**GMT20240425-152527\_Recording\_avo\_640x360**

0:40  
CDFW Broadcast: All right. Good morning, everyone. Thanks for coming to day 3.

0:47  
CDFW Broadcast: You all are the the troopers who are here first thing in the morning third day of a conference.

0:53  
CDFW Broadcast: Really glad to have you all here in person, and I know we've got a

0:59  
CDFW Broadcast: great audience tuning in virtually as well. I'm really excited that the one thing that the one good thing that Covid brought us is made it just routine to yeah, of course, live stream. So you, you know, if it took you a little while to

1:13  
CDFW Broadcast: finish breakfast, or get the kids out the door, you can watch it virtually

1:20  
CDFW Broadcast: so thank you all for joining I am really glad that we do have a lot of people in person, cause it's great to make those connections that we have here at the IEP workshop.

1:32  
CDFW Broadcast: We're really excited to be in our beautiful headquarters building. But few logistical things again. If you want the agenda. There is an electronic copy available on the QR codes that are posted around.

1:50  
CDFW Broadcast: Bathrooms are out the door around to your right, the ones on the bottom floor. There's no key code. If you go upstairs, there's a key code that is posted on the walls of the auditorium.

2:05  
CDFW Broadcast: There is no food or drink in the auditorium. Besides, water water should be in a water bottle or closed lid type. Deal no open containers of water. If you're drinking out of a travel mug, I'm gonna assume that's water. Please don't do anything to prove me wrong.

2:22  
CDFW Broadcast: And we do have coffee outside sponsored by ICF, so a huge thank you to ICF for sponsoring coffee. We all know that science runs on caffeine.

2:34  
CDFW Broadcast: If anyone needs any kind of accommodation help getting to the second floor. You do need a badge to use the elevators to get to the second floor. Listening devices anything like that. Please see Christine Joab at the registration desk.

2:48  
CDFW Broadcast: The Wi-fi Code. The Wi-fi is CNRAguest. No password.

2:56  
CDFW Broadcast: As I mentioned, the workshop is hybrid. It's being live streamed, and most of the talks those that have permission to record are being recorded to post online later. That means that if you are asking questions,

3:10  
CDFW Broadcast: these will also be recorded, so don't say anything that you would not want preserved for posterity.

3:17  
CDFW Broadcast: A huge thank you to all of the Organizing Committee, especially Christine Joab, who always keeps being in the lobby while I'm thanking her cause she's working so hard she doesn't actually get to see the conference that she works so hard to put together. And Stephanie Fong back here doing all of the logistics and technical things.

3:38  
CDFW Broadcast: Speaking of logistics and technical things. If you are speaking today and have not uploaded your presentation, please do so. At the break as soon as possible.

3:49  
CDFW Broadcast: If you had a poster upstairs in the poster hall. Over the past couple of days. Please pick it up before 2 o'clock this afternoon. That's when all the poster boards are being

4:01  
CDFW Broadcast: taken out of here, and we'll have to hunt you down and find your poster. And so yes, please pick those up. If you had any art that was on display, Christine Joab has that at the registration desk.

4:16  
CDFW Broadcast: Thank you also, to all of the volunteers who helped do timekeeping and mic running, and our California National Resource and Resources Volunteer program, who are running the registration desk outside, allowing all of the IEP folks who volunteer to do things inside, so you can watch the presentations.

4:41  
CDFW Broadcast: and I think that's all of my boring announcements. So now we get on to the fun part and first up our plenary speaker. Today, I'm really excited to have Anke Mueller-Solger who's the

4:55  
CDFW Broadcast: currently the Center Director at the USGS California Water Sciences Center. Former IEP lead scientist with a long career of working on science in the estuary, and being a real heart of IEP here to talk to us about the value of collaborative research and monitoring in IEP. So

5:21  
CDFW Broadcast: without further ado.

5:33  
CDFW Broadcast: Great! Thank you so much, Rosemarie, and thank you, Stephanie, and everybody else. Thanks for inviting me. Can't believe it's been 10 years since I gave my last IEP plenary talk. This is really true, and I strongly suspect that a lot of you just don't even know me at this point, and I'm really excited to see so many younger folks here in the audience. And I'm sure there's more online. Things have changed.

5:58  
CDFW Broadcast: Many things have stayed the same. Things have changed. This whole hybrid thing is obviously not something that happened 10 years ago, but there's advantages to it and disadvantages. Anyway, I have a somewhat odd title there. We are, smarter than me, and it's also grammatically questionable. But I would like to tell you about working together, and the value of that in the San Francisco Estuary.

6:23  
CDFW Broadcast: and of course, beyond as well. And some thoughts that I've had about this over the years, and

6:30  
CDFW Broadcast: I will tell you a little bit about me. But before I do that I will talk about we who do, I mean with this we are smarter than me, and who I'm going to be talking about as we is we, the science people. And I do mean this quite broadly. But I will start with the IEP here as an example. So the IEP

6:51  
CDFW Broadcast: is an interagency program that was started by a group of people from actually at the time, 4 different agencies coming together and deciding in 1970 quite a long time ago, right? Remarkably long time for a science program. To come together to create an ecological program. Actually, at the time they called it Ecological Studies program. It was the inner agency

7:16  
CDFW Broadcast: ecological studies program that went away at some point. And really it's over, the years become so much more than just this 4 agency program. It's grown to 9 agencies, and it's opened, and it is open these days to be a really productive, vibrant, open science, cooperative and collaborative.

7:39  
CDFW Broadcast: There's been a lot of change in growth, including this venue thing here, or even the the logo I learned recently. That's changed colors because of ADA considerations, slightly. So thank you for pointing that out to me, Stephanie, and of course many other things have changed as well. But what's never changed is that the

8:02  
CDFW Broadcast: goal of the IEP was to have people be able to come together, work together across agencies, across institutions, including academia, consultants, and and so forth, to provide the best possible signs for the management of the estuary.

8:18  
CDFW Broadcast: So that's never changed, and then I will tell you just a little bit about me, and I'll talk about me. But it could be any of you here. You're the science person, and I'm Anka. I guess I'm not an interagency group. I'm in more of an international traveler. I started that in Germany. And I've been in this country for quite a while long time. I I started in Germany in 1968. So I'm slightly older than the IP.

8:48  
CDFW Broadcast: I came to California in 1990 and pretty much stayed after that. And then in 1998, I started working in the estuary. So Rosie was right. Oh, my gosh! I've been around for a long time. I'm an aquatic ecologist with a PhD. From UC Davis. My main drivers. The things that motivate me are to help others do great work

9:13  
CDFW Broadcast: and to learn a lot of stuff along the way myself and help others learn. So that's what drives me. Of course I've gone through plenty of change and growth of all sorts over time. One big thing happened in 2005, which is when I became a mother, and that actually did mess with me a little bit in terms of my identity. Me, the person who am I? Me, the mother person you know

9:37  
CDFW Broadcast: me the science person. Can I combine the 2? How is it going to work? Well, somehow it worked, and in 2008 I became the first ever IEP Lead Scientist. So Steve Colbertson's predecessor and I did that until 2014. And, by the way.

9:53  
CDFW Broadcast: that's a hard job. It's a very exciting job. But Steve is doing hard work, and I want to acknowledge, that because I knew, and then in 2014, I switched to the USGS, where I was for quite a long time the Associate director for projects with the California Water Science Center. And now for a bit more than a year. I am the director of that center, which

10:15  
CDFW Broadcast: sort of unfortunately, I have to say, means that while we do do science for management, my own career path has been taking me into management. Because that's what happens when you have a center of more than 300 people, 14 facilities and all that sort of stuff and crazy Federal Government bureaucracy on top of all that. So that's about me. But it's also about you. This could be any of you, and we are the science people. I thought a little bit about how

10:40  
CDFW Broadcast: we even got here becoming we, the science people. And it turns out that there's quite a bit of research about how Western science collaborations in particular. But just even this whole concept of science really got started. And you are, I'm sure, familiar with these 2 gentlemen behind me here, but they were quite instrumental, and the big center pieces of the scientific revolution that took place in the sixteenth, seventeenth century.

11:04  
CDFW Broadcast: And then there was also the age of enlightenment and the whole thing. There was that reason, science, reason, not spiritual revelation, would enable humans to make sense of the world around us, and to gain knowledge, freedom, and happiness. That was a big deal, and it had a huge amount of societal consequences. So there were all sorts of revolutions that I'm sure you're all familiar with in the eighteenth and nineteenth century the Industrial Revolution, the French Revolution, of course, the American Revolution, leading to we the people, and

11:34  
CDFW Broadcast: thinking of ourselves, and how we govern our States, etc. In a whole new way. And science was an important part of that right from the beginning. But it also had a huge science impact, because earlier, there were basically a lot of individual, usually wealthy and most mostly male, not only, but mostly male folks, who were

11:58  
CDFW Broadcast: calling themselves natural philosophers, and all sorts of other interesting words, and they engaged mostly with science for science's sake. So basically basic science. And then this turned into a professional and merit-based in the end, scientific community that conducted science for use by people by society. And that really is where we, the science people, as we know ourselves today, came from.

12:22  
CDFW Broadcast: There are interestingly, scientists who study how scientists work. And they've been doing interesting things to to find out how this all studied. So I looked at some of these journal articles, and there is this one article where they mapped science collaborations in the eighteenth century. And that's what that's showing there. And they they found, among other things, that really this started taking off in France, because.

12:47  
CDFW Broadcast: with the French Revolution and the wars that were going on at that time, recognized that they had a need for scientific information to run the country. So they supported that which made these collaborations easier, and then it spread pretty quickly around the world, including, of course, the United States eventually. And you can see that this continues to this day. So one piece of evidence for

13:12  
CDFW Broadcast: that of people working together more and more. Science is not an individual sport anymore. It's a team sport. And you can see that by way of the number of authors who

13:22  
CDFW Broadcast: co-authoring journal articles in all kinds of disciplines going up a lot. And that's the graph on the I guess it's the left with mathematics, chemistry, and physics shown here. But this is also true for other disciplines. So this is the average number of co-authors. It's going up there since 1960, and this is, of course, about the time of the IEP, too, that the IEP. Started in 1970,

13:46  
CDFW Broadcast: and then the the single authors are disappearing at a really pretty high high rate. And in ecology. That's another journal article that showed that here they just simply extended out this trend and found that by the middle of this century there's going to be less than point 1% of single authored ecology papers. If the trend continues the way it is so clearly we work together.

14:11  
CDFW Broadcast: we, the science people work together. There are different ways of working together. And 2 really important words here are collaboration and cooperation. The IEP is

14:24  
CDFW Broadcast: cooperation, right? That's what's in the title

14:27  
CDFW Broadcast: Cooperative Ecological Investigations in the San Francisco estuary since since 1970. But as scientists, we're really used to this word collaboration. And one way to think about this, or at least the way I think about it is sort of like an orchestra using that as an analogy where everybody is playing from one common score, and the important part is that there's a common goal which is to play.

14:52  
CDFW Broadcast: Maybe it's Mozart. Maybe it's whatever to play that as well as possible and really have the audience enjoy it. They've got a plan about how they're going to go about this. They've got the conductor who helps them get through this, and they've got resources, their instruments, and the concert hall, etc. And then this ends when the collaboration ends, when the goal is met when the piece by Mozart is done and everybody has

15:17  
CDFW Broadcast: clapped, and the resources are used up such that the lights in the concert hall go up. So this this generally is how scientific collaborations work too. There's a project. We've got a clear go, or we better have one at least, and we've got funding, and we've got all the materials, all the people, etc. And then, by the time it's done, we might disband, or perhaps start a new project. But that's a very typical thing that scientists do.

15:42  
CDFW Broadcast: But the other very important thing. And the IEP is truly all about this. In fact, I think, what did Steve. Say, Steve, Steve talked about how cooperation is. I think the the root of all the success for working across agencies, etc, anyway. But it's a little different, because you don't have to have the exact same goals. So all the IEP agencies have different missions, different goals, but they come

16:06  
CDFW Broadcast: together because the science thing is sort of an overarching need and it and we are smarter than me. And I'll get to that, too. It's just really behooves us to work across these agencies, but the the things are a little more independent. But we do. This is really important. Have mutual considerations for each other. We need to care about each other and what each other's ideas are. Felicia and Marcus talked about this a lot yesterday.

16:31  
CDFW Broadcast: How, if you want to, you know, talk with policymakers. You do have to understand where they're coming from, and, you know, sort of get into that mindset and consider their needs for real. And of course they should also consider yours. But anyway, and there's going to be some mutual benefit. That's the whole idea. So then, people and I'm liking this to a drum circle. People can come and go in a drum circle.

16:56  
CDFW Broadcast: It'll just keep going right so it can keep going indefinitely. They don't have a score that they're playing from. But they're listening to each other, and they together make this amazing music. So there's this emergent property, to use an ecological ecological term here, where the hole is greater than the sum of the parts that can come from this kind of thing. If we listen to each other, if we really take care of each other that this whole thing

17:21  
CDFW Broadcast: really works out. So that's pretty simple analogies. But to put this into the IEP levels conceptual models. I do, too, to put this into a little bit of a conceptual model here. And the thing about this is, there are different parties here, and what we want in the end is that our science really gets used. That's why we do it right? So there are some ingredients that are needed

17:46  
CDFW Broadcast: in order for our science to get used, and I'll get to that. And these these parts of my conceptual models. They all sort of add up to the recipe for that. So the first thing I already talked about it, scientists

17:59  
CDFW Broadcast: collaborate a lot in all kinds of projects, each one of you, I'm sure, is part of at least one collaboration, usually a whole bunch. That's what we do. And then, in order to do that, we need some kind of

18:12  
CDFW Broadcast: well rules is perhaps the stronger word. But we need some kind of a structure. There usually is a project leader, right? There are lots of ways that we do things to make sure we do them right. The IEP, and pretty much any science organization out there has a review process, you know. That's a really important thing the USGS has this. And I really liked this about the USGS. By the way, was one of the reasons why I wanted to work for the USGS

18:37  
CDFW Broadcast: has this strong set of guidance and rules called fundamental science practices that are there to sorry, protect scientific integrity and quality of the science done by the USGS and the scientists who do it. So those kinds of things become pretty important.

18:56  
CDFW Broadcast: Oh, I listened too much to Rosie. I kept it close.

19:03  
CDFW Broadcast: Sorry. Alright. So again, this is super important that we have these rules, and that we are clear about what we're working on together, etc, to keep our science credible, which is actually the very first ingredient needed in order to be able to get our science used. If people don't

19:20  
CDFW Broadcast: think they did it right. And and and if you yourself don't even believe it, because you guys didn't follow your own rules, or whatever it's not going to be credible.

19:28  
CDFW Broadcast: Of course, scientists also cooperate a lot. So in this particular workshop here, this isn't one project, but there is work going on when you talk with each other. When you give each other ideas, when you give each other feedback, that is actually work. And that's basically this looser thing that can come and go. And there aren't all these rules, etc. But it's super important.

19:49  
CDFW Broadcast: The next group that is part of this. And, by the way, they are also part of we, the science people, because they use the science, are the resource managers and the policy makers. So Felicia Marcus again talked about that a lot yesterday, and I'm certainly not gonna repeat her talk. But it's super important that we, as scientists, communicate with research managers and policymakers, and I suspect there are some.

20:14  
CDFW Broadcast: perhaps, in this, in this room here, that would consider themselves be in that category too. So we cooperate with them, and they, of course, also cooperate with each other. For example, the IEP directors are generally not scientists, but they are working together cooperatively in the interagency ecological program.

20:35  
CDFW Broadcast: Because they they realize that this is where good science comes from. And this is a good way of doing this. And they talk about that a lot. Okay. And then this is super important because this is who uses the science research managers and policy makers. So in order for our science to be relevant, which is the second ingredient here. It's very important that we talk with these folks.

20:58  
CDFW Broadcast: The IEP is obviously cooperative investigations. That's what is called for a reason cause. This cooperation is so fundamental and important. I like about the USGS that more than a hundred years ago folks recognized that this is a good idea across agencies. So actually, even Congress recognized it and gives money to the USGS to match money that the USGS might get from others.

21:22  
CDFW Broadcast: or that others have to really work together. USGS cooperative matching funds have been around for more than 100 years, because cooperation is so important, and then the final group is, of course, all sorts of other stakeholders, community members, NGOs. Whoever who has an interest in what's going on in, say the San Francisco estuary, they might co-develop some of the scientific projects that we do. They might in some cases co-manage some resources.

21:48  
CDFW Broadcast: And they will watch what's going on. And it's so important that

21:55  
CDFW Broadcast: we are quite transparent about what we do, and that we keep talking with these people because the the third ingredient here of making science usable and get it used is that it's also got to be viewed as a legitimate. Was there a reason why you did it, and not someone else? Was it done right. Did we ask the community how this might affect them when when it comes out? Felicia Marcus mentioned one really good example

22:20  
CDFW Broadcast: yesterday of the San Francisco Bay shoreline adaptation, Atlas. So long word! I had to actually remind myself which was something that was produced in the San Francisco Bay Area, and where the lead authors

22:34  
CDFW Broadcast: talked a lot with community members before the thing ever came out. So then, when it did come out, the community members embraced it. Otherwise they might have been potentially even. you know.

22:46  
CDFW Broadcast: struck as this was something that that they wouldn't want. But they knew about it. It wasn't used to them they actually contributed a bit. And so this was a product that now the community can embrace and use. So that's really important, too. But in all of that obviously super important that we simply keep talking with each other, that we keep working together. Steve Colberton was talking about the constant dialogue that we need to have in order to have successful cooperation and success through cooperation.

23:16  
CDFW Broadcast: So sometimes that's really hard, right? So I want to acknowledge that. And why is it hard? And I know there's some hard times also in the IEP. This is no surprise, because there's a lot of people here and human relationships, that's thing one, are just tricky. You know, we're humans. We all come from different places. It's hard to work together at times

23:34  
CDFW Broadcast: for scientists, especially folks in academia that are trying to get tenure. Or in the Usgs. We have this research, great evaluation thing where individual contributions are being evaluated. This can be tricky sometimes because it might be hard to pick out individual contributions from the group. There are differences in motivations, goals, culture, etc. So that also comes into play a lot

23:59  
CDFW Broadcast: when you would try to work in groups, there are risks

24:02  
CDFW Broadcast: with forming groups, they can be groupthink. There can be exclusion of other people who have different different ideas or different values, or whatever it might be, it can become terribly rigid. As soon as you organize something. There can be internal conflict that can be. You can be more exposed to external pressure because you're more visible as a group. And this actually happened a lot in my day in the early 2000's

24:27  
CDFW Broadcast: when we came upon the pelagic organism decline, as we then called it, in the in the Delta, and I'm sure you've all heard about it. The pod it's on the Bingo cards, I noticed, and well then IEP scientists had to dress up in strange outfits and do strange things, and there was a lot of pressure, believe me, to get through that there is a need to support need

24:51  
CDFW Broadcast: for support, especially when times become hard support from other people, it doesn't work without support. So again, in France, this whole collaboration thing really started because there, as opposed to elsewhere, because the Government actually supported that there's a need for and already mentioned it. Internal organization, coordination, also conflict, resolution. At times

25:13  
CDFW Broadcast: there can be increasing bureaucracy and death by meeting. I suppose all of you been there, and at 1 point or another, and all of it can then add up into individual and even group stress, exhaustion, frustration, lots of bad things. So why the heck do we do it anyway? Right? One would wonder. Well, because it's smart, right? We are smarter than me. There is simply no 2 ways around that

25:38  
CDFW Broadcast: there is a lot of intellectual enrichment or cross fertilization, and all that kind of thing that I hope you all have actually experienced at this workshop here the last few days, and will still experience today things you would never think of if left to your own devices in your own room, or something so super important for science to make progress. Of course, it then also gives you access to diverse knowledge skills.

26:02  
CDFW Broadcast: lots of equipment that's being shared across the IEP facilities even, or hearing about these really important scientific needs or questions that resource managers, policy makers, or even other scientists have that you might have never thought of yourself.

26:18  
CDFW Broadcast: which then adds up into overall more efficient and effective use of time, labor, and equipment, and greater productivity with less which really the folks who are supporting these sorts of things should appreciate and perhaps understand even better than they do. But that's how we make progress, especially when it comes to tackling the super complex problems that we have here in the San Francisco estuary.

26:42  
CDFW Broadcast: Yes, they are extremely complex and have an impact make a difference in helping resource managers dealing with some of these problems and have all of this, then be relevant to them.

26:55  
CDFW Broadcast: Another thing is quality assurance, quality control. It is better when we look at each other's stuff and keep each other on the straight and narrow right? So the IP has a lot of review processes. In fact, this is how I got my start in the IP is when I was hired by the Department of Water Resources in 2000 and engaged, or was there to co-lead with Zach Hymans? And some of you might remember the name

27:19  
CDFW Broadcast: a review of the Environmental monitoring program it was a pretty

27:25  
CDFW Broadcast: sort of large scale review that resulted in lots of things, including, and the younger ones of you probably have don't have don't know this, including a change in the name of the program, because it was called the

27:37  
CDFW Broadcast: D. 1485. Compliance monitoring program doesn't exactly roll off the tongue right? I didn't think so either, anyway. So, talking together, we realized, you know, this was a relatively minor thing, but it was a thing, and it it is there, you know, it had made a difference to this day. But, more importantly, the quality and what we really do there was, of course, what we looked at, and that was really important. And the IEP

28:02  
CDFW Broadcast: continues to do this, the Delta Science program does this a lot. Every University does this. I can't be at this here workshop very much this week because we have internal center science reviews, project reviews going on right now that I have to be at. So it's very important. And we do this together. We can't do this alone. And then finally overall, almost finally overall increased visibility and recognition. People know that the IEP puts out great work.

28:29  
CDFW Broadcast: Well, some people know that more than others, but anyway, which gives it, you know, a great amount of of legit led. I can't say that right now. Legitimacy yeah, whatever. And finally, you know, like that picture right there. I felt very connected to these people. I felt like I found a group that I belonged to when I first started with the IEP.

28:53  
CDFW Broadcast: I hope you feel that way about your colleagues, about each other here. But this is something that's not to be underestimated. And also you know it. It really counteracts some of these negative things like the death by meeting and the frustration. When you have, you know, some conflict with somebody, etc. This is really an important thing, too.

29:15  
CDFW Broadcast: All right. So we, the IEP Science people work together. And what do we do? Of course we do a lot of monitoring. We do a lot of research

29:23  
CDFW Broadcast: that often comes together in the form of adaptive management, which is is a thing that's been around since, you know, 1978 formally at least. The Delta plan adopted it in 2013 as a way to bring the science and the management close together. The IPE did it before the work actually existed, or this thing as a concept existed. And, for example, here this early paper by Jim Arthur and Doug ball, which

29:51  
CDFW Broadcast: used a summer fall of outflow action to study the significance of the entrapment zone, as they call it, on on phytoplankton. And of course that's something that spawned enormous amounts of additional research over time along with regulations like X 2 and things like that and ways to manage the system, and then had successors such as, for example, in 2011, when

30:16  
CDFW Broadcast: there was a fall outflow action, and then the IEP. And there was 17 authors in that case wrote that up. So, by the way, 2 authors to 17 authors. So we work together more and more. Yes, and then, most recently, very recently, just came out this amazing special issue here of the San Francisco estuary and Watershed Science Journal, led by Rosemary Hartman. Over there. The IEP Synthesis group

30:41  
CDFW Broadcast: working on this about drought impacts on the estuary, which I think is just really remarkable. So whoever was all involved with this, or even if it's, you know, just collecting data or somewhere on the sidelines, congratulations to that kind of work.

30:58  
CDFW Broadcast: So we the IEP Science people work together on new IEP and science frontiers, too, and I have noticed on the agenda here that there are quite a number of talks about

31:11  
CDFW Broadcast: bringing in the human dimension of what we're doing here more and more social science, etc. So bringing science and society closer together than they have been in in the recent past, at least. So we, the science people, and we the people. Yeah. And I didn't notice that there were several amazing young people thank you for your work, who are working on exactly these types of things. And I find this very exciting. I think we'll see a lot

31:36  
CDFW Broadcast: more of this I'm wondering, and that's just me. And it's perhaps a little out there, if perhaps at some point there'll even be some spirituality brought back in, because during the scientific revolution that was basically tossed. Never mind that, the you know, spiritual stuff. But we do need to be inspired to do our work, and we are inspired right, and somehow, what might that mean? We don't know. I have no

32:01  
CDFW Broadcast: clue. But you know, some years ago, who would have thought that we would have talks such as you know, interweaving traditional knowledge and Western science at the IEP Science Science Conference. That was totally not something that people thought of when I started with the IEP. So I'm so glad to see that.

32:19  
CDFW Broadcast: So we, the IEP Science people, work together. We talk shop.

32:24  
CDFW Broadcast: That's why this is called a workshop folks. It's not called a conference, because this is about working. It's always been that way. It's traditional. There's a lot of work going on here. And I really like this about the IEP. I've always loved this. People really work with each other, talk shop, have a workshop, have all the project work teams which are just, in my opinion, basically the best thing about the IEP where people can come together and cooperate and

32:49  
CDFW Broadcast: sometimes collaborate to really produce this incredible science that you all are producing so great science. Great people. Thank you. IEP science people, and thank you again for having me at this workshop. It's lovely to be back 10 years later.

33:12  
CDFW Broadcast: Okay, thanks. Thank you so much. Anyone have any questions for Anka about any of the

33:21  
CDFW Broadcast: collaborative science topics that she brought up here.

33:27  
CDFW Broadcast: No, Delta smelt in it. Sorry no longfin smelt, either. Yeah, it's actually kind of weird for me to do a talk like this. It's still weird, you know, without lots of science graphs and things like that. But it really is worth thinking about these these bigger things, about working together, and the IEP is just such a model for how this can be done and persist. And you know the IEP's gone through lots of ups and downs, and I think there's some of that going on right now.

33:52  
CDFW Broadcast: But it's persisted, and the main reason is it's smart. We are smarter than me. You know, it really makes sense. Cooperation is the

34:01  
CDFW Broadcast: reason for success across agencies, etc, doing science together. That's what we do.

34:07  
CDFW Broadcast: So thanks again for having me. Thank you so much.

34:14  
CDFW Broadcast: And there's a couple of graphs in there now. I wanna like chart number of authors on Steve's master list of iep publications. See how that relates to time.

34:25  
CDFW Broadcast: alright. Well, now, up we're we have our next

34:33  
CDFW Broadcast: regular science talk full of lots of graphs, and for the next session we have Vanessa Tobias, who's going to be

34:44  
CDFW Broadcast: introducing the speakers.

34:48  
CDFW Broadcast: you know, we can do it quickly. So okay, so we're gonna start off the long session. And see. So we've got first up. We've got Nicholas talking about maturation and fecundity. I'm really excited about this.

35:04  
CDFW Broadcast: Good morning. Everyone okay. So thanks for coming up for

35:09  
CDFW Broadcast: early talks of day. 3. So since I'm kicking off the long fin talk. Well, first, I'd like to start by acknowledging our funders and our my, a bunch of my co-authors so I'm Nico Flores. I work in Levi Lewis's OGFL lab at UC. Davis. We are doing a big prop one funded project right now with a ton a ton of people so thank you for everyone you know who you are.

35:34  
CDFW Broadcast: I wanted to start with a little bit of background on Longfin for the folks in the crowd who don't know a ton.

35:39  
CDFW Broadcast: They're semi-anadromous

35:40  
CDFW Broadcast: They range from all the way up in Alaska down to here in San Francisco Bay. This is the southern extent of their of their range, and recently we figured out that the Longfin that live here in San Francisco Bay are genetically distinct, and are contributors genetically to the rest of the population up the coast.

36:02  
CDFW Broadcast: As I'm sure almost everyone here knows, they have been in stark decline, like many species here in the estuary. They were listed as threatened on the CSA. In 2009, and in 2024, they will very likely finally be listed as endangered federally.

36:20  
CDFW Broadcast: Which means that we should really be thinking about, how do we manage these fish?

36:26  
CDFW Broadcast: To do that? Well, we need life history models. And we need population models. And we need those to be informed by science. And so queque, the big prop one study that is, gonna try to answer a bunch of these questions.

36:39  
CDFW Broadcast: So, I'm sort of one half of this big project. And so I'm just gonna talk about sort of my half of the thing. So the objectives for us on the fecundity maturation side was to figure out, do longfin, melt synchronously, develop all their eggs, so that do they develop their whole gonad all at once?

36:58  
CDFW Broadcast: And then figure out how to

37:02  
CDFW Broadcast: stage. Those gonads get maturation staging for the gonads.

37:06  
CDFW Broadcast: so we can categorize that and then talk about the overall fecundity

37:11  
CDFW Broadcast: of fish.

37:14  
CDFW Broadcast: So to do this we had to get our hands on a bunch of fish at the OGFL. We do our own collections mostly down in Alviso Marsh, in the south of the bay.

37:24  
CDFW Broadcast: But we also got a ton of help getting fish from folks at CDFW. I want to particularly call out Christina Birdie and Tricia Biffis, who were a huge, huge help and helping us comb through CDFW's massive archive of Longfin smelt that is, that is huge.

37:41  
CDFW Broadcast: So at the end of all of that work we had over 1,600 fish for which we could do maturation staging on

37:50  
CDFW Broadcast: the 1,600 fish span over 20 years. They're all over the bay, and they vary in almost every month of the year, but of course, primarily in the the spawning season in the winter, as you can see

38:04  
CDFW Broadcast: so once we had all this fish, we had to get things that we needed out of them, so we dissect them. We get more from metrics. We remove the ovaries from their body cavity along with a bunch of other tissues and also their otoliths.

38:17  
CDFW Broadcast: We take those ovaries and we stage them. So, I'm gonna walk through this staging rubric. In case of folks who don't know this, a lot of people maybe are familiar. But basically it's a 0 through 6 scale. 0 is, there's no gonad, one through 3 are essentially immature developing eggs.

38:39  
CDFW Broadcast: 4, 5, and 6 are all sort of the big, distinct different stages. 4 is a ripe ready to spawn.

38:47  
CDFW Broadcast: Female 5 is an already spent female. There's no more eggs left, or there's almost no more eggs left. And then 6 is this weird, unusual thing that we've been seeing as we go through this, which is what we think is evidence of batch spawning so multiple clutches in the season.

39:04  
CDFW Broadcast: And we can well, in fact, I'll show you a second in a second in a picture how we know what that looks like. So here are sort of just 3 of those 6 stages to give you some some context. So stage one

39:15  
CDFW Broadcast: super, young, super early, immature gonad. The oocytes are very, very small. They kind of just look like a cloud unless you look at them under a microscope

39:23  
CDFW Broadcast: stage 4. You have these big, ripe eggs. They look like little fish eggs, just like you might see on sushi. And then Stage 6 can look a lot of different ways. This one's a really good example, because you can see in and amongst those sort of stage 3 ish eggs there are 3 or 4 big old, we think, sort of atrophied dark yellow eggs. That we believe were left over from the previous batch of eggs.

39:54  
CDFW Broadcast: So here's a nice little photo of those 2 lobes of the gonad with longfin the left lobe is always much larger than the right lobe. So here's the left and the right lobe of the longfin smelt to do our fecundity analysis.

40:07  
CDFW Broadcast: we essentially took 3 spatially distinct sections out of the left lobe, and we could use each one of those to. We can count all the eggs in each section and get an estimate that we then can sail for the whole lobe, and then, with the right lobe, we would just count the entire lobe, or, if it was quite large, we would like break it into 2 sections to count it.

40:28  
CDFW Broadcast: So with each one of those sections we take it out, we remove the eggs from all of the sort of gonadal tissue that's not the eggs, and we can flatten those eggs out into this nice, pretty flat plane, and we can photograph it, and once we photograph it, we can use a a program in a a plugin for Image J to go through a digitally count which is fantastic. It allows us to a not destroy a lot of the gonad and B have something we can go back on and do. Qc on.

40:58  
CDFW Broadcast: And again, I wanna point out that we are taking these 3 spatially distinct sections from the left lobe. So first off, we get 4 separate estimations that we can use for the ficity of the fish, and also on the left lob. We have these spatially distinct estimates, so we can look at if something's going on at one side of the lobe that's not in the back. So maybe, are the eggs more developed and sort of in the anterior the posterior? Or are they all developing simultaneously?

41:28  
CDFW Broadcast: so results do the eggs develop synchronously? So here, I'm showing a figure of egg density relative to those 3 sections and what we see. Density is a good proxy for maturation, by the way, because the eggs get bigger as they mature, and so they get less dense.

41:47  
CDFW Broadcast: And egg density is the same across a single lobe.

41:51  
CDFW Broadcast: If we compare the left and right lobe, egg density is the same between lobes. So we have pretty strong evidence that the eggs are maturing all at once.

42:02  
CDFW Broadcast: If we go into staging I wanna take a second to orient you to this

42:07  
CDFW Broadcast: big figure because I'm going to show a couple of them. So colors are stage.

42:12  
CDFW Broadcast: The so sort of gradient of blues are those 1, 2, 3 maturing eggs. Bright orange is a ripe female ready to spawn red. She's just spawned out, and then black are those stage sixes. Maybe she's getting ready to spawn a second time.

42:26  
CDFW Broadcast: So relative to size of the fish

42:30  
CDFW Broadcast: we see.

42:33  
CDFW Broadcast: There we go. Basically, they start maturing around 70 that's where we see most of the fish are like really getting beyond stage one. So, starting to mature by 90 mm most of the fish that we see, are either ripe, ready to spawn, or have already spawned out.

