DOSITS Webinar: Acoustic Tag Technologies and Applications (May 7, 2021)

Question and Answer Summary
(Questions asked/answered in real-time during the webinar or in the Q&A box)

Questions asked/answered live by Dr. Susan Parks and Dr. Jeff Kneebone during the webinar:

Question: What advice, do you give to someone with no acoustic monitoring experience but who wanted to get into acoustics and behavioral ecology?

Answers: (Dr. Susan Parks) I mean, for me it was just finding someone who is doing that work and reaching out to them to find opportunities to get experience. So, trying to help out with fieldwork or helping to analyze data and then I also would send the students to DOSITS. Not to plug the platform, but I actually send students that aren't familiar there to start, because there are a lot of really good links in education about all sorts of the basics of acoustics. So, for me that's where I send people who are really starting to look for links and references.

(Dr. Jeff Kneebone) I'll just chime in briefly, I completely agree. I got my start with the San Diego project as a student. So, I think we both have parallels that we started with acoustics as students. So, even if you don't have any experience there's an opportunity for you to get some.

Question: What are acoustic monitoring tags and how do they work? What are the limitations of passive acoustic tags and how do you imagine those might be overcome in the future?

Answers: (Dr. Susan Parks) So, I think part of that question is hard to answer because I have not worked with any real time tags. Everything [I use] is archival, so I don't know what's happening with the tags. It's sort of a fun package when we get it back because we don't have any idea what we're going to find. I believe that there are groups that have worked to develop those types of tags, but I don't know what's out there and available. We just sort of wait and hope to get the data back to see what's going on. So, we don't have the advantage of like what Dr. Kneebone was talking about of actually having sort of like a real time image of what might be happening right.

(Dr. Jeff Kneebone) There *are* real time acoustic receivers. So, I talked about putting out a receiver and having it collect all the data for you and then going back at the end and downloading it all. There are new aspects considering acoustic receiver interfaces that actually allow you to get that data in real time. So, they connect through maybe even cell phone towers and it connects the receiver to shore and as soon as a detection occurs, it can be uploaded. I dabbled in it only a little bit, but I do know that it exists and it is growing

in popularity despite its limitations. You need to be able to communicate to the shore basically to have that real time monitoring capability.

Question For Dr. Susan Parks: Why use mostly archival tags? Why not use tags to send data in real time, when the whales are near the surface?

Answers: When we unpack these tags, we are often recording at a 192 kilohertz sampling rate for hours and hours and hours. So, we're looking at terabytes of data when we unpack the tags, and I don't even have the tags that have Argos positioning data because that's expensive. So, the cost and the time for the transfer of the data is prohibitive for the type of information we're getting. I know that people are working towards trying to make tags that have real-time acoustic detections on them and then you could send detections…there's a really, really neat work being done by Mark Bumgardner in Woods Hole where he has gliders and other real time systems that have detectors and then come up and then report those detections back. We just don't have that kind of capability for the questions we are answering, just because the data set is so huge and we just can't afford to transmit it.

Question for Dr. Jeff Kneebone: Out of curiosity, have you detected any of your tiger sharks in locations you would not have expected them to be in?

Answer: Actually, yes, the biggest surprise was that a few that we tagged were coming back, year after year. I remember the day that I discovered that, and it was one of the most memorable moments of my career, just knowing that that we had the capability of monitoring a single animal over that time and having it come back to the same place. That was one of the most important discoveries of that entire project, and then just over time it's grown and snowballed as you saw with over 700 different receiver detections. Every one was a surprise, we didn't know where the juvenile sharks were going to go, and since we were able to track them over such a long time, as they grew up. It was kind of like looking at a new research question because with this we could say, okay, they were here when they were juveniles but when they're older they do something completely different. So, we're not only learning about where the animals are going, we're also learning about how that route changes over their life, which is a really new way of looking at animal migration.

Question: When you have a receiver network in a small area, and you are connected to shore monitoring stations, are you monitoring other things in parallel, what is a bigger picture piece there?

Answer: (Jeff Kneebone) We collected other environmental variables like temperature and light levels throughout the Bay and we correlated those with animal activity. So, we took this study a step further by being able to tell when the sharks were most active, which ended up happening to be at night. During certain phases of the moon when they were more active, we could say, okay they're probably feeding more actively during these specific times. So, we use some other environmental monitoring to try to get at different questions like what is their preferred temperature range, what depths are they used to in the Bay, how and when are they active? The detections outside of the bay, that I showed on the map of all the different places that they were observed along the coast, that was kind of how it plugged into a bigger regional monitoring framework. We are not the only

group that is tagging sand tigers, we just happened to do it in Massachusetts. There are other groups that have done it in North Carolina and Delaware and New Jersey in Long Island and we can put all that information together to really amplify the impact of the study and look at hundreds of animals, and try to get a really, really clear idea what what's going on in each portion of their range.

