Welcome, thank you all for tuning in this evening. My name is Haley Walker, and I'm the Communications Director here at The Freshwater Trust. I'm happy to be able to play MC for this event tonight and to introduce you all to some of the incredible work and the people who've been doing this work for now more than a decade in the Sandy River Basin. Just a little bit of background for you all on TFT. Our formal mission is to preserve and restore freshwater ecosystems. We were actually founded in 1983 as Oregon Trout, which was the first wild fish conservation group here in the Pacific Northwest. And over the past, about 37 years, our work has greatly expanded into new geographies, including California, Idaho, Washington as well. Now, in addition to geography, the nature of our work has also adapted with time, today we believe that only through strategic action and a laser focus on results can we really match the scale of the freshwater problems in our country on a timeline that matters. And speaking of outcomes, we are really fortunate to have the folks with us here to talk through some of what we've achieved together in the Sandy. Let me just go ahead and introduce you to them, we have Bruce Zoellick and Matt DeAngelo with the US Forest Service here, and we also have Mark McCollister and Daniel Baldwin with The Freshwater Trust. Before we dive into what they have to say, we just wanted to share a little quick video with you all that really sets the stage and provides a little context about our work here in the Sandy. So Caroline, can you take that away?

The Sandy River Basin starts at the very tip of Mount Hood, the very highest peak in Oregon, and tumbles down through Sandy and out towards Troutdale where its mouth meets the Columbia River. Following the ‘64 flood to reduce flood risk, the core of engineers and other government entities came into the Sandy River and diked the flood plains and took large wood and boulders out of the river. The thinking at the time was the quicker you can get water off the mountain, the less flood risk there'll be. That had detrimental impacts for flooding, and it also had really bad impacts for fish and fish habitat. So the Sandy Basin partners formed in 1999. They came together, comprised about a dozen different groups with one shared objective, and that's to restore habitat to benefit salmon and steelhead.

Today, we were using a helicopter to deliver large wood. The wood is what holds the rivers together. Without that wood, they start insizing and they get more and more degraded. One of the things people don't appreciate when they go out to rivers is how abundant wood would have been in the past, and how important is to fishing fish habitat. It is the large wood that knits everything together to create those scour pools, to create that pool tail out, to slow down that river so that gravel can be deposited for those fish to be laying their eggs in. We're actively putting wood back into the streams during a super tight in-water work window. We have 2000 pieces of wood going into these rivers to restore them. It's large wood that's kegged up in there that really creates nooks and crannies that juvenile salmon and steelhead rely on to complete their life history. So we'll do a restoration project, put water back onto the flood plain, and immediately we'll have juvenile coho in there September, October, instantly we'll have spring chinook spawning on the gravel that we created. Further into fall in November, we will have cohos spawning where water has not been on the flood plain for over 50 years. Fish always tell us if we've done a good job.

We have set up Still Creek to let the natural processes take over. Being done with Still Creek is a big deal because it confirms that we're on the right track, and it's something that provides momentum to continue work in the Sandy Basin.

Oh, awesome, thank you all for bearing with us there, you had to watch a minute or two the video over again, apologies for that, but I'm really excited to pass the mic over to Mark McCollister. Mark

is the habitat restoration director here at The Freshwater Trust. I also really wanna encourage you all to submit questions into the question and answer section of the webinar. We will have a whole Q and A after the presentation, so I encourage you to do that throughout the extent of the presentation and Mark, the mic is all yours.

Thanks, Haley and thanks everybody for joining. Salmon and steelhead are listed as threatened under the Endangered Species Act, and the loss or degradation of habitat is a primary factor in their status. In response to fish declines and Portland General Electric's decision to remove two dams on the Sandy Basin, the Sandy River Basin partners formed to restore habitat to benefit salmon and steelhead in the Sandy. This picture is of the Salmon River in Wildwood and like many sections in the river, you go out to the Sandy basin and you think it looks great, and it does look great, however, a deeper look shows that the river is still negatively impacted by two past landscape-scale disturbances. Next slide. The two primary drivers of degraded habitat conditions are basin scale clear-cut logging and responses to previous flood events. Extensive clear-cut logging occurred in the upper Sandy from the early 1900s to the 1970s. In large areas, logging cleared nearly every tree along miles of stream. Large trees and jams were moved from the stream channel as well. The second driver was our response to large floods. Specifically, the '64 flood on Sandy, which is the floor of record. The belief at the time was that the quicker you get water off the mountain, the less flood risk and less damage there would be to downstream landowners. To this end, the river was straightened and diked, and large wood was removed from the river corridor. These actions though eliminated the processes that are required to create the habitat conditions needed for abundant salmon and steel head. Without in stream roughness, rivers downcut and become disconnected from flood plains and off-channel habitat.

The picture on the right that you're looking at shows bulldozers on the upper Sandy following the 1964 flood, and then the picture on the left shows the resulting simplified stream channel. Next picture. This image is of the same reach, but shows an aerial view which really allows the viewer to see the straightened river segment. This is not the way a natural river is supposed to look. Next slide. To inform our restoration work, the partners developed a restoration strategy for the Sandy and prioritized sub-watersheds based on current strongholds of fish. The highest ranking sub-watersheds and where we are currently working include the Upper Sandy and Salmon River. Streams here include Clear Fork, the Zigzag River, Still Creek, the Salmon River and Salmon River tributaries, including the South Fork salmon, Sixes and Boulder Creek. Our approaches to identify current habitat conditions and reference or historic habitat conditions. Then the difference between these become our restoration targets. In this picture, you can see spring chinook holding on the Salmon River, and this image was taken a couple of weeks ago, right below one of our main project reaches. Bruce will now go into limiting factors and the restoration approaches we use...

