwater mussels?

Lyubov Burlakova [01:06:31] I'm actually really interested to know what will happen with the population, because you probably read that they were trying to introduce mussels from the Black River to the Delaware River, and that population seems to be surviving and even they found some Glochidia on fish and so on. And it was done in '14, '15. And '17 was when the spill happened and the spill happened above that area.

Lyubov Burlakova [01:07:05] So, I would imagine that probably (I didn't see more data on that), but I would imagine that will have big effects because we've seen devastating effects from spills in, here in the North, in Ohio and in Michigan and so on and so on, where, like, tons of oil were spilled into the river and all the mussels were covered completely and people were trying to salvage something. But it's really hard. And who knows how bad is the damage already done and so on and so on.

Lyubov Burlakova [01:07:40] And so, that gets me really worried about this population. So, basically now we know that the only big sustainable population, hopefully sustainable, are near and above Laredo. And that's exactly where we have the major areas for fracking of gas in Texas. If you're looking at fracking, wells, and fracking of gas wells, it's exactly in going from San Antonio to Laredo area.

Lyubov Burlakova [01:08:11] And when we worked there, it was just amazing to see how this activity from 2008 to 2013 will grow. And you will see all these oil wells and terminals growing like mushrooms. You see huge hotels in the desert, where there was nothing before. Yeah.

Lyubov Burlakova [01:08:33] And the problem with, like, even gas exploration (I'm not talking about even oil here), but gas exploration, because it's, the you don't expect, of course, anyoil spills, but they use a lot of water, first of all. They use, like, they just consume millions of gallons of water because that's what they need to drill. And they drill constantly for more water. So, see declining water tables that we have and we are not in a good place to start with. Right? Plus, this water that they use for drilling, it's really inserted with tons of chemicals and we don't even know what chemicals exactly. And they also have spills.

Lyubov Burlakova [01:09:18] So, all of this really worries me. And, it really worries me is that the largest population of Texas hornshell is exactly in the areas with all of this activity right there.

David Todd [01:09:36] Well, I guess this this all sort of begs the question of how the Texas hornshell came to be listed as endangered. I mean, I think you said that it was sort of a challenge because you were finding these new populations, but you were learning that they were remnants and that there was maybe a larger population that was, you know, would have been found many years ago. Can you talk about the process of it being listed? It must not have been an obvious, easy thing to do.

Lyubov Burlakova [01:10:12] Yeah, I know that, I think it's, Wild Earth Guardians was a non-profit organization which listed Texas, which submitted a petition for Texas hornshell, and it was done, I think you found it in '89, something like that. Right. But, when we started to work with the Texas hornshell in 2008, we found that the petition was already submitted, and the species was given consideration.

Lyubov Burlakova [01:10:52] So, that's why, like our research from one site, it, a little bit, slowed down the listing and then hopefully it sped up the listing and plus, more researchers came to the area. They started doing more surveys, and they have been able to kind of move things along.

Lyubov Burlakova [01:11:14] So, yeah. And eventually we got there, 2018, when the Texan hornshell was considered endangered. And, I really hope that that will help other endemic species in Texas to be listed as well because I know that there are several petitions right now for more species to be listed.

David Todd [01:11:39] I see. So, you think that the attention to the Texas hornshell may have led to concerns and interest in possibly listing other rare freshwater mussels in Texas?

Lyubov Burlakova [01:11:52] Yeah, actually, I think it was kind of in, I think in listing the Texas hornshell as endangered it will help in our further petitions.

Lyubov Burlakova [01:12:05] But I think the listing started, this process of other mussels in Texas listing, started a little bit before. And so, when we worked on the San Saba River and the Concho River in Texas, and remember I described to you there are like huge droughts and so on and so on. And in one part of the San Saba River and in the Concho River, we've been able to find a really good population of another endemic species, and we were very happy to find it, but it was the same problem like with Pecos mussels. There were lots of large mussels, but very, very few small mussels.

Lyubov Burlakova [01:12:59] And, the person who actually gave us access to sample this river in a really healthy stretch and finds this population, his name was Charlie Granstaff. He was the owner of the land and he was the owner of the land where there are painted rocks, pictograms, if you've heard about that. So, he was just an amazing guy, and he was very active in trying to protect the San Saba River from future building dams and from future, like, dairy farms coming to the shore and water withdrawal and so on and so on.