42:49  
CDFW Broadcast: and you can see also see that those stage 6 is sort of increase slowly as you as you get bigger and bigger fish

42:55  
CDFW Broadcast: I'll point out, in case anyone has, eyed the 120. That looks very strange if you look at the total count, you'll see that it's because there's only like 3 or 4 fish that are that big. So

43:07  
CDFW Broadcast: so if we look at the same thing. But now we're looking across across the year, seasonally as you might have anticipated, they mature during their spawning season. That maturation really kicks off around November, and, as you see, you get more and more ripe females, as more and more ripe or spent females as you move through the spawning season.

43:28  
CDFW Broadcast: Now for the big, for the big stuff

43:32  
CDFW Broadcast: fecundity. So

43:35  
CDFW Broadcast: here is total estimated eggs

43:38  
CDFW Broadcast: compared to the fork length for the fish.

43:41  
CDFW Broadcast: It goes up. There's not a I think it. It goes up with fork length. It's there's a little bit of a of a of an elementic curve, but it seems kind of linear. So we wanted to

43:55  
CDFW Broadcast: put this in historical context. See if

43:57  
CDFW Broadcast: these results look different than some fecundity metrics we have from the past. So

44:03  
CDFW Broadcast: here's those exact same data just simplified down

44:06  
CDFW Broadcast: to compare to some other studies. And I wanna point out real quick. I don't think I have a pointer. No, I don't. But you can see there's one fish over there that looks like oh, you probably should remove that. That's clearly an outlier. It's way more fecund than the other fish. So just keep an eye on that one. So these are all our data

44:23  
CDFW Broadcast: for the fish that we've done fecundity on so far. It's we're in the sort of like early 2000's. All the way up to 2022, I think, is the most recent

44:30  
CDFW Broadcast: and if we compare that to data from Randy Baxter back in the 1980's, 1990's, we see that our fig, our fecundity matches his pretty closely at small sizes, but the fish back in the eighties seem to be significantly more fecund once they get past that sort of 100-120 mm length, and our outlier is not looking so much like an outlier anymore.

44:55  
CDFW Broadcast: And now, if we compare it to Chigbu et. all study from way back in the 1960's.

45:02  
CDFW Broadcast: We see that they were a lot more fecund back then. So just I wanna highlight the difference there. So if we took out a fish that, let's say, is 120 millimeters.

45:14  
CDFW Broadcast: one of the fish that we see a hundred 20 millers we would expect to have around 7,000 eggs

45:18  
CDFW Broadcast: back in the eighties. We might have expected 10,000 eggs back in the sixties would have been essentially double what we see today at 15,000. And I wanna remind everyone that we're pretty sure we're seeing batch fecundity. So I'm giving you. I'm not giving you the total fecundity of the fish for a season. I'm giving you one batches fecundity. So when I say that back in the sixties they might have had double the eggs. That's per batch. So maybe in a season they would have put out 1,400 eggs today.

45:44  
CDFW Broadcast: A long time ago they might have put out 30,000 eggs. So it's we're really seeing a stark decrease. We think at least we're seeing a stark decrease in fecundity

45:53  
CDFW Broadcast: at for those larger size fish.

45:56  
CDFW Broadcast: So just to recap all of those takeaways.

46:00  
CDFW Broadcast: we seem to think that they

46:03  
CDFW Broadcast: synchronously develop their eggs.

46:06  
CDFW Broadcast: That maturation of eggs seems to happen, starting around 70 mm and by 90 most of them are developed.

46:15  
CDFW Broadcast: and the average of fecundity has reduced, compared to the past, especially for the larger fish.

46:20  
CDFW Broadcast: And I want to reiterate that this is sort of one half of a big project. As I mentioned, when we're dissecting those fish we're taking out those otoliths.

46:28  
CDFW Broadcast: I work for Dr. Levi Lewis, who, if any of you know, is an otolith guy, I happen to be the guy doing the not otolith stuff in the lab. So I just wanted to call out the poster by Alex Llama, which you have a little bit of time left to see today. If you go up and maybe you can find him walking around. He's essentially presenting on the other half of this big project, which is all of the otolith stuff. So we're taking this, we're taking the otoliths from the same fish that I have these gonads, for. We're aging those otoliths

46:55  
CDFW Broadcast: trying to tease apart. Not just size differences in fecundity, but also age-based differences in fecundity. Yeah. And so

47:05  
CDFW Broadcast: with all of that, I guess they'll take questions.

47:18  
CDFW Broadcast: Folks are coming with microphones.

47:20  
CDFW Broadcast: Thank you. That was great. I was wondering. Chigbu looked at a lot of fish in Lake Washington. Yeah, is that where those are from those are the Lake Washington fish, which, which, genetically distinct, genetically distinct, completely life, history, distinct right. They live in a lake. They live farther north in the range. There's a bunch of distinctions between them. But it is

47:44  
CDFW Broadcast: I. The reason I put it in there, because, like, that's these fish could do this. Given the circumstance right? Like.

47:49  
CDFW Broadcast: maybe maybe who knows?

47:53  
CDFW Broadcast: Okay, alright, yeah.

48:01  
CDFW Broadcast: So my question is about the like. What you think is the cause of this so potentially genetics? Or or did you see any association with condition and fecundity? You, said the cause of this, you mean? Oh, sorry. The dramatic decline, and for sure.

48:18  
CDFW Broadcast: So that's sort of the third leg of this project is looking at sort of spatially across the bay and across those years, looking at how condition changes how have a somatic index changes. And all of that, we're still super working on this data. So I don't. Wanna, I don't wanna try to draw conclusions from it. I think

48:36  
CDFW Broadcast: there could be a larger scale, simpler? Answer to this, which is that we are at the southern end of the range of this fish and climate change is causing ranges to shift north. So

48:48  
CDFW Broadcast: we are probably approaching. We're we're probably making like, more and more difficult for this fish as as sort of as their range would naturally shift further north to climate change. That could be what's going on. Yeah. So you're thinking, temperature, not necessarily food deprivation. I mean, while it could also super be food. Right? There's been a huge change in the food webs in the last, you know, 100 years in in the in the estuary. Yeah, cool. Thank you.

49:14  
CDFW Broadcast: Anyone else.

49:19  
CDFW Broadcast: Sean, again.

49:22  
CDFW Broadcast: Sorry. So if you're asking about the food, have you been able to examine? I know you don't have very many of them. But what about the cultured fish?

49:29  
CDFW Broadcast: The fecundity of those? No, we haven't. We've we have. We have some to process, but not very many, and we haven't done them yet. But that's on. That's on the block to do. Yeah. Yeah. Then you can test the food food theory. Okay, thanks. Yeah. We also, I will little shout out we. So we take the otoliths. We take the gonads, but we also take gut tracts, so we haven't touched anything about the gut tracts yet, but someone's looking for diet study stuff.

49:57  
CDFW Broadcast: Thank you, Brian.

50:10  
CDFW Broadcast: Alright. So next up we've got Morgan and Morgan's going to tell us about the larval and entrainment study.

50:17  
CDFW Broadcast: Thank you. I hope you all are as

50:20  
CDFW Broadcast: caffeinated as I am this morning. So if it ends up seeming like I'm speed running this. We all know we can blame that ICF coffee

50:28  
CDFW Broadcast: The other reason I might seem like I'm talking fast is that I've got to a lot talk to you about today. But the core of it is that less is more. In this case, it's more data, more replicates and more answers that modelers can generate for managers

50:45  
CDFW Broadcast: I'm going to be telling you about the larval entrainment study which is a new companion study running alongside the smelt larval and 20 mm survey programs.

50:54  
CDFW Broadcast: I'll fill you in on the logic behind this study and then run you through a short history of our sampling, including summaries of some of the special studies that we've completed this year, and then wrap up with a little bit about what we're planning on doing into the future.

51:08  
CDFW Broadcast: Before I get to all of that, I wanna take a moment to thank our funding agency, the Department of Water resources, and also acknowledge the many collaborators that have participated in developing this project.

51:19  
CDFW Broadcast: including the staff of the CDFW. Native fish unit and fish facilities, unit Water Branch, the Department of Water Resources and the US Fish and wildlife service.

51:29  
CDFW Broadcast: and of course, the many people that have participated either in the field or in developing the design of this project. We could not do this without you.

51:39  
CDFW Broadcast: anyhow. Let me loop all the way back to the beginning. As Vanessa mentioned, my name is Morton Gilbert. I'm an environmental scientist working for the California Department of Fish and Wildlife, and I work for the fish facilities and entrainment unit.

51:50  
CDFW Broadcast: You could even call me the E and FE.

51:53  
CDFW Broadcast: And that's because I lead the larval entrainment study. We started that study as the larval entertainment pilot study or LEPs back in 2022, and at some point in the last year we renamed it to just LES which transformed me from a LEP-er to a lesser. I'm still not sure whether that's an upgrade or not. But the P. There stood for pilot, and we're continuing in that vein, moving forward

52:21  
CDFW Broadcast: by taking an adaptive approach toward developing our study and addressing questions about the entrainment of longfin smelt

52:30  
CDFW Broadcast: entrainment's, an important issue, both from a scientific and a policy perspective enough, so that the incidental take permit for the long term operation of the State water project includes

52:42  
CDFW Broadcast: condition of agreement 7.6 point 2,

52:44  
CDFW Broadcast: which calls for a study to quantify longfin and Delta smelt entrainment into the Clifton Court Forebay, which I've circled here in red in the southern reaches of the Delta.

52:56  
CDFW Broadcast: Entrainment occurs when fishes are diverted by flows out of their preferred habitats into neighboring regions. A lot of the time when we talk about entrainment, what we're thinking about is direct entrainment right? Which is fish being drawn by flows into the water facilities.

53:10  
CDFW Broadcast: But that's actually just part of the problem. It is an issue. When Fisher brought in directly they become isolated, they experience mortality through a variety of mechanisms.

53:19  
CDFW Broadcast: but also present, is indirect entrainment.

53:23  
CDFW Broadcast: and that occurs over a broader area.

53:25  
CDFW Broadcast: and that happens when flows carry fish out of their preferred habitats into areas that might be lower quality. For a variety of reasons they could be stressful, dangerous

53:36  
CDFW Broadcast: and that tends to have negative consequences for the individuals and populations. Where that occurs.

53:43  
CDFW Broadcast: and so particular concern for our study is larval entrainment. Which, among other things, can negatively affect the population's ability to recruit new members.

53:51  
CDFW Broadcast: We know that some direct larval entrainment is happening.

53:56  
CDFW Broadcast: and that's because of the qualitative larval sampling program that the facility runs.

54:01  
CDFW Broadcast: Unfortunately, salvage is

54:05  
CDFW Broadcast: centered on diverting fish from the facility, and not necessarily in quantifying the take of those fishes, and because of that the methods that they use make it difficult for them to quantify the number of fish that are being entrained. There's low retention of larva in their sampling.

54:20  
CDFW Broadcast: And so, while salvage is a crucial step in mitigating the entrainment of adult fishes, it really can't tell us very much about what is happening at the facilities with entrainment other than that Osmerids are present and are being entrained.

54:36  
CDFW Broadcast: And so when we start to address this problem, we find ourselves joining a conversation that's been going since the 1960 s.

54:43  
CDFW Broadcast: Back, when the facilities were first constructed and biologists were starting to consider the impacts of entrainment.

54:48  
CDFW Broadcast: In fact, the Osmerids I'm talking about today were far from the first fish

54:53  
CDFW Broadcast: that came to the attention of biologists and managers. With impacts from entrainment. This 1985 paper from Stevens et. all found that their data suggested that the entrainment of striped bass larva was likely contributing to their decline in the system.

55:08  
CDFW Broadcast: The first alarm bells regarding the potential impact on Delta smelt came in 1992 from this paper by Moyle et all. The authors here suggested that the entrainment of larval and adult smelt it could be contributing to that species decline. And then the Federal listing under the endangered species act of that species. In 1993 had pretty profound

55:31  
CDFW Broadcast: implications for the operation of water extraction facilities within the Delta.

55:37  
CDFW Broadcast: That's prompted a long scientific conversation about Longfin and Delta smelt, and their entrainment in this 2021 paper, Smith et. all describes their modeling effort to explore the role that in entrainment, among several other factors, plays the driver of Delta smelt mortality, particularly during dry years, with turbid conditions.

55:56  
CDFW Broadcast: and in their conclusion the authors note that fully mitigating and losses to entrainment is unlikely, because

56:03  
CDFW Broadcast: human needs mean that water exports and entrainment related, mortality will be very difficult to reduce to 0, for these populations.

56:11  
CDFW Broadcast: According the authors, managers will need to accept some degree of attrition.

56:19  
CDFW Broadcast: Other modeling efforts have come to different conclusions about the impact of entrainment on Longfin smelt

56:25  
CDFW Broadcast: in their 2022 paper, Kimmerer and Gross described a particle tracking model that showed that under a variety of different hydrological conditions.

56:35  
CDFW Broadcast: that passive particles that represented larval, long, thin smelt.

56:40  
CDFW Broadcast: We're unlikely to be entrained in large numbers, and that's because their simulation showed that model smelt released in inferred hatching regions would drift seaward until either they were large enough to control their own movement, or we're just swept out to sea

56:54  
CDFW Broadcast: alongside. Further analysis, they concluded here that losses of longfin to entrainment are likely to be small in magnitude, and that other factors will be playing a larger role in the species population dynamics.

57:06  
CDFW Broadcast: And so

57:10  
CDFW Broadcast: that's why I'm here. We know that entrainment could be affecting the population dynamics of Longfin. But we don't necessarily have all the answers

57:19  
CDFW Broadcast: that. We need to mitigate those impacts. So less exists to address this gap

57:26  
CDFW Broadcast: and give managers a better picture of the cost of pumping while providing modelers with ground truthing and more data for future analysis.

57:36  
CDFW Broadcast: And now I get to tell you about what we've been doing out on the water. We started this project in 2022

57:42  
CDFW Broadcast: that year our sampling was conducted at West Canal, right adjacent to Clifton Court Forebay. We sampled 5 days a week we started using the same methods as the smelt larva survey. So it's a 500 micron mesh net mounted to a small sled.

57:58  
CDFW Broadcast: We did oblique toes, where we sampled whole water column

58:03  
CDFW Broadcast: that ran from January to the middle of April, when we switched to a 20 mm survey net which is below there. It's a larger sled with a larger mesh.

58:13  
CDFW Broadcast: 1,600 micron, and that wrapped up in mid May

58:17  
CDFW Broadcast: we collected 41 long fin between January and March, and saw a pretty steady increase in overall fork lengths

58:23  
CDFW Broadcast: until we switch to the 20 mm gear. And around that time our catch of long fin dropped to 0.

58:29  
CDFW Broadcast: That densities of longfin had peaked in February, and were declining by the time that we made that switch

58:37  
CDFW Broadcast: so that lack of catch likely just indicated that larval longfin.

58:41  
CDFW Broadcast: We're no longer present in the area, but it nonetheless sparked an interest in alternative gear types coming up in our 2023 season.

58:48  
CDFW Broadcast: Now, I've actually got some footage here my very first day, January third, 2023 of me coming on board the Larval entertainment project.

58:58  
CDFW Broadcast: and, as you can see, I've gotten a lot taller.

59:03  
CDFW Broadcast: but my personal growth aside, I was not the only newcomer this year. We also added a new net, which was a 9 40 micron mesh that we mounted to an SLS sled.

59:12  
CDFW Broadcast: Our sampling this year alternated between the 2 gears, the 500 and the 940 nets which made our season something like one big gear comparison.

59:21  
CDFW Broadcast: We discontinued our 20 mm sampling, due to the low catch that we observed in 2022,

59:25  
CDFW Broadcast: and sampled actively from January through April.

59:30  
CDFW Broadcast: likely due to the relatively wet hydrological conditions that we experience in 2023 we caught relatively few. Lonfin smelt this year. The species appeared early in our 500 micron sampling, and later, in our 940 micron sampling

59:44  
CDFW Broadcast: across all taxa, we had a variety of lengths with a mean around 7 our catch was mostly dominated by the native prickly sculpting.

59:52  
CDFW Broadcast: Our new 940 net did appear to be more efficient and capturing larva over 6 mm but overall our 500 micron net caught the most fish overall

1:00:03  
CDFW Broadcast: in 2024. We continued our adaptive approach by expanding out of West Canal to a series of SLS. Stations located along the Old and Middle River corridor.

1:00:14  
CDFW Broadcast: I've got 2 marked out here at the top of the Omar corridor, which I'll talk about in a second. But I wanna mention that while our sampling in West Canal was doing a good job at detecting long fin and they're

1:00:27  
CDFW Broadcast: direct entrainment. As we saw. That represents only part of the effect that pumping can have on their distribution.

1:00:35  
CDFW Broadcast: And so these 2 stations in red that I just called out. Those at the top of the Omar Corridor were our priority or early warning sites

1:00:43  
CDFW Broadcast: which received intensive sampling on the Monday of each week

1:00:47  
CDFW Broadcast: and then, on the remaining sampling days, we ran a longer

1:00:51  
CDFW Broadcast: transect, starting at those stations and then running down kind of the whole Omar Corridor and our hope there is that that will generate a broader and more consistent picture of what longfin distribution looks like within the zone of entrainment.

1:01:08  
CDFW Broadcast: Now, in 2024.

1:01:11  
CDFW Broadcast: We had hoped to continue sampling with our 500 and 940 micron nets side by side. But I gotta tell you folks the sea can be a harsh mistress

1:01:20  
CDFW Broadcast: our 940 net was lost during sampling very early in our season.

1:01:25  
CDFW Broadcast: It was nicknamed Captain America. And so maybe we'll be lucky, and he'll make a triumphant return

1:01:32  
CDFW Broadcast: sometime soon. But without him. We moved on and turned to the new hero, which was the wonder, twins.

1:01:41  
CDFW Broadcast: In that case they took the form of a bongo sled which is named for the drums that they resemble. And that I am very merciful, and not using as the soundtrack to this talk.

1:01:53  
CDFW Broadcast: Instead. Please just enjoy a picture

1:01:56  
CDFW Broadcast: we undertook oblique tows with this gear which allowed us to sample a higher volume of water with the same number of toes, hopefully providing us with a better chance of detecting the rare species that we're looking for

1:02:08  
CDFW Broadcast: and improving our ability to assess their densities at those sites

1:02:13  
CDFW Broadcast: developing this gear was a major investment during our 2024 season, including extensive work, designing, fabricating, and testing it. Our first gear naturally broke immediately, but it taught us a lot of important lessons

1:02:27  
CDFW Broadcast: with additional reinforcement, in the addition of a sled and frame, we found that this gear, sampled very similarly to an SLS sled in terms of its performance in the water and its depth profile. And this initial testing was so successful that we ultimately switched to this gear exclusively. After just the first few weeks of our sampling season.

1:02:44  
CDFW Broadcast: we're very excited to share our 2024 results. We're in the midst of processing the season's data. So please stay tuned

1:02:51  
CDFW Broadcast: here, I'm gonna give you a quick whirlwind tour of the special studies that we're performing these last few years.

1:02:57  
CDFW Broadcast: In 2022 we carried out a series of day, night comparison studies in January, March and February got those kind of mixed up.

1:03:05  
CDFW Broadcast: This study is actually written up in detail in our forthcoming IEP Newsletter article. So if you want more details. Please look there. But in summary we found that our early morning and evening sampling encountered more longfin

1:03:17  
CDFW Broadcast: than our daytime sampling.

1:03:20  
CDFW Broadcast: and 2023, we set out to more closely examine the 3 gear types that we've been using between the 500, 940 and 1,600 micron.

1:03:29  
CDFW Broadcast: We use 3 SLS sleds mounted with those nets, and found that we are sampling too late in the season, unfortunately to reliably catch longfin. But across all species. We found that the 500 continued to have the highest catch overall. But we did find that the 940 gear was somewhat more adept at capturing larger larva particularly some of the more common species like stripe bass.

1:03:53  
CDFW Broadcast: Our analysis of the data showed that the 940 and 1,600 micron nets produce pretty similar results, and the 500 had a distinct advantage and overall catch.

1:04:04  
CDFW Broadcast: We also did some night sampling. I'm gonna speed through this because we don't have any results yet, but I can't really undersell how pretty it is to be out in the Delta at night. Unfortunately, I don't have any good pictures to show that.

1:04:15  
CDFW Broadcast: So all you get is this picture of one of our samples and then kind of this horror movie version of the bongo coming up out of the water call it the dark bongo

1:04:23  
CDFW Broadcast: but please stay tuned for that. Those special collections are being processed along with our 2024 sample samples. And we're excited to share those results. Once they're in.

1:04:33  
CDFW Broadcast: As we look ahead to 2025, we're planning on continuing our core sampling within the high risk Omar Corridor.

1:04:40  
CDFW Broadcast: We're also planning to pursue additional special studies like surface bottom comparisons that will allow us to address the effect that our oblique tow methods have on our net's efficiencies.

1:04:48  
CDFW Broadcast: Excuse me, efficiency.

1:04:50  
CDFW Broadcast: and we also plan to carry out additional gear comparisons to critically examine the effectiveness of our equipment.

1:04:56  
CDFW Broadcast: I'd like to highlight that we're planning on publishing our data on the environmental data initiative, making it freely accessible to all of you in the greater scientific community within the Delta. And then I'd like to close out by noting that we're collaborating with DWR. Genetic monitoring lab. And we hope to be able to provide them with

1:05:13  
CDFW Broadcast: some ground truthing as they work on developing an e-DNA assay that can detect the presence of long fin smell

1:05:20  
CDFW Broadcast: stay tuned for more information.

1:05:23  
CDFW Broadcast: And if I can just wrap up real briefly I'll just tell you. That's the story of how less became more. We're still growing. I hope that we can advance the conversation around

1:05:33  
CDFW Broadcast: entrainment, and I'll close by saying that part of achieving that goal is engaging with broader IEP community so you're welcome to catch me during the break, because I'm pretty easy to find and I think I'm out of time, so I won't take any questions. But thank you all very much.

1:05:55  
CDFW Broadcast: Language.

1:05:56  
CDFW Broadcast: Thanks, Morgan. Sorry we don't have time for questions, but like Morgan said, that's what the breaks are for. So now we are going to start the Vanessa's talking about Longfin section of the longfin group. So this we have Vanessa Morris talking next about the expansion into San Pablo Bay. Alright. Hello, everyone. My name is Vanessa Mora, and I'm an environmental scientist within the Native Fishes unit at CDFW.

1:06:25  
CDFW Broadcast: I am one of the project leads for the smelt larva survey and the 20 mm survey.

1:06:30  
CDFW Broadcast: I'm here today to talk about our expansion into San Pablo Bay.

1:06:37  
CDFW Broadcast: Alright, the smelt larva survey was initiated in 2,009 to document the abundance and distribution of larval longfin smelt in the San Francisco Bay Estuary.

1:06:47  
CDFW Broadcast: Historically, the survey conducted biweekly, sampling from January through mid-March, among 44 fixed stations.

1:06:56  
CDFW Broadcast: The 20 mm survey was implemented in 1995, in response to the Federal ESA listing of Delta smelt as threatened. It runs every other week from mid-March to early July for a total of 9 sampling weeks.

1:07:08  
CDFW Broadcast: This sort, this survey, has historically sampled 47 fixed stations.

1:07:13  
CDFW Broadcast: while 20 mm targets post-larval to juvenile delta smelt. It is also useful for monitoring early juvenile longfin smelt

1:07:22  
CDFW Broadcast: Both projects are used by agency managers to assess the vulnerability of listed Osmerids to entrainment by the south Delta export pumps.

1:07:30  
CDFW Broadcast: Both conduct 10 min oblique tows and collect samples that are preserved in 10% formalin for later identification.

1:07:37  
CDFW Broadcast: A couple of differences to note between the 2 projects is that

1:07:43  
CDFW Broadcast: SLS

1:07:46  
CDFW Broadcast: is that SLS is most effective in capturing 5 to 15 mm larvae, while 20 mm survey averages a wider length. Frequency from 10 mm and up

1:07:57  
CDFW Broadcast: the SlS gear is the top left picture.

1:08:00  
CDFW Broadcast: and although it looks similar to the bottom, right picture of 20 mm gear, it is very different because of its smaller sled frame and mesh size.

1:08:08  
CDFW Broadcast: SlS. Does one tow at each station, whereas 20 mm does 3 replicate toes, including a concurrent zooplankton tow.

1:08:16  
CDFW Broadcast: These projects are well established, but the spatial and temporal distribution of larval long fence melt was found to extend beyond the historic sampling frame for both projects

1:08:27  
CDFW Broadcast: which limits the project's representation of inner annual variability.

1:08:31  
CDFW Broadcast: In response, we took steps to help improve representation.

1:08:36  
CDFW Broadcast: In the 2022 sampling season we added 2 supplemental surveys

1:08:40  
CDFW Broadcast: in December to SLS to help us detect larvae sooner than the first sampling week in January, when we usually already see longfin smelt catch.

1:08:49  
CDFW Broadcast: Starting in 2023, sampling the starting in the 2023 sampling season, we increased the sampling effort in San Pablo Bay.

1:08:57  
CDFW Broadcast: where larval and early juvenile populations reside during wetter years.

1:09:04  
CDFW Broadcast: Alright. The monitoring survey design team is a combined effort of multiple agencies with several goals. But I'll only be focusing on the ones relevant to 20 and SLS.

1:09:14  
CDFW Broadcast: One of the goals of this effort is to implement design-based estimators of abundance to provide a more standardized method for estimating abundance across projects and species.

1:09:24  
CDFW Broadcast: Another goal is to improve spatial balance by strata within and between projects, to increase certainty and improve species detection for the abundance estimate. So, these 2 goals go hand in hand. The picture on the right shows different regions, strata and sub regions.

1:09:42  
CDFW Broadcast: One of the ways to improve spatial balance is to increase the number of stations in areas where population estimates are desired for 20 mm and SLS Arun Malwani's analysis indicated the priority region for increased sampling is San Francisco Bay, where the abundance estimates standard error could be reduced by 25%

1:10:03  
CDFW Broadcast: with 6 to 15 additional tows per sampling

1:10:07  
CDFW Broadcast: week in the region.

1:10:12  
CDFW Broadcast: This is a map of where the SLS stations fall into the different regions and subregions. Our focus will be San Pablo Bay and Carquinez Strait.

1:10:22  
CDFW Broadcast: All of these new stations are actually preexisting sites for other surveys, except for 405, which is already a routinely sampled station for both projects. 323 is a routine, 20 mm station.

1:10:36  
CDFW Broadcast: 328, 335, 329, and 336 are 20 mm high outflow stations, and the rest are current fall midwater stations. There were certain considerations during the selection process, such as including a mix of deep channel and shallow shoal stations, and making sure each station was at least 2 kilometers apart.

1:10:58  
CDFW Broadcast: and then very quickly. This is just a 20 mm map, with all of our stations. A lot of the stations are the same. Except for some areas like the Napa, we have less stations and we have more in the North Delta

1:11:14  
CDFW Broadcast: for the San Pablo expansion, though they're the same stations that we picked for SLS.

1:11:21  
CDFW Broadcast: The reasons for the reasons for the move to design-based abundance estimates are, improved flexible and efficient for calculating project-specific regional estimates of regional of relative abundance

1:11:32  
CDFW Broadcast: along with the associated uncertainties.

1:11:35  
CDFW Broadcast: It provided a standardized method for estimating abundance across the studies and species.

1:11:41  
CDFW Broadcast: and it can be applied in fixed or probabilistic spatial designs. Essentially the design-based abundance estimate is CPUE times volume where the CPUE is average across stations within a region and then multiplied by a regional water volume. The real key is that this approach allows for variance calculations.

1:12:01  
CDFW Broadcast: The graph depicts, the design-based abundance estimate for longfin smelt and SLS, and the gray is the confidence intervals.

1:12:11  
CDFW Broadcast: This, the well-established population estimation approach employed in this effort is adapted from Polanski at all. 2019,

1:12:19  
CDFW Broadcast: all right. SLS added effort

1:12:21  
CDFW Broadcast: we added 15 stations to the San Pablo region, bringing the total number of stations for a sampling week from 44 to 59. It added a full extra day downstream. Overall, it adds 120 samples to our sampling year for SLS. The stations, highlighted in yellow are the additional stations

1:12:42  
CDFW Broadcast: for 20 mm,

1:12:44  
CDFW Broadcast: We added 14 stations to the San Pablo region, bringing the total number of stations per sampling week from 47 to 61. Overall, the expansion has added 504 samples, including zooplankton, to our sampling season.

1:13:00  
CDFW Broadcast: Let's dive into some average longfin smelt CPUE maps for SLS. 2022 was a critical dry year. The goal is to capture the complete longfin smelt distribution within the delta in a critical dry year. This is what that looks like. Notice. The majority of the distribution near in the middle, near the confluence, and it somewhat tapers off as you go into Carquinez Straight.

1:13:24  
CDFW Broadcast: Now let's compare that to 2017, a wet year, a very wet year. Where are the longfin? There's some as station 411, and there's some in the Napa, but the distribution is most likely outside of our sampling range for this year

1:13:42  
CDFW Broadcast: 2019, another wet year. The highest CPUE is in the confluence area, because we did not sample the Napa or San Pablo longfin smelt. We're most likely downstream, and just outside of our sampling range

1:13:55  
CDFW Broadcast: again.

1:13:57  
CDFW Broadcast: Now this is 2023 without the expansion sites. It was a wet year, and we can see high CPUE in Suisun Bay, leading into Carquinez Straight, and also in the Napa.

1:14:09  
CDFW Broadcast: and when you add in the expansion stations, you get a better view of the distribution. Otherwise we're only getting a fraction of the story.

1:14:18  
CDFW Broadcast: 2024,

1:14:20  
CDFW Broadcast: also, like above normal water year it tells a similar story. The distribution of longfin smelt are further downstream.

1:14:27  
CDFW Broadcast: and then I just like to toggle between them. This is what we're missing out when we don't sample the San Pablo region during wet years.

1:14:35  
CDFW Broadcast: Okay? A quick summary of SLS data. The figure to the left shows a total catch of longfin smelt and SLS broken up by routine South and central stations. Napa and the San Pablo expansion sites.

1:14:48  
CDFW Broadcast: I just wanted to point out that the Napa has not always been a region we sample in.

1:14:52  
CDFW Broadcast: We started in 2014 sample through 2018, stopped and then restarted in 2022.

1:14:59  
CDFW Broadcast: But now I want to draw your attention to the last 2 bars on our graph for years, 2023, and 2024.

1:15:07  
CDFW Broadcast: The green is the longfin smelt catch at the expansion sites and accounts

1:15:11  
CDFW Broadcast: for 23% of the total longfin smelt catch for 2023. For 2024, the expansion sites account for 16 of the total longfin smelt, catch.

1:15:22  
CDFW Broadcast: and fun fact.

1:15:24  
CDFW Broadcast: For 2023 we collected Id and processed 200,902 fish, 49% of that are solely from the expansion sites. Let me add some emphasis. We added 14 stations.

1:15:39  
CDFW Broadcast: 14 stations per sampling week accounts for 49% of total catch for 2023

1:15:46  
CDFW Broadcast: amazing

1:15:49  
CDFW Broadcast: alright, let's dive into the some 20 mm longfin smelt CPU averages 2017 a wet year similar to SLS. The distribution is westward with the highest average CPUE's at the high outflow stations, and the Napa

1:16:07  
CDFW Broadcast: 2019, another wet year, we see a similar pattern as 2017. The highest averages are westward

1:16:17  
CDFW Broadcast: again. This pattern for 2022 parallels SLS - the highest CPUE is centered near the lower Sacramento River. The distribution is more inland, typical of a drier year

1:16:31  
CDFW Broadcast: 2023 without the expansion. It's a wet year again strongly resembles SLS. When you add in those expansion stations. You just get a clearer picture of the distribution. It tapers off as it goes towards

1:16:44  
CDFW Broadcast: 306,

1:16:47  
CDFW Broadcast: a quick overview of the 20 mm data. During high outflow years we used to sample 5 stations in San Pablo. 4 out of the 5 are now part of our expansion stations.

1:16:57  
CDFW Broadcast: Let's take a quick look at 2023. The green shows the portion of longfin smelt captured from the San Pablo expansion, which accounts for 21%.

1:17:08  
CDFW Broadcast: Again, some fun facts, some fun facts. We collected, ID'd and enumerated 70,644 Pacific herring. The expansion accounts for 70%,

1:17:23  
CDFW Broadcast: some highlights

1:17:25  
CDFW Broadcast: just a couple of neat things. We captured larval, rockfish, California halibut, and ronquil for the first time at these expansion sites. The picture to the left is my new favorite little guy. It is a California halibut, and I think it's the most rock and roll fish I have ever seen. It looks like it has a Mohawk up. I love it 10 out of 10

1:17:44  
CDFW Broadcast: no critiques.

1:17:46  
CDFW Broadcast: We also captured a larval delta smelt 9 mm on May 10th, 2023. At Station 327.

1:17:56  
CDFW Broadcast: We captured one back in 2019, also in San Pablo Bay at the how high output station 335.

1:18:04  
CDFW Broadcast: So just Nope, think about that. But also think about this fish right here.

1:18:11  
CDFW Broadcast: Challenges with the expansion.

1:18:13  
CDFW Broadcast: Sampling in new territory brings new challenges, weather conditions like fog and rough waters.

1:18:19  
CDFW Broadcast: loads and loads of herring.

1:18:22  
CDFW Broadcast: All these things delay sampling and processing of the total time processing for fish for SLS in 2023, about 43% of that time was spent on the expansion stations.

1:18:33  
CDFW Broadcast: In part this high percentage is related to the picture on the right.

1:18:38  
CDFW Broadcast: In the 2023 SLS sampling season, one of the expansion site. Samples had 11,278 Pacific herring. Would anyone like to guess how many longfin smelt were in the sample?