Thanks, Mark. Could I have the next slide. To address the impacts and simplification of streams and river channels in the Sandy basin, we have used a natural river design approach to restoring complexity to stream channels. We build wood jams that emulate how stable wood accumulations naturally form in river channels, and we have also added back boulders and wood to channels to reduce the steepness of the channel and the incision of the channel from those past disturbances, and thereby increasing flood plain connectivity, and we do this in a way that both adding the boulders to the riffles emulates the natural processes that were there and the wood in the channel emulates the wood that would have naturally been there. By adding large wood in this way, and replacing boulders and riffle and pool tail outs, we restore river processes and maintain that complex fish habitat through time. By occupying the channel with jams, the river is no longer able

to quickly run down the valley and off the mountain. It has to find its way around the wood jams. As a result, water surface elevations are raised and flood plain connections are increased, river velocities are slowed and gravels are deposited upstream and downstream of the wood jams. Pool habitat is formed by flood flows, scouring pools against the face of the wood jams and inside channels where wood jams split the river flows helping to increase side channel connectivity.

These actions address limiting factors to fish production and many of the rivers in the upper Sandy basin, and those include limited amount of side channel or off-channel habitat for juvenile fish to rear in and adult fish to spawn in particularly coho salmon. And also a lack of pool or slow water habitats for both juvenile rearing and adult fish to hold in prior to spawning and a lack of spawning gravel with the size of gravels needed by salmon and steelhead to lay their eggs in. Next slide. At flow, as shown on the photo here on the left side, it seems like a pretty simple thing to add wood to a river channel, but in the photo on the right is the Salmon River on the same section of the river at a three to five-year flood stage, and it shows that adding complexity to large rivers is a pretty daunting task, there's a lot of energy in that river, and to do this successfully, you need a great team of hydrologist, hydraulic engineers and fish biologists. Next slide. Here's an example of a constructed wood jam that emulates the natural jam that would form at a point of a bar or an island.

Next slide. And here's an aerial view of the wood jam that was constructed on a bar on the Salmon River that shows the restoration of river functions by adding wood to the channel. Formerly wood in transport during flood flows was just leaving the river. By constructing this jam, we are now holding onto that wood and it's being trapped and held on to. The area this jam has increased almost seven times in size from the original, about 25 square meter sized jam to over 150 square meters of wood that have been recruited onto the jam during floods flows. Similarly, the amount of gravel area upstream of the jam has increased two to three times. So we have been doing these kind of restoration actions on multiple streams and rivers in the upper Sandy Basin, including the Clear Fork of the Sandy River, Lost Creek, Zigzag River, Still Creek, the Salmon River and several of its tributaries, but today we'll talk further in depth on three streams that we've been working on: the Salmon River, Still Creek and the Zigzag River. Next slide. I'll start out with the Salmon River. We have implemented restoration actions over the last decade on three miles of the Salmon River. This is an aerial view of two different side channel take-offs where we've constructed wood jams that have reconnected side channel habitat and off-channel and flood plains.

To date, we have constructed over 40 main channel jams through the addition of over 2000 pieces of large wood trees and logs. Next slide, please. Here's an example of two wood jams constructed on an outside meander of the Salmon River, and again, here's the river at a seven-year flood stage, so it's a dynamic river and wood is interacting with it at multiple clots. In addition to the main channel jams, we've built another 30 jams in side channels, and through this, we've reconnected 50 acres of flood plain habitat and 15 acres of off-channel habitat. Next slide. Here's wood jam that was constructed to reconnect river flows to over a three-quarter mile alongside channel, and the side channel takes off on the right side of the wood jam as you're looking upstream, and we've reconnected over three miles of side channel on the lower three miles of Salmon River. When we started work, there was only a tenth of a mile side channel per mile of river channel, and now we have a mile of river slide channel per mile of main channel, so almost a ten-fold increase in side channel habitat. Next slide, the slide shows gravel patches that were present on about a quarter mile long reach of the Salmon River prior to restoration on the left side. There was only one patch present. After the construction of eight wood jams and connectivity of two-side channels, the amount of gravel increased greatly on this quarter mile reach. There's a fivefold increase in gravel

availability from about 50 square meters of gravel available prior to restoration to greater than 250 square meters after construction of the wood jams, and the total number of patches increased from one, just one patch prior to restoration to 13 distinct patches on this reach. So again, that's an example of process-based restoration. We're adding wood and complexity back to the channel results in creation of quality fish habitat. Next, Daniel will talk a little bit about Still Creek.

Thanks, Bruce. Yeah, I'm gonna present on Still Creek for you guys, and this is a watershed that The Freshwater Trust has been working in since 2012, and we're really excited about it because it's really a good example of really a case where we're able to come in and work at the watershed scale and sort of walk away from it and hopefully close out and let it really function on its own. And so for folks who are unfamiliar with the basin, Still Creek is a tributary of this Zigzag River, which flows into the Sandy near Rhododendron, and it's a really important place because it's been identified as anchor habitat for all three threatened populations of an anadramous fish in the Sandy basin. So in Still Creek, we have spring chinook, coho and winter steelhead. So it was a really high priority watershed for us to start working in pretty early on, and Still Creek has been impacted by a lot of the same modifiers that Mark was talking about earlier, so this stream had a lot of its in-channel roughness removed. There was wood and boulders taken out of the channel, in addition to that, most of the side channels in the system were disconnected from the main stem, so the pre-project sort of conditions had a really sort of simple straight over steepened channel, which was really lacking in terms of the amount of complexity it could. Next slide, please. And so when we're throwing around words like flipping connection or complexity or side channels, this is sort of a map view of what we're talking about, so the map on the left is showing you an example of about a half mile of project work that went in between 2013-2017. And if you kinda look at the center of that map, there's a really sort of thick main channel that's going through there, and that would have been really the only wedded conditions that were present before we started work on this reach, and now our post-project kind of conditions, all those little smaller blue lines are essentially just showing you side channels that either reconnected from removing some of those historic firms or actually being constructed as sort of high flow refuge for fish, and the conditions that we have now are really a stream that's able to access its flood plain through a lot of different smaller hydraulic features, so now, whenever we have a seasonal flood, the river is able to disperse that energy out into its flood plain into smaller channels where fish can sort of take refuge and survive the winter, 'cause that's a really big throttling effect for juvenile fish and it really affects their survival rates.

