Transcript

Speaker 1: You're tuned in to 90.7 FM, k a l x Berkeley. My name is Tesla Munson and this is the graduates, the interview talk show where I speak with UC Berkeley students about their work here on campus and around the world today I'm joined by biologists, Nick Burnett from the Department of integrated biology. Welcome nick. Thank you. Thanks for being here. And uh, so as far as I know just from like walking around the building cause we're in the same building. You, you guys have like your own section cause you're a little bit different. You're in biomechanics.

Speaker 2: [00:00:30] Yes. So there are, within our department there's three labs that do by mechanics. I see three main labs but we have a shared space and then basement where there's a lot of the bigger equipment or the more expensive stuff that we all need access to. Um, that's the cyber center.

Speaker 1: So cyber big equipment in the basement. What exactly is biomechanics? Why is it its own section?

Speaker 2: So biomechanics is the combination of biology and engineering or [00:01:00] physics. So it's using principles of engineering or physics to answer biological questions or the reverse using biology to inspire a knowledge of edge engineering or physics.

Speaker 1: Can you give us an example that's either come out of your, your lab or your working group or just something that people might be familiar with?

Speaker 2: One of the things that came out of another lab in the biomechanics group, our adhesives that were inspired by Gecko feet and he said he sieves don't need glue [00:01:30] or don't need suction to stick to basically anything they can just using molecular bonds stick to everything.

Speaker 1: So that's like how they walk up walls. For example, you're talking about like, you know a little Geckos walking in mall walking on ceilings. So you're saying that people looked at the Geckos and they were like, man, how did they do that? And then once they figured it out they were like, Whoa, we could make other 80 we could make adhesives to do this. Cause I know I read about something about like adhesives in space, right? Or like [00:02:00] different applications for these crazy pieces.

Speaker 2: You could make a robots walk up walls if you put it's synthetic adhesives that are modeled after these Gecko adhesives onto the robot's feet. So you could, you know, send a robot up a wall or a, another application that I've heard about is using those adhesives on bandaid so that you would not need to have glue on the bandaid. Um, and you could just stick it on. And I think that would make a much [00:02:30] more sterile healing environment for your wound. And another cool thing about these bio inspired adhesives are that they are self cleaning. So you could have this Gecko walk through a bunch of dirt and then the dirt would kind of be pushed off. But that's not my particular area of research. So I can't answer.

Speaker 1: No worries. I'm glad you guys are called cyber and not skynet because then I'd be a little worried. Right.

Speaker 2: Those are the guys and the engineering mechanics.

Speaker 1: Okay. All the way. Okay. Um, so

Speaker 2: [00:03:00] you said you don't work on adhesives. What, what do you work on? So I work on the interaction of flexible organisms with their fluid environment. So whether that would be a, a plant in wind with wind and air being the fluid or seaweeds and water and the water is a fluid there obviously. So each organism experiences a unique flow environment in the ocean or near the coast. Seaweeds are experiencing water that moves back and forth as each wave comes up [00:03:30] onto shore then falls back again. And then there's also the slower timescale movement of currents where a current could change with the tides or more seasonally. So I, I kinda, I study how seaweeds are adapted mechanically to survive that kind of fluid motion. So whereas other people in the department might study the evolution of seaweeds or like who their closest relatives are, you're specifically interested in their mechanical properties.

Speaker 2: Correct. [00:04:00] Nice. Okay. So I guess the first question I have is, were you always really interested in engineering and mechanics? Were you building little things as a child? You know, break in tree branches down, trying to see, you know, how far you could throw them or whatever it is like you do. Growing up, people like me, I was always in the Legos and once I was yelled at by my parents for taking apart the computer, which I could not put back together, but I only ever took one physics class [00:04:30] in college and I really didn't even hear the term biomechanics until I was applying to graduate programs. So very much so. An ecologist and a biologist. And so what was your undergraduate and done? My undergraduate was in biological sciences and I had a minor in chemistry. And then you just like were deciding to apply to graduate school and you're like, oh biomechanics, that sounds cool.