1:18:52  
CDFW Broadcast: Just

1:18:53  
CDFW Broadcast: yes, you're right. It's 2,

1:18:58  
CDFW Broadcast: 2024 has been a lot smoother. No crazy amounts of Pacific herring, and the weather has been really nice. It feels like. I'm tempting fate to say those words out loud.

1:19:10  
CDFW Broadcast: But it's been really good thus far

1:19:16  
CDFW Broadcast: perfect

1:19:17  
CDFW Broadcast: closing. The main takeaway is during wet years. The increased. Sampling downstream is integral to integral to capturing a more complete picture of the distribution for longfin smelt, and this increased sampling has the added advantage of improving our design based abundance estimates. It's a win-win.

1:19:37  
CDFW Broadcast: 2023 SLS and 20 mm data is published online at the FTP site. 2024 SLS data will be published soon.

1:19:47  
CDFW Broadcast: and I just want to remind everyone of our fish distribution maps and length frequency graphs. The QR codes here link to our CDFW survey pages which have links to lead to both features as well as the FTP site.

1:20:01  
CDFW Broadcast: And yeah, so this is our fish distribution map. And this is our length frequency maps graphs.

1:20:08  
CDFW Broadcast: And then just a couple quick acknowledgments.

1:20:11  
CDFW Broadcast: takes a village to do monitoring.

1:20:15  
CDFW Broadcast: Yeah. And if I have time for questions, or if anyone has any questions

1:20:20  
CDFW Broadcast: that's it.

1:20:23  
CDFW Broadcast:

1:20:33  
CDFW Broadcast: Excellent presentation. Loved it. It looked like when you were comparing your catch to previous years.

1:20:41  
CDFW Broadcast: you know, you had Napa sampling in 2017, and then again, more recently, and in 2017 it looked like you hardly caught any in the Napa area, or any at all. And then the past 2 wet years you got a ton. Do you have any idea why? No, and it's

1:20:56  
CDFW Broadcast: for 2017. We only caught 79 Longfin, which is wild. 79 is a very, very low number, and I'm not sure why

1:21:07  
CDFW Broadcast: we only caught that many.

1:21:10  
CDFW Broadcast: Sorry I couldn't answer your question, but thank you for asking. Yes.

1:21:15  
CDFW Broadcast: thanks. Great presentation. I think. Both you and Morgan should should receive kudos for being poster children for displaying how the IEP adapts and updates its sampling programs to meet current management needs.

1:21:30  
CDFW Broadcast: Can you talk a little bit about what that took and about the challenges in doing that. We get criticized for not being too adaptable. And and I think I think this is a highlight for how this is happening. So just tell us a little bit about that. Yeah, so

1:21:45  
CDFW Broadcast: In

1:21:47  
CDFW Broadcast: like November 2022 I was pulled into. Hey? We need to increase sampling in the San Pablo region for these

1:21:57  
CDFW Broadcast: for the regions listed here, we want to increase the abundance estimate.

1:22:04  
CDFW Broadcast: We need to increase

1:22:06  
CDFW Broadcast: 6 to 15 tows in this region, and so I was pulled into like helping pick out stations. And then from there I'm very focused on the logistical side of fieldwork.

1:22:17  
CDFW Broadcast: And so

1:22:19  
CDFW Broadcast: I'm wrapping up, and maybe we can talk after. Sorry.

1:22:25  
CDFW Broadcast: Oh, it's on me. Excuse me.

1:22:35  
CDFW Broadcast: yeah, no, we could talk forever about this stuff. And I would love to so definitely. It's the most not going. Oh, no.

1:22:51  
CDFW Broadcast: okay.

1:22:56  
CDFW Broadcast: alright. So I'm last up today. So second half of the Vanessa section of our session here. So anyway, I'm Vanessa Tobias. I'm a statistician at the Lodi Fish and Wildlife office. And I'm the lead for the longfin smelt lifecycle model project. So today, I'm just gonna give you an overview of what we're doing. Where we're at with the lifecycle project. And really, there's 2 parts to this talk.

1:23:22  
CDFW Broadcast: So the first is we're gonna talk a little bit about how we're doing collaboration and how we're bringing in the community to help us set up the lifecycle model to make sure that it's a useful product for a wide range of of folks who wanna use it for different things. And then the second part is, gonna be our approach to building the model itself. So I'll give you a little bit of an update on where we're at with that in the data collection part.

1:23:45  
CDFW Broadcast: So of course, I have to acknowledge a lot of people. So we've got a modeling team which is made up of folks who have experience doing lifecycle models like for the Delta smelt life cycle model. We've got longfin smelt experts. Whole bunch of people on the modeling team. We also have an advisory team that we the modeling team goes to for advice. And to run stuff by them. We ask them questions. They give us good feedback. So there's a whole lot of people involved in this

1:24:11  
CDFW Broadcast: and I also wanna thank our funders. DWR, has a contract for us for the fish and wildlife service component of this.

1:24:20  
CDFW Broadcast: okay. So, starting with the project, timeline, the question I get asked the most already about the life cycle model is is it done yet? And I would love for that. To be the case. I would love to have something to give you guys right now. We just started so we are working on a lot of different pieces. It's a complicated project. And I'll point out that we our contract is up in 2027. So, we have some time. But this is a cartoon of our project. Timeline and

1:24:47  
CDFW Broadcast: it it really it's broken into a bunch of different steps. So starting with a model plan. So we start actually writing down what we were planning on doing, running it by our advisory team and writing up a document. So all of this stuff is kind of planned out already. Which is great because it helps us figure out like, what's the roadmap for this thing? And we can all agree on where we're going. So that was the first step. We're also need to build the data sets that we'll we'll use for the model. We'll actually write the modeling code, which is the pink part

1:25:15  
CDFW Broadcast: and then the big thing at the bottom is facilitating the collaboration and the open science part of it. So that's kind of where I'll start with today. But just so, you know, there's a lot of overlap, especially between the building the data sets and the model part. And that's because it's an iterative process, and we'll be getting feedback as we go.

1:25:33  
CDFW Broadcast: So where we're at right now again, we're building the data sets. We're starting the modeling process. We're starting to set up what the model looks like and like I said, I'll talk about that in the second part. Those 2 pieces. We're really deep into the the data discussions right now, which is kind of fun. But before I get into that, I wanna tell you a little bit about the open science and the collaboration part, because

1:25:55  
CDFW Broadcast: anybody who knows me knows that's my jam. So I can't leave that part out. Alright. So open science and collaboration. So we also wrote this down. So I wrote down all the discussions that we had about how we are. Gonna do the collaboration bit like, I said, there's a ton of people involved in this. So it really even comes down to like, how do we collaborate between the people that are part of the team, because you all know how hard it is when you've got people from the State and the Feds trying to figure out even what software do we have that we can all use at the same time and make this stuff work.

1:26:25  
CDFW Broadcast: So we had discussions about that and figured this stuff out. So I wrote it down in a plan. Things that are in the plan include who is a member of the teams? And how do they overlap? How are the teams gonna communicate with each other? And what are they responsible for? That's super important. So that everyone knows what they're doing when they're in a specific meeting. What's the focus?

1:26:45  
CDFW Broadcast: really helps a lot to know where where folks are are coming from, what their job is. We also included the fair principles. So making sure that our projects, the data and the products are gonna be findable, accessible and are interoperable and reusable.

1:27:01  
CDFW Broadcast: I put a little plus sign on there, too, because, in addition to the fair principles, we also want to make sure that we're protecting and crediting folks for their intellectual contributions so things like the data producers, and the folks who are rearranging the data should be getting credit for doing those things. We also have to think about since I come from fish and wildlife service, you have to think about the Federal open science standards and policies. So we're following those as well as the the fair standards, because there's some additional things

1:27:30  
CDFW Broadcast: like. I mentioned before, we also thought about the tools that we need to support. Our projects. How are we gonna do this collaborative thing like, what platform are we gonna use? What's accessible to everyone? And so some of the things that we've decided so far. And there's the little thing you probably can't read. That's like, Oh, we might change this as we go as needs as needs change. But so right now we're working on Github with a close repository. Because that meets the Federal standards.

1:27:57  
CDFW Broadcast: it will be accessible eventually.

1:28:01  
CDFW Broadcast: Okay, so that's the the open science and collaboration part. Actually, I will back up for just a second and say that for the fair principles.

1:28:08  
CDFW Broadcast: One of the other things that we're super interested in is the interoperability part. So we're talking to folks with who are doing other work on Longfin and trying to figure out, how can we incorporate what you're working on into the lifecycle model, trying to understand what else is going on, so that we're not doing this in a vacuum and if folks have got like models that could talk to our model, we wanna talk to you so coming soon, we'll be in touch or get in touch with me.

1:28:32  
CDFW Broadcast: Ok, so a little bit about the methods that we're using for the the model. So this whole thing, I'm really pushing this causal design idea. And here's some textbooks. If you're a methods geek like me.

1:28:43  
CDFW Broadcast: so that the idea of causal design is that you're putting the science first. So we're we're starting with the ideas about like what's going on in the system. And we're putting that ahead of the statistics. So the statistics will support the science. That's that's the big idea here. So you state your knowledge ahead of time. Using the first step is to make a conceptual model and then you use it for things like data collection and to design the stats so that it's really all of the

1:29:08  
CDFW Broadcast: pieces are supporting the science that you're doing.

1:29:14  
CDFW Broadcast: Okay? So as Anke mentioned earlier, IEP loves a conceptual model. So here are 6 examples from recent technical reports from IEP. It took me about 5 min to find these, because they are everywhere and the reason that we love conceptual models is because it helps us communicate right? We can put down our scientific understanding into a diagram. We can state our assumptions in the diagram.

1:29:39  
CDFW Broadcast: We can have a discussion about that. So they're really great for us as a collaborative group. For IEP to use conceptual models. And you can see that there's a lot of different ways. You can make a conceptual model right? So there's boxes up there. There's even like pictures and things like that. There's maps. These can all be conceptual models. For a causal design idea. We need a specific kind of

1:30:02  
CDFW Broadcast: conceptual model. It's called a directed acyclic graph

1:30:05  
CDFW Broadcast: or a dag for short. Here's an example of a super simple one for longfin. So

1:30:11  
CDFW Broadcast: the idea with a dag is that you have nodes and you have arrows. The nodes represent like data that you have in the system, or something that you're interested in. Maybe you don't have data for it. But it's it's an important piece. So it's like a noun, or like a thing. And then the arrows are the connections between those things. So how 1 one thing influences another. And the really cool thing about them is that they are non parametric, to begin with. So you do.

1:30:36  
CDFW Broadcast: You don't have to say what the arrows look like. You don't have to say what the relationship between say, temperature and longfin abundance is. You just have to say that there is a relationship, and that's how you start your conversation, which is very easy to do, right or relatively easy. We can say what's related to what?

1:30:52  
CDFW Broadcast: There are arrows because they're directed so it wouldn't make sense to save that long fit abundance influences temperature. That's kind of nonsense. And we know that. So we know which way the arrow goes. Simple, right? And then if we really wanna write out an equation, there's one at the bottom. So like the abundance is a function of the previous abundance and temperature. But yeah, notice, I didn't say what that function looks like. It's just a function. So that's a good way to start. And then eventually we'll use that to inform the model, and we can start seeing what those functions look like?

1:31:21  
CDFW Broadcast: So I think these are kind of fun, cause we get to draw pictures and then argue about them. So so the quickest introduction to Longfin life history ever. So you guys are like a lot of folks here. Talk about Delta smell for a long time. So forget about Delta smelt for a second. Longfin don't behave like like Delta smelt really

1:31:39  
CDFW Broadcast: Think, Steelhead, that's a really simple analog. It's not the best. I'm sure the steelhead people are gonna be like, no, that's not right. Close enough. So it's better than Delta smelt so the reason that I say that they're similar is longfin live for more than one year. They go out to the ocean. They're an anadromous. Some of them even, maybe don't go to the ocean. Some of them stay so like Steelhead, there's a little bit of plasticity there.

1:32:05  
CDFW Broadcast: and yeah. So there, there's a little bit closer to steelhead. So really quick. Because I'm gonna show you this is a dag, a directed acyclic graph for the life cycle of Longfin. And I gave a shout out to Laura Mitchell, for she's the one that actually put all these dags together in the beginning. So this is just for the life cycle. So this this is what you would expect. We've got. The nodes

1:32:27  
CDFW Broadcast: are the different life stages. You'll see. Larvae's in there a bunch because we have. There's a lot of things going on with larvae. So the the blue squares are nodes.

1:32:36  
CDFW Broadcast: and then the green circles are just labeling the arrows that are between them which are super short, because there's so much to cram on this. So you can see that we've got all the live stages in there. Then we split it out into whether they go to the ocean or not. And then the pre-spawning adults they're on the 2 ends, because this really connects it's really a circle.

1:32:58  
CDFW Broadcast: But anyway, so that's that's the beginnings of the lifecycle model. So we're gonna use that to design our data collection.

1:33:05  
CDFW Broadcast: This is synthesis project. So we're not collecting new data. We're using existing monitoring data. And we're we're

1:33:11  
CDFW Broadcast: breaking that out by time points. So one of the things we learned super early on in the process is that since longfin can live for more than one year, we really need to number the months, because, like, there's more than one June, and we were getting confused. So we'll see the months are always labeled with a number. And then we started lining that up with the existing monitoring data.

1:33:31  
CDFW Broadcast: Allright, so we actually started working on abundance indices. Or hopefully, eventually, they'll be

1:33:38  
CDFW Broadcast: estimates. But for now we're calling these indices using the existing data. So we've got.

1:33:45  
CDFW Broadcast: There's 6 different surveys. We've got different industries for all of them. These are just an example from base study what those look like. So these are things that Leo Plansky is working on and folks have probably seen that a little bit. So these are spatially resolved. They're using ratio estimators, and again, these have

1:34:03  
CDFW Broadcast: abundance. The abundance indices with

1:34:07  
CDFW Broadcast: confidence intervals on them. So that's helpful for us.

1:34:11  
CDFW Broadcast: The next part would be designing the statistical procedure. So we're going to use a state space model, most likely for this, and I won't go into all the reasons why.

1:34:20  
CDFW Broadcast: but we're also gonna start putting coverage. So I show you the abundance part of the dag. Well, now, things are gonna get complicated because we're gonna start thinking about, how does the environment play into the life cycle of longfin?

1:34:34  
CDFW Broadcast: So this is okay, you can actually see it. So this is our first draft of a a influence diagram with environmental variables. And you'll see that longfin. The abundance part is in the middle there. And then we put all the environmental variables around it, and it got really complicated, really fast. And I bet if you stare at this like closely, you'll be like, I don't like that part. I wanna move that. And that's okay. So we actually already have moved this around.

1:34:58  
CDFW Broadcast: We have a new graph of this. But this is the only one that's got everything altogether. And one of the things we realized again is that month matters so what time of the year you're in? So we actually broke these out in the new version. So each transition gets its own influence diagram or dag and so this is just one of the examples. There are 10 of them. Now, I'm not gonna show you all 10 but you can see that at the top. We've got that

1:35:22  
CDFW Broadcast: the the last. Now the lifecycle part, the the longfin data goes in the top. So those are the nodes that relate to larvae and juveniles, and then the habitat attributes have their own nodes at the bottom.

1:35:33  
CDFW Broadcast: and you can see that like it gets, it gets complicated quickly. And this is one of the the more simple ones really. But

1:35:40  
CDFW Broadcast: for instance, like you might be interested in how like down the line, once we fit this model you might be interested in like, how does hydrology affect Longfin and the the abundance. You know, moving forward. And so you can actually trace that through the graph. And even though it might be a complicated path. You can trace it. And we can say what that looks like. So that's that's a really useful thing about doing this with

1:36:03  
CDFW Broadcast: with these diagrams is that we can trace how the environmental variables will affect Longfin going forward.

1:36:11  
CDFW Broadcast: And like, I said, we have to agree on what what this looks like we have to figure out what what our model looks like and agree on it as a group, so that we can have some consensus around it. Otherwise, you know, if you don't believe the the model that produces the model, like the conceptual model that produces the mathematical model, you don't believe the whole thing. So that's where we're going with this now is we're we're advising and doing this with some some iterations with our advisory team.

1:36:38  
CDFW Broadcast: So I started talking about this a little bit already, but about the management question. So one of the things that we, as a modelers asked our advisory team for was like, What do you want this model to do? What's important to you? What's the end goal? And our advisory team actually gave us 90 ideas. So so that was actually why we started like going down the path of doing the guys is because how do you prioritize 90 ideas. And how do you say what's

1:37:02  
CDFW Broadcast: what's more important than what? So the idea is to try to incorporate as much as we can about the system into the environmental part of the model but we're also gonna have to be realistic about what's possible mathematically. So is this all gonna end up in the final model. Probably not. But we are in the the beautiful plans of this is all. Gonna be easy, and we have lots of time. So that's where right now. And but that's how you start. Right? So start big edit

1:37:27  
CDFW Broadcast: but we have a lot of stuff that we're we're interested in doing. And that's kind of where we're at with this.

1:37:33  
CDFW Broadcast: there's so much more under the the hood of this. So if you want details. Come, talk to me. I will be happy to to talk more about that. But that's the broad overview of the lifecycle model, and where we're at and where we're headed. But it's it's a super exciting place to be. And I'm really, really happy about this project. So that's what I have.

1:37:59  
CDFW Broadcast: Okay, we are out of time. It's time for the break. So come, talk to me after come, talk to the other folks who presented. If you have questions, and I'll give it back to Rosie.

1:38:11  
CDFW Broadcast: Alright! Yes, we're now going to break 20 min break. Be back here at 10:25 for the next session, which is my favorite title. So many fishes.

1:38:29  
CDFW Broadcast: All right, folks, we're going to get started. Sorry for the delay. We had a some technical difficulties.

1:38:36  
CDFW Broadcast: very unfortunate technical difficulties. And so the the first talk of the session we are going to have to miss for now, because the computer ate Will's presentation, and he was. He was very good and got it to us early. And then

1:38:54  
CDFW Broadcast: but we're gonna

1:38:58  
CDFW Broadcast: soldier on, and hopefully, we can

1:39:02  
CDFW Broadcast: find some time for him to give a reprise at a later date. And so I'll give it over to Claudia, who is the session chair of the so many fishes. Session.

1:39:19  
CDFW Broadcast: Welcome to the so many fishes. Section our first. I'm Claudi Mcfarland. I'm a database manager for the enhanced Delta smelt monitoring program at the Lodi Fish and Wildlife office. Our first talk is going to be by Andrew Veary about the automated fish tracking and enumeration in dynamic environments.

1:39:36  
CDFW Broadcast: Let's get going.

1:39:42  
CDFW Broadcast: Oh, I'm sorry. Am I weird? Do this. You just drag it over.

1:39:50  
CDFW Broadcast: That was easy. That works. Do you need presenter view? Yeah, I'll do presenter view for sure.

1:39:57  
CDFW Broadcast: Good morning, everybody.

1:40:00  
CDFW Broadcast: Just

1:40:04  
CDFW Broadcast: find the mouse.

1:40:08  
CDFW Broadcast: I got it. Okay, got it? Found it

1:40:11  
CDFW Broadcast: save button.

1:40:13  
CDFW Broadcast: Okay, do this.

1:40:16  
CDFW Broadcast: Is this not presenter again. Yes, so it's because we did the first time the other one out first.

1:40:30  
CDFW Broadcast: oh, something was taking over. Yes.

1:40:39  
CDFW Broadcast: okay.

1:40:41  
CDFW Broadcast: good morning, everybody. My name is Andrew Veary. I am the image analyst with Kramer Fish science, and the title of my presentation is Automated fish tracking and enumeration and dynamic environments.

1:40:51  
CDFW Broadcast: So we're going to count fish

1:40:53  
CDFW Broadcast: just a little overview of the project. This is a diagram of our sampling platform.

1:40:59  
CDFW Broadcast: What this is is a pontoon boat.

1:41:02  
CDFW Broadcast: rigged up with several sensors and different meters. It collects different environmental variables, GPS, location, depth, information as it. We travel continuously through our stable sites and at the same time

1:41:14  
CDFW Broadcast: beneath the boat.

1:41:16  
CDFW Broadcast: We have net forward the the bow where we, you know, sort of funnel

1:41:21  
CDFW Broadcast: fish through as we're driving through our sites, and the fish you see in the left will go through the the net and the sample system, and then it'll go past a box

1:41:30  
CDFW Broadcast: that includes 2 cameras that are go pros and then past that. It's another camera that collects images of the zooplankton, and they fish, discharge out the stern of the ship.

1:41:40  
CDFW Broadcast: So let me just give you a quick, quick video of you know the the issue we're dealing with here.

1:41:46  
CDFW Broadcast: This video. You'll notice

1:41:48  
CDFW Broadcast: few several species of fish.

1:41:50  
CDFW Broadcast: the direction they swim in, and some of the some of the debris and plant material we expect to see in these videos. So

1:41:58  
CDFW Broadcast: you see several fish from different directions, you know. Gonna get the idea. We're gonna be faced with a challenge here with counting them automatically. Right?

1:42:05  
CDFW Broadcast: So let's state our issue all right. So our fish in our system, they exhibit stochastic behaviors in both the the speed and the direction in which they're swimming in.

1:42:14  
CDFW Broadcast: And as we continue samples sample continuously through these sites, we are subject to variation in turbidity, plant material and other abiotic materials moving past our cameras.

1:42:26  
CDFW Broadcast: And so can we actually develop a cutting edge solution that is capable of enumerating and classifying the fish, while we also leverage leverage our costs.

1:42:34  
CDFW Broadcast: processing the speed and the accuracy of our models.

1:42:38  
CDFW Broadcast: So why do we collect data? Why do we collect videos for for monitoring behavior.

1:42:44  
CDFW Broadcast: for stock assessments and a little more important to cream of fish science. It's to provide crucial data to evaluate the impacts of our restoration products. So we wanna collect video before you know the restoration control. And then you wanna collect video after right? And see how we did.

1:42:59  
CDFW Broadcast: And the video is automated, you know, to dramatically reduce costs in the overall time. In between the analysis. So at the time in in which we collect the data, and you know, analysts get the reports out the end.

1:43:12  
CDFW Broadcast: and it completely eliminates human bias and error in the video review process. So on the right, you see a chart.

1:43:17  
CDFW Broadcast: it's steep. But that the bar chart on the left is the total hours for one of our projects, where our our total human reviews for that entire year, for that one project which came up to be 740 h, and with an optimized end game, model

1:43:34  
CDFW Broadcast: counter, fish tracker. Doing this all by itself, we estimate over a hundred times 3 reduced time for that down to something like 7, right? Just running scripts, moving files around.

1:43:45  
CDFW Broadcast: So how are we going to do this? Well, step one. We get to detect where the fish are in the, in the, in the frame. So for that, we're going to use a detection model

1:43:52  
CDFW Broadcast: texture model will also give us the class of the fish or the species and the size of it. And then we need to reassociate detections between each frame right? Because all the detection model is doing is telling us how many frames have fish in them, and how many fish are in that frame, but they don't know if 2 frames. All the fish are actually the same from the previous frame. Right? So we count that way. We're an over count

1:44:11  
CDFW Broadcast: thousands of times, potentially.

1:44:13  
CDFW Broadcast: So we use a tracking algorithm? What that does is these are these features

1:44:18  
CDFW Broadcast: about the image.

1:44:19  
CDFW Broadcast: and it compares it to detection from the previous frames or 2 frames go, and it uses these, this association logic to say whether a fish is the same from a previous frame.

1:44:30  
CDFW Broadcast: So there's 2 detection models. There's there's 2 main types of detections. Detector models is a single stage.

1:44:37  
CDFW Broadcast: which is the one we'll be using, that I'll be using this project describing some more how this works is, it takes the input image.

1:44:43  
CDFW Broadcast: So that's just a screenshot from our video that I showed you. For on the left.

1:44:47  
CDFW Broadcast: simultaneously, this divides it into a grid

1:44:51  
CDFW Broadcast: and creates this probability mask, probability map you see in the bottom, so which cells are most likely to contain a fish that we trained a model on, and which class it is.

1:45:01  
CDFW Broadcast: So you can see it's got some different colors for the different species of fish there, and even the the plants getting picked up, too, but that might be at a low confidence. Right? So we'll filter that out and then it simultaneously. It's projecting these bounding boxes around the grids, and the model is to say.

1:45:17  
CDFW Broadcast: is then to say which of those several boxes best fits

1:45:20  
CDFW Broadcast: that? The object we're trying to detect right. And so you see, in the output to the right

1:45:26  
CDFW Broadcast: we have the the 3 fish in the in the frame are successfully identified and boxed up right. We have sunfish, bass, and then the other one's a fish. It's unidentifiable, unidentifiable. There's no features that really say which one it is.

1:45:39  
CDFW Broadcast: And our outputs. There in a text file is the class, you know, the XY of the centroid of that box. How high the boxes and how wide it is.

1:45:46  
CDFW Broadcast: and the confidence value of how? How sure our model is. This belongs to that class.

1:45:52  
CDFW Broadcast: The other detector is a 2 stage, right? So that last one, I said, works in one stage. It passes through that image divided up

1:45:59  
CDFW Broadcast: this other detector, the 2 stage. This I can explain.

1:46:04  
CDFW Broadcast: like I said, that zoop. That zooplankton camera is behind our go pros right?

1:46:08  
CDFW Broadcast: So that an image

1:46:10  
CDFW Broadcast: you'll see in the top left that the top left graph there. How this works is, it shoots a light

1:46:17  
CDFW Broadcast: back at a lens, and then what you get back is the shadows. So you're able to detect these really small objects which are bugs, and a lot of bubbles, too. If you look at the top right image.

1:46:26  
CDFW Broadcast: that that there in the middle is a copapod. And it's about using the conversion rate. It's about 11 pixels high, which converts to about 380 micrometers.

1:46:38  
CDFW Broadcast: You need these 2 step detectors detectors to get these really small objects. A drawback of the single stage is that it really misses these super small objects. So we gotta use these 2 different detectors in our 2 different systems. But really

1:46:53  
CDFW Broadcast: in order to get this data. But you can see in that bar chart the speeds

1:46:57  
CDFW Broadcast: right comparison. So the FPS is about 35, with a single stage, and for that multi stage where it, where it actually goes over the image and uses these features to say, Here's an object. And then that object is detected as its own image. Right? So it's gonna do that, it's gonna scan the image. And then hundreds.

1:47:13  
CDFW Broadcast: or maybe tens, hundreds, will get classified, whereas a single stage it does it all at once. So this is way faster. But you sacrifice so small image right?

1:47:22  
CDFW Broadcast: And it's a little more less accurate, but it works out very well for us for our project.

1:47:28  
CDFW Broadcast: Alright. So we have a single stage detector. Now let's get to some tracking algorithms.

1:47:33  
CDFW Broadcast: The 3 I'm gonna go over is Euclidean, Euclidean distance and IoU. Those are just just using the information that our tracker that our detector provides. So the bounding boxes and the centroids.

1:47:44  
CDFW Broadcast: the particle filter.

1:47:45  
CDFW Broadcast: which is a little more advanced, we'll get into it, and the deep sort algorithm.

1:47:48  
CDFW Broadcast: So for this, you need to understand your system to the best you can, the different motions, how things work, identify patterns and variances. And then you need to factor in how powerful your computers are.

1:47:58  
CDFW Broadcast: So Euclidean distance the algorithms to the right. You're taking geometry right? It's just a hypotenuse. I guess right? This is extremely easy to implement

1:48:07  
CDFW Broadcast: extremely computationally inexpensive. Right? You can do tens of thousands of these operations in a second on a good computer.

1:48:16  
CDFW Broadcast: But the cons, you know, it's completely detected dependent on those detections, almost every single frame. Right? We're just using that bounding box to either. Say, the centroid so close. So we'll say, yep, that's the same fish or the overlap in that box that we drew.

1:48:29  
CDFW Broadcast: How, how how much they overlap! We can say it's confident it's the same fish. But like I said, this will not work with multiple objects nearby. Id switches the model, saying it's one class one frame, another class next frame. It's just not gonna work. And when it goes behind objects or other fish, right? It's just fails and

1:48:47  
CDFW Broadcast: several areas there.

1:48:49  
CDFW Broadcast: Next thing we go was the particle filter. It's also called the Monte Carlo localization method. So this uses a lot more

1:48:58  
CDFW Broadcast: random sampling to sort of predict the future state of your, of your of your object, which is our fish here. So we're gonna use 1 one single one detection from a detector to initialize this. So it's the first step we're gonna initialize and propagate the particles. So we'll create

1:49:14  
CDFW Broadcast: 100, 200 particles.

1:49:16  
CDFW Broadcast: And then we're gonna apply to each of those particles sort of like this function that we expect

1:49:22  
CDFW Broadcast: the the function that we can

1:49:25  
CDFW Broadcast: apply the particles so that we'll project them into the next frame, where we think our fish is going to end up

1:49:31  
CDFW Broadcast: so we can use. We introduce a lot of randomness here because we're not sure whether this fish is fish is gonna end up in the next frame. Right? It's it may be it's under this boat. It may be scared not know where to go. So we use standard deviations. Min maxes. We really wanna try to predict the best. The more I'll be. Obviously, the more particles you create

1:49:50  
CDFW Broadcast: the better chance. You have that fish landing on it. But the more you know resources, you need your computer

1:49:56  
CDFW Broadcast: and the next frame, it's frame 2. Those are the same particles. But your fish

1:50:01  
CDFW Broadcast: landed, landed on the protocol successfully. We, we apply these similarity functions. So for images, you know, I like to use color.

1:50:09  
CDFW Broadcast: We compare histograms in some sort, so a histogram of an image is in the bins. You have pixel intensities. It shows you how frequent certain colors are in the image and using a distance function, we can say

1:50:21  
CDFW Broadcast: how well those particles match that fish from the frame before

1:50:26  
CDFW Broadcast: we drop the we assign, and then, and based off the how we assign waste to every single particle.

1:50:31  
CDFW Broadcast: and the ones the particles are low rates we kind of get rid of to save resources and the heavier weights we select, and then we re-sample these particles and you, and then in the next frame you can expect the fish may land on those red dots, and you see how we're tracking through these frames. Now.

1:50:46  
CDFW Broadcast: that just depends on you need one detection in the beginning and the rest of it does it itself.

1:50:50  
CDFW Broadcast: So this is highly robust and nonlinear movements and occlusions. So fish

1:50:55  
CDFW Broadcast: and does not depend, like, I just said on consistent detections. But it's difficult to implement and very difficult to tune. And this is very computationally expensive.

1:51:05  
CDFW Broadcast: So I've tried implementing that, you know.

1:51:08  
CDFW Broadcast: just decided to go with something else. Then we're at deep sort now. So this, gonna this is gonna depend on 2 major components, motion and appearance.

1:51:16  
CDFW Broadcast: Let me explain the motion. So the sort part of the word that's a this is a, this is an algorithm that's been around for a while using a lot of other tracking out applications. This utilizes the common motion filter

1:51:27  
CDFW Broadcast: to predict the bounding boxes in the future frames right?

1:51:31  
CDFW Broadcast: So where it's lost, you see in the bottom left this. Those blue tracks are successful detections, and then the smiley face comes, because behind it those red boxes are where this motion filter predicts that box is behind that

1:51:44  
CDFW Broadcast: that green face right? So eventually, when that blue box is a detection

1:51:47  
CDFW Broadcast: gets in a previous, in in a future frame, it uses that IoU overlap to say, Oh, that's the same fish that we were looking at before.

1:51:55  
CDFW Broadcast: And it's readied. And it's we don't double count that fish.

1:51:59  
CDFW Broadcast: And the appearance vector utilizes this feature extractor of the classification model and then calculates similarities between the detections. So how these neural networks work is, there's tons of layers. And each of those layers has these nodes, which is just

1:52:14  
CDFW Broadcast: 100 and thousands of questions, maybe.

1:52:17  
CDFW Broadcast: that are just knowledge of why, the features that you're seeing belong to a class. Right? So you you take a class studying you ID things of salmon you pick out.

1:52:27  
CDFW Broadcast: You know your features of the fins. Maybe this or that.

1:52:30  
CDFW Broadcast: You have that knowledge, but you're just looking at the features.

1:52:33  
CDFW Broadcast: That's what's happening here. You just take that part of the model where it extracts like the edges of the patterns, and don't ask any more questions. You just take any features.

1:52:42  
CDFW Broadcast: and you're comparing it to the detection from like a previous frame. So now you have this, these, vector this hyperdimensional space here to describe these features. And you're just comparing, using another distance formula to compare that to previous detection. So now we have

1:52:56  
CDFW Broadcast: sort of like the space that describes.

1:52:59  
CDFW Broadcast: Maybe the edges of this fish you can see here it collapses matrix into something smaller, more easy to use while still retaining the features of that fish. So we have the motion part of it, and now we have the appearance. And you sort of cake those 2 together. And now we have this

1:53:14  
CDFW Broadcast: this tracker model. Essentially.

1:53:16  
CDFW Broadcast: So we're gonna get into now is a little bit of results.

1:53:20  
CDFW Broadcast: This is the the detection single, the single single stage detection and most classes deeper than I just planned working in conjunction in that first video I showed you. While these boxes are red, the fish is not yet counted. It's not yet successfully tracked. It needs, you know, 4, 5, 6 of those in a row successfully to then call the fish, and I'll change the color of the blocks to blue once it's successfully tracked.

1:53:49  
CDFW Broadcast: So you see here. You know, the occlusions handle that sometimes it's not perfect. Some of these tiny, teeny, tiny fish get missed when there's a lot of detects at the same time. It's sometimes it's

1:53:59  
CDFW Broadcast: works a little.

1:54:01  
CDFW Broadcast: It misses some. But this does a pretty good job, as you can see of classifying and tracking these fish

1:54:06  
CDFW Broadcast: in this next video. I've slowed this down 3 times. This is like a 10 secondf clip.