Next slide, please. And this is showing what that berm looks like on the ground. So these are photos are showing before and after conditions of our work from 2017 in the Pumpkin Patch Reach of Still Creek, which is about halfway up the watershed, and I kinda wanna call your attention to that little crooked tree that's in these two photos, it's right under where it says before and after, and you can kinda see it's the only feature that really stays constant between these two photos, and what we've done here is we've dug through this berm, which is actually, it's a pretty gigantic feature, and at this point it's been overgrown with vegetation, you have to get an eye for these sort of things, to see where they are, and it really would have taken just a catastrophic flow for the stream to be able to access the flood plain on the other side of that thing. So by just sort of plugging holes through the these berms and really opportunistic places with a minimal amount of work, we're sort of able to mostly just un-break the river instead of constructing these specific features, and by targeting our approach effectively, we're really able to access a lot more of that flood plain with a lot less work.

Next slide, please. And getting some of the processes that Bruce was talking about, this is an example of a project we cleared in 2015 that's had five years for the river to start to reach a new

equilibrium. In these two photos, I want you to look at the channel bed composition. In 2015, you can see that it's mostly kind of cobble size or baseball-sized substrate, which they really can't move around and they're not gonna spawn on it, it's not really functioning as habitat, but by coming in and regrading that stream and adding new roughness elements to it, we're really able to get it to a place where it will start to recruit those gravels naturally that fish spawn in. So if you look in the 2020 photo, you can see that the bed has really fined up really dramatically in just a short number of years. Next slide. And so this is just kind of showing what all that work amounts to, we've done a lot of work and still click over a number of years, and thousands of pieces of wood in here and hundreds of log jams, and we've really been able to restore a dramatic amount of ecological function to this watershed way that we're really proud of, and our hope now is that we can sort of walk away and just monitor it through time, and hopefully this river will now be able to function on its own without people needing to mess with it. So now I'm gonna turn it over to Matt, who's gonna talk about some of our work that's planned and done recently on the Zigzag River.

Thank you, Daniel. So I am here to talk about work that we performed in 2019 and 2020 on the Zigzag River, which is one of the really major tributaries to the upper Sandy watershed. So the Zigzag exact is actually a really heavily impacted river, even compared to some of the other rivers we've been talking about. It's in close proximity to Highway 26 and flows through the town of Rhododendron and there's a bunch of summer homes in the area, and so the core of engineers really, really focused on trying to control the river year by building firms and removing large wood, just like we talked about, however, we've learned that this type of control is bad for floods and also bad for fish, and so our working, the Zigzag is really primarily focused on removing those term structures, so the imagery that you're seeing right here is drone imagery from just one part of our 2019-2020 project, just one site, and you're seeing the main stem of the river and then one of the side channels coming off on the right side of the river and going off the floodplain. So that's just kind of an image of what it looks like in the air when we remove that berm material.

Next slide. So before we do a project like this, we start by modeling to try to figure out how we can kind of get the best impact, you know, the most bang for our buck, and so kind of this Daniel was talking about before, we try to identify key locations where we can remove berm material and activate a ton of flood plain, so the figure on the left shows the flood plain of the Zigzag restoration site. Before restoration, and this is showing the result of a hydraulic model during a biennial flood event, so that's a flood event that happens roughly once every two years, so when there is summer low flow, there was actually no water on the flood plain, and then in a biannual flood event like this, we really were just barely getting a little bit water onto the floodplain, however what that model does show us is also some channels that show up when the river does finally spills banks, it shows us where it naturally wants to go, so based off of this model, we were able to select six different sites where we could remove berm material strategically and then see what would happen.

So before we did that in the field, we did another model where we removed the berm material in those sites and then ran the model at the same flood event, and what you can see is just a tremendous increase in the amount of floodplain that was activated, so... Yeah, not only do we have water in the river at summer low flows, now we have it across the entire flood plain during winter events. Next slide. So this is the same restoration site, but on the ground, what it looks like, so this is one of the six sites that I mentioned where we removed berm material and then excavated just a little bit of a channel sending water out into the flood plain and just deep enough so that we have water there year-round, so this picture that you're looking at here, it actually shows the side channel only about four, four hours after it was opened up, so it looks pretty good for being just built. Next

slide. And so this is actually that exact same site, but just looking left to the little ways... And so this is to show you that it's not just about removing the berm and sending water onto the flood plain, in order to do that, we also have to do some work in the main channel, so it might not look like we did much here, but if you look at that sunny area, just kind of behind the log jam that you see is actually a wrestle that reconstruct it, so we took a bunch of the berm material and we actually put some of that into the main stem of the river to raise the elevation.

0:26:38 S2: And so what that does is it kinda back to water up a little bit, it kinda matches out the flood plain and the main channel a little bit better, and then it really helps to maintain that new side channel that we build. So all in all, in the end of this project, we ended up removing over 1900 cubic yards of berm material, we reactivated over 200200 feet of side channel, and we re-activated 12 acres of flood plain. Next slide. And so this is my last slide just to finish out, I wanted to show to two spawning chinook salmon, so you have the male on the top and the female on the bottom, you can tell 'cause their tails all beat up and she's been building her redd. So they're sitting on their nest, and the reason I showed this picture is just to bring it back to why we're doing all this work and why we're sending water out of the flood plain, why we're spending all this money. So this is actually from not from the Zigzag, but actually our Clear Fork restoration site, but three weeks after we did restoration work this year, we had spawning chinook right where we placed some large wood. So yeah, this is what it's all about, getting more healthy runs of wild fish. And now I'm going to send it back to Daniel.