Speaker 2: I'm going to do it or well I had always heard of biophysics, which is slightly [00:05:00] different than biomechanics that I guess it's using principles of physics to inform biology. But I did some work as an undergraduate and biophysics labs looking at how temperature effected bivalve mollusks so mussels and clams and oysters in the intertidal zone until you've oh, you did. You grew up near the ocean? I grew up in Charleston, South Carolina, so near the Atlantic Ocean. Um, I grew up, it was on a barrier island so I could look out my back window and see [00:05:30] the Charleston harbor. So that definitely influenced my thinking and a general attitude towards the ocean. Yeah. Cause it seems like a lot of your work takes place in the ocean or at least these title, so must be a connection there. Okay. You mentioned like malls and stuff. Is this where your Olympic project came into play?

Speaker 2: Yes. So that was, that was kind of the culmination of my undergraduate research experiences. So over three and a half years in [00:06:00] Undergrad worked in these labs and I kind of got a little bit of experience with basically building analog sensors that could measure simple things like humidity and temperature and then making physical models of these different bivalves so that we could measure what those bivalves were experiencing in the, in the real world. So we put these sensors in them and see how fast they're drying out or how fast are heating up. And then thanks to a very, uh, important undergraduate [00:06:30] mentor of mine, Dr Fernando Vima from Portugal. He showed me how to do some more soldering and use accelerometers to make a contact microphone. So basically something that you could stick onto the surface and pick up the vibrations of that surface. And with that you can listen to limpets and other snails chewing since these snails use a ribbon like tooth structure called a ratchet to drag across a surface and we [00:07:00] could record them in the field, their natural daily cycles of when they feed or when they don't feed, pairing that to the title cycle, you know, do they feed when the tide is high or do they feed when they're being hit by waves or went through they feed when the tide is low.

Speaker 2: So that was kind of a cool, like an observational study. Um, and I got a, a short publication out of that and that was kind of my first into true, well more independent project. Um, I did all the data collection myself [00:07:30] and then I did this all out at, uh, the Swire Institute of Marine Science with the University of Hong Kong. So I was able to record the rasping sounds of what I'm calling the fastest rasper in the, in the world, the fastest rasping rates recorded for limpets. And these aren't very exciting. I think we have, you'll play a recording of these, but they sound basically like sh and that's the sound of that cal carious structure [00:08:00] briefly dragging across the rock. So did you get to go to Hong Kong for this? Yes. I went to Hong Kong to start a collaboration between my university, the University of South Carolina, and uh, this professor, Dr Grey Williams at the University of Hong Kong.

Speaker 2: We took all the materials for building these contact microphones and then I basically sat out in the water listening to limpets Rasp for 12 or 16 hours. I got really sunburned, but we found out [00:08:30] that uh, this particular species of Olympic Shalonda grata, they have a really unique rasping pattern in that they feed only when they're being splashed by the waves, but not when they're totally covered or totally uncovered. So they have a, a unique time of feeding. And this helps us in our understanding of the biology of these Olympians because we can kind of predict much food they're getting based on how much time they have to feed and then [00:09:00] using other models of how does temperature affect their behavior or how does temperature affect their energetics. We can predict how climate change or other climate variables might affect their ability to grow and to reproduce.

Speaker 1: Okay. So because they're in Hong Kong, we can't call them the fastest rappers in the west, but they are the fastest raspberries in the east. That's, that's what you're telling me. Yeah. Yeah. Bang Day.

Speaker 2: It could be a temperature thing, but it could also be a, a species specific thing. [00:09:30] Um, obviously the waters and the tropics are a little bit warmer, so when things get hotter, they typically move a little bit faster, have faster metabolism. So then being the fastest ones measured as far as I know in the, in the literature, in the scientific literature could just be a, a fluke of the temperature.

Speaker 1: No, but that's really cool and it's cool that you got to go to Hong Kong, um, as an undergraduate. And yes, you're right. We do have a recording of these limpets raspy and then we're going [00:10:00] to play just so everyone can feel immersed in the, uh, warm waters of Hong Kong.

Speaker 2: And you can even hear in that recording when the, the waves lap over the shell of the Olympics. And that's pretty cool.

Speaker 1: Yeah, let's play it now.

Speaker 2: Okay.

Speaker 3: Okay.

Speaker 1: [00:10:30] Yeah, it's happening. It's happening. Okay, sweet. Yeah, thanks for sharing that audio clip. That was really cool. And get 16 hours of that whole process.

Speaker 2: More like, like 50 or so if you want more.

