Biologists and Graph Interpretation Network

BioGraphI Lesson Guide Template

The Impact of Climate Change on Sea Hare Respiration

A BioGraphI Module Lesson Guide for Instructors

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Course Information
Department/Program: Biological Sciences
Level: Introductory (first year to sophomores)
Course type: Intro Bio, Intro Ecology
Delivery mode: In person
Students: Biology majors/non-majors
Number of students: Flexible
Estimated duration of activity: 1 class period (~1 hour)

Expected date or dates of implementation
Spring Semester 2025

Purpose/Background
This lesson helps students understand basic graphical knowledge (such as error bars, sample sizes, understanding axis, etc) while simultaneously challenging students' assumptions about the impact of climate change on organisms.

List of materials needed for the lesson

- https://www.youtube.com/watch?v=TnkN-OZuni8
- The Impact of Climate Change on Sea Hare Respiration

About BioGraphI modules

This lesson is a BioGraphI module. BioGraphI modules address data literacy while fostering diversity in undergraduate biology classrooms. They are lessons about graph and data interpretation, featuring the scientific contributions of biologists who are members of historically excluded groups (HEGs). They include video interviews with these biologists, allowing students to hear directly from HEGs about their discoveries. For more information about how the BioGraphI project is advancing inclusion in biology and improving data literacy, visit our webpage.

Student Learning Objectives

The BioGraphI Student Learning Outcomes (LOs) describe what students can expect to gain by the end of the BioGraphI lesson. They are written in a format that can be shared directly with students.

Content learning objective(s)

1. Describe how the impacts of climate change vary depending on the organism in question.

Quantitative learning objective(s)

2. Interpret graphs and/or data figures related to the concepts from this lesson
3. Describe the purpose of error bars
4. Reflect on your perceptions about using graphs or figures in biology.

Diversity/equity/inclusion learning objective(s)

5. Reflect on your perceptions of people who do biology.
6. Reflect on when you felt a sense of belonging in science.
7. Compare your own interests and/or identities to those of people who do biology.

Assessments

To help the BioGraphI Project to measure the effectiveness of our modules in improving data literacy and fostering diversity in biology classrooms, we invite your students to participate in a voluntary, anonymous pre-/post-lesson survey (Geneseo IRB #202021048). This survey is designed as an opportunity for reflecting on the Quantitative and D/E/I learning objectives above and administered via LimeSurvey. Click Instructions for access to BioGraphI PrePost-Lesson Student Survey to request a survey to be set up for your students, at least 7 to 10 days in advance of your class meeting date.

See presentation slides Sea Hare Respiration Slides for formative and summative assessments activities

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Objective(s)	Formative Assessment	Summative Assessments
Describe how the impacts of climate change vary depending on the organism in question.		In class group project
Interpret graphs and/or data figures related to the concepts from this lesson	In class polling using poll everywhere	
Describe the purpose of error bars	Think-pair-share	
Reflect on when you felt a sense of belonging in science.	Short written reflection after the lesson is complete	
Reflect on your perceptions about using graphs or figures in biology.	BioGraphI Student Pre-Lesson Survey (link for instructions to access survey)	BioGraphI Student Post-Lesson Survey (link for instructions to access survey)
Reflect on your perceptions of people who do biology.	BioGraphI Student Pre-Lesson Survey (link for instructions to access survey)	BioGraphI Student Post-Lesson Survey (link for instructions to access survey)

Lesson context

Learning goals of unit

- Students will be able to communicate how climate change can have differential impacts depending on the organism being studied.
- Students will be able to amalgamate data, data visualizations and written information, and draw conclusions based on their evaluation.
- Students will be able to draw connections between their own identities and the role of science within their communities and/or interests.

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Prerequisite skills or knowledge

- **No prerequisite skills or knowledge needed.**

Preparation for lesson

- Assign BioGraphI Student Pre-Lesson Survey as homework for students to complete before this in-class activity.

Lesson sequence

Each row of this table is a step of the activity. Column headings reveal what the instructor, interviewee, and students do at each step.