Lyubov Burlakova [01:13:37] So in 2000, we sampled in the river. And then in 2012, I got a letter from him, and Charlie was asking me if I have any contacts at TCEQ or Texas Parks and Wildlife to explain that this river cannot be overdrawn because they maintain this population of rare endangered species. Not endangered by that time, but still.

Lyubov Burlakova [01:14:04] So, I wrote this letter explaining everything and explaining how few we have of this rare species, especially endemic species and endemic means that it cannot be found anywhere else. So, if we lose them, we lose them.

Lyubov Burlakova [01:14:18] And I wrote it to TCEQ and to Texas Parks and Wildlife. And then of course, I forgot about that. But then, people from TCEQ told me that this letter eventually ended up on a table of a Texas Parks and Wildlife lawyer and this lawyer was really interested in freshwater mussels. And when he saw this letter, he was, like, amazed that we still have lots of endemic species, rare species, and they're still alive. We still can preserve them. It's not too late. But, there is nothing done to preserve them, because at that point there was no freshwater mussel in Texas which was endangered. There was one actually, but it was in a different state. It was just once found in Texas. That was the only one.

Lyubov Burlakova [01:15:13] He was amazed by that. And he started asking questions and people started working on that. And the movement really gained support. And that actually, and within some time, several more endemic Texas species were enlisted in the state, were considered endangered. And then the petition went to Fish and Wildlife.

Lyubov Burlakova [01:15:40] So, sometimes things can be stirred up by people who just live on the land, like Charlie. If he wouldn't have asked me, I wouldn't probably have done it by myself.

Lyubov Burlakova [01:15:52] And also it helped that when in 2005 we started our surveys, we really found the species, the rare endemic species that were considered already kind of like, "They are gone" or "They are almost not surviving". So, because if you don't have anything, why protect them? If you have something, you have to protect these areas.

Lyubov Burlakova [01:16:16] Now, I know this this movement at Texas is very strong now. And there are a lot of people who are interested in mussels and trying to do lots of stuff to protect them, and plus state agencies and hopefully federal will work too soon if we will be able to enlist more species.

David Todd [01:16:35] This is great.

David Todd [01:16:37] So, I wanted to just ask you, would you like to get a drink of water? Are you getting a little bit dry?

Lyubov Burlakova [01:16:44] Yeah.

David Todd [01:16:44] Okay. We want you to be comfortable. I know this is a lot of talking.

Lyubov Burlakova [01:16:50] But it's fun talking about that.

David Todd [01:16:52] Oh, it's so interesting. And you do a wonderful job of explaining it. So, thank you.

Lyubov Burlakova [01:16:59] Thank you.

David Todd [01:16:59] So, we've talked about many of the problems facing these freshwater mussels, and the Texas hornshell in particular. And I was wondering if you might be able to talk about some of the efforts to protect them and restore them. For instance, I think that

there's some talk, and you mentioned this, that there was some effort to relocate Texas hornshell from the Black to the Delaware River. And do you have any sort of insights? I guess that's sensitive to spills. But has that been tried elsewhere, or do you think that there are good prospects for that?

Lyubov Burlakova [01:17:40] I don't know about, any efforts in Texas. I think in Texas, they are concerned right now in preserving populations of healthy populations that we have. But if I would talk about restoration, for example, I think it would be really nice to start to try at least reintroduction. And probably one of the first candidates, I would say, would be Las Moras Creek. It's a beautiful creek in South Texas. And it used to be a really beautiful transparent spring-fed creek.

Lyubov Burlakova [01:18:17] But in, I don't remember when, but in I would say '40s, '50s, people made swimming pools there. And of course, they chlorinated. And then they removed a lot of macrophytes using, I don't know, I don't remember what, maybe some chemicals. So, this creek and lots of agriculture on the shores, because we went through many places on this creek, but we were not able to find any mussels.

Lyubov Burlakova [01:18:44] So, maybe starting with some small project like that and see if that will work, because, and then because lots of some tributaries on the Rio Grande have documented presence of Texas hornshell in the past. So, it would be nice to start with them.

David Todd [01:19:03] I see: sort of as a demonstration.

Lyubov Burlakova [01:19:05] But, of course, first we have to restore the creeks. So, otherwise we will be wasting money. Yeah.

David Todd [01:19:11] Yeah. I see. So, I guess you don't want to get the cart before the horse. The habitat has to be right to welcome back these reintroduced populations.