Question: Is creating a constellation of acoustic tag sensors better (since they are getting smaller and more efficient and effective) for capturing pings in large swaths of area. Or are hydrophones and other sensors more appropriate and applicable?

Answer: (Dr. Jeff Kneebone) You really need to match the study area to your object or your objectives to your study area. So, unfortunately cost does factor in large into scientific research, the things that we use are not cheap. It's not cheap to deploy them, it's not cheap to buy them, and it's not cheap to maintain them, so it's kind of a balancing act between trying to maximize your return data and the return for your investment. So, it's really hard question and the best way I can answer is to try to match your receiver right and you're tagged deployments to your study objectives. So, in the context of offshore wind, we know that this process is going to be going on for decades and that we're just in the starting point now. We're trying to figure out what is the baseline, so what's going on, naturally, in this area with this species before any turbines are constructed. Then, after the turbines are built, we want to know what's going on once they're actually spinning and generating power so that turns into a really long-term study. So far, our approach is to go broad and maybe not have receivers as close together, but instead try to cover as much of the area, as we possibly can, and then over time we'll be able to piece together information from all the different receivers. That way we get a long-term idea of what the impacts are on a regional level. So, it's a really great question. In Plymouth Bay, we were looking really fine scale. It's a tiny Bay, we had a bunch of receivers clumped together. Then with offshore wind it's kind of different. It's a huge area and the receivers are really spread out. So you want to try to match with your study objective.

Question: What are the most common techniques that you use or the ways that you analyze the acoustic data that you get back from the archival tags?

Answer: (Dr. Susan Parks) The sad answer is that we just listen and look for the most part. We've tried so many times to do automated detectors and part of the complication of an acoustic tag is that it's a pressure sensor on the back of a whale that's diving. So, every time they break the surface it's really loud and so anytime they're near the surface, the flow noise or the breaking of the surface obscures a lot of things. I wrote a much longer talk and cut it back because there's so many cool things that you can do with the tag so you can estimate the speed of the whale from the flow noise. For example, that flow noise can then also mask the acoustic recording of the sounds and so fundamentally we go through it by hand. I have a student right now who's looking at some of these longer-term tags that are multiple weeks.

Question: People want to know the transmitters on the fish, do they make them more vulnerable to predators and can those predators detect the transmissions?

Answer: (Dr. Jeff Kneebone) It depends on what the predators can hear. It has been documented that some marine mammals can actually hear the pings on the transmitters and it's been suggested that they actually hone in on acoustically tagged fish, because they can hear the pings. So, it has been documented with us and we're using mostly large predators so it's not been an issue. I do know that people tagging things like salmon and maybe even eels have testified that it seems to attract predators.

Question: As a follow, up what frequencies are being used. What frequencies are the tags out operating on?

Answer: (Dr. Jeff Kneebone) So, most of the commercially available tags are and 69 kilohertz. Now tags are coming online at a higher frequency, I think 300 kilohertz. So, that's an attempt to get out of the detectability range and get away from this issue that has been correctly raised. So, the other aspect of this is, I talked about the how frequently the tags ping, and you can set that value so it depends on your study objective. For us our tags are pinging every two or three minutes and in the case of that sea bass study they were pinging every 10 minutes. So, if you can think about it, it might be hard to track something if you only hear a ping from it every two minutes or three minutes or even 10 minutes. If it's happening consistently, you can get a better idea of where it is. But when you increase that duration between the pings it becomes theoretically harder for animals to actually hone in on it and key in on a specific animal that has a tag.

Question: How are tags being configured to have such a long battery life? Is there a duty cycle, better electronics and betters, all of the above?

Answer: (Dr. Susan Parks) Yes. I was guessing that question was aimed for the acoustic tags? We don't have 10-year tags. Were super excited if we're getting 20 days' worth of data. All the wildlife biologists laugh when we call our tags "long term".

(Jeff Kneebone) Yes, it's basically battery technology has improved and that's allowed the acoustic transmitters to get smaller and smaller and smaller and the tag duration or lifespan to get longer and longer and longer.

Question: I know Susan you talked about having some recent data that was three weeks long. Is that continuous, so are you just getting better electronics and batteries, that the mostly.

Answer: (Dr. Susan Parks) Yeah, there are a lot of brilliant tag engineers that are working on it. I am just a user, hopefully, I made that clear in the talk. I am a blessed user of wonderful technology.

It's improvements in the technology and then it's also the species that you would apply to be able to apply them to rate. You need a bigger, better battery for a longer recording and so the recordings we've been working with are from the manatee tag where we have space to put a slightly larger battery. For that recording and then some of the papers that I cited we worked on seals. They were on the beach that they could have fit a slightly larger animal like an elephant seal. A little more space than trying to put something on a smaller animal.