Information from instructor (live in-class)	**Information from scientist (within pre-recorded video interview)**	**Student follow-up or transition activity**
Prior to class, assign any preparation activities	N/A	Students complete homework/pre-lesson survey for BioGraphI project (combination of reflective writing prompts and closed-ended questions) ● *Purpose*: prepare for class; LO 4 & 5 – Pre-lesson reflection on data literacy and perceptions of scientists
Allow students to reflect on Climate Change	N/A	Students answer questions regarding climate change and sea hares. ● *Purpose:* Warm-up and icebreaker, get students to think about their preconceived notions on climate change (LO 1)
Plays first video segment	● ***Required interview Q.*** Could you describe your approach to this study?	● **Fundamental activity:** Students receive more context on the study. ○ *Purpose:* Students learn more about sea hares and develop context.

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Plays next video segment	• ***Required interview Q.*** Could you tell us more about why you choses sea hares?	• **Fundamental activity:** Students receive more context on the sea hares. ○ *Purpose:* Students learn more about sea hares and develop context.
Provide empty graph on a ppt slide	N/A	**Fundamental activity:** Make reasonable guesses to what the graph is about, share out • *Purpose*: rewards creativity, normalizes errors (nearly impossible to be correct)
Plays next video segment	• ***Required interview Q.*** Orient us to this graph we've been working on. (What do these axes mean? How did you measure stuff? What do the units mean? How did you make this graph? Why did you decide to show the data in this way?) • *Vocabulary to incorporate:* types of graphs, units, independent (explanatory, predictor) variables, dependent (response) variables,	**Fundamental activity:** Students interpret/re-interpret graph with the correct axis labels. Infer the hypothesis that was studied. Evaluate whether or not the hypothesis was supported. Share out. • *Purpose*: LO 2A & 3 - Check student understanding of the concepts and vocabulary
Review Terms from video	N/A	**Fundamental activity:** Students review new terminology and apply it to the graph. • *Purpose:* Students have time to deconstruct complicated terminology and locate its position on the graph. Students will be able to better connect the terminology to what is happening scientifically. • Aligns with LO 2 and 3.
Plays next video	***Interview Q:*** Can you explain why	• Purpose: students learn

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segment	you used more than one individual at each temperature point?	about error bars and the importance of sampling. • Students apply knowledge from sampling to two different scenarios to test their understandings of the concepts • Aligns with LO 2 and 3.
Plays next video segment	***Required interview Q.*** Explain the significance of this research	• *Purpose*: Closes this portion of the lesson
Selects questions that align best to student generated questions; Must show the answers to at least the required interview Qs to students	***Required interview Qs*** **What kinds of scientific questions interest you the most?** **When and how did you know you wanted to be a scientist?** **Tell us about the paths that led you to your current job.** **What is it like being a scientist with [counterstereotypical identity or background]?** **Tell me about a moment when you felt like you really belonged in the field of science.** *Strongly suggested Qs* How do you balance work with other interests?	• *Purpose:* Students learn more about a diverse scientist and make connections about their own identities and reasons for wanting to be in science. • Aligns with LO 5, 6, 7
Small Group Project	***N/A***	• *Purpose:* Student apply what they learned on a different organism to create connections between climate change and its differential impacts • Aligns with LO 1

Alignment to Universal Design for Learning Guidelines

UDL Guideline	**Lesson Alignment**

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Multiple means of Engagement	Self-regulation: Students reflect on their dispositions and knowledge of scientists and graph interpretation before and after the lesson Sustaining Effort and Persistence: Students will foster collaboration through a group assignment on climate change impact for an organism of their choice.
Multiple means of Representation	Perception: Captions are provided on the interview video. Google Slides offers automatic captioning for presenter. Alt text for images provided in Google Slides. Language and Symbols: Illustrate through multiple media (video and text). Clarify vocabulary and symbols (scientific jargon and definitions as well as how to interpret symbols on graphs). Comprehension: Highlight patterns, critical features, big ideas, and relationships through ecosystems and climate change.
Multiple means of Action and Expression	Expression & communication: Multiple types of media are used in the lesson (visual, audio, text).

Implementation notes

- When walking through the graph slides (slides 15 - 37) I have the students discuss the definitions and what they mean for the graph in front of them. If you have a quiet class, you could turn this into a small group activity.
- For the group project, I do not create a rubric and allow students to be as creative as they want. This is more an exercise to get them to apply what they learned but this could be more structured if desired.