David Todd [01:19:23] So, one thing that I think has been intriguing is that in New Mexico, there are these voluntary candidate conservation agreements. And I was wondering if you've run across them in in your experience?

Lyubov Burlakova [01:19:39] It wasn't when we were in Texas. I think it's a pretty new initiative. But I know that in Texas, there are groups of people who are, for first of all, there are watermaster programs. And then, for example, on the San Saba River, they were not able to bring with the watermaster program when we worked there. But they were able to organize the non-profit Friends of San Saba River trying to kind of do something about protecting the watershed and protecting the river banks and so on.

Lyubov Burlakova [01:20:13] So, I know that there are very concerned landowners on the Devils River, or at least used to be. So, and Devils River is like a gem. Have you been on the Devils River? It's just such a beautiful place. And it's safe because it's remote. But who knows? Development is now going on everywhere, as you know.

Lyubov Burlakova [01:20:34] So, I believe that we have people who would be able to do that. And if we, yeah, if we look and, of course, state and federal agencies will have to help in this as well. But they think it'll be very, very promising. Yeah.

David Todd [01:20:52] Okay. Well, those are all good insights: this sort of non-profit option to trying to protect this, and I guess sort of landowner-based.

Lyubov Burlakova [01:21:02] Yes.

David Todd [01:21:02] Well, so we've of course talked about the Texas hornshell, but I think you've demonstrated that there are lots of freshwater mussels that are facing challenges, many of which are in Texas, as elsewhere. And, I was curious if you could help us understand, well, why there are these sort of overarching problems that seem to be facing, you know, scores of different species of freshwater mussels.

Lyubov Burlakova [01:21:33] Yeah. Because they all have the same complex lifestyles. So, they're one of the most. I know that amphibians are among the most vulnerable, and for sure, the mussels are among the most vulnerable because they really depend on water and sediment quality. So, they filter water. So, water should be of good quality for them to survive. They are sedentary, so they can't really ... if there is a spill, fish can go further downstream or upstream; they can't really move to avoid disturbance.

Lyubov Burlakova [01:22:10] Then, they rely on few, sometimes even one, species of fish to reproduce. And if this fish is gone, they are gone as well.

Lyubov Burlakova [01:22:23] And plus, they live for a long time, so they can accumulate much more. For example, compared to zooplankton that can live for a few weeks or a few months, they can accumulate much more in their body through the several decades of their lives. So that's why. Yeah.

Lyubov Burlakova [01:22:41] And unfortunately, it's, yeah, we have about 50 species of mussels in Texas. And, more species are described recently. We described one species and there was one more species described recently. So, it's good news.

Lyubov Burlakova [01:22:59] So, from one side, we are increasing diversity. From the other side, we also found, doing genetic work, that some of the species we considered related species are not related. So, it's like an ongoing process with genetics.

Lyubov Burlakova [01:23:15] So, but anyway, all of them have the same lifestyle and all of them are very vulnerable, extremely vulnerable.

Lyubov Burlakova [01:23:23] So, it's why we call them the canaries in the mine. You probably know the story that people who were mining took canaries with them. And if the air quality will be worse, the canary will die. And so, they have to go up.

Lyubov Burlakova [01:23:38] And that's our canary in the mine: all our mussels. Yeah.

David Todd [01:23:43] Well, it may be a kind of a related metaphor. You know, you're talking about the canary in the mine. Do you, see the Texas hornshell as kind of an overall indicator of the health of the Rio Grande?

Lyubov Burlakova [01:23:58] Absolutely.

David Todd [01:23:59] In what way?

Lyubov Burlakova [01:24:00] We've seen this again and again, like going through, because we covered a large stretch of the Rio Grande - not only around Laredo, but in other places, sometimes on kayaks, sometimes from the shore, sometimes on the airboat. And we've seen that as soon as you have a really nice, pristine-looking stretch of water, you can find mussels and you can find hornshell (of course, in the suitable habitats).

Lyubov Burlakova [01:24:30] But sometimes the habitats will look fine, but there are not any mussels. And you start feeling that something is there. But you just really can't point to it, because you need to do research to find it.

Lyubov Burlakova [01:24:44] But sometimes we've seen really damaged places with a huge amount of habitat destruction with like, water smelling like sewage, like I already told you.