Speaker 1: I think there are some shows here on Calex that, uh, my, like some of that for some, you know, 1:00 AM mood music. Okay, cool. So that was your undergrad project. What are you working [00:11:00] on here at Berkeley? So here at Berkeley clay,

Speaker 2: I am combining field ecology with biomechanics, so we can just call that ecological biomechanics. And I work on this species of kelp called the feather Boa Kelp. Many of you probably have have seen it. It's the largest inner titled Kelp that's on the west coast of North America and it's called a feather bull kelp because it looks like a feather boa. It's, it's basically a long [00:11:30] each. Each Kalb has multiple long strap like frons that are covered with these little leaves or blades and they can grow to be three feet or even 12 feet long depending on, you know, the time of year. And I study how these kelp can survive the harsh hydrodynamic forces of waves hitting them over and over again and how they grow and how their growth affects [00:12:00] the strength of them. And then lots of other cool things. So what it's like to be a flexible object that's constantly moving around, getting tangled, getting nodded. [inaudible]

Speaker 1: okay. And before we continue further, I should say, if you're just tuning in, you're listening to KLX Berkeley 90.7 FM. My name is Tesla and today I'm joined by Nick Burnett biologist in the Department of integrative biology, talking about his work in biomechanics and obviously with flexible organisms and fluid environments. So, uh, these kelp are [00:12:30] these ones you see on the beach all the time washed up.

Speaker 2: So it depends on where you are, but probably the, the kelp that you're most familiar with washing up on the beach is, it's the bull kelp or the giant Kelp. Those are two different species that bull kelp is the one has a single stem or a Stipe. And with that, with a big ball or float on the end of it, people often like to jump rope with them or, or pop the pop [00:13:00] eons. But the reason that the call while they're truly called the bull whip kelp and it's because they look like a, a giant whip. Then there's the giant Kelp and those are the ones that uh, are infamous because they can grow two feet a day. Um, they typically live further off shore. But yeah, those ones are, are like the big kelp forests that David Attenborough talks about. Exactly. Those are the, the ones that are famous for the Kelp forest.

Speaker 2: So the, the species that I study under the, the name is agrees. Yeah. I mean, ZCI, [00:13:30] uh, is not usually found where the giant kelp are found, but they live a little bit shallower and up into the intertidal zone. And because of the unique regime of waves constantly crashing on the shore, uh, this is the only kelp that can survive that. And so because of that unique ability and the largeness of their size, I study why they can survive there and why the other species can't. And we're talking [00:14:00] in California, right? California, Oregon, Washington, even in Canada.

Speaker 1: So how do you study these? Do you have to actually go out to the intertidal zone to look at them?

Speaker 2: Yes, I've been monitoring for populations or for areas where this kelp grows for the last two years. And because of their unique morphology, they're all, like I said, a bunch of straps, more or less. Uh, imagine your belt with a bunch of leaves on it. I go out and to measure their [00:14:30] size, I measure the length of every single frond on there. And they can have as many as a hundred fronds and a total length of 60 or even 80 feet. So it takes awhile and it's a little hard and mind numbing, but that's why no one's done it so far. And I'm good at the mind work.

Speaker 1: Well, and if we're talking about an area where there's like a lot of waves crashing, how do the tides play into when you're able to go out there [00:15:00] and do this work?

Speaker 2: Yeah, so I have to wait for a low tide and since these kelp live in the lower intertidal zone, that means I have to wait for the best low tides. Typically there's only a few each two weeks or each, uh, lunar cycle because the tides are low when there's a full moon and when there's a new moon and say I wait for these low tides and then I go out and, and I have probably a a two or three hour window at each site to work. And then the hard part is [00:15:30] when the tides are really early in the morning, which means I'm waking up at three o'clock or three 30 and then driving an hour and a half out to my field sites near Bodega Bay and also near point Reyes. Conversely, in the times when the tides are in the evening, I have to work really, really late. And that's just kind of tiring when you're doing multiple days over and over again.

Speaker 1: No, but that, I mean that sounds pretty cool. Not everyone gets to actually, especially in biomechanics, right? Not everyone actually gets to go out into the field [00:16:00] and interact with their organism. Cause I know you do a lot of lab work too.

Speaker 2: Yes. Well I told my advisor when I got here that if I could not do field work then I would not be happy and I probably wouldn't want to work here. So I kind of crafted a project that would require being out in the field but also doing technical stuff in the lab and it's worked out well so far. Yeah.

Speaker 1: Yeah. You mentioned earlier that you guys have like a bunch of big equipment that's associated with biomechanics. [00:16:30] What are some of the machines or some of the pieces of equipment that you guys use even in your own work or in collaborative projects?