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References/resources

1. Tanner, R. L., Faye, L. E., & Stillman, J. H. (2019). Temperature and salinity sensitivity of respiration, grazing, and defecation rates in the estuarine eelgrass sea hare, Phyllaplysia taylori. *Marine Biology*, *166*(8), 109. https://doi.org/10.1007/s00227-019-3559-4

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This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

Transcript of interview

Timestamps:
0:00 Introduction
0:46 Could you describe your approach to this study?
3:49 Could you define salinity and ocean acidification?
5:24 Why do you choose to use sea hares as a model organism?
8:54 Orient us to this graph! What are the axes measuring?
13:56 So what is happening here in this graph?
14: 54 Can you explain why you used more than one individual at each time point?
16:34 What is the significance of this research?
18:17 What kind of scientific questions interest you the most?
21:06 Tell us about the paths that led you to your current job
24:46 Could you tell us more about your experience as a scientist in relation to your own identities?
26:37 Can you tell me about a moment when you felt like you really belonged in the field of science?
28:11 How do you balance work with other interests?
30:09 What is the most important advice you would give students pursuing science?
31:37 Thank you!

0:00 Introduction

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Desiree Forsythe: Hi there everyone. I'm so excited to introduce you to Dr. Richelle Tanner. Dr Tanner and I had this conversation a while ago, but I wanted to make sure to introduce her properly. Dr. Tanner is the current program director and assistant professor of environmental science and policy at Chapman University, and she leads a research group that engages in multi-disciplinary climate research that aims to inform applied management, and this includes restoration genomics and ecophysiology, and research on the role of language in advocacy and environmental literacy. Today, Dr. Tanner is going to start us off by speaking on her approach to this study specifically, and her approach to science broadly. Dr. Tanner, take it away.

0:46 Could you describe your approach to this study?

Richelle Tanner: This study wasn't really any different from how I approach research more broadly. So my approach to science is rooted in natural history observations, which is kind of an old school way of approaching science. It comes from an influence both in my childhood, but also my PhD adviser, who was a really big advocate for going out into the world and looking at things without any assumptions about what patterns could mean. So I'm really interested in how coastal ecosystems are being affected by climate change. And sea slugs, that seems like a really far leap from that question, right?--but I grew up on the coast, and I grew up going tide pooling on the weekends. I would spend all of my summers in Hawaii looking at shells on the beach and animals that lived under rocks, and so it's just really not that different. When I arrived in graduate school, I really wanted to work on seagrass ecosystems because they're really threatened by human activity and warming oceans and changing salinity patterns, especially in California, as we get heavy rain one year and drought the other. When I showed up at my graduate program, there were all these sea hares on the eelgrass, and my advisor said, You should think about doing something with those, because you like slugs and they're here. So we started thinking about, well, are they impacted by climate change in certain ways and their physiology. And one thing led to another. We were looking at different aspects of how they responded to warming and to different ocean acidification scenarios and different salinity scenarios, and the second winter that I was in graduate school, it rained really hard. So much that the salinity of San Francisco Bay went to zero--so fresh water--and they all died! And from that we figured, well, it's really important for us to understand at what point do these sea hares lose their resilience, because they're actually pretty hardy. We call them, you know, some of the superheroes of the sea, right, they're going to--they're going to be around with climate change. They can deal with warming, but we just want to characterize why, and so all to say natural history kind of led me to that. And it also made the process a lot more enjoyable.

3:49 Could you define salinity and ocean acidification?
Desiree Forsythe: Yeah, thank you for that! That's wild that they all died because it became freshwater. That's interesting! And you used two terms, I just want to make sure that the students would know, one was I think ocean acidification and salinity could you give us a brief definition on those two terms?

Richelle Tanner: Yeah so salinity is how salty water is. So ocean animals like the water pretty salty and animals that live in streams like no salt and these sea hares live in the space between

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those two. It's called an estuary and this is where salty meets fresh and so the salinity can be very different day to day and so it's unusual to see an animal in this area being removed because of a salinity problem because they see so many different salties every day. And ocean acidification is kind of along the same lines but it has to do with ph and so without going into the chemistry of it, that's a long conversation, basically when we burned fossil fuels like coal, oil, and natural gas were contributing carbon dioxide into the atmosphere, this carbon dioxide is absorbed into our oceans because oxygen molecules in water bond really well to carbon dioxide. And when that happens the water becomes more acidic and it can affect animals that try to build shells but also just the physiology of a lot of animals so how their bodies work and we call that ocean acidification

5:24 Why do you choose to use sea hares as a model organism?