1:54:12  
CDFW Broadcast: I mean a 3 second clip. But it's gonna be 10 s here. And it's gonna show you how well this works when there's just not a lot of pandemonium and chaos and plants. This works very successfully, and these fish are moving fast, like I said, this is slowed down 3 times.

1:54:38  
CDFW Broadcast: And so in that clip, specifically, it's, you know, it's over 99% successful there.

1:54:44  
CDFW Broadcast: So that's most of the results I wanted to share with you. We're we're still early in implementing this in the production phase. So I don't have a ton of, you know performance metrics of how it compares to, you know, human review

1:54:56  
CDFW Broadcast: over time. But we can expect surely to be rolling those processes it out to get this to get this built out and into production.

1:55:05  
CDFW Broadcast: So, looking ahead and we just retune, retrain, repeat till we're happy with something, and even then, you know, a new model may come out. So this is just a you know, a never, never ending iterative process. Really, we optimize these models. There's technologies. Now, you can trace over your model and all the weights you can apply. You can change to a

1:55:26  
CDFW Broadcast: like a lighter number format. You know it sacrifices a little bit of accuracy, but these makes these models faster. I want to automate the links. So we have 2 go pros that are in stereo. And using those 2 2 go pros. You can you can get automated links, and we want to upgrade cameras and upgrade our computers.

1:55:43  
CDFW Broadcast: Some acknowledgements, the Cramer Fish Group. There's a lot of folks, you know here working on that same platform project so big, thanks to all them

1:55:51  
CDFW Broadcast: and our

1:55:53  
CDFW Broadcast: and a few few groups we have funding us, and I'll take any questions from the audience at the point if it's no time.

1:56:05  
CDFW Broadcast: Sorry. Let's see.

1:56:15  
CDFW Broadcast: we have

1:56:19  
CDFW Broadcast: now. They were in order.

1:56:28  
CDFW Broadcast: Next, we have Grace Auringer from the UC Davis genomic variation laboratory talking about lampreys in California, mitochondrial, phylogenetic analysis reveals previously unrecognized lamprey diversity.

1:56:45  
CDFW Broadcast: Thank you. I'm excited to talk to you all here about lamprey. I will share the results of a project I've been working on with Mac Campbell, Pascale Goertler, and Mandi finger.

1:56:58  
CDFW Broadcast: So we used genetic phylogenetic analysis and found that we didn't know all we can know about the diversity of lamprey in California.

1:57:08  
CDFW Broadcast: So why should we care about these lamprey in California? They actually contribute a lot of benefits to their environment. During this larval phase, where they're burrowed into the sediment and filter feeding, they participate in a lot of nutrient cycling. They maintain stream bed conditions improve water quality. And then, as they mature into their juvenile and adult life stages, they're a valuable prey item and anadromous species.

1:57:34  
CDFW Broadcast: Deliver marine, derive nutrients much like other anadromous salmonids you're familiar with.

1:57:40  
CDFW Broadcast: Also, they're a subsistence food and cultural resource for a lot of indigenous communities across the west coast, including in California

1:57:49  
CDFW Broadcast: and a cultural resource. They're also an ancient lineage with a really unique research potential. This timeline here by critics shows just how old they are relative to dinosaurs, even they've been around for 450 million years and therefore serve a really unique research purpose in evolutionary biology and biomedical science.

1:58:15  
CDFW Broadcast: So there are some barriers to lamprey conservation and management, especially in California.

1:58:20  
CDFW Broadcast: We have limited knowledge about diversity, abundance and distribution.

1:58:25  
CDFW Broadcast: There's a lack of awareness in the broader community and and management entities.

1:58:30  
CDFW Broadcast: We have an inadequate historical data, and the data we do have is geographically and temporally fragmented and not species-specific.

1:58:40  
CDFW Broadcast: Additionally, there's taxonomic uncertainty. So there are a lot of questions about where species boundaries actually are within this lineage. And there's life, history, variation. Some are anadromous and some are freshwater, resident, and we don't know how that life, history, variation, should be classified as separate species or variants of of one species.

1:59:03  
CDFW Broadcast: Because all of this

1:59:05  
CDFW Broadcast: taxonomy that exists today has been primarily based on morphology. Genetics are a great tool to help us dig a little deeper and understand the diversity.

1:59:18  
CDFW Broadcast: So with that, said the overarching Project goal was to characterize lamprey diversity. And this is important because it helps that management goals, for example, if they're if they're migratory lamprey present, we have to allocate some resources towards fish passage amongst other things, whereas if we only have non-migratory lamprey, we might be able to allocate more resources to larval habitat.

1:59:43  
CDFW Broadcast: Additionally, as we all know, legit legislative frameworks require distinct population units in order to move forward with conservation action and to characterize this diversity is fundamental for all future research.

1:59:58  
CDFW Broadcast: So the first part of this was to identify currently recognized species present at each sampled location. And to do this, we use genetic species, id, and to do that, we use a method called DNA barcoding.

2:00:11  
CDFW Broadcast: We basically take DNA from individual lamprey and sequence it and compare it to a public database to come up with a species ID.

2:00:22  
CDFW Broadcast: Second, we wanted to compare the current taxonomy. You know these species classifications based on morphology? How does that compare to the genetic patterns that we see? So to do that we estimated molecular phylogenetic trees and performed what's known as molecular species delimitation analysis that just takes all the genetic data and parses it into species delimitation based on the genetic patterns.

2:00:51  
CDFW Broadcast: Last, but not least, we wanted to see how this diversity is distributed across the landscape. Do we see it kind of randomly found throughout the State? Or are these pockets? Are, are there pockets of diversity and specific regions?

2:01:05  
CDFW Broadcast: So first, I wanted to just give a little bit of overview of the study. These are our sample locations. I do wanna highlight that this study would not have been possible without a collaborative network of fish monitoring programs throughout the State. This project was made possible by opportunistic sampling. And we were able to collect samples from 19 sites across 15 sub basins

2:01:32  
CDFW Broadcast: all the lamprey er sorry. Most of the lamprey we collected were larval individuals, and at this stage all species look virtually identical. So it's not surprising that over 50% of the samples were unidentified even to the genus level.

2:01:48  
CDFW Broadcast: So we took a fin clip, extracted DNA and sequenced what's called the cytochrome B gene. You don't need to know anything about the gene. It is widely used for phylogenetics. And there are a lot of lamprey sequences for this gene in these publicly available databases, which is key for the barcoding approach we used

2:02:08  
CDFW Broadcast: to give you an idea of what we expected to find. These are the currently recognized species that we expected in the study area. I do. Wanna point out that these 2 species mark grayed out here. We don't know very much about. There are like there's for each of these, there's like one paper describing these species, and then they've never really been found or recorded again. And there aren't sequences in the database. So we're not gonna talk a lot about those 2 species. But I do want you to

2:02:37  
CDFW Broadcast: remember that there are 5 Entosphenus species described, and 3 Lampetra species described

2:02:45  
CDFW Broadcast: as you can also see here, there

2:02:47  
CDFW Broadcast: is diversity in migratory behavior and feeding behavior. Some are parasitic, some are not

2:02:53  
CDFW Broadcast: they are all speed species of special concern in California.

2:02:59  
CDFW Broadcast: Peter Moyle, and 2015 indicated that these are all species of moderate or high concern.

2:03:06  
CDFW Broadcast: To give you a little bit of a better visual of what these, what the species diversity, looks like. Here are the 3 migratory lamprey we find in California. They are different and body size, and they have different oral disk, dentition patterns that are the most diagnostic features to distinguish between them. But again, these features are only present in the adult stage.

2:03:28  
CDFW Broadcast: The rest of these species are freshwater, resident, brook, lamprey. They are non-parasitic, and their oral disks are a little bit underdeveloped. The teeth are less sharp, but again, these distinguishing features are only present in the adult phase.

2:03:43  
CDFW Broadcast: so to get into our first goal, which species are present at each sampled site. We use this method called DNA barcoding, and this utilizes mismatch and DNA. So mismatches and DNA sequences between individuals.

2:03:57  
CDFW Broadcast: And if you sequence

2:03:59  
CDFW Broadcast: a number of individuals at a gene that's long enough, you get a pattern that looks like this.

2:04:04  
CDFW Broadcast: and it starts to look like a barcode. So then you can scan that barcode, so to speak. Compare it to the database and identify what species is present.

2:04:14  
CDFW Broadcast: So these are our results. For Lampetra. In yellow, this is the expected range of Western river Lamprey, Lampetra, ayresii, and the black dots represent sites where we did indeed find that species.

2:04:28  
CDFW Broadcast: Similarly in pink salmon color. That is the distribution of Kern Brook Lamprey.

2:04:35  
CDFW Broadcast: and that single green.in the Kings River is the site where we found

2:04:40  
CDFW Broadcast: the Kern brook Lamprey.

2:04:42  
CDFW Broadcast: Similarly in entosphenus Pacific lamprey. The species you all probably are more more familiar with is the most widely distributed and most abundant sample that we found.

2:04:55  
CDFW Broadcast: All of the black dots, including these

2:04:58  
CDFW Broadcast: black outlined purple dots. In the Klamath are sites where we found Pacific Lamprey.

2:05:05  
CDFW Broadcast: Pitt-Klammath, Brooke, Lamprey were found at 3 Sites, and the Pitt River and Goose Lake, Basin, Lasson Creek.

2:05:12  
CDFW Broadcast: and then, last, but not least, the Klamath River Lamprey was found.

2:05:16  
CDFW Broadcast: as expected, only in in the Klamath.

2:05:19  
CDFW Broadcast: But I do want to point out that

2:05:23  
CDFW Broadcast: There is a significant range overlap between the Klamath River and Pacific Lamprey Pacific Lamprey.

2:05:30  
CDFW Broadcast: just highlighting that species ID is really important when we're encountering these lamprey in the field.

2:05:37  
CDFW Broadcast: so, to summarize, we found Pacific lamprey at 14 sites western River Lamprey at 7 sites, mostly in the Sacramento Basin and then these other 3 are known to have more geographically restricted ranges. So it's not surprising. We found them at 3, 2, and one site

2:05:57  
CDFW Broadcast: moving on to our second aim.

2:06:01  
CDFW Broadcast: We wanted to compare the current taxonomy to the patterns that we found.

2:06:06  
CDFW Broadcast: So again in Lampetra there are really 2 recognized species,

2:06:13  
CDFW Broadcast: 3 maximum. But there's debate. And it Entosphenus 5 recognized species.

2:06:19  
CDFW Broadcast: Now, this tree is really hard to look at. It's tiny, and I don't want you to really try to read it. But what I do wanna highlight is that within Lampetra we see these really deep, divergent branches. So there are distinct clades and a lot of genetic differentiation between these groups, while in Entosphenus you can see there's there. You don't really see any branching. Everything's really shallow. Everything's really closely related to each other. And

2:06:48  
CDFW Broadcast: I want to highlight that at the genus level these

2:06:53  
CDFW Broadcast: the taxonomy is accurate. So everything that we thought was Lampetra is indeed Lampetra, and vice versa.

2:07:01  
CDFW Broadcast: This this pattern is also highlighted in our genetic distance measures, which is shown in this heat map table. Here. Different lineages within Lampetra have this moderate salmon colored genetic distance, indicating that these lineages within this genus are really different from one another, while in Entosphenus.

2:07:23  
CDFW Broadcast: these really low levels of genetic differentiation show that even these distinct lineages are really similar to one another.

2:07:33  
CDFW Broadcast: So, looking a little more closely at Lampetra alone. Again. This tree is kind of challenging to read. I will make it simpler in just a minute. But this is where we did the molecular species delimitation. And these are our outputs. Here a unique color represents a distinct species that was indicated by this analysis. We use multiple methods. And the most highly supported outputs are shown.

2:08:01  
CDFW Broadcast: Another thing I wanna highlight is that we pulled in publicly available sequence data from a study done in 2012 by Boguski et al. To help cover some more geographic ranges that we weren't able to sample.

2:08:15  
CDFW Broadcast: So

2:08:16  
CDFW Broadcast: to simplify this a little bit. I've just taken that consensus color from the species. Delimitation results and indicated it on the tree here. So it's easier to read.

2:08:26  
CDFW Broadcast: so we have our 2 recognized oops species. The Western river Lamprey, and it seems that there are 2 distinct populations.

2:08:36  
CDFW Broadcast: on the north coast and in the central valley.

2:08:40  
CDFW Broadcast: And then what gets really interesting is when we look outside of these currently recognized species, we found that there are new species that have not been described. In Alameda Creek, in the Russian River and the Napa River in Clear Lake, and possibly in Paines Creek, although that was based on a single sample. So we need a lot more research in that area to validate those results.

2:09:06  
CDFW Broadcast: So

2:09:09  
CDFW Broadcast: the Russian River, Paines Creek and Clear lake samples were from a previous study, but these populations on the Alameda Creek and Napa River had never been sampled or indicated that there was morphological differentiation. So it was really exciting to find that there are these 2 new species in the broader bay area, that were previously unknown.

2:09:31  
CDFW Broadcast: In Entosphenus, things were a little bit more like what we expected. There are 3 currently recognized species indicated in gray, yellow, and orange. Here

2:09:41  
CDFW Broadcast: we attempted molecular species delimitation. But all the programs performed very poorly. The analysis basically failed.

2:09:51  
CDFW Broadcast: and they were unable to delimit the currently recognized species likely due to the high sequence similarity.

2:09:58  
CDFW Broadcast: So to put this on a map. We see throughout the central valley and on the north coast. We see Pacific lamprey, all genetically, very, very similar, and then we do see some distinct populations

2:10:13  
CDFW Broadcast: that are known as species, the Pitt-Klamath Brook, Brook, Lamprey, and the Klamath River Lamprey, but there's really low genetic differentiation, in fact, lower than what we would expect between species.

2:10:26  
CDFW Broadcast: we're a little short on time. So I'm going to breeze through this last bit. How the diversity is

2:10:31  
CDFW Broadcast: distributed across the landscape is actually similar to these

2:10:36  
CDFW Broadcast: patterns of native fish diversity that have been observed in other lineages.

2:10:41  
CDFW Broadcast: These are zoo zoo geographic provinces. Defined by Peter Moyle in 2002 and if we overlay our results on top of this we can see that in Lampetra there's actually more diversity in the central valley than expected, based on these patterns observed in other fish taxa. It is the largest. So maybe it's not too shocking.

2:11:02  
CDFW Broadcast: But other than that there are lineages

2:11:06  
CDFW Broadcast: and like in the north coast,

2:11:09  
CDFW Broadcast: that we expect, and in Clear Lake that are distinct and follow other fish taxa patterns.

2:11:16  
CDFW Broadcast: In Entosphenus we see even more

2:11:20  
CDFW Broadcast: and even the lamprey follow even more closely the pattern, the pattern we see in other native fish taxa in the Pit River and Goose Lake Basin. There are distinct populations, as well as in the Klamath, not in the North Coast.

2:11:35  
CDFW Broadcast: but again, that's not too shocking.

2:11:37  
CDFW Broadcast: So to to conclude. There's really high lamprey diversity in California, I think most people know about the Pacific lamprey, but don't really know about these other species.

2:11:47  
CDFW Broadcast: Multiple species co-occur at many sites. And we see really high genetic differentiation. Lampetra, low genetic differentiation in Entosphenus, and the current taxonomy is not sufficient to describe all of this diversity. And the geographic distribution is similar to other native fish taxa.

2:12:07  
CDFW Broadcast: My time is up. So thank you. Everyone. Feel free to take a picture and ask me questions via email, since we don't have time here and thank you all for coming and listening.

2:12:24  
CDFW Broadcast: Thank you, Grace. We all love our lamprey friends.

2:12:30  
CDFW Broadcast: Next, we have Levi Lewis from UC. Davis talking about otolith-based insights and management implications

2:12:40  
CDFW Broadcast: or Delta smelt.

2:12:46  
CDFW Broadcast: Thank you. Finally, a smelt talk. Yeah. Oh, back to smelt my name is Levi Lewis. I'm the director of the Otolith geochemistry and Fish ecology Laboratory at UC Davis. We use otolith-based tools to look at the life, history, traits, demographic traits of invader fishes, and we also do surveys of fishes and wetland habitats

2:13:05  
CDFW Broadcast: today. What I'd like to do is provide you with a high level overview of a bunch of work that we've been doing off using otoliths to better understand Delta smelt demographic traits. And the what I really wanna try to achieve is to talk about what we found. What does it mean? And why it might matter.

2:13:22  
CDFW Broadcast: First, I wanna acknowledge a lot of my co-authors that are up there. There are many other individuals that have contributed to this work, and I just can't list them all funding came from the US Bureau of Reclamation, the directed outflow program for projects and the specimens came from US fish and wildlife service EDSM and CDFW.

2:13:38  
CDFW Broadcast: And I'm sure I'm missing people. But those are the main folks involved in this in these studies.

2:13:43  
CDFW Broadcast: So you know a lot about Delta smelt already they have a young one year life cycle. They've been described as anadromous migrants within this estuary system in the upper part of the SFE. However, distribution data suggests that maybe that's not quite right, and we'll touch on that more in a moment. This small anadromous fish was one of the most important components of this pelagic food web, and it is no more.

2:14:03  
CDFW Broadcast: So now it's critically endangered, due to many different possible factors. I won't list them all, but they're shown there. One of the main one of the ones of main concern that we deal with in this group are the effects of water exports, and it's been really important to try and think about how exports are interacting with all the other stressors to cause the decline of this fish and what we can do to try and stabilize and reverse it

2:14:25  
CDFW Broadcast: also. This has created conflict, both locally and even nationally, with Delta smelt showing up on fox news and the halls of Congress, and even spewing from the lips of past Presidents. And so the agencies and managers have really been trying to get a better grasp on the ecology and biology of this fish in order to be able to provide new tools that we can use to provide water to agriculture, industry and municipalities, while also trying to protect

2:14:51  
CDFW Broadcast: our natural heritage. Delta smelt live nowhere else. They are California.

2:14:56  
CDFW Broadcast: So

2:14:57  
CDFW Broadcast: there's been a lot of funding going into various different ways to do this, looking at distributional data and environmental data doing live experiments with cultured fish and what we've been funded to do over the last.

2:15:08  
CDFW Broadcast: The first Delta smell paper came out in 2007, but recently with the DOP over the last 5 years, is to use otolith-based tools to really understand what's going on in the wild population.

2:15:19  
CDFW Broadcast: So before we do that, we had a develop methods. And I'll just briefly show what that looks like so

2:15:25  
CDFW Broadcast: sorry. I think I double clicked there.

2:15:28  
CDFW Broadcast: Anyways. So we've used a a variety of different validation studies partnering with a fish conservation culture laboratory. This is a result of one of those validation studies where we received a bunch of known age Delta smelts. And we looked at how well could multiple different agers, many of them undergrads, but trained. How well they could reconstruct the known age! Of the fish, and you can see that line is pretty tight, and our accuracy and pursuit was pretty good. So we're pretty comfortable that the otoliths are providing

2:15:53  
CDFW Broadcast: really good age data on Delta smelt. What about growth rates. Well, we can also use the increments in otoliths and those increments. Can the increment widths can tell us something about growth. But we want to confirm that that's actually true. We can experiment. We can see the pictures above where we had fed fish and unfed fish, thus forcing differences in growth rate.

2:16:11  
CDFW Broadcast: And we looked at when we were able to detect that using otolith-based techniques. And so in this figure, you see the difference between fed and unfed treatments, and for the first 150 days you don't see really any major differences. And out of the 153 days when we imposed those feeding restrictions would see a dramatic change, and the growth rates of the otoliths in those fish which corresponds with the changes in the growth rates of the actual fish themselves.

2:16:34  
CDFW Broadcast: and also using odalis to track migration. We use geochemistry. I won't go into the into the details here. I'm showing strontium isotopes, and in the left plot. That's how strontium isotopes which are on the X axis vary in relation to salinity in the water, and we can use that to generate the model on the right, which allows us to examine how the salinity, the known salinity on the X axis corresponds to the estimated salinity on the y axis, and you can see that the error and or the confidence

2:17:00  
CDFW Broadcast: the error goes up and the confidence goes down in salinity estimates as we get above 6 to 10 ppt. And so we're really focusing on low salinity habitats, which is perfect, because that's where Delta smelt live.

2:17:11  
CDFW Broadcast: So we did an experiment where we had fish in the FCCL. And we've manipulated salinities. We had a treatment where Fisher at 0 PPT. And another group that moved to 3 PPT. And 6 PPT. And then we looked at how well we can reconstruct those salinities of those fish with their known histories, and, as you can see, it's pretty good, and not only that, but the timing of that first transition from 0 to 3. Again, in the low salinity transition, we got to it within 6 days. So

2:17:34  
CDFW Broadcast: I hope that those methods development studies that's a body of work on its own. But I hope that it convinces you, as it has convinced me, because I'm very skeptical that these tools are actually pretty good for looking at Delta smelt traits.

2:17:46  
CDFW Broadcast: But that's not really what I wanted to talk to you about what I really wanted to focus on is the application of these tools to better understand the wild population.

2:17:54  
CDFW Broadcast: So with respect to growth, we found that growth in wild Delta smelt is quite sensitive to environmental variation, and this confirms expectations from a bunch of different laboratory-based studies with cultured fish and distribution studies based on all the surveys.

2:18:07  
CDFW Broadcast: That folks have been talking about in these sessions. So with respect to temperature, we found that growth declines, maybe even at lower temperatures than we would expect at 18 degrees Celsius, we found that fish that are in brackish conditions are growing better than fish that are in freshwater conditions, and again, that supports

2:18:22  
CDFW Broadcast: several other studies, include, including others of ours, and fish are growing better when it's turbid. So when clarity is low, none of this is actually surprising. But what's really interesting is that this is the first time we demonstrated these hypothesized results in the wild population.

2:18:38  
CDFW Broadcast: We've also examined phonology or the timing of events in a population. And the way we did that is that we use the hatch date.

2:18:46  
CDFW Broadcast: Oh, sorry, no! We use the capture date, and we subtracted the age of the fish to get the hatch date. And then we looked at the patterns in the median hatch dates of multiple cohorts, and how that relates to environmental conditions specifically winter temperature. So on the X-axis, I have winter temperature, and on the Y axis I have the Median hatch date of an individual of each of multiple cohorts of Delta smell across different years, and the Hatch State span from roughly march at the earliest to maybe early June.

2:19:12  
CDFW Broadcast: and what we found is that hatch date is strongly, significantly correlated with winter temperatures, and so phonology, like growth, is sensitive to variation in environmental conditions, sensitive to environment and variation in climate.

2:19:27  
CDFW Broadcast: We've also been using olive geochemistry to retrace the life history of these fish. This first plot shows just the distance across an otolith. So that's the life history of a fish from birth until death.

2:19:39  
CDFW Broadcast: and the Y axis is showing the strontium isotope ratio, and you can see there's quite a spread of different patterns indicating that this fish is doing a lot of different things. We can use some classification tools to separate those out into at least 3 different life histories which are migrants or MIG fresh water residents FWR. Brackish water residents BWR.

2:20:00  
CDFW Broadcast: and so Delta smelt has a portfolio of behaviors that it uses. It is not just a migratory fish that moves from fresh water to salt water like a salmon, or like a a steelhead or

2:20:14  
CDFW Broadcast: as Vanessa pointed out, or a steelhead

2:20:16  
CDFW Broadcast: Delta smelt are really staying up in that estuary and doing lots of different things up in the upper estuary.

2:20:21  
CDFW Broadcast: And so this is what we're kind of proposing of the Delta smelt life history. And I'll I'll mention why that matters, and how it relates to our understanding of of

2:20:29  
CDFW Broadcast: life history, nomenclature shortly

2:20:32  
CDFW Broadcast: but not only that. What we've also found is that the relative proportion of those different life histories varies significantly across years, and not only does it differ or vary interanually, but it varies inter-annually

2:20:44  
CDFW Broadcast: in relation to the environmental conditions or the climate of that year. This is the result of a multinomial logistic regression which was looking at the relative proportions of the different life histories across years as a function of 2 main environmental drivers, one flow and 2 delta temperature, and on the left plot it shows the proportion of fresh water resonance. And where that high peak is, that's

2:21:08  
CDFW Broadcast: about 50% of the population being freshwater residents that occurs when flow is low and temperatures are really cool.

2:21:15  
CDFW Broadcast: and we see the opposite pattern with migrants. When you have really high outflow and really warm water. You get more migrants.

2:21:22  
CDFW Broadcast: I can explain in depth why we think we're finding that I don't have time, but I would love to talk more about it. Not only are we finding that climate is driving life history, but we're also finding that those life history patterns when we combine it with genomic data from the genomic variation lab. Specifically, Mandi Finger and Matthew Campbell, we find that the life history patterns are genetically linked, and we can use the genome of the fish to classify an individual into a migrant or freshwater resident with 95% confidence.

2:21:50  
CDFW Broadcast: So these are not just random life histories. But there seems to be some sort of potential heritability tied to this.

2:21:56  
CDFW Broadcast: And last, not only are we seeing that, but we're also finding that the life history determines the fecundity of these fish and the size of these fish and the growth rates of these fish.

2:22:06  
CDFW Broadcast: So, for example, this is work by my postdoc, Letisha Kovale, who isn't here because she's moving back to Brazil now, but I'm sure she's here in spirit, and hopefully she's listening. She's done a wonderful job working with Bruce Hemets Lab and Sweet Tay's lab to examine how life history relates to the fitness of a fish, and what these data are showing is that fishes that are rearing in saltier or brackish conditions for most of their lives, or migrating down to those habitats have higher body mass.

2:22:33  
CDFW Broadcast: They have higher gonad mass, and they have much, much higher fecundity.

2:22:40  
CDFW Broadcast: So

2:22:41  
CDFW Broadcast: life history is also directly tied to fitness.

2:22:46  
CDFW Broadcast: Okay, as I mentioned, those are all very high level kind of overviews of that body of work.

2:22:52  
CDFW Broadcast: Basically, what I want to focus on is that these data are really emphasizing the sensitivity of this fish to climate.

2:22:58  
CDFW Broadcast: And these data are really emphasizing the potential genetic component to that life history, variation, and how it influences the fitness of Delta smelt. And to my knowledge, and I'm happy to be corrected. I don't think any of this information has has really been incorporated into any of our models or our efforts to manage this species.

2:23:19  
CDFW Broadcast: So now I'm gonna get into the dangerous part of this talk was just to start musing about what I think personally. And these are just thoughts don't hold me accountable. I know it's being recorded. These are really my musings and some ideas to hopefully. So, you know, spurn some additional conversations about what we can do to protect this fish. So first.

2:23:39  
CDFW Broadcast: the first theme is about Delta smelt life, history, and habitats like what does it need, and the first is just a nomenclature.

2:23:48  
CDFW Broadcast: I would argue that Delta smelts should not be called anadromous, or even semi-anadromous. They're really different from a longfin smelt. As Vanessa pointed out, so we shouldn't be grouping them together.

2:23:59  
CDFW Broadcast: They do something different. And they also have complex life histories, and we should really say it and acknowledge it when we're talking about this fish.

2:24:07  
CDFW Broadcast: So in the literature.

2:24:09  
CDFW Broadcast: they might be called a freshwater estuarine opportunist really emphasizing that freshwater linkage which is why they're so susceptible to what we do in the Delta. Right?

2:24:17  
CDFW Broadcast: And if you look at our new conceptual model for Delta smelt in terms of their life history, you can see those 2 look quite similar.

2:24:27  
CDFW Broadcast: 2

2:24:29  
CDFW Broadcast: we really need to think about the likely importance of freshwater habitats. I know I don't need to say that to this group.

2:24:34  
CDFW Broadcast: but really emphasizing that just the migration itself is not the only thing keeping this population around the fresh water resident component of this population over evolutionary time, likely was really critical for its long term survival. We know that that's true for other fishes like lamprey, and we know that's likely true by other fishes like Steelhead. And that's probably an important component of of the life history of Delta smelt.

2:24:57  
CDFW Broadcast: and therefore the loss of habitats in the Delta, which in large part have been kind of ignored and their year round impact might be under appreciated. Because we assume they're leaving. And they're migratory.

2:25:10  
CDFW Broadcast: Okay? And then the third part of this theme is that we might have some issues of shifting baselines, or what they call ecological amnesia. With respect to what this fish does and what it needs. So everything that we know about Delta smells is based on the last 60 years, maybe even more last 20 years of data collection. But this fish has been around for a long time, and the conditions at which we're studying this fish are really different than the conditions under which it evolved.

2:25:35  
CDFW Broadcast: And so the so the ecological and life history strategies that it used may be maladapted. Now to what's happening, and our understanding of what it needs may also be a little bit a little bit misplaced. So, for example, what we know has been during this period of incredible warming

2:25:50  
CDFW Broadcast: and

2:25:51  
CDFW Broadcast: But prior to that, Delta Smelt had 4,000, many more thousands of generations in a completely different system. Again, where it was cooler.

2:26:00  
CDFW Broadcast: and there might have been a huge portion of freshwater residency that was adding stability to that population.

2:26:06  
CDFW Broadcast: Okay? And then the next theme is that climate change is the major problem. I do not need to belabor this point. But the key thing I wanna note is that I don't think there's a future for Delta smelt without addressing it directly.

2:26:17  
CDFW Broadcast: Growth, fecundity, life history, and fitness are all affected by this and that we probably need big, bold options and actions to deal with it. Including temperature management, assisted migration which has been described, and which has saved Sacramento perch and, Lahontan cutthroat a trout and has been described by TJ Lawyer many times, and even assisted evolution as I believe Joanna even talked about.

2:26:40  
CDFW Broadcast: And then the third is that life history, diversity is really important. We know that's true for many other species, and that in the Hatchery, we're currently producing 100% freshwater residents and then putting out putting them out in the environment. Whereas 80 to 90% of the wild population was migratory.

2:26:55  
CDFW Broadcast: That's the life history that it actually used, and that mismatch between conservation and ecology is something that we should probably talk about. We also have mismatches and phenology that we should discuss, and we should be concerned, because now there's directional selection every year, away from the dominant, the fittest, and the most fecund life history. And I don't know if that's really being discussed.

2:27:16  
CDFW Broadcast: And I just mentioned how awesome migrants are.

2:27:19  
CDFW Broadcast: So I'm gonna stop here. I know my time is short, and these are kind of those conclusions just summarized yet again, and I'm happy to leave it up. If we have time for questions

2:27:34  
CDFW Broadcast: the meeting, but

2:27:38  
CDFW Broadcast: we have one here. And then, yeah, happy to

2:27:44  
CDFW Broadcast: thanks for the talk. Levi. I was just confused a little bit by that last point. If the

2:27:50  
CDFW Broadcast: migratory strategy is somewhat heritable, how? How can we say that a hundred percent of the Hatchery fish.

2:27:58  
CDFW Broadcast: our fresh water residents. That's a really good question. And we have to talk about phenotypes and genotypes right? 100% of the hatchery fish that are being released have a fresh water resident phenotype, because that's how we rear them in the hatchery, and over time you can select out migratory genes if you push that and you have an annual fish every single year. That was, yeah, thank you for that clarification. Do we have time for more

2:28:23  
CDFW Broadcast: I was a little uncertain what your winter temperature is, and also your flow. So is it water, temperature, air, temperature? What is the period of the winter? And what were the units on your outflow?

2:28:41  
CDFW Broadcast: Yeah, that's a really good question. So we used for that study. We've done a couple of different analyses. For that study, if I recall correctly, we use the winter temperature index, which is a mean delta temperature, based on a series of selected sondes over the winter period, such as, like December, January, February, March. If I call, recall correctly and similar with flow, we are using a summertime migratory flow which was later on in the live history. I can send you the paper, if you if you'd like to see it. But I know we're short on time. Thank you.

2:29:18  
CDFW Broadcast: Thank you.

2:29:20  
CDFW Broadcast: Next we have Jonathan, Walter from UC Davis talking about environmental drivers

2:29:27  
CDFW Broadcast: of fish populations in Central California.

2:29:36  
CDFW Broadcast: Beautiful. Thanks very much. My name is Jon Walter. I'm a relatively newly minted PI in the watershed center at UC Davis. And I am a statistically ecologist. I use data, science, mathematical modeling statistics to better understand the dynamics of aquatic biodiversity and ecosystems.

2:29:59  
CDFW Broadcast: So to briefly contextualize the work I'm going to share with you today, there's deep concern for fish populations in California. I think the the many talks at this workshop helped. Bring that to the fore. But in this context there's been a lot of attention paid to a handful of species that are really already known to be in pretty dire straits.

2:30:20  
CDFW Broadcast: But we also have, if you know, in part driven by those

2:30:25  
CDFW Broadcast: conservation concerns, have these long running investments in monitoring that provide valuable data on many other species whose dynamics and environmental associations are not so well documented. Although I do wanna acknowledge that there's often internal knowledge of some of these species and data sets that isn't always well reflected in the published literature. And as someone kind of new to this system.

2:30:50  
CDFW Broadcast: I'm learning about that. And we'll continue to learn more, I think. As I get deeper into this role.

2:30:58  
CDFW Broadcast: so the objectives for this study. Was that for for a suite of 21 relatively common and abundant fishes, we wanted to characterize some long term interanual patterns in recruitment

2:31:12  
CDFW Broadcast: wanted to evaluate how those patterns are related to a range of environmental variables that are representing putative drivers of populations in the system.

2:31:22  
CDFW Broadcast: And we also wanted to quantify how different data sources relate to the modeled patterns as a means of better understanding, how different monitoring programs that have different designs and objectives actually contribute to providing complimentary or contrasting information about these populations.