Speaker 2: So I can talk about, so in my lab we need to be able to recreate certain flow regimes, so we have a lot of tanks and things that look like tanks that help us recreate either wave driven flows, so like a back and forth water motion or you need direction also in one direction water flow. One of them is called a flume and this just makes the water [00:17:00] kind of, it's like a treadmill for water. I just goes on a loop and then we on one side of this circular piece of equipment, we work with the whatever object measuring maybe the forces that are acting on that object, like the drag forces or we can use high speed video cameras to measure how that object or that structure moves in the flow. We also have tow tanks which help us achieve a very specific velocity and you might drag whatever [00:17:30] structure or piece of seaweed through the tow tank at half a meter per second for a total distance of two meters and then we can measure very accurately or precisely the the forces on that cope or whatever object.

Speaker 1: Okay. That sounds pretty cool. Let's see. I know you, you earlier that you did a collaborative project with some Undergrad, so it was like a little different than what you're doing for your own dissertation. Was that taking place in the lab mostly or out [00:18:00] in the field?

Speaker 2: Yes. So that was all lab work. So it's basically a terrestrial version of my dissertation work. So this was a collaborative project with an undergraduate who's now graduated a deet Qatari and we were looking at how leaves flutter in the wind and how herbivores sitting or chewing on that leaf might affect the interaction of the leaf with the wind. So this involved a lot of high speed, uh, video doing different experimental manipulations [00:18:30] and then going through and tracking the leaf frame by frame. Uh, that was very exhausting. And then seeing under different movement parameters. So like maybe how fast the leaf is fluttering or the amplitude of it's fluttering, how those parameters are affected by the presence or the mass of a, of a herbivore on the leaf.

Speaker 1: Okay. Can you tell us what the answer is?

Speaker 2: Leaves are very good at moving in wind. And the presence of an herbivore doesn't do much [00:19:00] to it. However, an herbivore chewing a hole into a leaf does make the leaf flutter a lot faster. And that's pretty interesting because botanists have have noticed previously that uh, damaged leaves, leaves damaged by herbivores tend to be dropped by the tree or the plant, uh, pretty quickly. And so we have, uh, an actual fluid structure interaction mechanism behind that, uh, observation. Yeah. [inaudible]

Speaker 1: okay. [00:19:30] And um, so you said this is like a terrestrial version, but it seems similar in that you're interested in and the fluids and their effects. And you also mentioned that the kelp or the seaweed that you look at is unique in being like the only one that can survive in these really aggressive intertitles zones. Do you know what properties of it make it that unique? So it has a unique

Speaker 2: cross-sectional shape. So when I said it looks like you're built with a bunch of leaves on it, it is actually kind of flat like a belt, whereas most other Kelp are circular [00:20:00] and cross section. So I'm trying to test the hypothesis that this unique cross-sectional shape is, is very important for the way it moves in the water and, uh, how long it can survive in the intertidal zone. So there's a lot of things that can damage and cause that kelp to break such as herbivores or being smashed up against a rock. And, um, I'm still looking at, at the mechanisms behind how this cross-sectional shape might help lessen [00:20:30] those particular effects.

Speaker 1: So do you have any other spoiler alerts for us in terms of your dissertation? Any other cool findings you want to throw at the audience?

Speaker 2: Yes, a cool finding that I have, uh, recently found, discovered, discovered. Yeah. So I found that the natural phenomenon of seaweeds getting tangled is very important for the size regulation of that Kelp. So if these kelp get too large, when the waves increase in [00:21:00] size and in the wintertime, those waves can kind of rip the entire Kelp off the shore. And that's no good for the kelp because if you're not on the shore, you dead and getting kind of pruned or beaten up and getting smaller as is good for the longterm survival of the camp. And so I found that these long frons through their interaction with the back and forth water motion are able to get tangled or able to get nodded and this helps them break more easily and decrease [00:21:30] or shorten the length of their friends and and survive. So I've done experiments both in the field and in the lab that show that when a kelp frond is nodded, it increases the drag forces on that Kelp.