Desiree Forsythe: Great thank you for that. And you were talking about these sea hares and so I wanted to ask a little bit more around why you chose sea hares, you're starting to get into that, and then maybe kind of describe like what they are because I'm sure they're not actually like rabbit hares which is what I think of when I think of a something called a hare.

Richelle Tanner: Yeah so they're slugs, ocean slugs, marine slugs, and they're called sea hares because when you look at them face on, they kind of look like a rabbit with their rhinopores, their little ear-like structures. And you know, I picked them for a lot of reasons and there's the reasons that I say in presentations and then there's the reasons that I admit to myself, right, and the bottom line is that they're really cute and they're fun to work with. You know when you work with them a lot you get to know that they have little personalities which which is unusual for invertebrates but from the you know strictly science perspective they are also really good models because they kind of can help us understand broad patterns of evolution uh they have interesting life history traits so like how they lay their eggs and what their lifespan is and how many babies they have because they live in such a unique environment where everything is always changing in an estuary so they're a really great model for looking at as we go into the future when everything changes even more with climate change they've already been kind of dealing with that for their entire evolutionary history. So they're probably going to be okay and we want to know how they're able to do that. The last reason that we pick them is they live on eelgrass, just a type of seagrass, and I mentioned that seagrasses are really threatened worldwide by human activity and climate change. So there's a lot of effort being put into restoring the eelgrass back to where it used to be in the bay, but the problem with that is that is not as easy as just planting a plant out there. But they've been trying to do that for the last maybe 15-20 years and the plant doesn't survive. So this sea hair provides a really great service to the plant because it cleans all of the gunk off of the leaf of the eelgrass as its food and so they have this indirect positive relationship where the sea hair gets a lot of food from living on eelgrass and then the eelgrass is able to better photosynthesize. And so when we think about restoration scenarios we want to make sure that the sea hair is included in that because they can, you know, make their eelgrass bed healthier. So three reasons.

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So if seagrasses were further threatened by warming oceans they they would lose part of their habitat but kind of the hopeful story here is that plants are actually not going to be all that negatively impacted by climate change especially underwater, because it's much colder at least on the west coast over here, it's much colder underwater than it is on the land. The temperatures are buffered. It's still warmer than they're used to but plants when they have more access to carbon dioxide and warmer conditions they actually produce sugars more quickly and so they actually grow more, and so that's kind of a nice hopeful element of the system I work on. I always try and work on something where you know we can see a future where resilience is possible and so you know the sea hares can help facilitate that growth and the eelgrass will continue to grow as long as they work together we're looking at a sustainable future.

8:54 Orient us to this graph! What are the axes measuring?

Richelle Tanner: So this is a lot going on in one graph, and it's a little different from the one in the paper, but I'm hoping that we can get a better overview of why we did this study with the way that the graph looks.

So on the x-axis we've got environmental temperature in degrees Celsius and so this is just the temperature that they're living in or existing in that we've measured respiration rate at and so respiration rate is pretty simple. It's how quickly something breathes. It's how much oxygen they consume in a given time period and so the units for that are micromoles of oxygen so just a unit of oxygen per gram of sea hare per hour. So it's taking into account the weight of the sea hare because obviously a bigger one is going to breathe more oxygen, hopefully, and so from that we can get this idea of how quickly does something breathe at a different temperature and if you take that logical line one step further and think about, okay why would we breathe more, your breathing rate is directly related to your metabolic rate which is how quickly you can make ATP energy sugars so that you can maintain body processes or you can grow.

And so we measure respiration rate using this little chamber. It's just a little jar with a fiber optic cable and a little sensor in it and we're measuring how much oxygen is left in the water as the sea hare is breathing and breathing. But we're actually really interested in how much energy is it using and so a higher respiration rate more energy being used and potentially produced. so it's kind of like a double-edged sword there.

13:56 So what is happening here in this graph?