Question: Are complex movements that you saw with the tiger shark expected, or is this an artifact of the location of the receivers?

Answer: (Dr. Jeff Kneebone) It's a great question. So sand tigers, by their nature, are home bodies. There's a term that we use called “site fidelity” which basically means that they have a strong attachment to specific places and we found that in Plymouth Bay. If you remember back to the animation, it was like two zones. There were sharks over here, there was sharks up here and they rarely, if ever, moved between the zones of the Bay. So, it was once they found their way into a spot, they stay there, in some cases, individuals stayed in the same spot swimming the same way for up to four even five months at a time. And that just showed us that, that is an important area. There was food there or something that they wanted…the temperature was right. They just kept coming back and year after year. It was basically the same movements over and over. We always knew where they were going to go after the first year. When we looked at all of our data, we said wow they are really sticking to this one spot and it held true every year that we looked.

Questions asked/answered in the chat box during the webinar:

Question: Do those suction cups really stay on through a whale's deep dive. I can't even get suctions cups to stay on the shower wall.
Answer [Susan Parks]: Yes! These suction cups stick very well. The dive to depth actually helps hold them on due to the increased pressure from the surround water at depth. So, each time the whale dives, the water essentially pushes the suction cup on the whale again which helps with attachment.

Question: What were the frequency of humpback feeding clicks?
Answer [Susan Parks]: They are relatively broadband pulses, but most of the energy is below 1 kHz.

Question: How do these suction cups gets mounted on the animal?
Answer [Susan Parks]: For the whales I have worked with, we use a long (12m or more) hand-held carbon fiber pole from the bow of a small boat to attach the tags to the back of the whales as they surface.

Question: How easy is to fit the audio recorder to the manatee belt? How about costs?
Answer [Susan Parks]: Currently this is a research development project, so just in the prototype development stage right now. They seem to fit pretty well inside the belts, though still working on the size/shape/battery questions.

Question: Very interesting! You mentioned that tags are archival meaning the data remains on the tag, so how do you get the tags back?
Answer [Susan Parks]: Yes. The data are recorded on to the tag for the versions I have worked with. We typically use VHF radio transmitters and radio tracking gear that allows us to keep track of the whale/tag or recover the tag after it detaches from the whale. Some tags have ARGOS satellite data and VHF, allowing you to relocate the tag.

Question: What % of blow exhales correlate with surfacing?
Answer [Susan Parks]: Typically we only hear the exhalations from the tagged whale at the surface when they are alone. When the tagged whale is in an area with other whales, we can often hear the blows from other whales at the surface when the tagged whale is on a dive.

Question: Does the call rate decrease or increase due to the effect of tags after attachment?
Answer [Susan Parks]: Based on behavioral observations without tagging, we haven't seen a significant difference in the call rate between tagged vs. untagged whales. For example, for right whale mother-calf pairs, the tag data was a follow up to confirm hydrophone recordings from small boats that had documented extremely low call rates. The data between the two methods for the call rates for the louder calls was the same, but the acoustic tags allowed us to detect the quiet calls that they seem to use to maintain contact.

Question: Are you able to apply these suction cups on dolphins as well or is there a better type of tag?
Answer [Susan Parks]: Definitely! Several researchers have used acoustic tags for studies of a range of smaller cetaceans, including porpoise and dolphins. Some of the review references I provided have good summaries of those studies.

Question: I guess it depends on the scope of the study, but how many individuals should be attached to investigate the call rate?
Answer: As many as possible, and trying to account for age/sex or time of year differences is important. We've found that understanding the context of sound production is really important to understand variability in call rates.

Question: Are the lactating mothers possibly making quieter calls to avoid detection of their calf by predators?

Answer: This is our current hypothesis for why the mothers have such low call rates of louder calls. There have been a few studies from other baleen whale species showing similar results of ‘acoustic crypsis’ of mothers with young calves.

Question: Are different whale calls important to understanding their culture and how do you interpret the type of behavior associated with a call?
Answer [Susan Parks] It would be great to get to questions of culture, but for right whales at least, we still are at the stage of identifying their full acoustic repertoire! From the tags, the sensor data allows us to recreate the movement patterns of the whales, which we can use to infer the behavior of the whale when calls are produced.

Question: The individuals that produced quiet calls were the same (or from the same population) from those who produced the louder calls? Just different places and times of the year?
Answer [Susan Parks]: For the right whales, the quiet calls were detected primarily in mothers with young calves. We have data from pregnant females shortly prior to calving, and they make very few quiet calls, so they seem to function to communicate with the calf when it is very young.