Speaker 2: And it also causes the kelp to to break more easily. So a lot of climbers out there might know that if you have a knot in your rope, that the knot reduces the strength of that rope. The same thing happens with the Kelp. So a knotted kelp will break with about [00:22:00] 15% smaller loads or smaller forces and an unknotted kelp front. So if you have water kind of smashing against a bunch of Kelp fronts, the one that's not at will break more easily. Tangled fronds kind of cool. They are infested with herbivores a lot more because they provide a more hospitable environment for small crustaceans and other organisms to, to live in. And those organisms are not very grateful. They, they kind [00:22:30] of chew and eat up the front and that causes it to break more easily because a wounded frond is not as strong as and wounded front.

Speaker 2: So I've done a bunch of experiments that measure the forces that are required to break fronds that are nodded fronds that are wounded and also measuring that the amount of herbivores that live inside all of these tangled or untangled fronds. And I've found some pretty cool results. So that's a unique, a novel discovery. And that same principle of flexible objects being pushed around [00:23:00] and tangled by the fluid environment also exists with a hair. And so I'm doing some experiments that show that tangled hair experience, little smaller drag forces, uh, which is perhaps unexpected for some. And I'm doing more experiments now to see how that reduction in drag or reduction in the forces that tangled here experience changes with the, the length of the hair or the [00:23:30] amount of time that the hair is tangled and also the number of hairs. And so that's more of a a physics based question cause a lot of, I don't know, well maybe humans are the only organism that have pretty long hair but we have the, the tools to untangle that here. Um, a lot of animals, and you could probably correct me on this, don't have yaks and wooly mammoths probably have an horse tails and that kind of thing. But for the most part a lot of animals [00:24:00] don't have pretty long hair.

Speaker 1: Yeah, there are definitely some monkeys was like some really long tail hairs and things like that. But okay. I, I thought of so many questions I want to ask while you were talking. One, does this mean that you are going to be really important in like the salon industry? Are you working on some new like fabulous hairstyles?

Speaker 2: No. So nothing with hairstyles, styles, just straight up physics. Like, what, what does it take to be, [00:24:30] I guess if you're, if you have to have hair, would you want to have a lot of really short hair or if you long hairs cause there are other physical consequences of having hair. So if you have a lot of long hair and you, you know, take a plunge in the river or whatever else, then uh, the more hair you have, that hair can hold more water and that's, uh, you know, an extra mass. And so if you're an animal trying to escape or Predator and you're weighed down, or if you're a really, really big [00:25:00] and you've got a lot of, uh, extra mass, that's a bigger energetic constraint and that could affect, you know, if you survived or not or if you get enough food. But then in terms of temperature regulation here, um, can be important for buffering when you're really cold or staying dry or helping to promote evaporative cooling. Um, there's a lot of cool physical consequences of having hair and I'm just looking at a, a novel approach of that fluid hair interaction.

Speaker 1: [00:25:30] So, not just humans, although many of those things you said apply to me with my hair, obviously. Yes. After like a day or two actually get headaches cause it's so heavy that it actually pulls down on my head and I use it when it's too hot. I use it to cover my shoulders so I don't get sunburned. All these things.

Speaker 2: I don't think about the amount of time that you or someone you know, might spend untangling their hair or even spending money on products like conditioner that help untangle their hair and then imagine [00:26:00] for an animal if they had that much hair that the time or the, the money that they would've spent if they had a job and could spend money.

Speaker 1: And now all I'm, I'm Paul, I'm imagining is like an animal with a bouffant or something. Yes. A Bovis. Nice. Okay. Second question. So you kept mentioning, um, the kelp braking, but in this scenario it's actually better to break right then to actually unroot entirely. Yes. So there is a seasonal cycle in the, in the summer

Speaker 2: in California and [00:26:30] along the west coast, the waves are typically a little bit smaller and then winter they get bigger. So when the waves are smaller, it's okay for the kelp to, to grow to be pretty big. And that's when they can reach those lengths that I talked about before of 12 feet or I think the largest one that I've seen. It was 20. Yeah, about 20 feet. And that's in the intertidal zone. You can find really long things in the subtitle zone. So when they're always underwater, but in the intertidal zone and there's a unique environment that they're being smashed against rocks and the waves are actually breaking [00:27:00] on them. So yes, it's good to be big in the summer and because that means that you can, uh, kind of compete against other organisms for, for light and space and you can use that light to reproduce more, but you want to get small.