Richelle Tanner: So the black lines and shapes are the actual data that we collected at a lower salinity. So we measured two different salinities, but I'm going to show you the lower one because it's more relevant to when it rains a lot. What we're looking at here is a combination of a sea hare, or many many sea hares because there are error bars, that were subjected to an acclimation period. They lived in the lab for two weeks at two different temperatures, so the triangles are the warmer temperature and the circles are the cooler temperature and they were both held at the same salinity. So what we're looking at here is after they were held in the lab for two weeks at those conditions we measured their respiration rate at a bunch of different other

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conditions. We measured it at 18° c, 22° c, 26° c, and 30° c. And these are temperatures that are representative of kind of on the warmer side of normal conditions to something that looks like a heatwave at 30 degrees celsius. This is something that feels to us near about 90 degrees Fahrenheit, which in Orange County maybe not that hot, but if you're in water that is that warm, that's pretty hot. And so we're looking at, I realized you can't see my mouse, we're looking at the average and then the standard deviation of the respiration rates of all of the six to 10 individuals that were measured at each of those. And we measured the same individual at each of the temperatures so they're all linked. And you can see that it's it's going up, right, respiration rate goes up with temperature and that's pretty common, especially in ectotherms, which are animals that can't control the temperature of their own body. So we are endotherms, as temperatures increase our respiration rate doesn't change very much, but these guys are kind of at the mercy of their environment.

I've put the gray line in the background because it kind of shows the broader physiological framework, the fundamental biology framework behind why we do these kinds of measurements. So what you're looking at with that gray line is called a a thermal performance curve and they all look a little bit different, some of them are squished together some of them are very flat, but they all have that Peak at T Optimum. That's the optimal temperature that respiration rate is maximized at. This doesn't mean that it's necessarily great to be there it just means you're breathing the fastest right there. Then it kind of drops off and you get the critical thermal maximum so this is the temperature at which they lose the ability to right themselves, basically if you pushed one over on its back it wouldn't be able to flip back over again. There's an analogous CTmin on the other side and this is the minimum temperature that they can't right themselves. And so we're trying to characterize some portion of that thermal performance curve by taking measurements every four degrees and based on some other data of many other studies that I've done, I kind of know what this thermal performance curve looks like. This was one of the first studies that we did, actually I think it was the first study we published on their respiration rates, and now we know that their CTmax is closer to 34 degrees celsius. So what we've got here is we measured a really good chunk of the range of of their thermal breath, or where they are happy to be, and so what this shows us is, you know, these sea hares uh no matter what temperature they are acclimated at or they live in for a long time they're going to be fine. And the salinity, they're also going to be fine. So this was kind of a confirmation of the resilience

14: 54 Can you explain why you used more than one individual at each time point?

Richelle Tanner: Yeah so what we're looking at is that the error bars are overlapping, right, and and when I teach this in my 101 class uh an error bar overlapping is a good indication that those two groups are not different from each other. And so these two groups of sea hares were acclimated to two different temperatures but they effectively look the same when you measure their physiology. The only thing that I would point out is when we say adapt so that's kind of a word that is a sticking point with biologists right. So adapt can me a lot of different things to a lot of us, and short term adaptation we often call that acclimation or acclimatization or in this case

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they are plastic in their traits. And so yes they are, but their genetic code has not changed which is technically the formal definition for adaptation.

So this is going to sound a little corny but everyone's unique. So uh when we want to get a better idea of an entire population it's really important for us to randomly sample that population. This is because there could be one really strong sea hare that's like it's going to persist through anything you throw at it or there could be one that like has a cold like I do. And so you can, you know, really skew your sample if you don't have a large enough sample size and when you measure lots and lots of individuals you have a better idea of what an average individual in a population looks like.

16:34 What is the significance of this research?

Richelle Tanner: It's a little far-reaching but the the idea that there is hope for our restoration scenarios is what I take away from the study and this graph, in that you know as we acclimate sea hares to warmer conditions and less salty conditions, which is what we're going to see in the future, they're fine! And they are, you know, following the normal processes or like biological processes that we would expect. Not normal, but things that we would expect, no such thing as normal in biology. We expect respiration rate to increase with temperature and they're doing that and that means that there's not a breakdown in some cellular process that's causing them to not be able to respire enough. So this is very simply a story of hope but it's also a confirmation that we've measured these sea hares within a range of temperatures that allow them to, you know, function as we would expect as ectotherms.

Yeah I think this goes back to that question of selecting the right model system. I've picked a model system that we are looking to for help. And so this is going to be a species that we heavily rely on, and it doesn't mean that it's not threatened by other human caused problems, so like pollution. Sea hares are mollusks, even though they don't have shells, slugs are mollusks and so they're really susceptible to heavy metal poisoning which is really common in estuaries. And so even though we've got this story of hope here, and we can build off of it, I've picked a system that we expected that to be in.

18:17 What kind of scientific questions interest you the most?