Lyubov Burlakova [01:24:54] And also, overall, actually, you know, it was really interesting to travel on the Rio Grande because, when you go especially above Laredo, you see on the Mexican side, the river is beautiful. There are shores, there are trees, there are lots of people on the shores there, fishing, picnicking, swimming. And on the American side, there is no one there. It's like huge, huge carizzo, that's an invasive plant. And it's just like, even if you touch it, you will get, I developed a very big sensitivity to it.

Lyubov Burlakova [01:25:34] So, it's like it's like day and night. So, our shores are not populated. There are no people on the shore to enjoy the river. And maybe that's why it's kind of more neglected, I don't know.

Lyubov Burlakova [01:25:49] Yeah, but protecting, actually, Texas hornshell: we have in ecology and in conservation biology, a term called, "umbrella species". It's when one species gets protected, and then, with the species, because these areas on the Rio Grande will be protected, lots of different species will benefit from that. So, that's why it's really important sometimes to protect at least one species. Then you will ensure that everything else can survive there as well.

David Todd [01:26:24] Well. And it sounds like the challenges that freshwater mussels and Texas hornshell are facing in the Rio Grande in Texas, New Mexico, and Mexico are not unique? I gather you're seeing and studying mussel problems in your native country and then now in the Great Lakes. What do you, again, what are the sort of connecting points, where are the overlaps? Why do you think this is such a widespread problem?

Lyubov Burlakova [01:27:00] Yeah, because people are widespread, you know, unfortunately. Like I said, in the Great Lakes, problem was invasive species. I don't think it will be a problem for Texas hornshell on the Rio Grande. But, again, we still have a really good diversity of mussels in tributaries of the Great Lakes. If tributaries are in good, healthy conditions, we have still the same amount of freshwater mussels there. And as soon as conditions will allow, they will have freshwater mussels again.

Lyubov Burlakova [01:27:36] But the problem is, like everywhere, damming rivers, polluting rivers, withdrawing water, modifying water, modifying shores. For example, we live on the Niagara River and it used to be a beautiful river. It's still beautiful, but lots of shores, from especially the New York side, are heavily modified.

Lyubov Burlakova [01:27:59] And it's really like people are trying to invest money and to change that, and they are changing and so on. But it's still like a big problem.

Lyubov Burlakova [01:28:08] So, it's everywhere. In Belarus, we've seen, like we're talking about zebra and quagga mussels, like the horrible things that they are, because they're changing so much in the ecosystem. But we've seen lakes in Belarus where we had population of zebra mussels. And they disappeared because people polluted the lakes. And zebra mussels actually don't have a high tolerance to pollution. They're kind of in the middle range. So, if it will be very polluted waters, zebra mussels won't be there as well. Yeah.

David Todd [01:28:39] So, that's a little silver lining.

Lyubov Burlakova [01:28:41] It's, it's us. Yes. It's always us. And, yeah, in the more populated areas, there is more of course damage to water flows and rivers.

Lyubov Burlakova [01:28:53] But, on the other side, when, when places are more populated, like with Niagara River, we changed. But now, there is more money and more people are thinking about restoration of the river and so on. And so, the river is getting restored. But sometimes, of course, when it's too late, then we don't even know where to restore it: to which, what was the original status, you know, to restore it to? Yeah.

David Todd [01:29:24] Yes. I guess you don't know what the starting point is, if it's been so long ago and so radically different.

Lyubov Burlakova [01:29:30] Yeah.

David Todd [01:29:31] So, I think it's really intriguing to me that you have invested a lot of your life in studying these mussels, which, for a lot of people, it may not be something that's front and center for them. You know, there may be more used to thinking of things that are larger, or that move around, or sing a song, or have songs written about them. And, I'm curious what sort of intrinsic value you see in these mussels. What, what draws you to them?

Lyubov Burlakova [01:30:10] So, first of all, probably from my childhood, I really think that every living creature on the earth has its own intrinsic value. And unfortunately, that's our anthropocentric mentality, which probably develops when we started developing agriculture and started raning, "Okay, this is useful. This is not." Because people who were hunter / gatherers or like Native Americans, they've been able to live and to benefit from lots of different, much, much more different creatures and plants and animals that we can, and live in peace with them, because somehow they understood the concept of ecosystem much better than we did later.

Lyubov Burlakova [01:30:57] So, we at some point we started to value species because it gives us something, or like we say now, it indicates something - quality of water. So, it's basically just like our mentality is that something should be useful to have the right to exist.