Speaker 2: If the Kelp, you know, we're going to give them the ability to want things here. The Kelp knew what was happening. They would want to get small and they, they get small due to this interaction with the fluid environment, you know, being tangled [00:27:30] and ripped up. But also, uh, the interaction with their herbivores that chew on the front and, and weaken it. And then there's also, um, because the, the wintertime has less sunlight, they slow down their growth and that can also help, you know, they don't heal any wounds as quickly and they can kind of just deteriorate due to slowed growth. So there's a lot of different biological and physical reasons that this happens, but um, is there a really cool seasonal cycle in, uh, when it's good to be big [00:28:00] and when it's bad to be big?

Speaker 1: Yeah. Okay. If you're just tuning in, you're listening to KLX Berkeley 90.7 FM. This is the graduates are definitely coming towards the end here. But another question I wanted to ask, you mentioned invertebrates a little bit, but just in general, this kelp, this is not just like an isolated system, right? We're talking about the intertitles. So there must be a lot of organisms that rely on Kelp or that interact with it. Just in general.

Speaker 2: Yes. Because, uh, kelp are a dominant canopy forming organism. [00:28:30] You've got lots of other seaweeds that might grow on the kelp. Even other individuals of the same species might grow on an older individual. There is, there's species of amphipods, these little shrimp like organisms that will burrow into the Kelp and they live there and have their, their family there. And then there's even for this particular species of Kelp, um, there's a specific limpet that only lives on that kelps that's a really cool system for how [00:29:00] does this particular species have Olympic effect, the Kelp, and then how does the Kelp affect the Olympic, kind of a mutual back and forth in terms of the fluid structure interaction. Because if the celt breaks and that Olympics home is gone, but if the Olympic doesn't wound the kelp, then there's, you know, there's no, you can't live there. Yeah. Just, yeah, there's a lot of cool things that live on the kelp and in terms of tangling, increasing the amount of herbivores that live on the kelp. And I had [00:29:30] some undergrads helping me pick out every single amphipods, you know, shrimp like organism. I'm on a, a tangled kelp individual and there was over 6,000 of them. So we are in the picking out individual little, you know, these are smaller than a centimeter in length. So it was very excruciating and then we had to count them all.

Speaker 1: Nice Fun. So you're taking undergrads then, Huh? Okay. Well we are out of time here on the graduates, but I always give everyone a chance to get on the soapbox [00:30:00] if they want. If there's anything you know, the things really important to say to the public about your work or about science, now's the time. If not, that's fine, but I want to give you the option.

Speaker 2: Okay. Well so specific to my uh, study system. The next time that you're out walking on the beach and you happen to see a big massive of Kelp that's been washed up instead of jump roping or whipping your friends with it, take a take a chance to, to dig through that massive [00:30:30] kelp and see, you know, the amount of Kelp that's there, all the animals living on it. And um, and you know, maybe you could even ask yourself a few questions of what happened to this scalp and why is it washed up and what's going to happen to it now. Um, this kind of basic curiosity questions, you know, that might help your child or your, your relative or even you begin a whole career that you never thought possible. Cause that's kind of how I got started on this journey.

Speaker 1: [00:31:00] Yeah. And we're definitely in a lucky place here in California having the Pacific Ocean nearby. So it's just a whole nother world out there in the ocean. Right. And the beaches are our way to connect to it. So, yeah, unless you want to get, do you wear a giant like boots in like a water overalls to go into the tide?

Speaker 2: Uh, boots and rain pants. Yeah. I don't want to get swept off. Um, does that the ocean, I guess another important things is that the ocean is very dangerous. So if you do find yourself like wanting to go tide pooling, always [00:31:30] take people with you and uh, be wary of the ocean because we've got rogue waves that can suddenly come up on shore and rip you away in our, you know, push you over and uh, you can get hurt in that way. So it's good to be curious, but it's also good to be safe and [inaudible].

Speaker 1: Yeah. And a WHO said plants aren't dangerous, right? Indeed. Indeed. At least the ocean. Okay. That's it for us here on the graduates. My name's Tesla months and today I've been joined by biologists, Nick Burnett from the Department of [00:32:00] integrative biology, talking about his work in biomechanics and specifically with Kelp here in the intertidal zones of California. And trying to understand the forces that affect that Kelp. And, uh, specifically in the water and all these mechanical things. And uh, yeah, it's been great having you, nick. Thanks for being here. Thanks for having me anytime. And that's it. As I said, for the graduates, we'll be back in two weeks with another episode until then, stay tuned. You're listening to 90.7 FM, k a l X.