Richelle Tanner: So Natural History questions are kind of what I started with. You know, as a kid and in undergrad. But increasingly as I've become you know as a professor, I was a scientist the whole time, but as I've become a professor I've been more interested in issues that are impacting our society at large. I think scientists in this new age are increasingly investing in solutions to problems that have to do with the communities that they live in or communities that are disproportionately affected by climate change. And so even though I have a background in fundamental biology for my PhD, I actually did my undergraduate degree in Environmental Studies which is a Humanities major and music which is a Performing Arts major. And so I think that really helped me kind of roll everything together as I became a professor and to ask these applied questions that can help us become better stewards of our Earth. You know we still

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address questions that are fundamental questions in biology, so key questions about how like life works, like why are we here, these like big esoteric questions that Berkeley is famous for, but I I think the applications of my work increasingly--I'm interested in these stories of hope on our coastline. Whether that's with specific species or you know opportunities to uplift communities that haven't had a voice in climate decision making through science.

So I think one of the great things about being at an institution where undergraduate research is important is that students can come into the lab and ask a question that's important to them, but my framework for the questions we ask in the lab is, you know, we have to be asking a question that a community member or a community organization has requested we look into. So this is under the umbrella of science and service of society. That can look a lot of different ways we still do physiology research and ecology we go out to the field we collect animals, you know, because there are government agencies that are really interested in that data, but it also means that we're working with communities to build educational programming and literacy in other languages, and so we use techniques in physiology, ecology, genomics, but also psychology, sociology, risk assessment, and you know, I think that that kind of training is kind of the future of what a lot of applied science fields will look like.

21:06 Tell us about the paths that led you to your current job

Richelle Tanner: Oh, I've always known and that's a really unsatisfying answer for students. I think very few people have known their entire lives that they wanted to be a scientist. I did not think that I would be this kind of scientist, I'll tell you that, I thought that I would work for a government agency because I grew up in an area where fisheries were really common--in Seattle--and so I thought, well, I could, I could go work for NOAA, which is the National Oceanographic Atmospheric Administration, and you know, I still could. This is, you know, got a long career ahead of me. But I didn't really fully understand the social and cultural responsibilities that scientists face, and I think those have really come to the forefront within the last 10 years and I've been lucky to kind of jump on that learning train, and the skills that I pursued in K-12 and in undergrad were set me up really well for being able to just learn more about other things. I think it didn't really matter that I was studying a particular field, like, you know, I didn't--I don't have an undergrad in Marine Biology, even though we do a lot of Marine Science. I have a really broad, interdisciplinary training and that is kind of what helped me confirm that I wanted to be a scientist, but I wanted to redefine what a scientist was.

So my undergraduate degrees, I have a Bachelor of Science in a humanities field, Environmental Studies, and I have a bachelor of Music which is a conservatory degree, in jazz performance and that was just something that I couldn't let go of, and I wanted to keep learning about. I'm glad I did. It taught me a lot about, you know, improvisation and working on teams, but also kind of the realities of structural inequities in our society, because music industry is really rich with those, and so after that I went on to do a biology PhD degree, and I thought I wanted to be an evolutionary biologist and then the pandemic hit, and I did not want to be an evolutionary biologist anymore, I wanted to do something that people could really benefit from. And that's how I ended up at Chapman, but in between there, I worked at a nonprofit. I was the

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science director for the National Network for Ocean and Climate Change Interpretation, simultaneously while doing my postdoc in bioinformatics, which is, you know, computational biology, and so even though I took this really traditional path on the surface. I sought out opportunities along the way that really fed into who I am as a professor I I wrote a lot of educational curriculum for community organizations but also I I wrote the environmental literacy state standards for California when I was in grad school. That was a fantastic experience. I sit on a lot of government boards and work really closely with our government management colleagues and so I feel that I have a really broad background despite you know you could say that I was a very traditional, you know I did a four-year degree, I did my PhD I did a couple post talks and I became a professor. But there were so many things that I did on the side because they weren't valued by academia that you know once I became a professor I'm allowed to have all of those pieces of my identity in one position which is why I'm here right.

24:46 Could you tell us more about your experience as a scientist in relation to your own identities?