Thanks a lot, Matt. So I'm gonna split this section with Bruce a bit and talk about some of the results that we've seen from our monitoring and over-modeling throughout the Sandy River basin. And so one of the ways that The Freshwater Trust tries to quantify something is kind of fuzzy and weird as an idea of complexity or ecosystem function is by using the Stream functional assessment of model, and this is an EPA tool that was developed to take into account things like local hydrology and landscape dynamics and sediment composition and large wood and roughness in side channels and really try to distill that down into, Okay, well, how much of this habitat is actually being utilized by fish before and after... So this is a little bit different than just, say, measuring the scope of your project and saying that We worked along X miles of stream. What this is saying is the amount of habitat that's available to fish they wouldn't have been available before. And so this is sort of a new habitat, if you will, that we've been able to quantify in a really honest and open way about the work that we're doing, and this comes straight from some of our construction metrics and some of our long-term monitoring, just looking at metrics on the ground, like the substrate composition, the channel features, and the density of those different features and how different they are from each other, but I think when people get really excited about is the fish, so Bruce is gonna chat some more about some of those really excited results that we've seen pretty recently throughout the basin.

Thanks, Daniel. So we have accomplished a lot of habitat restoration work, but the big question is What do the fish think about it? Well, the short answer is the salmon and steelhead are just as excited about the work as we are. Here's a picture of spring chinook spawning in the Salmon River, tributary to the Sandy. In the last six years, the number of chinook returning to the restoration reach on the lower Salmon River has been more than 150% of the long-term average, and that works out to about 32 to 35 redds per mile, and the redd is the term for where a female lays her eggs in the gravel of the river. And two of the last four years, we've had 70 reds per mile or three and a half times the long-term average number of fish spawning in the Lower Salmon. Next slide. Similarly, the number of steelhead spawning on the restored reaches of the Salmon River has greatly increased

in this figure on the left side shows the number of redds found about a quarter mile long restoration reach for the three years previous to restoration. And on the right side, the finger shows the number of redds during the three years following restoration in addition of eight large wood jams and the number of steelhead spawning in this reach has increased significantly, the average increase from five redds a year to 21 redds per year. And if you look at basin returns, you're seeing is we're seeing a similar response. In steelhead returns to the basin as a whole, two of the last six years, or about 6000 adults have returned to the Sandy basin, and that compares to the long-term average of about 1000 fish prior to restoration efforts and removal of the Mormon dam in 2007. Next slide. The number of coho using the restorative side channels is also significantly increased through time, and next slide, and in this graphic, you can see that we've actually increased fresh water production in two of our banner watersheds Still Creek and Salmon River, the number of smolts which are juvenile salmon or steelhead that have reared in this freshwater for one to two years and are now ready to go to the ocean to get big... Well, those number of smolts have increased 8 to 10 times over the eight-year time period in the Still Creek and Salmon River for steelhead, and the number of coho smolts have almost doubled or more than doubled during that time period.

So this is really exciting to us because it shows that we're not just concentrating fish in our restoration reaches, but that it shows that fish are actually surviving better and producing more juveniles through time. So now I'll turn it over to Mark, he'll talk about some of the ancillary results of doing restoration in the basin, too.

Thanks for, Bruce. In addition to benefitting fish, project actions, as you've heard, are designed to restore in stream processes, so not only is high quality habitat self-sustaining in the future, but riparian wildlife community benefit as well, additionally, in the Pacific Northwest is expected to see increases in peak winter flood flows and more rain in the winter and spring in response to climate change project actions that restore natural river processes and riparian functions anticipated to disperse flood flows and lessen downstream floods. And finally, as the slide says, since 2008, we've spent nearly 7 million on restoration work in the Sandy, the bulk of these funds going into local economy for services, including services like heavy equipment operators. In this picture is typical of a heavy lift helicopter that we use to place wood and stream channels. Back to you, Haley.

Awesome, Wow, you guys are really pitching some questions our way, hopefully these panelists are ready for what I'm about to throw them... Keep the questions coming. We likely won't get to all of them, but I really wanna encourage you to ask them because we're gonna save them and then hopefully get back to you after the event as well. So this first question, I think, goes to Mark. Mark, how do you decide on the appropriate size of a jam or a large wood structure for a given location? And that can be for Mark or Bruce, whoever wants to take that...

That's a great question. I think all of us have something to add, but I'll take the first step, so when we think about large wood, we really think about pieces, which are pieces that are gonna be stable over time and across different flows, so on a tributary like Sixes Creek or Boulder Creek, you could have a key piece that's one and a half to two times the active channel width versus on a bigger River like the Salmon River, which probably has a bank full width of over 100 feet, a key piece historically would be a Doug Fir or a Cedar that probably is five feet diameter and a full length of tree, obviously, we don't have access to those, so in larger stream systems, we rely on engineering principles, and we try to overcome drag and wind speed and sheer by dragging that key piece of wood into the stream bank and then adding boulders for balance. Anybody else wanna add to that?

I'll jump in a little bit, too, Mark, on larger channels like the Salmon River, the river just has a lot of energy, and we do... As Mark said, we don't have size of trees that would be stable in that river, so in addition to using engineering calculations to withstand the drag forces, and we also look at what the maxim scour depths are on the river and we bury this jams or found the jams below the maximum scour depth which on the Salmon River is about 8 feet, so the wood jams that you'll see that we have constructed, there's actually a lot more wood that's actually underground, that forms a superstructure of that jam. So typically, to build a stable jam on the sizes of the salmon river, we'll be using 35 to 40 trees that are two foot in diameter.

Awesome, we have gotten a ton of questions about beavers, so I'm gonna try and wrap it up into one for any of you guys, what has the beaver response been to some of our restoration projects, particularly on Still Creek?