Question: For the suction cup attachment method, what is the mechanism that triggers it to fall off when the recording period has ended?
Answer [Susan Parks]: It’s really a nice system. The tag engineers designed the tag to have a small plastic tube (like a straw) that connects to the suction cup. When they are on the whale, that tube is held closed with a small wire. When the tag comes off, a small current is run through the wire to make it corrode, causing the tube to open, allowing water to flood the suction cup and break the suction.

Question: Is it possible for real-time acoustic tags know where they are?
Answer: There are tags that provide real-time position data, but I’m not sure if there are tags that give you real-time acoustic recordings available yet.

Question: I'm curious if you see differences in call structure through ontogeny with any of the whale species you tag?
Answer [Susan Parks]: Thanks for the question! This is actually one of my research areas. I’m very interested in how whales develop their sound production. With right whales, over 15 years, we were able to collect data from whales across age groups to start to get at that question. We’ve been surprised that after the first year of ‘babbling’, right whales continue to gradually improve in voice control across their entire life.

Question: @Dr. Parks: how do you know which behaviors the animals take part in, when doing the recorded calls?
Answer [Susan Parks]: Hi. So we generally use the other sensors on the tag to recreate the movement patterns of the whales. We can link those data to observed behaviors from visual observations, and then use that to interpret the behavior of the whale recorded by the tag.

Question: Are there potential problems for other marine life in adding these sounds to the ocean?
Answer: Thanks for your interest! The tags are actually quite quiet, with detection range of less than a half mile, so they don't add much to the background noise field.

Question: What caused the decline in the sand tiger shark population? Was it related to bycatch?
Answer: Sand tigers are slow growing and take several years to reach maturity. They also only have two pups at a time so their ability to recover from overfishing a few decades ago has been slow. They've been prohibited from fishing since the late 90's and the population is now rebounding.

Question: How long do the tags last?
Answer: Battery life averages 6-7 years but tags are still being detected more than 10 years after tagging!

Question: Are there offshore applications for these acoustic receivers or are they mostly used in coastal regions?
Answer: This technology is increasingly being used in offshore environments as the technology advances and improves.

Question: What happens with these tags when an animal gets eaten? Are tags ever recovered in this instance? Is the unintended data from a predator of interest?
Answer: There is actually a new type of acoustic tag that can actually detect when a tagged fish has been eaten! These data can be useful for all sorts of studies.

Question: Are your tags archiving anything other than location based on receivers? Especially interested in underwater sound?
Answer: The acoustic receivers can pick up some ambient noise levels and can also record environmental data such as temperature.

Question: I would like to triangulate small animals in a tank to study their interactions. The tag would need to be the size of a grain of rice. Are there tags that would reflect a signal instead of transmitting one and this way not require a battery?
Answer: Interesting study! I am not aware of any tags that would reflect a signal and not require a battery. Good luck!

Question: Anyone using acoustic modem to connect u/w receivers to in air transmission of real-time data?
Answer: Probably only the military! That is a very complex and expensive setup that would be beyond most research groups.

Question: What are the battery constraints and is there thought to having remotely rechargeable?
Answer: The acoustic tags have an average battery life of 6-7 years with some fish still being detected more than 10 years after tagging. So, these tags to have very good battery life.

Question: These may be dumb questions from a livestock guy! 1. I am simply learning about these tags and wondering if there might be any application in livestock or other land animals given we want to learn more about their vocalization relationship to specific behaviors. 2. There are plenty of tags/wearables for land animals to track activity but most have short battery life. What battery technology is in the sand tiger tag that might help us with battery life?
Answer: Not dumb questions at all! The sand tiger tag is able to last so long because it isn't doing anything too complex - just transmitting a short ping every few minutes or so. I would imagine the terrestrial tags are more like the tags that Dr. Parks spoke about where they are recording data, which does take a lot of battery life.

Question: How about acoustic tags on invertebrates? Is it legit?
Answer: Some people have attached them to lobsters and crabs, though molting can lead to shedding of the tag. So, it's not easy but has been done!

Question: How well do the D tags function in colder Arctic waters? Is there a preferred tag for extreme temperatures and potential bumping against floating ice?
Answer: There have definitely been groups that have used acoustic tags with Arctic species (for example bowheads, narwhals and belugas). The primary concern might be decreased battery life in colder water and the potential for the tag to come off under the ice.

Question: Is wave energy or atm. pressures every measured as an attribute/proxy to understanding specific species responses and behaviors (tides and energy in daytime vs night time compared with seasonal cyclings)?
Answer: the wave energy and atm pressures are often correlated at a later time, not measured on the tags.

Question: Has this been published? I would love to read more about it.
Answer: Sure! There is a paper in Animal Behavior:Root-Gutteridge, H., Cusano, D. A., Shiu, Y., Nowacek, D. P., Van Parijs, S. M., & Parks, S. E. (2018). A lifetime of changing calls: North Atlantic right whales, Eubalaena glacialis, refine call production as they age. Animal Behaviour, 137, 21-34.