Richelle Tanner: You can look at me and you can say what you think I am but I think what's important to to learn as you continue to interact with lots of diverse peoples is not always what it seems, right. So my mom is from Hong Kong, she's an immigrant and so I'm first generation American, even though I look very white, didn't get any of her genes but got all of her heritage, right. So like everything about the way I live my life is culturally very Chinese. And so I think that has given me perspective in higher education that uh makes me a safe space for a lot of students but also able to advocate very strongly for change at the institutional level because I look white. and yes women are marginalized minoritized in STEM, and I've definitely faced a lot of those problems as we all have, but I think I have a ton of privilege in this area. But I also have the experiences of you know, BIPOC communities. And I think academia is a place to embrace a lot of this diversity, something that I learned about after I got my graduate degree was the increasing prevalence of neurodivergence people, in higher education where the system really breeds people who can take their wandering interests and make them into something, which I think is really cool. And so you know all of those aspects of my identity are important to me and even though they sometimes make the path more difficult, I think it I I wouldn't want to go through academia the easy way, even if I could.

26:37 Can you tell me about a moment when you felt like you really belonged in the field of science?

Richelle Tanner: So I want to define belonging first because it's something I think about a lot. I do some work on evaluating sense of belonging and so it means something different to everybody. But for me sense of belonging is a safety to bring your whole self to an experience and those moments are honestly far and few between in higher education. But I feel like for me belonging is that I'm interested and hoping that I'm, or dedicating my career to creating these moments for other people, which hopefully I'm doing for the students in my lab at least some of them. But as a student, my undergraduate adviser told me that I deserve to do a PhD which was an interesting wording, right. And I think that was super impactful I think the way that we talk to

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students about what they've accomplished is really important and as a faculty member, you know I said I'm really interested in creating these spaces and dedicating my career to that. I think for me belonging is when people like the Dean of our College protects the space and the opportunity for me to do that. And so I think people who facilitate other spaces, even if they're not the ones stewarding them, I think that really goes a long way in fostering a sense of belonging.

28:11 How do you balance work with other interests?

Richelle Tanner: It is difficult as an early career Professor, or really early career scientist, and also as a director of a program, which those two are not supposed to go together right. But I will say that I still take my weekends off, which is more than I can say for most of my colleagues, and that's super important. Because we need to rest and I have a lot of hobbies that are really far away so I have to go do them. I really like hiking and so you know seeing the sun rise on a mountain love it. I go scuba diving which obviously is intertwined with my job too. I like tide pooling, just like my job. And I think, you know a lot of my hobbies are directly related to the things that I do at work which, don't they say like if you if you do something you love you don't work a day in your life something like that? And so you know I set aside the time to do that. And people are always like 'how do you find the time?' 'how do you sleep enough?' I still sleep eight hours a day, you know our careers are not life and death, science is not life and death. I'm sorry Academia, we're not doing anything that could fundamentally change the way that society looks tomorrow. We're doing things that are going to be seen in 20 years, the effects of. And so it's you know it's appropriate to treat work like that and it took me a really long time to learn that because the way that graduate school, and even undergrad, is structured is that you work really hard with long hours. And I think that's still important, like you want to dedicate enough time to do a good job especially if there are other people relying on you in your lab or your professor but you also want to be realistic about what those goals are. I don't have all the answers. You know some semesters are better than others. This semester, I'm not doing so good but next semester I'll do a lot better.

30:09 What is the most important advice you would give students pursuing science?

Richelle Tanner: I think we're in a space in Academia and in society where it's important to stay true to who you are and what your values are and don't sacrifice that for a job because there will be another job that values those things. I think seeking a wide and diverse mentorship network is super important. There isn't one person out there that can serve all of your needs. You know I think a lot of people go into a research lab and undergrad and think okay my adviser is going to help me with all of these different things. And yes I'm going to try to, but there's going to be things that either I don't have the personal or professional expertise for so I'm going to refer you to someone else and it's important to rely, both professionally and personally, like you know you don't have just one friend you have lots of different friends who support you in different ways. So that's super important to me. There's actually an exercise that you can do to look at like how full your mentorship network. It is important to understand that there are structures in place in science that are designed to weed out people who don't fit the European male view of what a

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scientist is. Both in, you know your demographics but also in what you think science is. And so you know, knowing that that there's a dichotomy between you know bringing our whole self to an experience but also understanding that we have to work within these structures to be able to dismantle them.

31:37 Thank you!

Desiree Forsythe: That concludes the conversation with Dr. Tanner and I. I want to express my gratitude and just gratefulness that she joined this conversation with me. I hope she inspires you as much as she she inspires me!

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