Lyubov Burlakova [01:31:21] But, we're not the only species on this Earth. Unfortunately, we are one of the most numerous now. But we are not the only ones.

Lyubov Burlakova [01:31:31] But of course, like, to explain that to people is harder because, of course it's much easier to feel love for pandas or for other furry animals than to our mussels.

Lyubov Burlakova [01:31:47] And we also, even though we have some expression, unfortunately, mussels are not as furry and nice, but they're great. So, that's why we're trying ... the concept of intrinsic value, I think it's where we would come eventually, but not everyone is at that point yet. So, that's why using it may not be a very effective way to have to explain to people.

Lyubov Burlakova [01:32:13] So, we have to explain to people that they should be concerned about other creatures because they mean a lot for health; some of them will be important for their wealth. They mean a lot for future generations and so on and so on.

Lyubov Burlakova [01:32:32] That's why right now we're talking about indicator values of mussels or the umbrella role of the species. So, using that, we're basically, in fact, we're trying to protect the species. We're also trying to protect the ecosystem. Yeah.

Lyubov Burlakova [01:32:50] So, but, what I see lately, actually, is that students that are coming, they're not, they're really interested in the environment much more than I think previous generations, because they've started realizing that we're damaging the environment so quickly, that they may have to live in a completely different place very soon. So, that gives me a lot of hope.

David Todd [01:33:14] That's good to hear. That's very encouraging. I mean, I guess that's a silver lining to some of these declines and concerns that you've pointed out that I guess your students are sharing those concerns, and maybe focusing more of their efforts and maybe their future lives. Is that fair to say?

Lyubov Burlakova [01:33:32] Yes, I would love to see that, and at least that's what we're trying to do. We, for example, I taught conservation biology, using a really great book and we not only, I not only gave lectures, I also had really interesting software that will show you how you can exactly protect the species. What should be the critical size of population to protect? What should you do? How do you do this analysis? So, teach them that there is a practical way of doing that. And we already have a lot of examples of success. So, it's not only possible, it's really timely to conserve the environment and species diversity.

Lyubov Burlakova [01:34:20] So, we've had huge debates about climate change and about how to ... because it's controversial, because, you know, every law is a controversy because there are lots of contrasting interests. Something that important for me may not be that important for a farmer whose income could be damaged and so on. And so, we have to be just really smart in how we can do that.

Lyubov Burlakova [01:34:49] I also try to, with students, we try to take them to surveys, because as soon as you take someone to a survey, they love freshwater mussels forever, because you go into a river, and in Texas, most rivers are so muddy, you can't really ... they are not very transparent so you can't really see anything. But you put your hand and you find the mussel. It's really like a treasure hunt.

Lyubov Burlakova [01:35:12] So, I try to show them the fun of doing science, because I believe there is a child inside of each of us. And it's good to preserve the child, as we are humans, because this child is always curious about nature. He wants to know more and more. He wants to tweak. So, I'm just like, I want them to keep this child inside them, and have him play. Yeah.

Lyubov Burlakova [01:35:40] Yeah. Well, so, I guess, as we wrap up, I'm curious if you could look back on your career as a biologist and ecologist and tell us a little bit about your view of that kind of profession, because it seems like such an interesting combination of, you know, curiosity, as you said, that a child might have, but then the tools of science, and then there's, I think that there's a lot of idealism wrapped up in that.

Lyubov Burlakova [01:36:12] Absolutely.

David Todd [01:36:12] And of course, it's been a good career for you. You've had a really interesting job. How do you put all those factors together when you think about your career?

Lyubov Burlakova [01:36:26] I think I'm really fortunate that I met my husband, and I decided to change fields. It's a really satisfying career. I think we all, as humans, we really feel that we need to do a little bit more than just, like, you know, get money, get ourselves fed, and have our family and so on. We need to give more to society.

Lyubov Burlakova [01:36:51] And that was an amazing way for me to do that and to be able to, not only find and discover something, but also to sometimes maybe influence and change the policy a little bit, and publish research so more people around the world will read about that, and maybe they will learn some lessons or use it in research.

Lyubov Burlakova [01:37:19] So, and plus this really part of field research, you know, when you're just like in Texas sometimes our sample sites were like 800 kilometers away and not 800, but like 500 kilometers away. So, every trip is an adventure. You don't know. You going to this river which was studied in the '30s and never since, and you don't know what you will find.