I can sort of speak to that a little bit, so we don't see a lot of beaver activity on Still Creek, and actually there have been a couple of efforts in the past, I believe by DFW, but it was before my time with the Forest Service, where they tried to re-introduce some beavers on Still Creek, my understanding is that there's so much mountain lion activity in the area that they pretty frequently just don't make it long enough to have a sort of reproducing population of beavers, so that's kind of a short quick answer on it. There's probably more to it than that, but that's what I have I heard through the grapevine. Wild speculation. That could be it.

Cool. Does anyone wanna add anything to that? Before I jump to the next one.

Yeah, in the Salmon River, when we've seen a similar reaction, we have beavers that show up in the side channels, and a lot of times they add complexity to the side channel habitats by constructing dams and building some great pool habitat, and so we'll see them show up for a while. And then they'll disappear. So we think it might very well be related to mountain line predation. One of the other projects we've done on the Salmon River in the Wildwood Park area, and we reconnected river flows to the wetland, that's the board walk wetland or Sixes Creek wetland, and there's deeper in that wetland, and we're really hoping that with the addition of river flows to that wetland, they'll really build up larger series of dams that will produce some really quality pool habitat for coho-rearing.

Awesome. This next question is for you, Bruce. In the figure that compared the 2014 and 2017 flow paths along the Salmon River, was there any flood plain grading involved in that project in particular?

In that particular project, there was because that was actually part of some area that was disturbed by historic quarry operations, and there was a lot of quarry fill that was placed in the flood plain of the river. So we actually had to remove a lot of that non-native fill to be able to reconnect up that side channel habitat complex.

So thanks. Daniel or Bruce, how do we actually monitor fish response, and in particular, what are some of our coho counts? Are we doing pit-tagging? What are their survival rates and how?

Bruce, I think I'll kick this one to you.

Well, that's a great question. The partners are monitoring coho primarily through redd surveys, so

we count the number of adult fish that are using the side channel habitat that we re-connected up. We have also done some juvenile snorkel surveys in the side channel habitats, so we have a good idea of the rearing densities of the juveniles in the side channels, we don't have any specific survival estimates, but the other big thing the partners are doing are running small traps which are rotary screw traps that are out in the main channel, the river during the spring migration period, and they sample a proportion of the fish they're out migrating, and we can statistically come up with an estimate of the number of smolts that are leaving. And so those are our main monitoring efforts right now.

I wanna touch on that real quick, too. Particularly the smolt trapping part of it, just because we do run many smolt traps. We partner with DFW, obviously, me, the Forest Service and then the Portland Water Bureau, and by running smolt traps, we actually cover something like 80 to 90% of the production of smolts in the entire basin, and obviously we don't capture all of them, but like Bruce said we capture a portion of them, we mark them with a little clip or a little tattoo that we give them, and then we're able to figure out how many…we use some statistics and we figure out how many fish are in the basin or migrating from the basic... You don't do any kind of permanent marking on them, so we don't... We don't put in PIT tags, we don't put in any other sort of tag, so we can't really tell which ones that we marked are coming back, but we at least know in the short term how many smolts we are producing.

Awesome, Matt, this next one is for you, perhaps you can touch upon the great amount of siltation and sediment that's been happening in the Sandy this past fall.

So I saw that question and I specifically requested to answer it because it's something that we've been speculating on a lot, so the Sandy in particular, it's always Sandy and it's kind of hard to tell if it's so much more, so much less. The zigzag River on the other hand, which is, like I said, one of the big trips we have noticed so much more sand and sediment that has just hung around way late into the season and it's really, really abnormal, and so my speculation is that a lot of that sediment is coming from the Zigzag River, and why that's happening, we've had a lot of internal talk and we're kinda guessing it has to do with glacial retreat and opening up new areas for some of the headwaters to kind of erode, if anybody's been up around like timber line, you've probably seen... It's very, very sandy. One of the tributaries is called Sandy River, which goes into Sand Canyon, so there's a lot of opportunity for sand to come down and wash out into the river, so that's... Our guess is that we're getting, again, relative more areas exposed and maybe some kind of big event happened up there, I've been meaning to check it out, but because of winter we can't get up there now, but... Yeah, that's the best guess right now.

Awesome, thanks, Matt. Daniel, was the monitoring that you all have done conducted voluntarily, or was a monitoring plan built into the original recovery plan on the onset of it?

To my knowledge it was built into all the proposals, but those pre-date me by a couple of years, I feel like Mark is gonna have a slightly more robust answer than I will.

Mark, do you have anything to add to that?

So, we don't have any regulatory requirements to do monitoring, we do it based on providing information to our funders on project effectiveness as well as we discussed earlier, the partners have a goal of restoring salmon and steelhead at the basin scale, so this basically by a modern fish

response we can actively manage our restoration plan and see what's on the right trajectory, and if it's not, we can tweak it, and if it's working well, then we can apply those same techniques to new surroundings.

Awesome. While we're on the topic of monitoring, have we investigated how water temperature has responded to this restoration work, maybe Daniel or Mark or any of you all.

We're currently doing a water temperature restored side channels with the BLM and USFS on a number of the systems particularly Still Creek and Salmon River, where we're measuring, if reactivating flood plain and off channel habitat leads to cooling of the mainstem river, so right now we've got side channel inlets and we're measuring water temperature at side channel outlets and then the mainstem water temperature. And once we analyze that data will have a better idea of what kind of impact we're having on water temperature.

Daniel, this one's for you, what type of metrics are you using to demonstrate complexity and connectivity. Are metrics different between Main stems and side channels? And what flow events, are you using for measurement? That was a lot. Feel free to pitch one of those three questions to any of your colleagues.

Yeah, I'll try and get to all of those. So a lot of the metrics that we're looking for can be gotten through a level two fresh water inventory survey, which is doing things like looking at things like what is width, average residual depth, substrate composition, gradient and a lot of other physical factors, and then once we've gotten that data will bring it back into the office and we'll look at things like What's the density of tools, how many of them do we have per reach, and we can look at that through time, and we can also use that to kind of assess how they're changing, and if they're getting more or less complex, and you said they were in but missed the flow part at the end...