2:31:43  
CDFW Broadcast: So for data we used a selection from this product that was developed by the Bashevkin and colleagues a nice example of how the IEP has produced publicly available data that can support a lot of interesting work, and there was a huge lift to do all of this work, I'm sure. So thanks for that.

2:32:07  
CDFW Broadcast: So we focused in this study on some of the the 4 longest running programs

2:32:14  
CDFW Broadcast: and use that to produce 1980 to 2020 time series of annual fall age -0 abundance. We use this as an index of recruitment.

2:32:26  
CDFW Broadcast: And for each species we analyzed aggregated time series for unique region monitoring program and sampling method combinations where those sort of combinations provided adequate data

2:32:41  
CDFW Broadcast: to be used in model fitting.

2:32:45  
CDFW Broadcast: So along the way we developed a set of maximum length, thresholds for age-0 fish, by species, monitoring program and month. Although there are some existing thresholds and and knowledge of this available the ones that we could access didn't cover the complete set of species that we wanted to consider in this work.

2:33:04  
CDFW Broadcast: So we went ahead and developed our own, based on a combination of information, including some existing thresholds that were used by the base study

2:33:14  
CDFW Broadcast: interpreting histograms like you see behind me. And then a quantitative technique called normal mixture modeling.

2:33:21  
CDFW Broadcast: And then, just to provide an example. For this starry flounder using base study data in the month of November. We could

2:33:31  
CDFW Broadcast: kind of set our threshold at this trough in between peaks in this length. Frequency. Histogram on this has a nice clear by modality, of course not. All of them were quite so clean.

2:33:46  
CDFW Broadcast: But just to give you an idea of of how this sort of thing works.

2:33:50  
CDFW Broadcast: And then here a time series for this set of environmental covariates that we considered delta inflow was included to represent sort of an aggregate of some upstream conditions, and might be especially important for some more fresh water associated species in this, in this pool

2:34:07  
CDFW Broadcast: several variables that were supported by various

2:34:12  
CDFW Broadcast: programs for environmental monitoring

2:34:16  
CDFW Broadcast: represent different delta and estuary conditions. And then we also included some a pair of coastal ocean

2:34:26  
CDFW Broadcast: variables, and these are included because some of these species are also using marine habitats, and, as we know from some prior work by Jim Klern and others, there is some pretty strong correlations, especially near the mouth of the bay, between ocean conditions and the estuary conditions.

2:34:44  
CDFW Broadcast: So we analyzed these data using multivariate auto regressive state space models. I'm gonna like

2:34:51  
CDFW Broadcast: totally gloss over the maths here. But just to kind of unpack some of the key features of this approach.

2:34:58  
CDFW Broadcast: multivariate just reflects that our response data are multidimensional, these being time series from different combinations of region monitoring program and sampling method. And we considered these to be independent records of overall population trends

2:35:16  
CDFW Broadcast: autoregressive. Just means that the values of our response variable. This age, 0 abundance index depend on prior values.

2:35:26  
CDFW Broadcast: And then state space means that we had explicit models of both fish population change and the observation process. And and really explicitly modeling the observation process helps us to deal with variation that's associated in different practices between the monitoring programs. That isn't really explaining the dynamics of these populations.

2:35:51  
CDFW Broadcast: And then, we use information theoretic model selection methods to tell us which environmental, variable or no environmental variable from the that candidate set that you saw previously. Best explain the dynamics of each species.

2:36:08  
CDFW Broadcast: So finally, when it gets to some results here. So here are some model trends in age-0 abundance for the 21 species that we successfully modeled, and these represent a a single trend shared across regions where there was sufficient data to model them.

2:36:26  
CDFW Broadcast: Oh.

2:36:28  
CDFW Broadcast: and then these are also organized roughly, so that more marine associated species are toward the top of this graph, and then more fresh water associated species are toward the bottom.

2:36:40  
CDFW Broadcast: And then significant. Increasing trends are in blue and significant decreasing ones are in red. So one thing that probably stands out to folks is the preponderance of species that inhabit more marine to brackish salinities.

2:36:56  
CDFW Broadcast: and one other thing that's sort of of comfort here is that our approach to handling these data. First, some of these better known better studied species like stripe bass, like Longfin, smelt like delta smelt show long term trends that accord well with what we expect. So we probably haven't done something really stupid with these data.

2:37:22  
CDFW Broadcast: This figure summarizes how each of these species are related to environmental drivers.

2:37:28  
CDFW Broadcast: we considered models with no or one environmental driver. The color in this heat map indicates the aic weight, and this can be interpreted as the probability that a model is best in its group.

2:37:42  
CDFW Broadcast: and the top model for each species is identified with a star. If the no covariate model outperformed all the others. I'm sorry this figure is looking a bit darker on the screen. It's a little bit more difficult to read.

2:37:58  
CDFW Broadcast: but the there are plus or minus signs indicating the direction of the relationship with the top covariant.

2:38:07  
CDFW Broadcast: A few highlights that I wanted to to raise from this. So what are temperatures in the Delta where the most commonly selected top covariate, and across all of those species

2:38:19  
CDFW Broadcast: they were negatively associated.

2:38:22  
CDFW Broadcast: With with warmer water temperatures.

2:38:25  
CDFW Broadcast: If we look at that time series for Delta water temperatures, we we don't really see strong long term trends in those data. But if you do think about the impacts of climate change,

2:38:40  
CDFW Broadcast: we can expect warmer atmosphere conditions, possibly also, periods of of lower flows and all else being equal, we would expect those things to translate to warmer water temperatures.

2:38:52  
CDFW Broadcast: So I think this result really in reinforces concern for what the fish assemblage may look like in the future.

2:39:00  
CDFW Broadcast: One other point plenty of previous previous work has documented increases in water clarity and lower pelagic primary production in the system, and this analysis suggests mixed effects on different species.

2:39:14  
CDFW Broadcast: And then, lastly, we did see some statistical relationships where there is not a plausible, direct, mechanistic effect. And notably this is this trio of more freshwater associated species that were statistically related to ocean variables. This is likely explained through relationships between ocean conditions and large scale climate that also impact inland aquatic habitats.

2:39:37  
CDFW Broadcast: And it's also a good reminder that this is a correlative study with those kind of inherent limitations to it.

2:39:46  
CDFW Broadcast: The last piece of results I want to share is this figure that represents the correlation between the modeled Age 0 abundances and the unique input time series from different combinations of data source sampling year and region and white indicates a combination that wasn't used due to insufficient data.

2:40:08  
CDFW Broadcast: The blues indicate positive correlations. And the red indicates negative correlations. And the big takeaway. Here is the preponderance of blue in this figure.

2:40:19  
CDFW Broadcast: And this indicates consistency among data sources in the representation of inner annual variation and recruitment

2:40:28  
CDFW Broadcast: to kind of begin wrapping these results up. We see a diversity of positive and negative trends, and this is kind of consistent with a reorganization of the fish assemblage. And these were also shared among native and non native species about in proportion to their prevalence in this this data set.

2:40:45  
CDFW Broadcast: That diversity of trends was also underpinned by a diversity of relationships with environmental drivers. And we didn't really see evidence that species that shared a driver exhibited similar long term trends.

2:40:58  
CDFW Broadcast: But we did see many, many species negatively associated with Delta water temperatures, and this is likely a key variable to think about considering climate change.

2:41:09  
CDFW Broadcast: And then, lastly, we saw the different monitoring programs and gears. We're generally providing consistent information about fluctuations and trends. It's not necessarily the case for true abundances. We know that different years have different biases, but for interannual variability they tend to track each other in consistent ways, at least for this set of species.

2:41:30  
CDFW Broadcast: There were a number of species, a handful of species. That sort of met our criteria for commonness and abundance, but weren't successfully modeled, and

2:41:40  
CDFW Broadcast: in general these were species where there was greater disagreement between different regions, different gear types in what those

2:41:50  
CDFW Broadcast: populations were doing. They didn't fit very well the assumptions of our modeling framework, and so we we left them out.

2:41:58  
CDFW Broadcast: But that's one caveat. So our next steps for this work are to quantify potential indicators of instability of these populations. It'd be a real benefit to know what species are at the risk before their populations exhibit signs of crashing

2:42:16  
CDFW Broadcast: and traditional methods for doing that. Like population viability analyses, and some of the modeling efforts that you saw presented on earlier require data that aren't really available for many of these lesser studied species.

2:42:32  
CDFW Broadcast: and the gears that we use in these programs are generally best for small or juvenile fishes. Leaving out information about the

2:42:42  
CDFW Broadcast: the larger and older fish. So we're gonna apply a selection of some generic statistical indicators of stability, and regime shifts as an alternative approach to investigating risk of collapse. Given these available data, and one example of this is seen at the bottom of this slide

2:43:03  
CDFW Broadcast: is for longfin smelt

2:43:06  
CDFW Broadcast: on the bottom is a population trend, I believe, from fall midwater trawl data.

2:43:13  
CDFW Broadcast: and on the top, in blue is a time series of the lag. One autocorrelation coefficient.

2:43:23  
CDFW Broadcast: And this is one of these generic stability indicators with increases potentially indicating loss of stability. We see this ticking up as we see populations of of longfin tracking down.

2:43:37  
CDFW Broadcast: So that's all for now. Thank you very much for listening especially for CDFW for funding so folks that can provide feedback on earlier versions of this work. And I think I might have like a hot second

2:43:52  
CDFW Broadcast: cool. Thank you very much.

2:44:14  
CDFW Broadcast: I'm sorry if I missed this. Were you only looking at the fall months?

2:44:18  
CDFW Broadcast: Okay, are you at all concerned that there's a lot of seasonal variability

2:44:25  
CDFW Broadcast: like a ton of seasonal variability. And so I think, if you wanted to expand on this, you should look at

2:44:31  
CDFW Broadcast: trends throughout the year, especially there are many species that are young in the spring.

2:44:37  
CDFW Broadcast: Yeah, thanks thanks for that. Yeah. Certainly. That's the case. There's a good deal of of variability we wanted to focus on the the fall months.

2:44:50  
CDFW Broadcast: and restrict this to, you know, age 0 to try and to try and control sort of control for that, to have sort of one common thing that we could apply across. Species, of course, is the case that it's not gonna be ideal for every species in this set but was an attempt that we made to try and get something that could be comparable across a broad set of species. But yeah, thanks for that

2:45:17  
CDFW Broadcast: cool thanks so much.

2:45:31  
CDFW Broadcast: Thank you, Jonathan. Lastly, we have Scott Meyer talking about biofouling impacts to field enclosure studies on Delta smelt

2:45:44  
CDFW Broadcast: alright. Thanks for tuning in. I'll promise to keep it short so we can all get to lunch.

2:45:50  
CDFW Broadcast: but thanks for tuning in. I'm Scott Meyer. I'm with DWR. Today. I'll be presenting the work that we did on the effects of biofouling on field enclosures, on Delta smelt.

2:46:00  
CDFW Broadcast: So I'll start off with a quick introduction of the field enclosures themselves. So these enclosures were designed by the fish Physiology lab at UC Davis to conduct in situ experiments with Delta smelt. So. This process was pretty in depth. Everything, from

2:46:14  
CDFW Broadcast: the mesh size to the angle of the floats was considered when and when making these, and so we we got the enclosures, and we started using them. And over time we started to observe something that kind of concerned us, and that might be like confounding the effects of the work that we do, and that was bio fouling.

2:46:33  
CDFW Broadcast: So what we're calling biofalling is just this build up of organic material on the enclosures, mostly made up of algae and macro invertebrates, so a big concern would be like that. The algae is growing on those enclosures and causing water like keeping water from coming, exchanging in and out of the enclosures so that could affect the water quality and the the ability of the smelt to be in there also. All of those macro invertebrates that grow.

2:46:58  
CDFW Broadcast: that algae we were concerned that the smelt would be picking those off and eating those, and that's subsidizing their diet and keeping them healthy, and something of that otherwise shouldn't be the case.

2:47:09  
CDFW Broadcast: So we set out to investigate that biofouling. And with these kind of research questions in mind. So first off, we wanted to see if we're even able to eliminate or reduce the biofiling in the field. So this is a problem in the summer, in the fall, in the winter this biofiling really doesn't grow, but in the summer fall it can go pretty quickly, so you know, we can't go out there every day and clean up these cage enclosures. And so we wanted to make sure that we're able to do this feasibly.

2:47:36  
CDFW Broadcast: And then the second question was that do the smelt held in the enclosures exhibit a difference between 2 different field sites so like a big question that we wanna use with these enclosures for is to answer like, if the smelt are able to respond

2:47:54  
CDFW Broadcast: response from the Delta smelt held in the enclosures. Is that so like, if we see a difference in the condition of the smelt, is that because of the bio fouling, or because of the habitat and location that they're being held at. And so we wanted to use 2 different field sites to test that out.

2:48:10  
CDFW Broadcast: And so our first method here is to come up with 2 techniques to test out. So our first was to just scrub the enclosures every week. So it's pretty simple. We never thought to take any pictures, so I don't have any fun graphics. But we just went out every week and we scrub the outside of each enclosure. We didn't scrub the inside because we would. Didn't wanna like cause undue harm and stress to the smelt.

2:48:33  
CDFW Broadcast: And then the second was to replace the enclosure. And we are calling this the flip method. So what this looks like in the field was attaching a clean enclosure to the top of the already pre-existing enclosure, and then we would rotate them in the water. So this makes for a water to water transfer of the smelt so hopefully they don't get too stressed out. And that's kind of we are also kinda looking at that kind of stuff.

2:48:56  
CDFW Broadcast: And this was done every 2 weeks, because in in practice this takes 2 boats and like 6 people and a lot of work. So we wanted to kinda test this all out. And there at the end, we just detach it. Take off the top and put the lid back on, and we're out

2:49:13  
CDFW Broadcast: so then our second question, we were talking about the 2 different sites, and this we chose 2 sites that were pretty different habitats, and the first is what we're calling monizoma. It's in Montezuma, slew right by Beldon's landing, for those that are familiar, but it's pictured on the map, and then the second is Rio Vista, which is just south of the town of Rio Vista on the lower Sacramento River.

2:49:36  
CDFW Broadcast: and these 2 sites have been used for enclosure studies in the past, so we knew that they were feasible going into it, cause we didn't, we didn't. Wanna also just add that to the to the list of things that we were testing out.

2:49:47  
CDFW Broadcast: So at each of the sites, we set up a total of 4 enclosures, 2 for each treatment. We were limited by the number of enclosures that we have, so we were only able to get 2 replicates per. And then we weren't able to include a no bio fouling treatment. Control would be the word. But we were able to hold fish at FCCL and use those kind of as a a baseline

2:50:14  
CDFW Broadcast: control fish

2:50:15  
CDFW Broadcast: to compare to. So the setup was that we did this experiment over a total of 6 weeks, so that that flip method was done twice at weeks 2 and 4 and week 6 is when everything comes out. So you don't have to clean everything up that week, and the scrub was done every week throughout, and each enclosure got 70 delta smelt.

2:50:35  
CDFW Broadcast: So to assess whether the biofouling or the sites was having any effects on the condition of the Delta smelt. We measured their survival hepato-somatic index, condition factor, liver glycogen, critical thermal maximum, and diets. These data were collected at the end of the experiment by taking a final count for survival. Critical thermal maximum was measured in the field, so a subset was taken out of each enclosure and

2:50:59  
CDFW Broadcast: to a treatment tank area, and they did that. That was all done by the fish conservation, fish, physiology, lab.

2:51:07  
CDFW Broadcast: and

2:51:08  
CDFW Broadcast: and then everything else. We just took a sub sample out and preserved them appropriately to the method. Some things went into liquid nitrogen, others went to ice or formalin that kind of thing. And so, for all those metrics we wanted to kind of try to make a prediction of what type of relationship we could expect to see with biofouling. But since all these metrics, including biofouling, are pretty multifaceted, we weren't able to come up with a single conclusion. So we kind of have to let the data talk for itself.

2:51:35  
CDFW Broadcast: like, for example, the biofouling could reduce the water quality inside of the enclosure. Kinda as I was saying earlier, and that could lead to increased mortality of the smelt or the the macroinvertebrates could be increasing survival of this mountain side. So we just had to test out and see what happens.

2:51:53  
CDFW Broadcast: So going into the first set of data here I have the results for hepatosomatic index. For this data we found that the control fish that were held at the FCCL. In that orange box scored significantly higher than all of the fish that were in the field. But there was no significant effect of hepatosomatic index on the smelt by the biofouling treatment. So that would be between

2:52:16  
CDFW Broadcast: the

2:52:18  
CDFW Broadcast: the exchange and scrub. So those 2, those 2 sets of box spots next to each other?

2:52:24  
CDFW Broadcast: So because there's so many plots look at. That was a lot of different metrics. I that's just one example of the data. And I'm just gonna kinda show the results, the all of the data for the metrics that we measured on the smelt. Except for the diet, I'll get to that in a little bit. None of that was significant in what we found, according to the biofouling.

2:52:46  
CDFW Broadcast: but the

2:52:49  
CDFW Broadcast: it exited out with it.

2:52:51  
CDFW Broadcast: Delicate one.

2:52:54  
CDFW Broadcast: However, okay, when we look at these metrics by site, we did find some some significant fact effects. Here's the data for the critical thermal maximum and

2:53:06  
CDFW Broadcast: as before, like the FCCL control fish scored higher than all the other fish. But this data found that the fish held at Rio Vista, where it's significantly higher than at Montezuma.

2:53:17  
CDFW Broadcast: So this same pattern held for condition factor and liver glycogen, we did not find any significant effect of location or of location on survival or condition factor. So our results indicate that some of the Delta smelt condition metrics were significantly affected by site, but not by the biofouling

2:53:38  
CDFW Broadcast: but since there's so, here's the diet data. And since there's so many factors to consider with diets, it's getting its own slide here. But we're still waiting on some other data and some more analyses to kinda get stats. But anecdotally, we can kinda tell a story that the species most commonly eaten at Monizuma was

2:53:57  
CDFW Broadcast: Limnoithona, and the species most commonly eaten at Rio Vista was pseudodioptomous. Both of these species hang out in the water column, so we wouldn't really expect those to be coming out of the bio fouling itself. So that's probably more attributed to the site rather than the bio fouling.

2:54:13  
CDFW Broadcast: And then we also measured a bunch of different effects on the conditions inside of the enclosures.

2:54:21  
CDFW Broadcast: So this is kind of getting at

2:54:23  
CDFW Broadcast: whether the smelt are really experiencing something different being caused by biofouling, or, if they care or not.

2:54:31  
CDFW Broadcast: So we measured the macro invertebrate abundance. I'll go biomass flow inside of the enclosures and then collected. So plankton samples so for macro invertebrate abundance and algal biomass, we measured the amount of macro invertebrates and algae that grew on the surface of the enclosure. Throughout the experiment.

2:54:48  
CDFW Broadcast: The flow inside of the enclosure was measure was a relative measurement. We use what's called clog cards, and it's just this as water flows over it, it kind of erodes away. And so we can get the weight. And so it's relative. And it tells you like between each enclosure if they're experiencing more or less

2:55:06  
CDFW Broadcast: exchange of water. And then we also collected zooplankton. This was done every 2 weeks. Using pumps from inside of the enclosures.

2:55:15  
CDFW Broadcast: So for these methods are a little more straightforward, and we were venture willing to venture some predictions. So for the macro invertebrate abundance, and algal biomass. We hypothesize that as biofouling increase, so, too, would those metrics. This also makes a lot of sense, because those are the 2 main components that make out biofouling.

2:55:33  
CDFW Broadcast: and then, inversely, we predicted that flow in zooplankton inside of the enclosures would decrease with biofouling, thinking the increasing growth on the enclosures would reduce water and zoolankton's ability to enter the enclosure.

2:55:47  
CDFW Broadcast: So here's some more data, and this I have the results for the macro and vertebrate abundance being shown, and we found that the flip method significantly reduced the macroinvertebrates that were growing on the enclosures compared to the scrub method.

2:56:03  
CDFW Broadcast: however, we did not find a significant effect of those 2 treatments, so the flip, or the exchange method, or by scrubbing method between algal biomass and flow inside of the enclosures.

2:56:17  
CDFW Broadcast: And then next we when we're looking at that same data by site, we found that the flow was the only metric significantly affected by site. This should likely be due to the larger title influence Montezuma experiences compared to Rio Vista. So the flow there is actually higher. So it kinda just follows, what's being experienced at the site.

2:56:38  
CDFW Broadcast: But that was what we found. We found that that was the only significant effect.

2:56:43  
CDFW Broadcast: by site.

2:56:46  
CDFW Broadcast: and then same as the diet. The diet data zooplankton is getting its own side, cause it's pretty. There's so many factors to it. So and like the diet data. We are still like waiting on more data. So we wanna compare this to other

2:57:02  
CDFW Broadcast: other surveys that are in the area. So we can get kind of a if our if our equipment has a bias or not, and we can kind of try to get to those answers.

2:57:10  
CDFW Broadcast: But with what we have. Now we can kind of anecdotally get

2:57:13  
CDFW Broadcast: get a little story. So we found.

2:57:18  
CDFW Broadcast: Let's see. So we'll just look at what was most important in the diets for this quick conversation, and we found that Limnoithona was pretty dominant, according to the count, at Montezuma, and then pseudodiaptomus was not nearly as dominant as Limnoithona was, but it is one of the more abundant individual species at Rio Vista.

2:57:43  
CDFW Broadcast: and so to wrap this all up, we found that all the smelt condition factors that were significant, that scored significantly

2:57:50  
CDFW Broadcast: sorry. All the smelt condition factors that were significant scored higher at Rio Vista than at Montezuma.

2:57:57  
CDFW Broadcast: Macro invertebrate abundance was significantly reduced by the flip method. But this was the only factor that was significantly affected by biofouling treatment.

2:58:07  
CDFW Broadcast: and anecdotally we found that pseudodiaptomus the most common food at Rio Vista and not at Montezuma, indicating maybe the food at Rio Vista was a little higher quality, for Delta smelt.

2:58:19  
CDFW Broadcast: And so we'll kinda looking into the future, since our results indicated that biofouling had limited to no effect on the condition of the smelt inside of the enclosures. We wanna focus future enclosure work on investigating habitats and reduce our efforts on mitigating that enclosure biofouling. So with the freedom from reducing our efforts on biofouling treatment, we can utilize those resources to expand enclosure studies to new sites and new habitats.

2:58:47  
CDFW Broadcast: and then, by expanding enclosure studies to more habitats. We can deepen our understanding of how Delta smelt respond to different habitats and locations, and this can allow us to more effectively utilize enclosure studies

2:59:00  
CDFW Broadcast: more effectively utilizing closure studies to to inform how things like summer fall habitat actions are affecting Delta smelt.

2:59:10  
CDFW Broadcast: And with that I wanna thank everyone that made this possible. It was a huge undertaking. There's a lot of field work and a lot of lab work that was done.

2:59:18  
CDFW Broadcast: and I think I have time for questions.

2:59:32  
CDFW Broadcast: Thanks for that talk. I was curious. I may have missed this. But

2:59:36  
CDFW Broadcast: did did you do anything like not treat any of the cages like, were there some cages that you just didn't treat? And look at that effect? Yeah, we weren't. We didn't have enough enclosures to be able to have replicates and do a no treatment.

2:59:51  
CDFW Broadcast: like, no scrubbing, no exchange treatment. But we were kind of like, well, regardless like we're gonna go scrub those enclosures just for to make ourselves feel better. So so we felt like that. That's kind of will be the baseline, regardless of if we did or did not

3:00:07  
CDFW Broadcast: do a treatment.

3:00:16  
CDFW Broadcast: Here's one.

3:00:22  
CDFW Broadcast: I don't know if I missed it. Did you say when you had the cages? In what time of year? Great question we did this in like September through October. So 6 weeks total, so almost 2 months. But yeah.

3:00:38  
CDFW Broadcast: yeah, pretty hot. And this was 2023. So also, like that kind of Rio Vista Montezuma. It might have been a little switch, just because it was such a wet year, and the conditions were very different than what we would

3:00:50  
CDFW Broadcast: expect. Normally.

3:00:53  
CDFW Broadcast: I think that's it.

3:01:04  
CDFW Broadcast: Alright. Thank you. Everyone. Excellent fishes, all of them were wonderful. We're now gonna go to lunch. We have a little extra time for lunch today, so be back here at 1:40. Any other announcements.

3:01:25  
CDFW Broadcast: Speakers for the next session still need to get there. Yeah, if you're speaking soon, get your slides uploaded

3:01:34  
CDFW Broadcast: ideally now, and not at the end of lunch

3:02:17  
CDFW Broadcast: folks. We're gonna be starting in 1 min ago. So please filter in and take your seats

3:02:41  
CDFW Broadcast: participated. Let's see.

3:02:46  
CDFW Broadcast: All right, everyone we're starting.

3:02:51  
CDFW Broadcast: Okay. I know we're we're coming in after lunch. It's a little

3:02:57  
CDFW Broadcast: people are filtering in, please. Quiet down we're now going to our salmon session, and the chair of this session is Marcia, and I will let her introduce the first presenter. Thank you.

3:03:12  
CDFW Broadcast: Good afternoon, everyone. My name is Márcia Scavone-Tansey, and welcome to IEP. Workshop, section

3:03:19  
CDFW Broadcast: 14 Salmonid Habitat monitoring and modeling.

3:03:26  
CDFW Broadcast: Our first presenter is Alison Collins.

3:03:29  
CDFW Broadcast: Alison is a senior research specialist with the metropolitan water District of Southern California working with salmonid ecology. Her work is focused on utilizing sciences to inform salmonid related management and policy. Welcome Allison.

3:03:50  
CDFW Broadcast: Thank you. Thanks everyone for coming back to lunch.

3:03:54  
CDFW Broadcast: kind of as this project is trying to reorient ourselves and the processes we work in, I wanna just take a moment to acknowledge that we're on the ancestral territory of the Miwok and Nisenan people and affirm their sovereign rights as first people.

3:04:09  
CDFW Broadcast: So today, I'm gonna speak about quantitative tools and frameworks that can be used to help a group of people work collaboratively in a transparent process. To achieve salmon recovery. As this graphic from British Columbia shows.

3:04:23  
CDFW Broadcast: there's a lot of people that care about salmon. There's a lot of people that are implementing different actions to help salmon to recover salmon ideas and values around salmon. And there's a lot of resources that are data dedicated to this species. It's not easy, though, to balance the limited natural resources that we have among the many different parties that live in and use the central valley, we have a lot of competing objectives that we're trying to manage at different scales

3:04:48  
CDFW Broadcast: across different landscapes in a really complex ecosystem.

3:04:53  
CDFW Broadcast: For example, what happens when one group comes in and says that they wanna recover salmon because they want to have more fishing opportunities. And one way they think they can achieve that is, by increasing hatchery production.

3:05:05  
CDFW Broadcast: And then you have another group that comes in and says, we wanna help salmon by increasing their survival. And we actually have this great idea that we can flood rice fields as a means to increase growth and then promote overall survival.

3:05:17  
CDFW Broadcast: Maybe your groups talk about this, and they say like, that's a great idea.

3:05:27  
CDFW Broadcast: And we actually think that flooding rice yields might lead to more fishing opportunities, and that our idea of increasing hatch reproduction might increase survival.

3:05:34  
CDFW Broadcast: And now you have a third group that comes in and says that we actually really care about seeing natural origin fish in the system. And we're concerned that increasing Hatchery production might reduce the number of natural origin fish but floating rice fields might increase this number of fish. So what we have here is a lot of competing objectives, a lot of different interests that are in conflict with one another. As you keep adding objectives to this, tables and alternative

3:05:59  
CDFW Broadcast: alternatives and how to achieve those objectives. Your table is gonna grow exponentially right? But luckily there's quantitative tools and frameworks that can be used to, you know, solve this problem in a transparent and collaborative way which brings us to the process that I'm presenting on today the goal of the reorienting to recovery project is to identify, preferred broadly supported scenarios across all interested parties that support recovery of Central

3:06:24  
CDFW Broadcast: valley salmonids so this work is going to identify a suite of implementable and impactful actions to advance recovery of the 4 distinct runs of salmon in the central valley, while establishing broad support and buy-in for these preferred actions.

3:06:38  
CDFW Broadcast: We're accomplishing this by using decision support tools and a structured decision making framework. This group and process will be producing recommendations, not formal decisions. However, it is anticipated that these recommendations will inform future decisions around coordinated actions to cover salmonids that can be implemented by a variety of parties.

3:07:01  
CDFW Broadcast: So, as I mentioned, this project is using structured decision making to create scenarios, to recover cell monitors while balancing multiple other competing objectives. So structured decision making is a systematic, transparent method that has been effectively used for navigating many complex environmental resource issues. It helps groups work collaboratively, collaboratively, to build a shared understanding of the trade-offs, and make informed and transparent choices

3:07:27  
CDFW Broadcast: as a planning framework. It consists of a set of core principles, a series of fundamental steps, and a series of applied methods and tools that draw from decision sciences. So it really allows groups to come together and talk about what's the context of what we're deciding about, what kind of objectives do we want to achieve? What alternatives can we implement?

3:07:46  
CDFW Broadcast: What are the consequences of implementing those alternatives? What are the trade offs that exist. Once you implement those actions, and then, once you kind of set on a group of actions or a strategy put in place, you can monitor and learn and and adjust. And

3:07:59  
CDFW Broadcast: while I mentioned that this is really great for large, like complex, natural resource problems, Corey and I have used it many times in our marriage, including if we should remodel or buy a new house, and which car seat to buy for our children, so it can be used in lots of different places whenever you're trying to make a decision.

3:08:18  
CDFW Broadcast: so in our process, the first step was to define, what do we mean when we say we want to recover salmon. So we gathered a group of experts on salmon biology and over several minutes several meetings. This group developed measurable objectives that are based on the viable salmon population parameters. So those include abundance, productivity, spatial structure and diversity.

3:08:40  
CDFW Broadcast: The groups also group also identified performance metrics as ways to measure the objectives and set specific targets. So, for example, here is productivity. You know, we have a measure of cohort placement rate. And there's specific targets that we want to meet in this recovery. Process.

3:08:56  
CDFW Broadcast: The group also decided that we're talking about broad scale recovery. So this is recovery that goes like above and beyond delisting and recovery criteria for these species, and it applies to all runs of salmonids in the listed and non-listed species.

3:09:11  
CDFW Broadcast: Right? So we're talking when people got together like we wanna see, you know, be able to walk across Salmon's back and have so many extra salmon that the killer whales can eat it and we can fish without, you know, quotas like we're talking about really big recovery here. And it's outside of the regulatory environment that we some of the other recovery definitions.

3:09:28  
CDFW Broadcast: Are currently in

3:09:30  
CDFW Broadcast: phase 2. We brought together interested parties to develop a project catalog. So what are people doing to help benefit salmon and define ecological, social, cultural, and economic values? So we had representatives from State and Federal agencies.

3:09:46  
CDFW Broadcast: NGOs, tribal governments, Water and Ag. Interests all come together, and over a series of meetings. They told us what projects they were working on. And then we did kind of a storytelling workshop, where we asked participants

3:09:59  
CDFW Broadcast: to tell us their values related to salmon by asking questions like, How do you imagine salmon recovery might benefit or impact you? And kind of collected everyone's ideas around that. We collected over 500 statements, and we distilled those into 24 objectives that we could track throughout this process. So an example of this is values, we heard, were traditional food source, like salmon as a traditional food source and recreational fishing opportunities.

3:10:24  
CDFW Broadcast: So we kind of group these values together into a refined value around Sam and harvest and then develop some performance metrics that we can track throughout the system. So as we're kind of going along and evaluating strategies to recover some on it. We can make sure that we're capturing all the values from interested parties that we heard

3:10:41  
CDFW Broadcast: phase 3 which we're in now uses structured decision making to collectively build and assess different combinations of management, actions or recovery scenarios towards a broadly supported strategy. So we are using decision support tools to predict the consequences of different recovery, actions and scenarios on the objectives defined in phase one and phase 2. So this serves several purposes, such as improving our understanding of the effects regarding scenarios on the objectives and discussing the trade-offs.

3:11:09  
CDFW Broadcast: So the reorienting to recovery or R2R decision support model is adapted from the CVPIA science integration teams model. That's an open source model. So our modeling team essentially flow west, took that model and made extensive updates to better represent hatchery, dynamics, adult harvest rates to better reflect current harvest numbers. And in the San Joaquin Basin they extended spring run habitat up to Friant dam.

3:11:34  
CDFW Broadcast: So recovery actions that can be modeled in in this decision support tool are related to the 4 H's habitat, hydrology, hatch trees and harvest

3:11:45  
CDFW Broadcast: examples of some of the actions we can model and represent our like gravel augmentation projects, reintroduction, restoration, changes in flow, the timing and magnitude changes to hatchery and harvest practices. There's a lot of different knobs that we can kind of turn and tweak. So once the group decides what kind of recovery scenarios they wanna evaluate those can be ran through the decision support, model

3:12:09  
CDFW Broadcast: and results are presented in a consequence table. So, at this point our process has done 2 rounds of modeling. We're about to embark on a third round. I'm gonna show you generic results today just to show you how consequence tables work and they can be used to kind of evaluate tradeoffs that exist.

3:12:26  
CDFW Broadcast: So this is what a consequence table looks like on the left. We have the objective. So, though, remember, those represent the biological and non-biological values, the interest that were defined in phase one and 2 of this process

3:12:40  
CDFW Broadcast: in yellow, the columns on the top right represent the different recovery scenarios, so each column represents distinct scenarios that contain different actions to recover the species.

3:12:51  
CDFW Broadcast: and on the right are the predicted consequences of recovery actions on each objective. So the legend at the top shows you how to read the different colors. And just because talks are so short. I'm just gonna say that at the moment, you know, darker colors of blue and purple are more preferred.