Lyubov Burlakova [01:37:46] So, it's like a perfect combination of lot of fun, satisfaction of doing something more than just for yourself, giving something back to humanity. I think that's a perfect combination. And I would recommend everyone to do that.

David Todd [01:38:05] You're very persuasive.

Lyubov Burlakova [01:38:08] Hopefully.

David Todd [01:38:09] Well, we've covered a lot of ground, and, I thought before we have to say goodbye, is there anything that you would like to add, that we might not have given the proper amount of attention to, something you'd like to add?

Lyubov Burlakova [01:38:27] Yeah. I think, actually it would be nice to say a few words. First of all, yeah, like I already said, field work brings so much joy. And, like, we've, through field work, we've seen lots of Texas, beautiful Texas nature, amazing people everywhere that helped us a lot.

Lyubov Burlakova [01:38:50] And, you know, I'm saying that because, like, a couple of years ago, we met with our Portuguese colleague, and he said that he was going to Africa to do some research. And he asked this big class, "Who would like to go with me, everything paid?" No one wanted to go. Yes. It's like we could do it. We said, "We will go tomorrow, if needed."

Lyubov Burlakova [01:39:18] There is now a new generation of kids who just really think they are comfortable at home. They don't want to do anything or to go anywhere. So, that's

really, important, of course, to give a taste of that in childhood and in families. That's a really important thing. Yeah.

Lyubov Burlakova [01:39:39] So, I just wanted to say that, it makes such a difference when you work as a team with your family. So, my husband, he has, like, very different skills and a very different, like, nature from me. But we work amazingly together because he is, like, so goal-oriented. He will set a goal and he will not succeed until he targets his goal. He would, he always insists that we (and of course, I do the same) that we finish every study with a publication. Because you can do as much research, but unless you publish it, it's not known and it's kind of useless.

Lyubov Burlakova [01:40:33] Then he was taking care of every shell he would find, label everything, maintain the collection and so on and so on. Now we have a really amazing collection that we use.

Lyubov Burlakova [01:40:44] And of course he loves field work as much as I do, and our kids helped us a lot. I mentioned already about one of our sons. We would take him to our field trips starting in Belarus when he was two and a half. The second we would take him when he was five years old. So, they love field work and one of them became an ecologist - the result I hoped for.

Lyubov Burlakova [01:41:08] So, it's really important to have this big support in your family when you do your career. And if you can involve other people, that will be really, really beneficial for everyone. Yeah.

Lyubov Burlakova [01:41:20] And I also wanted to ask ... Texas is such an amazing place. But it's amazingly fragile, especially now. So, please take care of these ecosystems. I know gas and oil and money's all good, but we should start taking much better care of that than we used to do, because we are losing water. And in the future, we will have even less water than we have now.

Lyubov Burlakova [01:41:50] And without water, lots of different species will disappear, and plants as well. So. Yeah.

David Todd [01:41:58] A good reminder. And a good message.

David Todd [01:42:02] So, well, thank you, Luba, so much for your time today. I know that you have papers to write and stories to share for the public, and I wanted to thank you again, and also to stress that I would very much like to talk to your husband because I understand the teamwork that you two participated in.

Lyubov Burlakova [01:42:29] Yes. Amazing

David Todd [01:42:29] And it'd be nice to get his views as well. So, if we can arrange that, I'd look forward to it.

Lyubov Burlakova [01:42:36] Yep. He will just probably write when there is a good time for him. Yeah.

David Todd [01:42:40] Okay. I would look forward to that.

Lyubov Burlakova [01:42:43] And thank you, David. I really appreciate that you have this initiative and you have this program because I think it's extremely important. There was a really amazing scientist who studied freshwater mussels in '30s and '40s and '50s in Texas: [John] Strecker. He has his collection and he has his amazing notes of how he's sampled on different creeks and different rivers. And it's just such an amazing thing to read. So, I think the more we have of those, the better we will be. Yeah.

David Todd [01:43:16] It's a really important story. And, of course it wouldn't be a story if you weren't doing it!

Lyubov Burlakova [01:43:21] Thank you very much.

Lyubov Burlakova [01:43:21] So, thank you for all your work on this, and I wish you the best.

Lyubov Burlakova [01:43:27] Thank you.

David Todd [01:43:28] All right. I have a button on my end. I'll cut off the recording. And, again, thank you so much.

Lyubov Burlakova [01:43:35] Thank you, David. Bye bye.

David Todd [01:43:36] Bye now.