Yeah, are you monitoring or tracking flow events in relation to how you guys are monitoring the overall project?

Yeah, so we'll usually go in and repeat some of our channel surveys after a meaningful event, and then we are waiting for a really large flow to go through some of these systems so we can see how they respond with all this new wood in them. Then we are also doing some discharge monitoring in our site channels, particularly up in the Clear Fork River, we are taking to measurement like the top and bottom of our project reaches to see if the flow is pretty consistent, the time much is dropping into ground water. How much is being diverted proportionally each of the side channels, and we can look at that usually three or four times a year.

Matt, In side channels, are you modeling hydraulics to demonstrate change following wood introduction?

Am I modeling hydraulics to demonstrate change Okay, so this is, I will say, I'm relatively new to the modeling world and the models that I showed you earlier, were actually done by a separate engineer, I'm learning about this stuff right now, however, and we're trying to figure out how to model wood... And that's something that's really, really difficult. 'cause there's multiple ways that you can do it. I think I saw another question in there where somebody asked about, Are we changing the roughness coefficient, which is basically how well or how slow is the surface... Make the water go. Are we modeling the terrain for people who don't know, hydraulic modeling, basically

lots of options for, you can do this, and we're still looking... I'm in figuring out the best way to model wood... To see how it changes. And so whoever asked that question, if you would like to contact me and talk to me, I would love to hear if you have any kind of specific thoughts on it as well, because wood does add a whole new level of complexity that the modeling program that we use head grads does not necessarily have built into the program, so that's my kind of non-answer for you.

Nice. Thanks, Matt. Mark, can you explain more about what goes into the planning of these restoration projects? How many years in advance is planning bin?

The initial basin scale planning we did over several years in the late 2000s, and that's where we really came together in the group and prioritized sub-watersheds where we wanted to focus on restoration, we did that a bit earlier based on current strongholds of this, that's based on the foundations of conservation biology, where it's a lot easier to build off existing populations and expand their range, then they go into a subwatershed that has really reduced populations and hope to see that response.

Awesome, Bruce. I think this one is for you, where do we get all of this large wood? Is it from logged areas or downed trees?

That's a great question because it's probably one of our most vexing problems in restoring rivers, you would think what would be highly available on the Forest Service and BLM, but most of the land uses make it difficult for us to give wood. So we get a number of different ways. The Forest Service has had several areas where we specifically identify timber sales for the wood to go to restoration, sometimes we get wood from hazard tree removal or windfall, wind storms that blow down a lot of wood. For a long time, the BLM was getting wood for the lower Salmon River project from the hearing seed orchard near Estacada as the plantations of trees that were originally planted to produce seed crops as those trees became essentially too tall to use to efficiently harvest the seed, that orchard was actually trying to figure out how to remove them and we just said, we'll go in and take those trees for free, we'll remove them. And you won't even know that they were there. So there's a number of places where we get them, sometimes we contract with private timber farm owners, and by wood The Freshwater Trust has done that somewhat, so there's just… whatever we can find. Trees we're after him.

And then just to add that our preferred method is to find live trees that are standing and then tipping them over with an excavator so we can have the whole tree and the root fan, and that has got to be a significant part of the restoration cost, the actual acquiring trees and then hauling them to a restoration site.

Alright. Can you explain a little bit why that root is so important?

The root is really important for a couple of reasons, the primary, I guess it's not a primary, two reasons, one is that it really adds stability, it's a lot harder for the stream to move a piece of wood down a stream if it has a root vain attached it really acts as an anchor, and then additionally, it has a lot of a complexity to the stream channel, if you have a root fan down in a pool and you're doing a snorkel survey for our juvenile fish, they are all just caged around, all those little tiny nooks and crannies that root provides.

Awesome, so we are obviously seeing tremendous loss of fish, so how does that correlate to returns that you guys are seeing over the years? This is for any of you guys.

I'll start off a little bit with that. In the mid-2010s, about 2015 through 2017, we had what was turned the blob, a huge area of warm water in the North Pacific that greatly decreased survival of juvenile salmon out in the ocean, and that's why some of the return numbers that we were showing on fish returns and smolt production pretty amazing, because those increases in fresh water production have occurred during a time period when ocean survival was really low, and if we could have both good ocean conditions at the same time of increasing fresh water production and survival, I think we could really increase salmon and steelhead stocks in the Sandy basin, and the salmon and steelhead life cycle is complex, they rear in fresh water for one to three years and then go to the ocean for generally two to three years, so they use a lot of habitat, both stream, open ocean and then fresh water habitats, so they're really dependent on a large amount of habitat that we've had to effect from human development and human uses, so it's kind of a credit to the efforts of the partnership that we actually are increasing fish numbers during a time period when ocean conditions have really been poor for salmon and steelhead.

Yeah, just to add to that is interesting that over the last decade, responded out the Sandy has typically been an outlier in that where many runs up and down the coast are declining, the Sandy has seen increases in fish, and I think that really speaks to this basin scale applied restoration approach, and then it also speaks to the impact of PGE’s decision to take out the little sandy Dam.

Great. Do we have any specific goals for fish propagation and return that we're shooting for, and if so, in what time frame in particular are we looking for that specific return? And maybe as a follow-up, Daniel, how do we continue to measure that? And how often will we measure that? Pitching you guys some hard ones here.

I will start to say something... So as far as goals for the specific number of fish, I think it's a little bit hard to put a specific number on exactly what we want, because the Sandy is one basin out of many in a very big world with changing ocean conditions and what runs look like 100 years ago, we're probably never gonna get quite back at that point, so I don't know that I have a specific number, maybe Mark or Bruce have something that they'd like to say to that, but as far as timeframe goes, I would say that a lot of the work that we do is what we call process-based restoration, it's what Bruce was talking about a little bit earlier. And so it's not just doing things right now, it's doing things that are focused on how the river responds in the long term, and so yeah, there's immediate benefits, but then we also do things like planting trees, protecting riparian areas that in 100 or 200 years that'll be new old growth and that'll be stuff that eventually falls into the river and makes its own wood, has its own large wood recruitment, and so the timeline...There's an immediate timeline. Yeah, fish are threatened and salmon are threatened and we need to have a short-term improvement, but also we really are looking at the long term... For what's gonna happen to this space?