3:13:06  
CDFW Broadcast: Alright. So this is a I'm gonna show you some real results. But in a generic way to kinda just talk through this consequence table. So I selected some biological metrics related to adult abundance, coho replacement rate and pHOS,

3:13:21  
CDFW Broadcast: and then we have some other socioeconomic values that were identified, including ecosystem health wetlands, ocean harvest water supply, flood risk and hydro power. So you you don't. You know, if you're not an expert in salmon biology, it's okay. You don't need to really know what these mean for the purposes of this particular talk. The performance measures are how we're gonna measure each of these objectives and the preferred direction just reminds you if we wanna see higher or lower values predicted in a consequence. Table.

3:13:49  
CDFW Broadcast: so this is showing results for 2 alternatives. Again, I'm not giving you any details about what are in these alternatives. It's just for illustrative purposes to show you kind of the differences that exist here. So what I see, when I look at this table, remember that colors in dark blue or purple are more preferred. So I see that alternative. One kind of looking down this alternative. It's doing a better job at achieving values that we prefer related to the biological metrics and ecosystem health

3:14:19  
CDFW Broadcast: shown by these dark colors here, and it's not doing as good of a job satisfying some of the other objectives that we care about. And the opposite is true for alternative. 2. Right. So like looking at adult abundance and alternative one, we have a lot more fish that are produced under this alternative in the Sacramento and San Joaquin systems.

3:14:35  
CDFW Broadcast: That also directly relates to marine drive nutrients, which is a proxy for ecosystem health. This value includes the number of fish that are spawning, right? So it makes sense that if you have more fish present at spawning grounds, you're gonna have a higher value of marine drive nutrients

3:14:51  
CDFW Broadcast: alternative. One produces less fish that are available for ocean harvest and has less water supplies. You know you can look down this table and look at the objectives that you care about?

3:15:01  
CDFW Broadcast: So this is just to give you an example of some of the trade offs that exist between a couple of the alternatives that we've looked at. And you can imagine that this is gonna lead to like a healthy discussion along participants about what trade offs. There are, what scenarios. They prefer and how they wanna prioritize these objectives. So we are actually having that discussion with our decision makers next week during a 2 day workshop.

3:15:23  
CDFW Broadcast: Again, these decision makers represent State and Federal agencies, NGOs water and Ag interests. We're working in a separate process with tribal governments to get their input and feedback and preferences in this

3:15:35  
CDFW Broadcast: and at this workshop we'll be asking participants to brainstorm the next round of modeling scenarios that we wanna do to try to balance some of the trade-offs that are existing in the results that we're seeing.

3:15:48  
CDFW Broadcast: So you know, I hope to that today, you know, I've shown you that there are quantitative tools and frameworks that are in place to help groups with diverse values and interests, explore complex natural resource problems with competing objectives.

3:16:00  
CDFW Broadcast: These tools really do allow a diverse group of users to come together. And in a collaborative process to build an understanding of what they're trying to achieve, and examine the consequences of implementing different alternative recovery actions and discuss the consequences of what implementing those actions are. So tools like this really allow diverse groups to make well informed, transparent choices

3:16:23  
CDFW Broadcast: there, with that, if you're interested in this project, there's a whole slew of resources. Also just want to mention that I'm one of like, you know, a

3:16:30  
CDFW Broadcast: 20 person planning team. So all of us are happy to talk to anyone who's have more interested and then I wanna thank our funders, the Delta Science program and State water contractors so that I'll take any questions.

3:16:44  
CDFW Broadcast: One

3:16:45  
CDFW Broadcast:

3:16:53  
CDFW Broadcast: Hi, great talk! Thanks. I was just curious about the the interpretation of those numbers that you just had in your last figure, for example, where the alternative one had 6 million adult salmon. Why are there only 500,000 that could be harvested? Is that just? Is that just regulation? It wasn't quite clear to me. Why, that would occur. Yeah, it has to do with different assumptions that are in the alternative regarding harvest and hatchery practices. So those 2 different assumptions and different alternatives lead to different outcomes on harvestable fish.

3:17:31  
CDFW Broadcast: Okay, thanks. You guys.

3:17:35  
CDFW Broadcast: maybe I'm gonna message.

3:17:38  
CDFW Broadcast: Thank you Alison

3:17:43  
CDFW Broadcast: Okay, the next presenter is Brian Mathias

3:17:46  
CDFW Broadcast: Brian, the supervisory fish biologist, with the US. Fish and wildlife service in Lodi.

3:17:54  
CDFW Broadcast: He leads studies to assess the survival migration and abundance patterns of juvenile chinook salmon and steelhead migrating through the central valley. Welcome, Brian.

3:18:08  
CDFW Broadcast: thank you.

3:18:09  
CDFW Broadcast: So today I'm going to talk about the estimating abundance of endangered winter run chinook salmon exiting the Delta.

3:18:17  
CDFW Broadcast: and this is a project sort of we. My group has been working on for several years with, a bunch of collaborators. And I want to specifically call out Russ Perry. This he's been doing. The vast majority of the analysis on this project. And this project is adapted from several that he has given in the the past couple of years.

3:18:39  
CDFW Broadcast: So several years ago there was group of individuals that was looking at the winter run monitoring network.

3:18:46  
CDFW Broadcast: and they came to the conclusion that we didn't need more monitoring for winter run Chinook. We just needed more focused monitoring.

3:18:54  
CDFW Broadcast: And they came up with 6 system wide recommendations.

3:18:59  
CDFW Broadcast: first being making sure we're incorporating genetic run identification, getting abundance, looking at survival, diversity, condition and data access.

3:19:07  
CDFW Broadcast: This project

3:19:09  
CDFW Broadcast: is really looking at the the first 2 components of that. So the run, the genetic run, identification and abundance components. So we did this project for both the Sacramento trawl site and the Chipps Island Trawl site from DJFMP. And today I am going to be focusing just on the Chips Island. Component of this

3:19:28  
CDFW Broadcast: this effort.

3:19:29  
CDFW Broadcast: So why is abundance at Chipps Island? Important? Well, it is a critical nexus between the freshwater and ocean phases for juvenile salmon.

3:19:39  
CDFW Broadcast: It is a really good place to monitor the status of endangered populations, because it can provide an early indicator of year-class strength and allows us to take action if there is low abundance.

3:19:50  
CDFW Broadcast: this is also really useful to inform life cycle models. So the science integration team, winter run decision support models

3:19:58  
CDFW Broadcast: ideally will be calibrated with abundance data calibrated and validated with abundance data. And this is one source of information that we can use to do that.

3:20:08  
CDFW Broadcast: However, there are plenty of challenges that we have when we're sampling at Chipps island. One is just the the mass amount of water that's passing past Chipps Island every day, and the small fraction of water that we are sampling. So if you squint really hard, you can see a little white dot up there. And that is actually one of our trawls. So this really shows you how like big of a needle in the haystack, we're actually doing when we're sampling. So that is one of the challenges.

3:20:35  
CDFW Broadcast: The other challenge. When we actually catch a fish? What are we looking at?

3:20:38  
CDFW Broadcast: Are we looking at a hatchery origin fish? If so, what hatchery did it come from? And the best tool we have for that is coded wire tags. However, there are certain runs that only have the 25% marking. So not all of our hatchery fish are actually marked with coded wire tags. If it's a naturally produced fish.

3:20:57  
CDFW Broadcast: what population did it come from? Did it come from fall or late fall which are harvestable. Did it come from threatened spring run or endangered winter run, and the best tool we have for that is genetic stock identification.

3:21:09  
CDFW Broadcast: So this study started off as a 5 year, I guess. Pilot study

3:21:14  
CDFW Broadcast: and it can really be broken up into 3 different parts. Before I get into that. I wanna talk a little bit about this figure. So we've got a couple of different boxes. We've got the boxes with a nice bold blue border, and that is part of our existing monitoring network.

3:21:31  
CDFW Broadcast: The the boxes that have the dashboarder, those are the data that we are collecting, each and every day we go out sampling

3:21:38  
CDFW Broadcast: the circles. Those are the model estimates. And ultimately we want to link that back and get estimates for run specific abundance. So linking that back to the little yellow box on top.

3:21:50  
CDFW Broadcast: Now there are 2 parts that we are modifying with this study and it. Those are the boxes in green that I'll talk about in a little bit. So the first one, we are pairing coded wire tag releases with acoustics elementary. So we are taking a small proportion of the Hatchery production with acoustic tags and releasing them with the coded wire tag fish.

3:22:10  
CDFW Broadcast: This way we can use acoustic telemetry, then to estimate the survival to both Sacramento and Chips Island. So how many of our coded wire tagged fish are expected to make it to the trawl sites.

3:22:21  
CDFW Broadcast: It also gives us information on runtime. So when do they actually get to these trawl sites?

3:22:27  
CDFW Broadcast: Part 2 is linking our coded wire to catch, and ultimately estimating our trawl efficiency. So traditionally, our sampling at both of these sites is done 3 days per week

3:22:39  
CDFW Broadcast: with our efficiency sampling. We're increasing that. So on average, we're going out roughly 5 days per week between December and May, and this allows us to maximize the number of coded wire tag fish we are catching.

3:22:49  
CDFW Broadcast: So then.

3:22:51  
CDFW Broadcast: to estimate our trawl efficiency, we have known coded wire tag catches. So we know how many coded wire tags we're catching at any given time, and we have estimates of the number of coded wire tagged fish available to be captured

3:23:03  
CDFW Broadcast: at each trawl site from those paired releases.

3:23:08  
CDFW Broadcast: And then

3:23:09  
CDFW Broadcast: I'm

3:23:10  
CDFW Broadcast: the genetic component. We're again looking our trawl catch with genetic IDs

3:23:15  
CDFW Broadcast: relying on the increased sampling so sampling again at 5 days per week. So we can maximize the number of true genetic link to run that we're catching. So then we can estimate our winter run abundance. With that genetic sampling?

3:23:28  
CDFW Broadcast: We know the proportion of fish that were are actually true Winter run in our sampling

3:23:34  
CDFW Broadcast: are in our catches, and then we are able to use those efficiency estimates that would be talked about in Part 2 to scale our winter, run abundance, to get the true winter run abundance.

3:23:47  
CDFW Broadcast: Okay.

3:23:49  
CDFW Broadcast: Part one just quickly going over some of the paired release and acoustic tag summaries. So with this initial part of the

3:23:56  
CDFW Broadcast: the model. We have data from 2016 to 2021 and 31 different paired releases.

3:24:03  
CDFW Broadcast: These come from across the years we have, I think, at least 4 paired releases every year.

3:24:10  
CDFW Broadcast: and they're coming from the various hatcheries and runs. So we would have representatives from each of the different runs and numerous hatcheries.

3:24:17  
CDFW Broadcast: All in all we relate, we tagged close to 10,000 acoustic or 10,000 fish with acoustic tags, and roughly 1,500 of them were detected at Chipps Island

3:24:28  
CDFW Broadcast: at the same time. With these paired releases there were approximately 12.5 million coded wire tags, released and just shy of 1,900 were caught at Chipps Island

3:24:39  
CDFW Broadcast: onto our fun coded wire tag catch and trawl efficiency. So here we've got our base model efficiency. So to orient you to this figure each of those little dots represents the individual trawl efficiency for a paired release group.

3:24:57  
CDFW Broadcast: now we've got this oriented based on the run and hatchery. So on the left. We've got Coleman Fall. Next to that, we've got Coleman light fall, and so on.

3:25:07  
CDFW Broadcast: The red line that's going across is our overall mean

3:25:12  
CDFW Broadcast: efficiency. So on average, we're about 3 quarters of a percent. So

3:25:19  
CDFW Broadcast: this is actually remarkably remarkably consistent across time and across all of the releases.

3:25:26  
CDFW Broadcast: Individual release groups are going from maybe about a quarter of a percent all the way up to maybe one and 3 quarters of a percent. So we are, I would argue, we're pretty efficient, or we're we're doing a good job at estimating our efficiency.

3:25:39  
CDFW Broadcast: we also integrated or looked at factors affecting trawl efficiencies. So some of the fixed effects delta outflow a velocity, deviation representing title movements interaction between upflow and velocity tow location. We tow in 3 different locations, North Channel Center Channel, South Channel, and then tow action, whether we're going upstream or downstream, the 2 biggest ones delta upflow and to location. So

3:26:04  
CDFW Broadcast: we are less effective at or less efficient at catching fish at high water levels and the south channel, for whatever reason, has the highest efficiency

3:26:14  
CDFW Broadcast: OK?

3:26:16  
CDFW Broadcast: Getting onto some of the genetics data?

3:26:22  
CDFW Broadcast: Here, we've got

3:26:24  
CDFW Broadcast: the data for the genetics samples. And each of these are broken up into the length at date category. So we've got the genetic samples

3:26:33  
CDFW Broadcast: that we've that we collected and analyzed kind of on the left, in that yellow box

3:26:37  
CDFW Broadcast: and on the right. It's the assignment for actual, true winter run.

3:26:41  
CDFW Broadcast: So if we take a look at 2017 for the genetic samples analyze those we looked at. 17 late fall. Length at date fish for fall run. We looked at 24, and so on.

3:26:54  
CDFW Broadcast: All in all. We collected about 3,000 genetic samples. Throughout these years

3:27:01  
CDFW Broadcast: 212 of them were assigned to Winter Run.

3:27:04  
CDFW Broadcast: And roughly, 95% of the true winter run. We're located. We're within that winter on length at date group, and a couple of them were in the spring run, and a pair were in the late fall. Run.

3:27:14  
CDFW Broadcast: Okay, under the fun stuff. The actual abundance estimates. So here we have our abundance estimates for genetic winter run in 2017 to 2021 ranges we had a low in 2021 of about 32,000, and a high in 2020 of about 92,000

3:27:32  
CDFW Broadcast: of

3:27:33  
CDFW Broadcast: so, taking a kind of a step farther, Russ Perry has been doing a few more analyses on this.

3:27:41  
CDFW Broadcast: and I was kind of interested to see how well we are doing compared to other estimates of abundance. So a couple well over a decade ago Brian Piper published a manuscript, looking at genetic winter run abundance at Chipps Island, and also just interested in applying the the trawl efficiency model to the length at date went to run. So how well did those 2 methods match?

3:28:05  
CDFW Broadcast: So here we have

3:28:06  
CDFW Broadcast: winter run abundance estimates from 2008 to 2021

3:28:11  
CDFW Broadcast: again, we've got those 3 different methods. The the weird pink color is from Piper at all. 2,013. The black is trawl efficiency, and then the

3:28:21  
CDFW Broadcast: like. The length-at-date is the weird, brownish orange color. So again, this is the length-at-date model applied for the trawl efficiency product or trawl efficiency model.

3:28:30  
CDFW Broadcast: And the first thing that I noticed is looking at the Piper et all data and the trawl efficiency model. They're very, very close

3:28:37  
CDFW Broadcast: especially in the first 3 years, the second or the the last year 2011 there is a difference in, or it was a high water year, and the Piper model didn't account for the high water as well as the trawl efficiency model does

3:28:52  
CDFW Broadcast: length-at-date winter run

3:28:53  
CDFW Broadcast: big surprise. We are overestimating abundance, using the length-at-date model.

3:28:59  
CDFW Broadcast: That is not a huge surprise by anyone. However, I do wanna point out 2017, also another big water year. We, for whatever reason that year there were a lot of fall run fish that were collected

3:29:11  
CDFW Broadcast: in or that were classified in that length-at-date category. So, it was just

3:29:17  
CDFW Broadcast: fall runner everywhere that year.

3:29:20  
CDFW Broadcast: and kind of moving on to some of the future efforts. So we are continuing this project, and we have transition to long term operations. So in with the goal to develop an annual abundance estimates for winter run, both entering and exiting the Delta again. We. I didn't talk at all today about the

3:29:38  
CDFW Broadcast: efforts at the Sacramento trawl site.

3:29:43  
CDFW Broadcast: and we've got

3:29:44  
CDFW Broadcast: we did all of the paired releases for winter run in 2021 and 2022. And we're still analyzing those data to get these estimates, and we've got funded efforts to apply these models to estimate both spring run abundance and fall run abundance.

3:30:02  
CDFW Broadcast: so with that, I really need to thank all of our partners and our funding agencies and the copious amounts of field staff that have helped throughout this project.

3:30:10  
CDFW Broadcast: And it

3:30:12  
CDFW Broadcast: I think I've got a couple of minutes for questions as well.

3:30:30  
CDFW Broadcast: Yeah, great talk. It seemed like in your efficiency analysis that the channels were significantly different. I just wonder if you might comment on why and

3:30:40  
CDFW Broadcast: what might be going on there.

3:30:42  
CDFW Broadcast: We've had that conversation. It was a number of years ago now, and I don't remember all the specifics I think it has to do with channel morphology

3:30:50  
CDFW Broadcast: that think.

3:30:52  
CDFW Broadcast: I think it was a south channel. That was a little bit higher efficiency, and I

3:30:57  
CDFW Broadcast: I think it, for whatever reason the flows might be pushing them a little bit more towards that south channel. As they're coming out of the Sacramento River. That's

3:31:08  
CDFW Broadcast: that's our best working hypothesis at this point.

3:31:16  
CDFW Broadcast: Alright, thank you very much.

3:31:19  
CDFW Broadcast: I'm just going to tell you

3:31:22  
CDFW Broadcast: everything

3:31:27  
CDFW Broadcast: next word

3:31:29  
CDFW Broadcast: it. I'm sorry.

3:31:32  
CDFW Broadcast: So

3:31:33  
CDFW Broadcast: thank you, Brian. The next present is Matt

3:31:37  
CDFW Broadcast: Peterson. Matt is a senior fisheries. Biologist with fish bio in Chico.

3:31:45  
CDFW Broadcast: His recent work focuses on steelhead predator-prey dynamics and mark-recapture modeling to estimate abundance and movement patterns on both native and non-native species. Welcome, Matt.

3:32:10  
CDFW Broadcast: Alright, thank you. Everyone.

3:32:12  
CDFW Broadcast: Well, today I'm gonna be talking about a exciting new project. We're getting up off the ground we began this work in late 2023 and using by using multi state mark recapture models to both estimate mortality sources of immigrating salmonids and also assess how well restoration activities might be working or different restoration areas.

3:32:41  
CDFW Broadcast: First, I'd like to thank our funding sources and my co-authors. This project wouldn't be possible without the efforts of Dr. Reid Nelson and Elizabeth Greenheck, both both from George Mason University and I'd also like to acknowledge some feedback we've received on the project thus far from various agency staff.

3:33:04  
CDFW Broadcast: especially on the 1 one of the objectives I'll talk about today.

3:33:10  
CDFW Broadcast: So this project is essentially doing our homework before we do the real final exam. And I'm treating the final exam as conducting a very large complicated acoustic telemetry study.

3:33:27  
CDFW Broadcast: That may cost millions of millions of dollars to do so. Basically, this project is essentially figuring out what types of questions we can ask with these multi-state models. And whether we can partition mortality of

3:33:45  
CDFW Broadcast: of salmonids as they migrate downstream through any system in the central or in the central Valley watershed? And then ask also, can we assess the survival benefits of habitat restoration with these same multi-state models. We think we can.

3:34:02  
CDFW Broadcast: We think we have some good ideas. But one of the objectives is to specifically reach out to folks that have done these types of studies, that are actually working on habitat restoration, whether it be in the upper river, in the Delta or in more tidal habitats down in the estuary.

3:34:22  
CDFW Broadcast: And so we're trying to incorporate some of that feedback into our models, our different scenarios. And these different research questions, and then

3:34:32  
CDFW Broadcast: eventually down the road. In

3:34:36  
CDFW Broadcast: several years, which I'll get to in a second. We hope to share those findings in several publications and also share the source code to

3:34:49  
CDFW Broadcast: to allow other folks to be able to use these models, to ask specific questions, that they are interested in using what we've learned in our in our assessment.

3:34:59  
CDFW Broadcast: So we're not doing the fun field work yet. We're doing the office work. We're using a simulation simulation based approach to answer these questions. So that's relatively cheap to do. And we can make all the mistakes we want. Right? What? What?

3:35:18  
CDFW Broadcast: This is more of a personal stance like, I think it's really important to know whether your question can be answered by the study, design, and study approach you're using. And so this is one of those ways. We can do that.

3:35:34  
CDFW Broadcast: So we are fairly early on in this process. Right now, we're developing our initial research questions, our initial models and incorporating feedback on both the mortality side of things and the habitat restoration side of things

3:35:52  
CDFW Broadcast: this year. And next, we're going to be

3:35:56  
CDFW Broadcast: basically

3:35:59  
CDFW Broadcast: us running all those models. And with those different questions. And 1 one thing, we really wanna take advantage of is that there's a lot of new tag technologies, acoustic tag technologies that can both sense temperature sense pressure and also new ones that can also detect whether a fish has been consumed by another fish predator.

3:36:27  
CDFW Broadcast: But when we're doing all this, we want to make sure that we're getting reliable, robust results from these types of studies.

3:36:37  
CDFW Broadcast: So that the technical, this is this technical as I'll get today. Cause I'm really out over my skis on this stuff. This is more Dr. Nelson's expertise here. But basically, we are taking the Cormack Jolly Seber models to the next step by using multi-state models. So for Cormack, jolly Sieber models, you essentially only can estimate 2 different states of the fish.

3:37:04  
CDFW Broadcast: They're either alive or they're dead.

3:37:07  
CDFW Broadcast: That's fine. We've learned a lot of good information about how salmonids are surviving through the system by using Cormack jolly Sieber models. But we think the multi-state models

3:37:19  
CDFW Broadcast: can.

3:37:21  
CDFW Broadcast: add more information to what we've already learned. And the reason why

3:37:28  
CDFW Broadcast: is because we can

3:37:30  
CDFW Broadcast: both estimate survival and as long as you

3:37:36  
CDFW Broadcast: develop your questions, develop your research, design, or your state design the right way and collect observable data on different States. You can then ask more nuanced questions about

3:37:54  
CDFW Broadcast: why, fish went in certain habitats. They go into habitat, A or habitat B,

3:38:01  
CDFW Broadcast: or if they died, how they died.

3:38:06  
CDFW Broadcast: And so a recent example is from the East Coast. This is work published earlier this year by men singer et al.

3:38:15  
CDFW Broadcast: and this is a study where they use used such a multi-state model to partition mortality of Atlantic salmon smolts as they move down, and I'm blanking on the river

3:38:27  
CDFW Broadcast: right now as they move down the river. And what is really important to highlight is that

3:38:34  
CDFW Broadcast: the reason why the fish died changed

3:38:38  
CDFW Broadcast: as they move downstream. It's not surprising, right? But in their in this study they had a lot of unknown mortality, a lot of fish predation.

3:38:49  
CDFW Broadcast: mortality in the upper river, and then a lot of that transition to mammalian

3:38:54  
CDFW Broadcast: mortality down in the estuary.

3:38:58  
CDFW Broadcast: And so one can easily imagine that same type of scenario occurring in the Central Valley. So we think this has tremendous promise

3:39:06  
CDFW Broadcast: here.

3:39:08  
CDFW Broadcast: So transitioning just to one of our potential research questions, or one of our scenarios.

3:39:15  
CDFW Broadcast: Here we have just a example conceptual model where we've released pat acoustically tagged fish

3:39:24  
CDFW Broadcast: with predation detection tags

3:39:28  
CDFW Broadcast: in the upper reach. The reason named label B.

3:39:32  
CDFW Broadcast: Those fish, then migrate downstream.

3:39:36  
CDFW Broadcast: They're either detected by receivers or not. Those receivers are denoted by the the black dots.

3:39:43  
CDFW Broadcast: And then we've set up reaches where they die at certain rates.

3:39:48  
CDFW Broadcast: and they die from certain causes.

3:39:51  
CDFW Broadcast: And so for reach one we have also. We have poor detection, probability in reach one, and they die. From an unknown cause. We can't quite figure that out

3:40:05  
CDFW Broadcast: in reach. 3. We have good detection, and those fish

3:40:10  
CDFW Broadcast: are lost from fish predation.

3:40:14  
CDFW Broadcast: And so what we're trying to get out with a simulation is to figure out

3:40:21  
CDFW Broadcast: under what scenarios. So if you release lots of tags or very few tags. How well does this model work in this particular scenario?

3:40:30  
CDFW Broadcast: And as you can see, and it's not really a surprise. The more tags you release, the better your the precision of your estimates. So the the dots on the graphs represent the true the truth essentially

3:40:46  
CDFW Broadcast: of how those fish died. And then the box bots show how based on like a hundred. Believe it's a hundred simulations how far apart? Your simulation is to the truth.

3:41:01  
CDFW Broadcast: So you can see a lot of variability in the top row where you've released very few tags and very good precision on the bottom row where you've released a lot of tags. So what we wanna try to do is find the sweet spot here, right cause you might not have the money to

3:41:17  
CDFW Broadcast: estimate lots of different states like we have here, or you might not have enough money to

3:41:25  
CDFW Broadcast: release a thousand tags. It might cost

3:41:27  
CDFW Broadcast: $800 a pop or

3:41:30  
CDFW Broadcast: $500 a pop.

3:41:35  
CDFW Broadcast: I think that's all I was. Gonna say on that

3:41:39  
CDFW Broadcast: so that covers the predation mortality and trying to part partition the mortality sources. The other component of this

3:41:49  
CDFW Broadcast: project is to try to assess the survival benefits of whether fish of fish that use different habitats and particularly restored habitats. We think this has a lot of value. Given the high amounts of restoration that are proposed in the Central Valley, through programs such as California Ecore and the healthy rivers and landscapes programs. We think.

3:42:18  
CDFW Broadcast: just getting the data on how tagged salmonids are using some of these restoration areas has just value there to learn how they're using those restored areas. And for this particular component, we're actively seeking researchers and managers, and restoration practitioners to give us feedback on some of the questions they might want to ask of their particular rest restoration areas.

3:42:48  
CDFW Broadcast: So like, I said,

3:42:50  
CDFW Broadcast: project is just getting underway. We are refining all the all the different questions and scenarios and the models incorporating feedback on objective number 3, which is the habitat restoration component and obviously continuing our simulation based approaches.

3:43:13  
CDFW Broadcast: That was a really quick rundown of a very complex project. I highly recommend everyone to

3:43:22  
CDFW Broadcast: check out our project fact sheet, which gives a little bit more detail on this project. And if anyone has questions, feedback suggestions feel free to ask ask now, or please email me or give me a call

3:43:38  
CDFW Broadcast: with that. Thank you.

3:43:45  
CDFW Broadcast: Thank you. John

3:43:47  
CDFW Broadcast: Refresher.

3:44:00  
CDFW Broadcast: Thanks, Matt. Awesome talk. I was just curious. How do you get at the causal differences of mortality. How do you know whether a bird or a fish or a mammal is eaten? That is a good question.

3:44:14  
CDFW Broadcast: the for for the fish predation. It's fairly simple with the newer predation detection tags. Assuming those are working good for to pin down the mammalian or avian predation. I know Men-Singer et al. They used the temperature sensing tags.

3:44:37  
CDFW Broadcast: and they were able to get that information off those tags. And essentially figure out whether the tag was in a bird or a mammal based on the internal temperature of the tag.

3:44:52  
CDFW Broadcast: Thank you. Good question.

3:45:02  
CDFW Broadcast: No more questions.

3:45:06  
CDFW Broadcast: Alright. Thank you, Matt. Alright, thank you so much.

3:45:14  
CDFW Broadcast: Our next presenter is Garfield Kwan.

3:45:19  
CDFW Broadcast: Garfield is a Delta Science Fellow and Post-doc researcher at UC Davis.

3:45:26  
CDFW Broadcast: he's working with metabolic index

3:45:29  
CDFW Broadcast: models to determine the viability of to examine. And Bell.

3:45:38  
CDFW Broadcast: and the last but not least presenter is is Brandon Lehman

3:45:45  
CDFW Broadcast: Brandon is a researcher with UC. Santa Cruz

3:45:49  
CDFW Broadcast: Institute of Marine Sciences, and he's affiliated with the NOAA South West Fisheries Sciences Center.

3:46:00  
CDFW Broadcast: He's worked with a variety of anadromous fish across California with a focus on how anthropogenic stress will affect interaction between predators and prey. Welcome, Brandon. Thank you thanks for the introduction and thanks for the opportunity to speak here. I'm gonna be sharing some work about artificial nighttime illumination, which is a topic I don't think has received a lot of attention in our system.

3:46:29  
CDFW Broadcast: So

3:46:30  
CDFW Broadcast: throughout the history of life on Earth, animals adapted to reliable cycles of night and day, using the cover of darkness to evade predation, shifts in the zenith of the sun to navigate, and the timing of sunset and sunrise to queue migration and reproduction.

3:46:45  
CDFW Broadcast: Artificial light is a form of pollution. It's an environmental disturbance that affects organisms and the way they interact with their surroundings and with each other.

3:46:55  
CDFW Broadcast: There's been a recent increase in attention in the scientific literature to the effects of artificial light and wildlife. Although most of this research has focused on birds, insects, sea turtles and mammals.

3:47:06  
CDFW Broadcast: There have been a handful of studies on fish, and a lot of that works actually been done in the Pacific Northwest and on salmonids, which is fortunate for us. But there's been a fairly limited conversation about the effects of artificial illumination on fish in California.

3:47:23  
CDFW Broadcast: That being said, there's a good reason to think about light pollution

3:47:27  
CDFW Broadcast: here in the Bay area. This is the San Francisco Bay and

3:47:32  
CDFW Broadcast: This is this is the Delta here. This is this little oh, good! You could see that. That's Rio Vista right there.

3:47:39  
CDFW Broadcast: We've created a huge infrastructure of nighttime lighting

3:47:43  
CDFW Broadcast: in 2018 UC Santa Cruz was funded by a CVPIA fish and Wildlife restoration Grant to study How Physical Habitat Features Influence predation on Juvenile Salmon in the Central Valley.

3:47:56  
CDFW Broadcast: The intention of this was to collect data that allows the CVPIA Science integration team to parameterize a structured decision-making model that helps prioritize funds that are allocated for restoration projects. So essentially, our goal was to help figure out how many fewer salmon die if we mitigate for the effects of specific types of habitat features that are present in the Delta.

3:48:23  
CDFW Broadcast: One of these turned out to be artificial illumination.

3:48:26  
CDFW Broadcast: We started with a literature review that helped inform subsequent field experiments quantifying the predation risk of juvenile salmon around artificial lights in the Delta, and the summary is pretty simple. Light pollution is bad for juvenile sized fish.

3:48:43  
CDFW Broadcast: such as salmon smolts.

3:48:48  
CDFW Broadcast: Next we conducted a series of field experiments.

3:48:51  
CDFW Broadcast: Which I'm not even gonna be covering the methods of those there. But basically we we were able to. We we observed extremely elevated levels of predation on juvenile salmon in areas that were artificially lit at night in the Delta which allowed us to develop a model for predation risk in relation to specific illumination levels in these lit areas.

3:49:17  
CDFW Broadcast: so the next task would be to translate this to a landscape or population level.

3:49:25  
CDFW Broadcast: however, there's no inventory of lights in the Delta, and, in fact, there's not really any inventory of lights

3:49:32  
CDFW Broadcast: hardly anywhere, because there's not a lot of regulatory framework about installing lights. You're you're able to install lights generally, anywhere anytime if you want and there's not a lot of rules about that.

3:49:47  
CDFW Broadcast: So we we wanted to. We wanted to inventory all of the lighting sources in the Delta, and we started off thinking about using satellite imagery or flying drones around at night with cameras. But in the end these were kind of boondoggle ventures, and we ended up collecting this data through brute force. So we essentially

3:50:08  
CDFW Broadcast: drove around the Delta at night in a little aluminum skiff. This is. This is the light meter. They're cheap. They're easy to use. This thing costs about $2,000, and we mounted it to the bow of our boat and waited until well after sunset on moonless nights, and drove around with a GPS

3:50:27  
CDFW Broadcast: anytime we got to an area where we observed illumination that appeared to be shining on the water. We'd stop and take transects to develop 2 dimensional raster data of the distribution and intensity of light.

3:50:44  
CDFW Broadcast: So this is. This is what that looked like at a landscape level. In general, the Delta is a pretty dark place, because it's not super urbanized.

3:50:53  
CDFW Broadcast: Although we did identify about 150 areas that had measurable amounts of artificial illumination docks, bridges, marinas, street lights.

3:51:03  
CDFW Broadcast: houseboats that were permanently moored.

3:51:05  
CDFW Broadcast: etc, and these light sources are generally evenly distributed through all of the channels that are relevant for migrating fish. So up to San Joaquin, down the Sacramento and all the

3:51:16  
CDFW Broadcast: steamboat Sutter Slough, Georgiana, etc. There's a lot of variability in the brightness of these spots, and also the area like some of these are just one single light source. Others could be an entire like Marina complex.

3:51:32  
CDFW Broadcast: So I'll show you a couple examples of

3:51:34  
CDFW Broadcast: what that data looked like

3:51:36  
CDFW Broadcast: this is the old River railroad bridge just downstream of the Delta, the South Delta intake pup facility. So any fish that's getting sucked that way from the north. Delta's going under this

3:51:46  
CDFW Broadcast: bridge

3:51:48  
CDFW Broadcast: and you can, see they're super bright lights. The channel here is like maybe a couple of hundred feet wide, and it's super shallow there. So any fish that's headed this direction is gonna be caught up in that

3:52:02  
CDFW Broadcast: and as far as I can tell, these lights aren't really even serving any kind of purpose.

3:52:09  
CDFW Broadcast: here's another example. This is some industrial facility along the Sacramento River, near Ayleton.

3:52:15  
CDFW Broadcast: This the light here only permit. So this, this is like.