And then I would just add that, that I think our initial target or benchmark is to hit the abundances in that in the recovery plan for lower Columbia river salmon and steelhead, and we're pretty close to hitting those for spring chinook and winter steelhead. Coho aren't responding to as well and part of that is the challenge is getting water up on the flood plain, and then once we can consistently hit those abundant targets, we'd like to hit some of those higher broad sense recovery targets so people can enjoy all of the benefits that salmon and steelhead provide and not just long-term resistance, which is really what the abundance in the recovery plan shoot for.

Great, Mark and Daniel, how do we choose the streams or the reaches that we wanna work on?

I can start, we have... We have a full kind of prioritize list of all the difference of basis in the Sandy watershed, and so we've been sort of steadily working our way down that list, so I believe it's the mainstem Sandy and the Salmon are one and two. Still Creek is three and having wrapped up on still Creek, were now starting to move into, I think the Zigzag, Clear Fork and other reaches of the Salmon which are ranked a little bit lower, and there are places that we expect to be able to get the best response, and that's all kind of basing that initial prioritization that was with the ecosystem in diagnosis and treatment tool, so EDT... Back in the 90s, when we first came up with this prioritization and, Mark, if you wanna add to that, I'm saying is something...

Yeah, just to add to what Daniel said, so we do have the overarching prioritization, which is all of the streams from is priority to lowest priority, and then when we enter a new system, for example, a couple of years ago, we started doing work on Sixes Creek what we did is we look at the existing habitat conditions, and since we knew large wood was controlling variable on Sixes Creek, we went out there, we measured current large wood abundance, we then did quite a bit of analytical work with our partners and identified what the historical reference condition should be for amount of pieces in Still Creek, and then that difference became our restoration target, so we basically started treating breaches on Sixes Creek to hit that limiting factor of large wood, and then we'll monitor fish and the habitat conditions in response to that to see additional actions are necessary.

Do we have any work plans for the Delta?

So, our work right now to focus on the upper Sandy, but there's other Sander basin partners that are working down on the Delta, the Forest Service is working down in the Delta, as is the Sandy Basin Watershed Council.

Awesome, can you talk a little bit about the other partners who might be involved in this project, other contractors maybe that we use, what does the partnership look like?

Yeah, sure. Well, obviously, the sandy river basin partners as a whole, which you introduced a little bit earlier, but contractors, so we try to use local contractors for the most part, so we've worked extensively in the past with O'Malley brothers who are based out of Estacade, and then aquatic contracting Inc. does a lot of our in-water work, and they're, I think based in Portland or somewhere in the Portland metro area. So we have a really, really great long-term relationship with Aquatic Contracting and they've done excellent work for us. Let's see, we also have a lot of volunteers that we rely on from year to year, particularly for doing things like rearing plantings or invasive species removal or camp site decommissioning or anything like that. And in the past, we've had the Sandy River Watershed Council to work with us. We've had... Mazamas. One of the ones I really wanna call out is wilderness volunteers, which is a national group that would come out and they'll spend a week with us every single year, and they send people all over the country. We're just one of many projects, but they'll spend a week with us, and they'll usually do a lot of the mop up work after our restoration sites, so we like to make sure everything is all pretty, we have native vegetation planted and we didn't introduce any invasives and we have erosion controls in place for where we had to make a disturbance. They are really the people that help us out with a lot of that work. Unfortunately, this year, our volunteer situation has been a lot lower, well we're pretty much non-existent because of covid, but we do rely heavily on volunteers, so with that question, I really

wanna get a call out to our volunteers.

Matt, thanks. Daniel, how long will we continue to monitor our restoration sites?

The plan is at least 10 years, but I think of regularly into the future, following major flow events sort of indefinitely. There might be more concrete plans, I don't know if it's at least 10, it sort of depends on the funder where we're working, how long that work is been going on for. A lot of our large wood placement projects, they sort of mandate five years and then we'll usually go back and visit them anyway for longer periods of time, so there are sort of hard cut-offs and soft cutoffs.

Cool, the next question is still for you, can you explain a little bit more about how functional linear feet is calculated?

Oh yeah. So that's... Functional linear feet is a pretty ambitious model, it's essentially, it boils down to a very wildly complicated Excel spreadsheet, and it's basically broken down into the sort of field surveying component and an office analysis component. And what it's trying to get at is, there's these four big functional groups, there is a hydrologic function group, A geometric function group, A biological function group, and a water quality function group, and there's basically a mix of sampling methods to try and just get a rapid idea of each of those main things, 'cause each of those functions are broken down into four or five different metrics, and I saw there was a follow-up to that about which aspects of that were the main driver behind our numbers, and it's really the side channel length and the large wood, which are the things that are really gonna change before and after a project. The model also takes into consideration things like the flood plain height, and the flood plain bedrock composition and all this other stuff that is really... There's a lot of landscape as landscape scale metrics that go into that model that aren't gonna change too much, but what we're interested in the parts that we can change and that we can have sort of take a before and after look, so the numbers that we showed earlier aren't the total functional feet available, they are the difference that we've been able to make with our projects... I hope that answers it, is you can really go into the weeds with the stuff of it, and if you wanna ask me more about it, I'm more than having an about it.

Yeah, absolutely, thanks, Daniel. So this is for all of our panelists. I love this question. Thank you, Kevin. What are some of the primary perceived negatives of all of this work, we've talked about the outcomes and a lot of positive, what are some of the things that you guys struggle with just seeing implementing some of these projects?