3:52:19  
CDFW Broadcast: this is where the picture is taken here, and the light is only permeating at least a measurable amount about halfway across the channel.

3:52:28  
CDFW Broadcast: And again, these lights are not intending to light up the water for any reason. They're just in the parking lot.

3:52:37  
CDFW Broadcast: this is the Rio Vista Bridge, which is kind of a medium level of brightness all the way across. So any fish headed this direction is going to get

3:52:46  
CDFW Broadcast: caught up in that.

3:52:48  
CDFW Broadcast: So yeah, we have this for basically all of the navigable waterways in the Delta. Now.

3:52:56  
CDFW Broadcast: and so this what I'm what I'm going to share here is kind of more of a thought experiment than anything else. This this isn't really like

3:53:06  
CDFW Broadcast: the numbers aren't really quotable. And I guess this is like my comic relief slide with all the equations that I can't really fully explain right now. And I also have a phi, but it's a totally different phi than Garfield is explained there. But basically we know from telemetry studies that

3:53:23  
CDFW Broadcast: fish migrating through the Delta. And we're gonna use the example of the main stem Sacramento, from like Freeport to Rio Vista. They can experience anywhere from a hundred percent to 0 mortality. So like, if a million fish

3:53:37  
CDFW Broadcast: enter the delta depending on the conditions, when these smolts are migrating through, like all of them, might die if it's really poor conditions sometimes almost all of them make it. Super variable cross years.

3:53:51  
CDFW Broadcast: So we have that whole like

3:53:54  
CDFW Broadcast: suite of baseline survival scenarios

3:53:57  
CDFW Broadcast: and what we did is we broke that 50 kilometer section of river into 10 meter segments

3:54:04  
CDFW Broadcast: assign a proportional survival associated with whatever the baseline survival rate is. And then along these transect lines like, let's use this one as an example. These are a bunch of points. So each one of those points has a baseline survival rate, and then we assign the additional risk associated with the actual brightness of that point. And that's that's data that's informed from our empirical studies back in 2019.

3:54:31  
CDFW Broadcast: We take the average of all of the points along any given transect to come up with a new adjusted survival for that 10 meter reach. And then, if you multiply those altogether, you get an adjusted region, wide survival rate for an entire cohort of fish that are traveling through, and then, if you subtract that from whatever your baseline scenario was, you have an estimate of how many

3:54:55  
CDFW Broadcast: fish are dying because of these lights? Or, conversely, if you were to remove the lights and and do that restoration action like, how many might it save and again, this is super back of the envelope. But I think it's really useful to think about

3:55:12  
CDFW Broadcast: And so this is what that looks like on the X axis. This is this, this is the baseline survival rate. So 0 fish are making it as a baseline. A 100 fish are making it as a baseline like not accounting for the lights.

3:55:26  
CDFW Broadcast: And then on. We'll talk about this black axis first. This is the number of fish that would be saved by removing the lights for every 1 million fish that enter the Delta.

3:55:38  
CDFW Broadcast: So like just in the middle of our baseline here, like, let's say, we're assuming a 50% survival rate. A 1 million fish enter the Delta. 500,000 are making it pass through your vista. If we were to turn off all the lights that we observed in our survey. We estimate that, like somewhere between 2 or 300 fish would be

3:56:00  
CDFW Broadcast: saved. Which doesn't sound like a lot. But as a percentage of the population increase for this like life stage, which is only a couple of days long, we're, you know. And we're talking about fifths or tenths of a percentage point which, like sounds puny. But there's millions and millions of fish that

3:56:19  
CDFW Broadcast: move through this system every year, and it's year after year, and we throw all kinds of money at

3:56:25  
CDFW Broadcast: restoration. Actually, though, we can't even we don't even know if it's having an effect on, you know, a positive effect on whatever it is we're trying to measure. So

3:56:34  
CDFW Broadcast: anyway, it's just kind of something to think about.

3:56:39  
CDFW Broadcast: this is another product that came of this. It would maybe be a little ambitious to go address every single source of artificial illumination in the entire region. But can we rank

3:56:50  
CDFW Broadcast: them or prioritize potential restoration sites? And so at least, using our framework for what might be affecting fish? The each one of these points is a specific location, like it might be a marina, or a bridge, or dock, or streetlight, or whatever and then the darkness of that spot is a z-scored estimate of how many fish it might be affecting negatively. And there's some pretty clear outliers.

3:57:17  
CDFW Broadcast: And then on the axes. There's the like, the surface area as well as the actual brightness, intensity. And so in our framework, at least, it's not just one of those that is skewing all of these points. It. It also depends on the

3:57:32  
CDFW Broadcast: the channel size and things like that.

3:57:35  
CDFW Broadcast: So that's just another product to come of this.

3:57:39  
CDFW Broadcast: So

3:57:40  
CDFW Broadcast: this is my summary slide here. I'm making a pitch to restore darkness. I think this is a

3:57:47  
CDFW Broadcast: a worthwhile thing to think about in an ever brightening world. There's some really obvious solutions most of the time. We have lights that aren't even doing anything at night like

3:57:59  
CDFW Broadcast: parking lots and industrial facilities. Just leave lights on and like. Sometimes it's for security reasons. But like.

3:58:06  
CDFW Broadcast: who knows how much that really matters? And there's, you know, automatic timers.

3:58:12  
CDFW Broadcast: You can just ask people to turn them off when they're not using them. You could install scaffolding to just minimize how much the light is reaching the water surface.

3:58:23  
CDFW Broadcast: There's there's obvious benefits like. I only talked about

3:58:27  
CDFW Broadcast: this one paradigm of juvenile salmon smolts swimming down this linear dimension of the river, but like this could have benefits to all kinds of other wildlife. It's presumably affecting all kinds of

3:58:40  
CDFW Broadcast: fish up and down the food web as well as like non aquatic species.

3:58:44  
CDFW Broadcast: And there's also uncontroversial compared to a lot of other types of restoration actions that we talk about. It's inexpensive. It might even save people money, and it can be implemented quickly.

3:58:57  
CDFW Broadcast: and then the benefits reoccur like you only have to do this once and then, and then you're good, like you don't have to go do it as long as

3:59:05  
CDFW Broadcast: is left. And yeah, if if they're leaving the lights off

3:59:10  
CDFW Broadcast: and then, of course, the caveats is that lights are getting cheaper, and we're installing them

3:59:16  
CDFW Broadcast: quicker than ever. And since we did this survey a couple of years ago. Going back out to these places. There's even more like housing developments with super bright lights that weren't even there. And then, most importantly, this is obviously not a pitch to say this is a silver bullet solution to restoring salmon populations at all.

3:59:37  
CDFW Broadcast: But something we're thinking about

3:59:40  
CDFW Broadcast: and with that I'd like to say thanks, and I think I might have time for a question or 2.

3:59:48  
CDFW Broadcast: Look for anything else.

3:59:56  
CDFW Broadcast: Yeah, really interesting ideas. Do you? Do you know anything about

4:00:02  
CDFW Broadcast: the characteristics of the light underwater below the surface? In other words, what? The what the fish might actually be experiencing?

4:00:10  
CDFW Broadcast: Yeah, totally. Yeah. Simplified. Alright, yeah. Glass. By an entire body of literature and also studies we've done about. Obviously, the light attenuates quickly underwater

4:00:24  
CDFW Broadcast: and the the the way fish experience. It depends on the angle that it's coming in, and the wavelength or the distribution of different wavelengths

4:00:32  
CDFW Broadcast: that it's coming in. And that's like a huge question. But yeah, these the the risk estimates that we made were for the surface intensity in the Delta. So in the like.

4:00:45  
CDFW Broadcast: in this actual environment?

4:00:49  
CDFW Broadcast: and so it's it's most comparable to just think about like, what is the

4:00:55  
CDFW Broadcast: intensity of the light at the surface of the water?

4:00:58  
CDFW Broadcast: Assuming that you're not talking about a super deep habitat.

4:01:02  
CDFW Broadcast: Yeah, yeah, I guess I get the sense that

4:01:06  
CDFW Broadcast: it's it's a logical place to start. But I could imagine that some of these lights would could differ considerably, you know, depending on the angle of incidence, perhaps more than in anything you know, that's gonna have a big effect on how much of those you know, what? What? What proportion of that light energy is actually penetrating the surface.

4:01:26  
CDFW Broadcast: yeah, I think there's lots to do, obviously. But it's a great start. Super interesting.

4:01:36  
CDFW Broadcast: Thank you. Thank you.

4:01:38  
CDFW Broadcast: Copy

4:01:46  
CDFW Broadcast: alright. Thank you very much. Everybody. We're gonna go to a break now before our final session for the workshop which is on troubled waters. So you're definitely gonna want to stick around for that. And please be back here at 3:15.

4:02:01  
CDFW Broadcast: There should still be coffee in the lobby, so

4:02:05  
CDFW Broadcast: get your last little caffeine fix.

4:02:08  
CDFW Broadcast: and, thanks again to ICF for sponsoring the coffee.

4:02:19  
CDFW Broadcast: Hi, everyone! I'm gonna be moderating for you all. Thanks for sticking around for the last session. But please also stick around for the early career awards which are gonna happen right after this.

4:02:32  
CDFW Broadcast: So first up, we have Anna Feerick. She's a PhD. Student at UC Davis. She's gonna present on identification of toxic contaminants in California sediments using non-targeted analysis and Hyalella azteca toxicity.

4:02:51  
CDFW Broadcast: Take it away. Thank you very much. Also you killed it on the pronunciation of everything. Hi, I'm Anna Feeric, and as you can see, my project is on non-targeted analysis. But first, before I introduce exactly what that is. I wanna focus on the bigger picture which you're all very aware. Why, we monitor aquatic environments. But I wanna talk about it in context of contamination.

4:03:11  
CDFW Broadcast: So monitoring aquatic environments ensures ecosystem health and organism survival specifically in a world of increasing contamination.

4:03:18  
CDFW Broadcast: California, in particular, where all these lovely photos were taken from various water bodies across the State

4:03:24  
CDFW Broadcast: has several monitoring programs, such as my collaborators, sediment monitoring program which use targeted analysis to focus on compounds that are already known to be toxic

4:03:34  
CDFW Broadcast:

4:03:36  
CDFW Broadcast: as people who study aquatic environments. We know that this isn't the whole story, and that there are plenty of chemicals out there that are unmonitored things like emerging contaminants, transformation products and complete unknowns, like the 6 ppb quinone that was recently discovered. That's killing the coho segment up in Washington.

4:03:52  
CDFW Broadcast: So for emerging contaminants, such as you know, 6 ppb. Quinone, how do we develop a cost effective method for monitoring all contaminants that may be present in our aquatic environments.

4:04:05  
CDFW Broadcast: One approach is nontarget analysis. Now, first, I want to explain target analysis. So this is when you use a chemical standard

4:04:15  
CDFW Broadcast: to identify a compound in a sample and quantify it. So if you think of chemical just chemicals in a sample as like a see, and each individual chemical is a fish. Targeted analysis is like a fishing rod where each bait is associated with one chemical.

4:04:33  
CDFW Broadcast: This means you have a limited scope because you're limited by the number of chemicals you have.

4:04:38  
CDFW Broadcast: but you get instant identification because you know exactly what your bait is, and you match it to your fish, or in this case you know exactly what your standard is, and you match it to your chemical.

4:04:48  
CDFW Broadcast: Unfortunately, we have a much bigger problem than just the limited scope we're working with. So the

4:04:54  
CDFW Broadcast: parallel approach is non-target analysis, which is theoretically capable of catching all chemicals that might be in a sample. Think of this instead of a fishing line. It's like a net.

4:05:03  
CDFW Broadcast: So this is a broad scope. Approach that you're able to scoop up everything that might be in your sample.

4:05:09  
CDFW Broadcast: But because you're taking such a broad approach, you're being way less specific. So you start out with something unidentified. You've got a whole bunch of fish, and you don't know what they are. So you start looking at identifying features like fins or color. In this case, when we're comparing it to this analysis method. We're looking at retention time on a chromatogram.

4:05:30  
CDFW Broadcast: And it's mass. So that's our 2 markers that we start out with. And as we go through the data collection process, we add more and more markers that give us a confirmed chemical identification.

4:05:40  
CDFW Broadcast: But you still need to purchase a standard to get that 100% confident identification.

4:05:46  
CDFW Broadcast: So we've got a little fisherman on the left, and he's caught 6 chemicals from his sample.

4:05:52  
CDFW Broadcast: It takes a lot of time and energy to identify each of these chemicals. So how do we select which chemicals we want to put our time and energy into? In this case, what's actually toxic in our sample.

4:06:05  
CDFW Broadcast: the approach for this is non-target prioritization. This is when you have a parallel or a separate data stream like toxicity that you use to select which chemicals are of interest. So in this case someone has developed a machine learning approach

4:06:20  
CDFW Broadcast: to predict toxicity for a whole bunch of compounds, which is theoretically usable for things like water samples. But, as I said before, we're using sediment samples.

4:06:31  
CDFW Broadcast: Not only is this a computationally intensive process, additional error because we're using predictive numbers.

4:06:37  
CDFW Broadcast: It doesn't work on messy samples. Sediment is too complicated and has too much organic matter and too much natural products to actually use a machine learning-based method that the EPA tends to favor.

4:06:49  
CDFW Broadcast: Things like Q. Stars for those of you who are familiar. But

4:06:54  
CDFW Broadcast: we have a whole bunch of measured toxicity data already being collected by California's monitoring programs.

4:06:59  
CDFW Broadcast: So using this data.

4:07:02  
CDFW Broadcast: is it possible to combine that data, this toxicity data with non-targeted analysis to improve our environmental monitoring.

4:07:12  
CDFW Broadcast: So

4:07:13  
CDFW Broadcast: now that we've had our question, I want to set the stage of, how do we get this data so that we can effectively prioritize our chemicals of interest. So the first thing we do is sample selection.

4:07:23  
CDFW Broadcast: We have historical data from the stream pollution trends program, which is my collaborator

4:07:27  
CDFW Broadcast: that has values from nontoxic to toxic over a range of site types.

4:07:33  
CDFW Broadcast: So we used historical data and got non-toxic and highly toxic as well as moderately toxic samples over agricultural open and urban locations from across California, which is the map on the left.

4:07:46  
CDFW Broadcast: We've also covered a bunch of geographical areas as well as a bunch of population densities. The reason we need a range of toxicities is because you can't prioritize chemicals when you think everything in them is toxic or nothing in them is toxic. So you need high concentrations as well as non toxic, or

4:08:04  
CDFW Broadcast: high toxicity values as well as non toxic values, so that you can properly correlate your data.

4:08:10  
CDFW Broadcast: So now that we've got our sample selection, we move on to our nontarget methodology coverage.

4:08:16  
CDFW Broadcast: What I want you guys to take away from this picture is that we've used several different instrumentation techniques to cover a bunch of different chemical types. So we've got volatile and non-volatile as well as polar and non-polar compounds. So we're trying to get as big of a net as possible.

4:08:31  
CDFW Broadcast: So what we ended up with after casting this net is 2,449 features.

4:08:37  
CDFW Broadcast: This is where the prioritization starts.

4:08:40  
CDFW Broadcast: So collecting our actual data that we're prioritizing with. We did 2 kinds of tests, really 3, but 2 parallel data

4:08:48  
CDFW Broadcast: collections. The first was our standard toxicity tests. This is when we take our segment samples, sticking them in a beaker, put clean water on top, and put our high Llalaesco organisms inside, and we see if they grow, or if they die.

4:09:01  
CDFW Broadcast: this is mimicking a natural environment. So we have chemicals that are naturally leaching out of the sediment.

4:09:08  
CDFW Broadcast: And should hopefully mimic. What would happen in a stream bed system, or something similar

4:09:15  
CDFW Broadcast: parallel to that. We took our non-target extracts that were put in our instrument, and we did the same kind of toxic toxicity tests. We stuck organisms in clean water. We stuck some of our sample inside, and we saw if they died. The reason we did this is because we wanted to confirm that we were able to extract toxic compounds. We can't guarantee without this step that we have actually

4:09:40  
CDFW Broadcast: extracted and analyzed and detected compounds that we know to be toxic. So these are 2. Think of them as like Venn diagrams where they let line up our chemicals that we can detect. And we know Leach out in a natural system.

4:09:54  
CDFW Broadcast: So we've got our toxicity data. We've got our non-target data. Now it's time to correlate them. Hooray! For all the data, lots of data points. So like I said before.

4:10:05  
CDFW Broadcast: this on the left is our 2,449 features. It's a lot of dots.

4:10:12  
CDFW Broadcast: But the point I want you guys to pay attention to

4:10:15  
CDFW Broadcast: are those green and blue boxes that is the those are. The features are unidentified chemicals that were correlated with toxicity. You can see all those green triangles

4:10:28  
CDFW Broadcast: that is our direct. That's our extract

4:10:32  
CDFW Broadcast: tests. Those are extract toxicities. Those are all the features that were in our extract that were correlated with toxicity. This means our extract can extract

4:10:42  
CDFW Broadcast: or method can extract toxic compounds. Fantastic job for us. Now we've got to actually do that Venn diagram step to see where these 2 overlap. So where are features of interest actually sitting.

4:10:56  
CDFW Broadcast: So on the left, we've got our growth and survival toxicity tests. We ended up with 606 features

4:11:03  
CDFW Broadcast: correlated with

4:11:04  
CDFW Broadcast: natural system toxicity. And then on the right, we've got our extract tests with 802 features that were correlated with our sample. That was put our extract that was put on our instrument, and we use for detection. Together we get 290 features. Now, what does this actually mean.

4:11:21  
CDFW Broadcast: Well, we started out with 2,449 features. We got it down to 290 features correlated with toxicity. That's a 10 times reduction in the amount of data we have to go through. That is a huge decrease in the amount of time I have to spend looking at. I don't know

4:11:39  
CDFW Broadcast: almost 2,000 features that don't matter.

4:11:43  
CDFW Broadcast: or at least aren't necessarily of interest.

4:11:45  
CDFW Broadcast: Now

4:11:46  
CDFW Broadcast: we have to check this because just because they're correlated with toxicity doesn't mean they're actually toxic. Or, conversely, just because they're not correlated with toxicity doesn't mean they're not actually toxic how effective was this approach.

4:12:00  
CDFW Broadcast: So I want to just talk about the gas chromatography data, because that's the I think most straightforward of this.

4:12:07  
CDFW Broadcast: I know you guys are not chemists. So I'm going to walk you through this step by step.

4:12:12  
CDFW Broadcast: We started out with 700 features. This just means we got 700 mystery chemicals from this instrument

4:12:19  
CDFW Broadcast: after we did things like blank subtraction. Signal to noise ratio. Basically. Anything that we're like this might just be, I don't know a missed. This is just from the instrument. This isn't important.

4:12:32  
CDFW Broadcast: That got us down to 573.

4:12:35  
CDFW Broadcast: Then we library matched. That means we took the NIST mass library

4:12:39  
CDFW Broadcast: and

4:12:40  
CDFW Broadcast: compared it to the additional data we got through our instrument process to kind of give fingerprints to each of our, to each chemical compared to the NIST library. If those 2 line up, we say, yes, this is probably the chemical we're looking for.

4:12:57  
CDFW Broadcast: Then we took those and correlated them with toxicity. So on the far left we have core any compounds any library match features correlated with growth. Anything in bolded letters means I purchased a standard, and I confirmed, yes, this is the chemical we're looking for. We've we've gone through the whole process, and I can say with confidence, check, yes, this is absolutely identified. So

4:13:21  
CDFW Broadcast: some of the reasons these don't have bolts. Next to them is these chemicals

4:13:25  
CDFW Broadcast: either aren't purchasable or incredibly expensive to purchase or like for the PAH on the top left. Not found. We don't know what PAH, that is. We're pretty sure it's a PAH, because it's got a very distinct fingerprint.

4:13:41  
CDFW Broadcast: but

4:13:42  
CDFW Broadcast: actually doing the digging means that we have to go through several iterations of identification. But

4:13:48  
CDFW Broadcast: that being said.

4:13:50  
CDFW Broadcast: we were able to find industrial chemicals, plasticizers, 3 kinds of

4:13:56  
CDFW Broadcast: highly monitored pesticides, synthetic pesticide or synthetic musk as well as crude oil components, fossil fuels pesticide derivatives that's DDE I just have to confirm it.

4:14:09  
CDFW Broadcast: That were a hundred percent

4:14:13  
CDFW Broadcast: correlated with toxicity.

4:14:15  
CDFW Broadcast: Things we know to be toxic things that are of concern to the the Greater California monitoring program, we were able to say, yes, our

4:14:26  
CDFW Broadcast: procedure, our methodology, is able to find toxic features effectively. Now.

4:14:33  
CDFW Broadcast: is it able to find everything that's toxic.

4:14:36  
CDFW Broadcast: Well, we've got a whole bunch of not correlated stuff that you could see. Yeah, some of that's probably pretty toxic. We've got UV compounds. We've got PAH's plasticizers, gas-related compounds, a whole bunch of mystery pesticides, or

4:14:51  
CDFW Broadcast: a whole range of mystery, pesticides that

4:14:55  
CDFW Broadcast: might be there. So how do we go about

4:15:00  
CDFW Broadcast: incorporating additional toxicity measures so that we don't miss these compounds.

4:15:06  
CDFW Broadcast: One way to do this is incorporating bioassays. So we're not necessarily need to look for just mortality. We can also really hone in on what compounds are causing things like estrogen activity or aerial hydrocarbon receptor activity. So to really get an idea of what's happening on maybe a sub lethal effect scale, or on, you know, to the macro organisms you guys are interested in

4:15:33  
CDFW Broadcast: by incorporating these additional levels, we're able to start

4:15:37  
CDFW Broadcast: highlighting different areas of that big chemical ocean that I was talking about before and hopefully prioritize new areas of interest going forward. So in conclusion, it is possible to use toxicity results in combination with nontarget analysis, to improve environmental monitoring.

4:15:55  
CDFW Broadcast: combining multiple toxicity pathways. That is the growth and survival versus our direct extract tests, improves feature selection, and reduces the total feature space we're working with. So it narrows the amount of

4:16:07  
CDFW Broadcast: chemicals we're looking for. And then, if we incorporate orthogonal toxicity assays like bioassays, it should increase our prioritization power with this technique. And with that I want to thank our my lovely collaborators in my lab, and I will happily take any questions. Thank you.

4:16:28  
CDFW Broadcast: Thank you, Anna. We probably have time for one question. Quick, one.

4:16:41  
CDFW Broadcast: Hi, a really good job. Can you give me an example?

4:16:47  
CDFW Broadcast: Yeah, just one of the ones that's on the list that was correlated, correlated with toxicity, or just like, generally we found.

4:16:55  
CDFW Broadcast: Okay, so I believe there were quite a few terpenes and sesquiterpenes that ended up in there. I'd have to go back through and get like specific

4:17:07  
CDFW Broadcast: identifications for that. But there were a lot of terpenes ending up in this mix. So yeah, sorry I can't give you a better detail. But if you want to reach out to me, I will be able to give you that exact list.

4:17:20  
CDFW Broadcast: Thank you.

4:17:21  
CDFW Broadcast: Yeah.

4:17:34  
CDFW Broadcast: Okay. Next up. We have Louise Cominassi, Postdoc in the Segarra lab

4:17:41  
CDFW Broadcast: and in the department of Anatomy, physiology and cell biology at UC Davis.

4:17:48  
CDFW Broadcast: Take it away.

4:17:51  
CDFW Broadcast: Okay, thank you for the introduction and thank you for. So today I'm gonna talk a little bit about Chinook salmon just after the salmon session. So you probably know a lot already. But I'm gonna talk about it in context of this side.

4:18:06  
CDFW Broadcast: So in California it is 3 species of salmon and all of them are in decline, and Chinook salmon among them is no exception. In the 1800s we contain about 2 million spawning adults, and since then it's plummeted, and last year 2023. It was the third lowest record of adult spawning.

4:18:30  
CDFW Broadcast: and is the decline touches the full run. That's with the winter run and the spring run, characterized as endangered and threatened by the endangered species act.

4:18:42  
CDFW Broadcast: So why is that there? The reason are complex, but can be both down to the use of the landscape and the water. So in the 1800s the Delta was mostly fresh water and seasonal wetland. But in 200 years it's really shifted to urban area and agriculture. And with this shift gonna use up a lot of contaminant and pesticide.

4:19:06  
CDFW Broadcast: So the Bay-Delta is the receiving point of urban runoff and other source of contaminant.

4:19:13  
CDFW Broadcast: and in addition.

4:19:15  
CDFW Broadcast: insecticide use is predicted to increase by 4 to 174 by 2099.

4:19:23  
CDFW Broadcast: So when we talk about insecticide, they are multiple and in make sure in the Delta. But one that I'm gonna talk about today is by bifenthrin, which is the most commonly detected, insecticide the Bay-Delta system.

4:19:36  
CDFW Broadcast: and it's used for pest control. Again, for example, termite a cockroach, and ants it's from the family of pyrethoids and acts as a neurotoxin that binds to the sodium channel, affecting the release of neurotransmitter. So it over exceed the neural system leading to the death of the pest.

4:19:56  
CDFW Broadcast: And it's a problem because it acts not only on those species, but also on non targeting species in the Delta, so on, all fish and some studies show, for example, on juvenile Chinook, that it affected the olfactory system and them sensing predator, but also on other species, and they make to the Delta, and longfiin smelt affected the

4:20:22  
CDFW Broadcast: the size of the hatchling and the yolk volume or the behavior.

4:20:28  
CDFW Broadcast: So what was a question here? We wanted to assess the effect of different concentration of bifenthrin on the chinook that, exposed to them as they migrate in the Delta.

4:20:40  
CDFW Broadcast: and we are not. We're interested in the aquatic concentration, but also the body residue, because the pesticide accumulate in the fish. Throughout the diet.

4:20:52  
CDFW Broadcast: and it's part of a bigger project that want to create a spectral framework or tool that establish a relationship between the body burden or the tissue residue and different physiology aspect.

4:21:07  
CDFW Broadcast: So how we did that we had fish that were about 4 to 5 months old, and we exposed them for 10 days to different concentration of bifenthrin. So we had first a control, a low condition. I went 215 nanogram per liter a medium condition at 500 nanogram per liter and a high concentration.

4:21:26  
CDFW Broadcast: So we had a first exposure at 2,000 nanogram per liter. But we had a lot of mortality. So we ran different exposure. We've lower at 1,000 nanogram per liter. And I'm going to explain why multiple exposure in a minute.

4:21:40  
CDFW Broadcast: But both concentration might appear a bit higher than what is found in the Delta. But, as I mentioned, the goal was really looking to the body residue, and if we have an example of low concentration. The body residue that we end up with. It is close to what we have in field called fish.

4:22:00  
CDFW Broadcast: So we wanted to measure a lot of different endpoint. And that's why we ran different exposures. So we needed enough fish to have strong and robust statistics. So we ran a first exposure with at the end we measure for thermal tolerance, and then the second one, where we measure different endpoint as behavior and exposure tolerance.

4:22:20  
CDFW Broadcast: and a little bit more about those endpoints of physiology. So upper thermal tolerance and hypoxia tolerance are great indicator of the fish health as they give input about the cardio respiratory system and behavior is a good indicator of fitness. I give input on the locomotion the ability for foraging and the ability to escape predator.

4:22:45  
CDFW Broadcast: So for upper thermal tolerance we slowly increase the temperature of the water and fish in which fish are until they lose equilibrium, so they turn body belly up, at which we remove them from the challenge, and for hypoxia it's similar, but we slowly decrease the oxygen, and if they turn belly up earlier, it mean that they are more sensitive to the either the temperature or the decreased oxygen.

4:23:14  
CDFW Broadcast: We measure also different behavior tray. So you can see, it's the type of recording that we get in this video. But for that we move fish in an arena, we let them to habituate for 10 min, after which we turn on the light and start the recording, and for the first 5 min we looked into the response to the light stimuli, and the next 10 min we looked at different

4:23:41  
CDFW Broadcast: routine behavior change, such as locomotion, so total distance move, velocity, cruising, the frequency of bursting, or the time they were freezing.

4:23:51  
CDFW Broadcast: but also trade off

4:23:53  
CDFW Broadcast: anxiety, thigmotaxis, which is also called wall hugging is the amount of time they spend closer to the wall, so the wall can kind of act as a shelter, or if they are more in the center of the arena.

4:24:07  
CDFW Broadcast: and finally, social interaction. So how much they stay close together, and we measure one body length from each other, and shrouding is a strategy against predator as it acts as dilution of confusion against the predator.

4:24:21  
CDFW Broadcast: So now for the result, there's gonna be a lot of result, but they are really interesting. So bear with me start starting with thermal tolerance. So, it was after the first exposure, so I don't have the high highest concentration. But we can see here it's this type of graph which is a survival graph. But instead of survival is the time where they turn belly up.

4:24:43  
CDFW Broadcast: and we have the time axis and the number of fish in one axis.

4:24:47  
CDFW Broadcast: and here, at medium condition, fish turn faster than other conditions, so they were more sensible to the increase of temperature

4:24:58  
CDFW Broadcast: compared to the control.

4:25:00  
CDFW Broadcast: And if we look at hypoxia tolerance, so, it's the same type of graph. But this time we had no difference between the treatment. They were all similar to the control.

4:25:12  
CDFW Broadcast: Now, looking at the response to a stimulus. So for Chinook salmon, when there is a stress they tend to either dive down. But since the arena is, is really shallow, the other type of responses they tend to freeze.

4:25:26  
CDFW Broadcast: That's what we can see in blue and a control. And it's after with time after the stimuli.

4:25:34  
CDFW Broadcast: and we group bin of 30 s, and we measure the time they were freezing within this bin of 30 s. So for control alone, just after the stimuli, they were freezing a lot well for medium and high they were.

4:25:47  
CDFW Broadcast:

4:25:48  
CDFW Broadcast: not freezing as much. So they didn't response this similar way as the control.

4:25:54  
CDFW Broadcast: and after 5 min they were all back at the same level of breathing time. So we think they recover from the stress of the stimuli at that point.

4:26:04  
CDFW Broadcast: So Bifenthrin changes the response to the stressor at medium and high concentrations

4:26:11  
CDFW Broadcast: for locomotion. There's a lot of parameters. So I choose to represent them on the spider plots. So what we have here, we have the control in blue, and if the parameter is closer to the center, it means that the parameter of the treatment decreased

4:26:26  
CDFW Broadcast: compared to the control. But if it's outside of the plot, it increased. And if you look first to the low concentration, we can see that there's a lot more freezing than the control while bursting and other parameters were reduced. And this type of behavior can be characterized as they overall move less

4:26:46  
CDFW Broadcast: for the medium. There were no significant difference between control and medium concentration

4:26:51  
CDFW Broadcast: and for the high it's the other way. Around. The freezing was reduced the while the bursting and over parameter will increase. So they were moving overall more. And we characterize this behavior by hyperactive.

4:27:06  
CDFW Broadcast: If we now look at the thigmotaxis. So, as I mentioned, is a proxy for anxiety and for the different treatments we looked, if they were more at the center of the arena or the border, and here, for medium and high concentration. They tend to go a little bit more in the center of the arena, so they have a reduced thigmotaxis or more like anti-anxiety, like behavior we can, which might suggest that they were more bold, and they likely to expose themselves to predator

4:27:36  
CDFW Broadcast: for social interaction. Again, we have the 4 different treatment. And this time we look into. If the fish we're staying closer to each other, and all of treatment were different from the control they tend to swim further away from each other. So they are losing this.

4:27:54  
CDFW Broadcast: social interaction. They're losing their shoaling formation and again shoaling is a good strategy against predators, so they might be more vulnerable to predators.

4:28:07  
CDFW Broadcast: So as a discussion. And that's where my title is not completely true and more nuanced than that because juvenile chinook salmon exposed to a concentration bifenthrin show more sensitivity with temperature but were pretty tolerant to different with hypoxia.

4:28:27  
CDFW Broadcast: So I can't really conclude yet what happened at the cardio-respiratory system, and it might be partially affected, and I will need to look more into underlying mechanism.

4:28:38  
CDFW Broadcast: But we clearly see an effect on behavior. We saw hyperactivity combined with reduced thigmotaxis, which

4:28:51  
CDFW Broadcast: overall suggest that the ability to hide from predators might be reduce.

4:28:57  
CDFW Broadcast: And it's actually, I've been seeing other species from the Delta like longfin smelt or delta smelt.

4:29:04  
CDFW Broadcast: and in addition to that, they are swimming less with the con specific, or at least away from con specific. So they are losing their own predator. Advantage from shoaling behavior

4:29:17  
CDFW Broadcast: so overall. It might, like higher concentration of befment, might increase the risk of tradition, which probably add pressure on this already declining population.

4:29:29  
CDFW Broadcast: So as future direction, we wanna look more into predator cue, and how predator directly affect the fish under the different concentrations of pesticide. And we're gonna also test all those endpoints with different insecticides, like fipronil, DDE, and mixtures of the three by entering bifenthrin, fipronil, DDE.

4:29:51  
CDFW Broadcast: And build the spectrum with this data, and actually, with this bifenthrin, the spectrum is kind of already built, and I might just Mike Lydy is gonna present more about the spectrum just after I finish here.

4:30:07  
CDFW Broadcast: So with that, I want to acknowledge the

4:30:10  
CDFW Broadcast: all the people in my lab, the Segarra lab, and Mike Lydy, and his lab in at SIU, and thank you, and I think I have some time for question.

4:30:26  
CDFW Broadcast: I think that

4:30:27  
CDFW Broadcast: 2 questions there?

4:30:33  
CDFW Broadcast: So it's a 2 part question. The first is, how did you administer the toxicant like? And then the second is in the environment. Do you expect them to get it through the gills or through feeding?

4:30:46  
CDFW Broadcast: So how we administer is we spike the water of the tank

4:30:51  
CDFW Broadcast: and then we measure both what we spike like in the water and in the body of the fish.

4:30:58  
CDFW Broadcast: but in the wild fish are both exposed to aqua concentration and through the diets, and by fenturing there's a lot in the sediment as well. So it's likely that what they eat gonna be exposed in the sediment or in the water column, and then, as they eat is gonna accumulate in their body.

4:31:20  
CDFW Broadcast: Thank you.

4:31:21  
CDFW Broadcast: I think I had a second question, if I have time. Okay.

4:31:26  
CDFW Broadcast: Hi, a wonderful talk. In your spidergram, it seemed that the low concentration resulted in one behavior and the high concentration resulted in the complete opposite behavior. I wonder if you just comment on that like, maybe why, or if that's common. Yeah, it actually happened sometime in toxicology with toxicology, and I usually use the example of when you drink alcohol. If you drink alcohol you might be a little bit tipsy and excited and social at the beginning. As you

4:31:55  
CDFW Broadcast: increase your consumption of alcohol, you might be more sleepy. So it's kind of a dose-basede response that's happening there.

4:32:02  
CDFW Broadcast: But yeah, I don't know the underlying mechanism that

4:32:06  
CDFW Broadcast: that hall explaining that.

4:32:09  
CDFW Broadcast: Thank you.

4:32:21  
CDFW Broadcast:

4:32:27  
CDFW Broadcast: Okay, next up we're Jacqueline Lang. She's a Ph. D. Student at UC Davis, Department of Anatomy, Physiology, and Cell Biology. Her research focuses on microplastic contamination in Lake Tahoe, and the effects of tire related chemicals on, threatened Delta fish species, and I'll let you introduce your topic. Go ahead.

4:32:48  
CDFW Broadcast: Thank you. Hi. I'm Jackie Lang. And today I'm gonna be talking to you about a project that I've been working on for the past year and a half, looking at the toxicity of 6PPD-Quinone in California fish species.

4:33:01  
CDFW Broadcast: So up in Seattle, Washington. For the past 30 years people have been observing coho salmon like the one on the picture on the left after stormwater events where the salmon is observed, surface swimming and losing equilibrium. They have increased gasping and ventilation.

4:33:20  
CDFW Broadcast: and then, within a couple of hours of observing these fish. They almost always result in mortality. And it took a lot of researchers a long time to figure out what was happening, and they narrowed it down to a chemical that is, related to tire rubber.

4:33:36  
CDFW Broadcast: And so they they looked at the lethal concentration of this chemical in coho salmon, and found that the LC 50 is 0.95 micrograms per liter. Which is one of the lowest LC 50's. That the EPA has ever seen with a chemical they also looked at concentrations of this chemical in road runoff and receiving waters.

4:33:59  
CDFW Broadcast: And we see that in roadway runoff the concentration is much higher than the LC 50. And even in receiving letters in both Seattle and San Francisco, sometimes the concentration exceeds the LC 50 threshold and often it's just kind of hovering right around it.

4:34:15  
CDFW Broadcast: And so in the San Francisco Bay Delta. It's a highly urbanized ecosystem. It's home to many threatened and endangered aquatic species. And there's and that's equivalent to approximately 43,000 whole tires flowing into the San Francisco Bay every year in the form of tirewear particles.

4:34:35  
CDFW Broadcast: And so 6PPD-quinone is not actually an ingredient entire rubber. But it's the transformation product of an ingredient in rubber. The ingredient is 6PPD.

4:34:44  
CDFW Broadcast: And it's a really important chemical to the safety of tires and the longevity of tires because it protects the rubber from attack by ozone, which causes cracking and crazing, and can lead to blowouts on the road. And without 6PPD. We would be burning through tires much quickly than we currently do. It is ubiquitous. It's in almost every commercial and passenger tire on the planet.

4:35:09  
CDFW Broadcast: And this reaction that it's designed to undergo unfortunately, results in this unintended transformation product 6 ppd, quinone.

4:35:19  
CDFW Broadcast: and so this was all discovered back in 2020. It's very still very recent, and California is the first to regulate 6PPD. The Department of Toxic Substances control listed 6PPD. As a priority product back in October, and then, just a few weeks ago, the US Tire Manufacturers Association submitted a stage one alternatives assessment. Looking at a bunch of different chemicals that could potentially replace

4:35:42  
CDFW Broadcast: 6PPD and scoring them based on their hazard toxicity of the parents and the derivatives to salmonids exposure potential, and also the performance as an anti-degradent and this alternatives analysis resulted in 5 out of the 40 can candidate chemicals moving on to stage 2. So in about a year we can expect an updated literature search and in depth evaluation of hazard and exposure potential

4:36:07  
CDFW Broadcast: and also quantification of the economic impacts of potentially making a switch

4:36:13  
CDFW Broadcast: but the goal of my project is to assess the lethal and sublethal effects of 6PPD-quinone to California fish species of concern. These are the 5 species I'm working with coho salmon, Steelhead, Chinook salmon, Delta smelt, and longfin smelt and I'm Gonna mostly focus on the salmon results today because I'm still working on the smelt but for each of these species I tested the larval and juvenile stages and so

4:36:38  
CDFW Broadcast: for each species and life stage that I'm testing. I start by determining the Lc 50 or the lethal concentration for 50% of the population. And we get a curve that looks like this. We have a concentration on the X axis and mortality on the Y and these curves are really helpful for risk assessments. But it was also really helpful for us, because it allowed us to determine the no observed effect concentration.

4:37:01  
CDFW Broadcast: and that was helpful, because, after figuring out the Lc. 50, we move on to sub lethal effects tests, and that no absorbed effect concentration is the highest concentration that we use for our sub lethal exposures.

4:37:13  
CDFW Broadcast: So Louise and Mike already talked a little bit about thermal tolerance. So I won't touch on this too much. But basically, after a 96 h exposure, the fish will be put into a bath like in the picture on the right, and the temperature heated slowly over the course of a day, and the the fish are separated, based on the treatment that they were exposed to. And the fish are observed until they lose their equilibrium. At what's

4:37:38  
CDFW Broadcast: point. They're removed from the heated tank and put into a recovery bath. And we chose to do this test because of those observations in the field of the increased gas being and ventilation. Which suggested there might be some cardio respiratory effects. And this thermal tolerance test assesses overall cardio respiratory fitness.

4:37:59  
CDFW Broadcast: Then we also are assessing changes to behavior and to do this we do again do a 96 h sub lethal exposure, and then we take individual fish and place them in bowls.

4:38:09  
CDFW Broadcast: where we record their movements over the course of 30 min and then use ethosion animal tracking software to track their movements. And so similar endpoints to Mike and Louise's studies like bursting, cruising, and freezing and we chose this endpoint as well, because the

4:38:29  
CDFW Broadcast: observations in the field of the loss of equilibrium and surface swimming suggest that there might be some neurologic changes happening as well. And that behavior is a sometimes a good test for for neurologic effects.

4:38:44  
CDFW Broadcast: Okay, so the preliminary results from, for lethality are here. I have an example of one of the Lc. 50 curves that I generated for a coho salmon larva on the left. But on in the turn on the right you can see that the Lc. 50 that I got for coho salmon larva was 0.086 micrograms per liter which is right about what other researchers are seeing as well. So it kind of acted as a positive control for the rest of our species that we tested.

4:39:11  
CDFW Broadcast: The juveniles are slightly less sensitive with an Lc. 50 of 0.138 micrograms per liter and then Chinook salmon do not seem to be sensitive at all. We tested concentrations as high as 538 micrograms per liter, which is way higher than what we see in the environment. And we didn't see any mortality

4:39:28  
CDFW Broadcast: and that's kind of interesting, because there was a study that was published in BC. Canada recently, where they were testing Chinook up to a concentration of 67 micrograms per liter, and they were seeing mortality. So we think that there may be. You know, there's obviously differences in susceptibility between species, but also potentially within species based on genetically distinct populations.

4:39:51  
CDFW Broadcast: And then in a larval and juvenile steelhead, we got an Lc 50 of about 3.3 and 3.5 micrograms per liter and this is really similar to what people are seeing in rainbow trout as well.

4:40:03  
CDFW Broadcast: but based on the concentrations that we're seeing in the San Francisco Bay region. We expect that 100% of coho salmon will experience mortality due to 6PPD-quinone exposure and 14% of steelhead are expected to experience mortality as well.

4:40:20  
CDFW Broadcast: These are the results for the critical thermal tolerance. Test. Read an example of what our data looks like on the left this is the Chinook salmon larva and we see that in the 100 micrograms per liter treatment the fish did slightly better than the control. And we think the reason for that is that the

4:40:40  
CDFW Broadcast: fish that are exposed to sublethal 6PPD-quinone are kind of up regulating their stress response mechanisms. And so they were potentially just a little bit better equipped to handle that thermal stress compared to the controls. And so for coho salmon and steelhead, we did see changes in critical thermal tolerance at environmentally relevant concentrations. But for Chinook salmon we did see a change, but it was at a really high concentration.

4:41:08  
CDFW Broadcast: This is a lot of data. So I'm not going to go too much into it. But basically the plots

4:41:14  
CDFW Broadcast: on the top row are for larva, and the plots on the bottom row are for juveniles, and then we have the 3 species in each column, and what we can see is there are changes to behavior. And actually, every single species and life stage has a change to behavior at an environmentally relevant concentration, including the Chinook salmon, which again, we weren't seeing any mortality for

4:41:38  
CDFW Broadcast: and this is concerning because changes in behavior can affect the fish's ability to escape predation and to forage for food and can overall affect fish populations.

4:41:54  
CDFW Broadcast: So, in conclusion, coho, salmon and steelhead experience, acute lethality at environmentally relevant concentrations of 6 PDD-quinone. There might be differences in susceptibility between populations of the same species like what we're seeing with our Chinook

4:42:09  
CDFW Broadcast: and environmentally relevant concentrations of 6 ppd. Quinone cause changes to behavior in all tested species and life stages, suggesting that 6PPD-quinone may act as a neurotoxicant, which is also slightly supported with some other studies that have been coming out recently.

4:42:25  
CDFW Broadcast: And we've been saving our exposed fish in the minus 80. So we're hoping to do some future mechanistic studies. But we're in the process of looking for funding for that and I was really bummed that yesterday I missed the poetry slam. So. This is my unofficial submission in the form of a Haiku

4:42:42  
CDFW Broadcast: rubber meets the road

4:42:44  
CDFW Broadcast: Salmon dance in toxic streams

4:42:48  
CDFW Broadcast: Fish drama unfolds

4:42:52  
CDFW Broadcast: Thank you I'd like to say thank you to Amelie Segarra. Who's my PI, and everybody in my lab who has helped so much on this project. And all of the other PI's. The funding came from California Department of Fish and Wildlife through prop One. So I'm happy to take any questions.

4:43:11  
CDFW Broadcast: Thanks, Jacqueline, we have time for a couple questions.

4:43:28  
CDFW Broadcast: How long has this chemical been present in tires

4:43:33  
CDFW Broadcast: since? Like the 50 s.

4:43:35  
CDFW Broadcast: Yeah. So

4:43:37  
CDFW Broadcast: it was developed by the US Military for military vehicles, and within 5 years of it being developed, was in pretty much every single tire on the planet. So since the fifties, it's been around and it is interesting that coho Salmon have been extirpated from the bay for a long time.

4:43:58  
CDFW Broadcast: you know, can't really make any definitive conclusions about that. But it's interesting.

4:44:04  
CDFW Broadcast: Thanks, great talk. What's our monitoring like for this chemical in the watershed? It's the data is very sparse still. There have been a few detections in the San Francisco Bay, and a couple of other

4:44:21  
CDFW Broadcast: A tribute tributary is really close to the bay, but in the general Delta. We we really don't know what the concentration is like, but we're finding 6PPD-quinone all around the planet. The highest concentration I've seen is in the Don River, near Toronto. We're finding it in air, and soil, and urine, and fish in supermarkets.

4:44:45  
CDFW Broadcast: It's everywhere.

4:44:50  
CDFW Broadcast: Thanks.

4:45:00  
CDFW Broadcast: Oops.

4:45:01  
CDFW Broadcast: Okay?

4:45:03  
CDFW Broadcast: Me?

4:45:06  
CDFW Broadcast: Okay. Last, but not least. We have Miles Daniels, assistant researcher from UC Santa Cruz and a NOAA affiliate. He will present monitoring and modeling pathogen exposure is salmon migrating to the Delta.

4:45:23  
CDFW Broadcast: Great thanks, everybody.

4:45:24  
CDFW Broadcast: I just came from a 3 day conference. I've been talking for 3 days. My voice is like toast. I had to leave the cough a couple of times, so if I start coughing during this I apologize. I need some rest of my vocal cords. So yeah, so I'm gonna be talking about basically how juvenile chinook are moving down through the system, how they're exposed to different pathogens, and what that means for their health outcomes.

4:45:44  
CDFW Broadcast: So

4:45:45  
CDFW Broadcast: I'm an epidemiologist, I think about things in this kind of epi triad, right? We have a host salmon. We've got some pathogens out there. And the environment. And what we're really trying to do is figure out how all those things are interact. Right. It's not just about the concentration of the pathogens. It's not just about the susceptibility of the Chinook or the temperature they're moving through, but it's all the combination of those 3 things, how that really plays out. And so this goal, the project of this or the goal of this project, is really to fill data gaps essentially, around disease transmission in Central Valley, Chinook salmon.

4:46:14  
CDFW Broadcast: And we're kind of doing it through a 2 tiered approach. We're taking environmental monitoring data as one to see what's out there, and then merge that with kind of models to try and understand, what can we predict to occur under these different circumstances.

4:46:29  
CDFW Broadcast: So my goal for today is really to kind of give you a brief overview of this project I should have mentioned. This was a project funded by prop one with some other funders, which I'll get to at the end. And so there was a lot that was done. There's been a few publications coming out more to be expected. But I really just want to peak people's interest, because this project was a 2 year project. We discovered some things. But we really developed more questions than anything.

4:46:55  
CDFW Broadcast: So here are the 4 main objectives. Step, one is really just screening what's in the environment. There's been some work done, but it really hasn't been done in a systematic fashion. So we need to know what's in the environment right before we can kind of start looking at effects on salmon. If we were to find no pathogens, it would be unlikely that any fish will be getting sick, unlikely to find no pathogens, of course, but that's a good thing to first do.

4:47:17  
CDFW Broadcast: Of course, if we find pathogens in the water that doesn't really mean that all fish are getting sick right? There's this different susceptibilities. And so we wanna be able to look at what are fish actually experiencing?

4:47:28  
CDFW Broadcast: And then we want to build a model. Simulate this right? I'm a modeler. I like taking data, putting in the model, playing around with things. And then we want to build a web-based decision support tool to share this information. Not going really to talk about that today. Really, it's more 1, 2, 3.

4:47:42  
CDFW Broadcast: So screening the environment. What I mean by this is really collecting water samples. Right? Fish are moving through water. Of course we want to collect water samples to see what's in there.

4:47:50  
CDFW Broadcast: This map off to the side over here, showing you where our 12 sites were. We basically had 10 sites on the Sacramento River, 2 sites on the Feather river kind of longitudinally spread throughout those systems. And we'd go every 2 weeks.

4:48:03  
CDFW Broadcast: click, grab water samples for 2 years and have those analyzed.

4:48:08  
CDFW Broadcast: We analyze a few different things. One is, if you've heard anything about diseases in Pacific, Northwest salmon you've heard of C. shasta. It's very prevalent. It's endemic. It's supposed to be here. They've evolved together salmon and C. shasta, but we wanted to really identify that pathogen a little bit more and look into it because there's been some evidence indicating that it might be having some population health impacts.

4:48:27  
CDFW Broadcast: But we also wanted to be more broad, too. We wanted to say, Well, what else is out there. Guarantee. There's more things than C. shasta out in the system. It would be strange if there wasn't.

4:48:35  
CDFW Broadcast: So we did a kind of a large scale kind of broad screening approach, using some assays developed by Christy Miller up in Canada to look for 36 different pathogens that are known to infect some on it's this is kind of a mix of bacterial parasitic as well as some viruses.

4:48:50  
CDFW Broadcast: So that was creating the water.

4:48:52  
CDFW Broadcast: But, as I mentioned. It's not just about what's in the water, right? We need kind of multiple lines of evidence here to say that. Yep, we see it in the water. Do we also see it infecting fish?

4:49:01  
CDFW Broadcast: So to get at that a little bit more, we did what are called sentinel fish trials. This is essentially where we take fish of a known infection status, put them in enclosures in the river, let them be exposed to ambient conditions, and then kind of monitor them at different time points and essentially sample their tissues, which we think are targeted by certain parasites to see if we find, yes.

4:49:22  
CDFW Broadcast: this parasite which targets the intestine is actually in the intestine, i.e. there is some infection occurring.

4:49:27  
CDFW Broadcast: and we did this while screening the same, you know, collecting water, etc. So we can have that kind of matching up of evidence. And we did this at 4 sites shown on this map here. So Red Bluff Wilkins Slough, so kind of an upper and a lower on the river, as well as a Gridley, and Boyds landing on the Feather River.

4:49:44  
CDFW Broadcast: So that's screening tissues. But

4:49:47  
CDFW Broadcast: many of you are probably wondering. Well, you put a fish in a cage at one location. There are all kinds of cage effects that occur with study designs right around that. And so natural fish are moving through their environment in a much different way than a fish stationary at one location. So to try and get at that a little bit. We also partnered with folks at US Fish and Wildlife service up at Red Bluff, and took some of their rotary screw trap samples and looked at what kind of while out migrating salmon are doing

4:50:12  
CDFW Broadcast: for these fish. We only looked at their gills. So a gill is kind of a good indicator, but not necessarily gonna tell you if it's actually infected. So some of those samples are also assessed via histology with our collaborator, Dr. Scott Foot, to kind of really be able to say, yes.

4:50:27  
CDFW Broadcast: We see the pathogen, and we see the effect in the tissues kind of the gold standard.

4:50:33  
CDFW Broadcast: the model not going to go into it in depth. If you want to talk about it. I would love to talk to you more about them.

4:50:38  
CDFW Broadcast: But it's pretty simple model. It's used for not just salmon pathogens, but any other type of infectious disease. Essentially as an sir model where you break up your population into a susceptible, infected, or removed or recovered group. And then you can kind of really look at what the population dynamics are in response to a pathogen exposure

4:50:57  
CDFW Broadcast: for this model. We're really again focusing on C. shasta. It's a well documented pathogen. There's lots of other literature that's been done, and lots of other studies that have been done looking at like Lc, 50 curves and things like that. So we can kind of leverage that when we're modeling this and use that kind of out of out of basin information.

4:51:13  
CDFW Broadcast: But I will note that this is a flexible approach. Right? If you have a package of interest.

4:51:19  
CDFW Broadcast: The the framework is there. It's really a data limitation thing. If you don't have the data to be able to parameterize your model, it's not gonna work, but the framework is is very flexible.

4:51:29  
CDFW Broadcast: Okay, some results.

4:51:33  
CDFW Broadcast: this was a large effort. There is a lot more than I can talk about in this short amount of time. I'm gonna give you a very high level overview. But again, the goal is to peak interest, and we're always interested in having more collaborators and involvement. So if this kind of relates to your work somehow reach out.

4:51:50  
CDFW Broadcast: So what did we find in the water?

4:51:53  
CDFW Broadcast: very busy map. There's a lot going on here. This is really just focus on C. shasta, and what we observed in the water. So you've got the map. You're generally familiar with that. I'm pretty sure if you look at that pie chart at the very top saying global prevalence, that's just saying out of all the samples we took. How many had C. shasta at a detectable level? And it's about 3 quarters. So it's pretty prevalent in the environment.

4:52:16  
CDFW Broadcast: Next you can look at the kind of circles along all those little locations that we sampled right.

4:52:21  
CDFW Broadcast: The larger the circle, the generally the larger the levels of C. shasta that we detected right? And so this is kind of interesting, because you can see there's kind of a clear spatial pattern occurring right. There's kind of hotspots that we see in terms of where we see C. shasta on the systems, and that could be pretty important for delving deeper into what's happening in terms of population responses, salmon exposure, etc.

4:52:44  
CDFW Broadcast: And then those little bars. A lot of information here. Those little bars are essentially giving you the temporal signal. So each little grid area represents a sample from a biweekly sample

4:52:55  
CDFW Broadcast: color coded to that scale at the very top there. So red high levels of concentration blue, very low levels of concentration. And you can see there's not just you're right spatial variability. But there's often lots of temporal variability as well. And so when we're talking about Chinook runs for different runs right moving through the system at different times, different life stages. This is gonna play out pretty interestingly, in some of the modeling we do in terms of exposure and risk.

4:53:22  
CDFW Broadcast: So that's C. shasta, the real pathogen that we kind of focused on.

4:53:26  
CDFW Broadcast: But again, we looked for other things as well. I don't expect you to read this, although these screens are so massive that you actually can, which is great. So we've got basically the 36 pathogens we screen, for they're scaled to just relative abundance from the molecular work. It's not like there's more of them. It's just kind of a

4:53:42  
CDFW Broadcast: a proxy for that. But what you, what I want you to really focus on are the top ones, right? We found about 6 or 7 that were frequently detected in all of our sites, for the most part at pretty high levels.

4:53:54  
CDFW Broadcast: And so this is just begging the point that yes, you know, C. shasta is out there. People know about it. It gets a lot of press. There's other things that are going on. You know they're not. C. shasta is not working in a vacuum and affecting these fish. There's other pathogens that might be interacting that. So it's good to kinda keep that in the back of our minds when we're when we're looking at diseases and how they're

4:54:13  
CDFW Broadcast: affecting populations.

4:54:17  
CDFW Broadcast: That was what we found in the water. What do we find in some of the fish? This was some work published in conservation physiology, so I don't have time to go into it in detail. But read that talk to me, and we'll we'll discuss it more.

4:54:28  
CDFW Broadcast: Basically what we did. I would say, focus just on that top left. Yeah, your left. C. shasta plot. It says

4:54:37  
CDFW Broadcast: there's 2 kind of sections to this plot. There's a gill and a kidney tissue. You might be able to see it. I'm not gonna be able to find the cursor. Let's see, maybe I can

4:54:46  
CDFW Broadcast: laser pen. So that's day 0. This is day 7. This is day, 14, day, 21 after exposure from being put in the river right, the bars are representing essentially the prevalence. Just was it detected or not. And then these little cluster of dots is representing kind of the log abundance in terms of gene copies.

4:55:04  
CDFW Broadcast: What we see is that basically by day. 7.

4:55:07  
CDFW Broadcast: All the fish have it detected on their gills. That's not too surprising. Right? I mean, the gills are basically a filter. They're filtering all this water, so if we find it in the find in the water, it's likely to be found on the gill. What's more interesting is we do find it in the kidney tissue at day 14 and day 21, which meaning it's maybe it's going systemic. And it is low, actually a level of infection that we care about

4:55:26  
CDFW Broadcast: 5 min right? I got hurry up.

4:55:29  
CDFW Broadcast: So we we find it in the water, and we find it in the tissues.

4:55:34  
CDFW Broadcast: Another thing we did, which I didn't really go into too deeply was gene expression. This is just looking at different genes, and how they're up regulated. So we looked at pro inflammatory, anti inflammatory stress response.

4:55:45  
CDFW Broadcast: This is in the paper. I definitely don't have time to go into it. But there are associations between exposure and the up regulation or down regulation of certain genes. And that's just another line of evidence saying, yes, these fish are infected and physiologically responding to this infection, and that can have important implications right for avoiding predators, eating food, energy, the whole, the whole list of things.

4:56:07  
CDFW Broadcast: This is what we found in the wild salmon. So all those other fish we were looking at right? Those are kind of caged fish. This is the wild salmon. So this is about 2 years of sampling 80 fish per year at Red Bluff. Diversion dam.

4:56:19  
CDFW Broadcast: All the pathogens that we screen for on here don't really pay attention to that so much more just focus on that. We do see C. shasta very frequently in our samples.

4:56:29  
CDFW Broadcast: And so again, this is just another line of evidence that we see it in the water. See it in the caged fish, and we see it in the wild fish, too, and we're seeing it in the wild fish that have made it to that point in time.

4:56:43  
CDFW Broadcast: alright integrating the data into a disease transmission model. So this is is not gonna go. I'm not gonna be able to talk about this very detailed, but I will kind of give you a very high, level summary and again reach out if you want to talk about this more, you have ideas on how to improve it or collaborate. We're all ears.

4:56:59  
CDFW Broadcast: We kind of broke it out into these 4 main components here. So we need to know when fish are moving down through the system. That's our movement model.

4:57:07  
CDFW Broadcast: We need to know what they're exposed to as they're moving downstream. So we have a variety of models to do that. We care about temperature. We have a temperature model. We care about hydraulic conditions. We can have a model for that. And we also have kind of A C Shasta model based off some empirical data. So we can get a basically a time series of their exposure.

4:57:22  
CDFW Broadcast: We take that information and then we assess risk, and we do it through this approach called QMRA - quantitative microbial risk assessment. This is very popular in human health where I used to work a lot in. It's used by WHO. EPA. It's the way that you assess risk. Right? Say you're if you're swimming in a contaminated river, etc. So we're supplying those same principles to fish.

4:57:42  
CDFW Broadcast: And then I already mentioned this, where we kind of break it out. Into this, SIR model, this large kind of compartment model, we, we combine all that to be able to say what fraction of the population is susceptible, infected, or removed from being exposed.

4:57:56  
CDFW Broadcast: just like some other dose response people over here. We want to have a dose response. Right? We assume there is a dose response relationship. The higher the dose, the greater the response.

4:58:06  
CDFW Broadcast: This is coming out in the paper hopefully soon where we basically took 4 parameters. We have C. shasta to concentration. That's very relevant water temperature and channel velocity and duration of exposure. Mind, those kind of in a mixed effects. Logistic regression approach. There's some Bayesian fitting, and we wanna be able to predict what's the infection? Probability given your exposure history.

4:58:30  
CDFW Broadcast: Here are those results from those caging studies I talked about, so Red Bluff at the top Wilkins Slough at the bottom, Gridley at the top Feather River and Boyds Landing at the Bottom Feather River. The grayish is the prediction from the model, and the colored one is like the actual empirical data that we got.

4:58:47  
CDFW Broadcast: So you can see that one. The model fits the data pretty well. R squared is greater than 8 per 85%. So that's that's good. But more interesting to me, aside from a well fitting model is that there's some pretty interesting dynamics again occurring here that we kind of I kind of touched on already.

4:59:01  
CDFW Broadcast: where, for the most part after day, 14, which it might be hard for you to see. But prevalence of infection is very high, and this is in the intestine, I should note. So this is actual infection of fish. They're they're actually infected with C. shasta. So it's it's pretty evident there. But there's a lot of variation in day 7. some day 7 fish are not, and some day 7 fish are. And so there's a lot of variability there. And we also have to take this in context, right?

4:59:26  
CDFW Broadcast: You know, some fish might be moving through the system very fast, and spending less than 7 days in the system. Some might be spending a little bit longer in the system, such as natural, real fry, and so how this plays out in terms of population dynamics is something we're exploring a little bit further.

4:59:43  
CDFW Broadcast: All right, wrapping it up. Conclusions.

4:59:47  
CDFW Broadcast: We wanted multiple lines of evidence, right? Not just a single line of evidence. So we have water sentinel studies, rotary screw traps, and they really do point to see shafts of being detected pretty frequently in our samples as well as other pathogens of interest.

5:00:00  
CDFW Broadcast: But it's not just that we see it in the gene expression as well, and the histology that these fish are responding to these infections. So it's important for them.

5:00:08  
CDFW Broadcast: But this last point is very important, and something we really want to dive more into

5:00:13  
CDFW Broadcast: We really need to understand the fate of these infected fish. Right do they recover? Do they not recover? Are they are there. Side effects right that occur allows them to be eaten more frequently or just consume less energy. All these other things that we really need to take into account. We've kind of scratched the surface, but we need to do more.

5:00:32  
CDFW Broadcast: Think my time is up, so I will not go into future efforts. But I do want to say this was a large effort. A lot of people here involved on this, and a lot of names that aren't even on here. This is a big effort. I'm just here talking about it funding again from Cdfw. Metropolitan Water District, as well as some from California Department of water resources, and I think I put those

5:00:51  
CDFW Broadcast: up at the very beginning of the slides. Want to give them credit, and I'll say, Thank you.

5:01:02  
CDFW Broadcast: Thanks so much, Miles, I think in the interest of time we're gonna move on to the early career awards. Thanks again for your time.

5:01:30  
CDFW Broadcast: Alright, thanks, everyone. It's I've have some good news and some bad news. The good news is we're gonna finish early. The bad news is is because I haven't finished calculating all the scores for the early career awards.

5:01:44  
CDFW Broadcast: It's basically a function of the fact that we had a really great crew of early career scientists at the meeting this year, and we also had a lot of judges volunteer to spend part of their time at the meeting, going and meeting with early career scientists listening to their talks and taking detailed notes to evaluate

5:02:05  
CDFW Broadcast: which would be our our winning presentation. So keep your eye on your inbox. We'll be announcing the the winners over email. I did wanna share a couple of things with you, you know, for a little background about the process. All of the early career judges are scientists. Some of them are sitting in this room and they spent a lot of time looking at the posters. You know. I think a lot of us who, you know, are maybe mid-career, later career scientists, we kind of honed our chops in meetings like this.

5:02:31  
CDFW Broadcast: Even if you're new to the system. If this is your first IEP, you know these are the types of meetings where you, when you are a grad student or scientific aid or starting out as an entry level environmental scientist or a biologist.

5:02:43  
CDFW Broadcast: You know, these are the types of meetings where you honed those chops, you learn how to give a poster. You learn how to talk to experts. You learn how to talk to non experts. And you know, I think a lot of people maybe, are a little scared of doing that.

5:02:56  
CDFW Broadcast: But you know, I think the reality is, this is a incredibly welcoming environment for early career researchers. This is an excellent place to get started, because you're surrounded by a lot of folks who've been doing this for a long time and want you to succeed, and they want you to be better, and they want you to

5:03:15  
CDFW Broadcast: evolve as a scientist.

5:03:18  
CDFW Broadcast: So I just wanted to highlight, because I, you know, can't give up

5:03:22  
CDFW Broadcast: 20 min speaking slot jeez. When am I just gonna sit down? No, I wanted to highlight some of the words of encouragement that our judges gave to these next generation of IEP scientists. So these are some. There are some really excited judges. Wow! That is a complicated system of data. But nice job pulling together a whole lot of it.

5:03:44  
CDFW Broadcast: Lots of use of the word "cool", "cool use of existing, monitoring to ask questions, and a cool pilot study to address a clear monitoring gap."

5:03:52  
CDFW Broadcast: Important work for the exciting important work with an exciting future, very important research. With huge implications.

5:04:00  
CDFW Broadcast: The presenter was very articulate and knowledgeable about her topic. Super interesting, well executed study with extremely important conservation implications.

5:04:12  
CDFW Broadcast: Also some tips on. You know, people weren't afraid to pull punches. How would someone who uses this data explain it to their mom? Now, notwithstanding there are a lot of moms in this room with PhDs in ecology. So you know what I think, they're gonna be doing a lot of explaining to us data.

5:04:28  
CDFW Broadcast: but still good to think about. How would you explain this to a perhaps not all our moms have Phds in ecology or biology. How would you explain it to someone who's not a scientist? How would you explain it to someone who is a scientist who's not in your expert. There's a huge range of expertise as we've seen over the last 3 days, and being able to

5:04:47  
CDFW Broadcast: create a compelling and informative IEP talk is going to depend on your ability to speak to, not just those people in your niche. But everyone in this whole auditorium and and listening at home.

5:05:00  
CDFW Broadcast: For example, one of the judges "a nice addition of plain language to your talking points that really helps the broader audience's understanding." So anyway, that's it for me. Keep your eye on your inbox and we'll be announcing the winners soon.

5:05:22  
CDFW Broadcast: Yes, thank you, Ted. Thank you. Everyone. I've had a lot of people come up to me over the past few days. Oh, Rosie, you know you did a really nice job like putting together a great workshops like, what did I do? I took a amazing

5:05:40  
CDFW Broadcast: group of submitted abstracts, and I ordered them in a way that seemed to kind of make sense with the help of our whole planning committee. The

5:05:50  
CDFW Broadcast: great part of this workshop is the caliber of the science done at IEP, and the caliber of the presentations put together from that science. So I think everyone deserves a huge round of applause.

5:06:09  
CDFW Broadcast: But I do want to give a special round of applause to all of the people who really did

5:06:19  
CDFW Broadcast: the behind the scenes work getting the building reserved, getting the audio visual equipment working, getting the coffee bar in place, doing mic running, so can I have a huge round of applause for the planning committee, and our IT folks in the back.

5:06:47  
CDFW Broadcast: and one more round of applause in particular, for the IEP program support team, Christine Joab and Stephanie Fong.

5:06:57  
CDFW Broadcast: Christine in the back.

5:07:04  
CDFW Broadcast: and with that I think we can wrap up the 2024 IEP workshop. Continue doing the great science you do, and look for next year's workshop, planning to kick up in the fall. So if you enjoyed the workshop and wanna participate more actively next year we'll be putting out a call for planning committee members in

5:07:30  
CDFW Broadcast: in the fall. Yeah, anything I miss?

5:07:32  
CDFW Broadcast: All right.

5:07:34  
CDFW Broadcast: Well, thanks again for coming and all of the recorded talks will be posted online in a couple of weeks once we finish all of the closed captioning.

5:07:45  
CDFW Broadcast: All right.

5:07:46  
CDFW Broadcast: have a good night. Everyone.