I'll go first. So I think some of the biggest negative impacts are short-term disturbances to riparian and stream channels, we are building a lot of these projects with track excavators or dump trucks, so during the six-week construction and season, it looks a lot like a job site. Obviously, we have best management practices that are developed on a regional basis that tells us what we can and can do, and they're designed to protect aquatic resources with riparian, but when we're in there, it's loud, it's dusty, and it definitely has a negative impact on vegetation the good news is I'm working on the West side of Mount Hood is how quickly riparian areas recover, so we can be in there, and we'll have a lot of excavation and we'll restore side channel like Matt was showing you... We'll have ingress and egress routes in and out of the site, and in a couple or three years, especially if we have a couple of high water events, our goal and what we've seen is you can walk out to the side chain and not even know that it was restored by us, basically looks like a naturally functioning feature on the environment.

Yeah, and I'd like to just build off of that a little bit, and I don't necessarily do what I'm gonna say as a negative, but I think that some people do view it as a negative, is that... A lot of people when they think of a stream, they think of that picture of the Mark showed at the beginning of the presentation of the Salmon River flowing under the bridge of Wildwood where there's just not a lot going on, but it's just a kind of like a neat, tidy stream. What I view is a beautiful stream is something that has a lot of large wood in it, a lot of complexity and fish everywhere, but you do kinda need to have a change of reference of what you're looking for. I know sometimes when we're doing projects, we think a lot about in the visual aspect of it, how well cabin owners see the project, or how well people who are hiking through the area see it... Or fisherman or boaters, or... You have to think a little bit about those things because... Yeah, because not everybody views large wood in the stream as a positive, so... Yeah, just looking kind of your perceptions, I guess...

And then one last negative before I let Bruce or Daniel answer is that a lot of invasive plants are very adept at colonizing disturbed riparian areas, so it's something that we really pay attention to, we have heavy equipment operators power wash clean their equipment before they come in to make sure we're not bringing in invasions from outside the basin, but there's even a number of reason Sandy basin and that'll start in colonizing sites once we've disturbed them, so it's something where we work with other partners who are focused on treating weeds and then as we go out and treat those weeds and really try to make sure that natives are coming so places aren't overrun by things like reed canary grass.

To jump in on some of the stuff that Matt and Mark we're talking about is... We have a really short time frame where we have in water work period on the Salmon River and many of these other streams, we only have six weeks to accomplish these projects, and so that really condenses this work into a really short time frame, and you really feel the pressure to get it done because you've lined up the work and you've done all the planning and you really wanna pull it off, and you know that you're gonna have great benefits to the system and to the fish that depend on it, and so there's some stress involved in trying to get a project in, and I think it's just part of it, but I think that's kind of a negative, it's just...it can be stressful, and also kind of the short-term impacts that Mark was talking about, it is a construction site, and you try to minimize those as best as possible, and so those are all happening at once when you're building things.

Awesome, thanks guys. Bruce, I think this next one would be for you, are there desired future large wood projects that have been cost-prohibitive to date, but that would really complement this work that we know we wanna engage in?

Yeah, we're looking at the Sandy River, which is even more big and powerful than the salmon, and so far, a lot of those ideas that we have... That would be hard to pull off. They're pretty expensive projects. That's the first thing that comes to mind to me, just that also the scope and the scale of working on a watershed scale, it's tough to fund this work, I think Mark mentioned over $7 million of work so far in the past decade, and so... Just in general, where we take a bite off at a time, but we still have quite a ways to go.

Mark, you've obviously seen the basin change a lot, so Mark has been with The Freshwater Trust for 20 years now. Obviously, you've seen a lot change. What can you expect in the next 20 years, not suggesting that you'll be at TFT for the next 20 years, but what do you expect to see?

In the Upper Sandy where we're working, we have a long-term target of having all applied restorations completed in the next 10 to 12 years, which will cost somewhere around $15 million, so if we're successful in raising that money in 12 years, if we've completed all applied restoration actions and then give that another eight to 10 years of passive restoration working on all this large wood and on the flood plain, I really expect that we can have a fully restored upper Sandy, that's where it needs to be to hit those recovery targets.

Awesome, I love this question, and I'll pitch it to you, Daniel, are we doing similar work on other rivers in Oregon?

Yeah, we're doing this sort of physical habitat work, not just to understand if we have similar projects down in the road Basin, we've done a lot of side channel reconnection and large wood placement down there, which has been with different challenges, 'cause they're usually in urban streams where there's a lot more people living in the watershed right next to these projects, we actually just had another webinar about that last week, which is on our website if folks wanna learn more about that. We also do replanting projects all across OR, which is really focused on temperature reduction in streams as part of our water quality training program, and those are the two really big ones, but if you're looking for the large wood placement type work, the really physical stuff, the other big hot spot is the Rogue.

Awesome, thanks guys. Well, some of these other questions are a little bit more technical in nature, so what I would love for you to do is if your specific technical question has not been answered in this session, I would love for you to email it to Caroline at Caroline at the freshwater trust dot org, and we're gonna pass it along to one of our presenters or another member of The Freshwater Trust team to just really take care of and make sure that you're getting your technical question answered and will also pass it along to Matt or Bruce as well. I wanna thank everybody for joining us this evening, especially our panelists. We're really, really fortunate to have a number of really great partners that help us make this work happen, but I would really encourage you, if you've been inspired by the outcomes that you've seen tonight and a lot of the results to consider to give to The Freshwater Trust right now. Philanthropy is really the catalyst for all of this work. Clearly grants and partnerships and contracts really go into it, but philanthropy is kind of what propels all of this to happen.

So if you're inspired, please go to thefreshwatertrust.org to consider to give a gift tonight and follow us on all of our social media channels, and like I said, you can feel free to send one of those technical questions over to Caroline and we'll be sure to get it answered. Thank you guys so much for joining us, we really appreciate it.