Turning Ecological Stream Classifications into Actionable Science

Ashley Fortune Isham: Good afternoon, or good morning from the U.S. Fish and Wildlife Service's National Conservation Training Center in Shepherdstown, West Virginia. My name is Ashley Fortune Isham, and I would like to welcome you to our webinar series that's held in partnership with the U.S. Geological Survey's National Climate Change and Wildlife Science Center, or NCCWSC. They're located in Reston, Virginia.

The NCCWSC's Climate Change Science and Management webinar series highlights their sponsored science projects related to climate change impacts and adaptation and aims to increase awareness and inform participants like you about potential and predicted climate change impacts on fish and wildlife.

Right now I'd like to welcome Emily Fort, Data and Information Coordinator from the NCCWSC to introduce today's speaker. Emily, welcome.

Emily Fort: Thanks, Ashley, and thank you all for attending. Today's speaker is Ralph Tingley, a PhD candidate in the Department of Fisheries and Wildlife at Michigan State University. Ralph received his Bachelors of Science from the University of Connecticut and his Masters of Science from Michigan State University under Dr. Dana Infante.

In recent years, Ralph has been heavily involved in the National Fish Habitat Partnership's Inland Assessment of Hawaiian Streams while also conducting research on the effects of differing flow regimes on a native atyid shrimp.

Ralph's research interests span a broad range of fluvial topics that he hopes to continue to focus on applied research that can be used to inform conservation decisions in the face of climate change.

Ralph is one of two individuals from Michigan State to receive this year's Science to Action Fellowship from the National Climate Change and Wildlife Science Center. With that, I'll turn it over to Ralph. Thanks.

Ralph Tingley: Thank you very much, and thank you to everyone here today that's attending this webinar. I'd like to start out with just a brief outline of what I'll be discussing in today's webinar. It will start with a short introduction about the National Climate Change and Wildlife Science Center Science to Action (StA) Fellowship, specifically its overall goals, and then my specific fellowship goal.

From there, I'll focus on the Hawaii stream reach classification, which is a portion of my dissertation that I have been attempting to incorporate into management products through the Science to Action Fellowship. I'll specifically talk about methods and results, as well as the implementation of these results through the Science to Action Fellowship.

Finally, I'll talk about some of the products that are in development now through stakeholder input and potentially some of the uses that might come from them. The USGS National Climate

Change and Wildlife Science Center (NCCWSC) Science to Action Fellowship, or the NCCWSC Fellowship, is really of two main objectives.

The first is to expose the students to NCCWSC and the Climate Science Centers, and really to be able to see how the National Center operates and manages and works with the Climate Science Centers across the U.S. as well as aims to direct certain types of research at the broad scale.

Part of this experience is actually going down to Reston, Virginia for an exposure experience where the student gets paired with an agency mentor. In my case, that was Dr. Shawn Carter. You really start to learn about NCCWSC itself, and also have involvement with the USGS in a broader sense as well.

The second purpose of the Science to Action Fellowship is really to enhance the student's research by developing products or tools that are useful for management or decision making. Really what this means is to try to create...essentially either take a portion of their research or develop a new part of their research that puts science into action.

The 2015 Science to Action Fellows are myself and Tracy Swem. I am actually at the end of my PhD, in the final year, while Tracy just finished her Masters and is now moving into her PhD. We have students that are at different points in their careers.

My research, in particular, for my PhD is really about linking multiple scales of stream research in support of conservation management. My study area of focus has been Hawaii. This type of research really spans from doing regional analysis on changes in flow regimes on native atyid shrimp or ‘opae kala’ole, and really inter-annual differences in both condition of those shrimp, as well as population structure to those differences in flow.

Another portion of my research however, is looking at how...We can understand trends in species across the islands of Hawaii, specifically thinking about a stream classification of river reaches, which I'll talk about a little bit more in just a second.

My fellowship goal is to incorporate this ecological stream reach classification into products that help prioritize conservation initiatives in Hawaii with a specific emphasis on climate change. Really there were two objectives to achieve this goal.

The first was really presenting this to these stakeholders and getting them familiar with the results, and also identifying needs of particular groups that might be able to utilize it. The second is really to incorporate the classifications into these tools to aid in conservation of stream habitat.

With that, I'd like to talk about the Hawaii stream classification methods and results, but first to acknowledge my co-authors on this work. My advisor, Dr. Dana Infante, who was also my university mentor for the fellowship, Dr. Richard MacKenzie from the U.S. Forest Service Institute of Pacific Island Forestry, and Dr. Yin-Phan Tsang who's now at the University of Hawaii at Manoa.

I'll mention that this work was a collaborative effort between MSU and the Institute of Pacific Island Forestry. When considering habitats across large regions, it's often of interest to inventory the complexity across these very vast areas in order to make management decisions.

In river systems in particular, we know that they are complex heterogeneous systems that change throughout the network with differences in the landscape. Documenting this complexity across the region is often of interest to stream managers as it can affect how we think about the protection of native species.

The landscape approach, which suggests that the landscape through which a river flows influences it's habitat, which in turn influences biology, allows researchers to consider or quantify differences across the region by examining relationships between landscape and biology.

However, actually documenting these differences can be pretty difficult. One possible tool that is used are stream classifications. Stream classifications essentially allow us to synthesize knowledge and organize information within the stream systems across a region.

These can range from simple classifications such as stream orders, or more complex within reach classification dealing with sinuosity or channel slope. They can also incorporate natural landscape data. What this really allows you to do is, following the idea of the landscape approach, to account for some of that natural variation across your study region and identify those rare or common habitat types.

This in turn can help prioritize management action. Additionally, when classifications are based on habitat characteristics or landscape factors, it's also important to, or ideally, you can examine the relationships between those factors and species, or distributions or densities.

What this can result in is a classification of ecological potential in which we can indicate a stream's ability to support given species or community. For instance, in the case of changes in watershed size you might see a decline in the density of a given species as size increase.

An important component here is that it's not just a single landscape variable that's going to predict density changes or presence/absence of species, but often interactions among landscape variables that can potentially be related to species distributions or presence or absence. In Hawaii's stream systems, we really do see quite a bit of variation across the island, with perennial streams.

Even within individual catchments, sharp changes in rainfall over short distances, differences in geology and ground water delivery related to volcanic age, as well as changes in slope and elevation, all have a role in shaping species distribution via habitat. In Hawaii we also have this species assemblage with native species assemblage of amphidromous organisms.

Specifically gobies and other fish as well as snails, shrimp, and prawns, which have a very unique life history where they spawn in freshwater systems, drift passively to the ocean where they spend a short period of time up to six months, and then migrate back into the stream for a majority of their lifecycle.

However, when they migrate back up they stratify based on their climbing abilities and their use of habitat. You actually see some very strong relationships between these species and the physical landscape.

This brings me to the goal of this initial stream reach classification for my dissertation research, which was to develop a reach classification that captures this ecological potential in Hawaii.

Therefore, we can control for some of this natural variation within stream systems, and allow for the examinations of different types of disturbance. Whether they be anthropogenic or climate on potential species distributions and health.

The key point here is that we propose to use multiple factors including physical landscape characteristics as well as climate variables, and see how they shape the distributions in multiple species.

This is a general overview of the classification methods, which is really five steps starting with the development of a spatial framework, and then identifying, and obtaining, and attributing data both biological and natural landscape variables to that spatial framework.

From there I selected a set of natural landscape variables that have the strongest relationships with species distribution and use these variables and those relationships to generate the initial stream grouping.

These groupings were then finalized using both expert opinion and ecological knowledge to come up with ecologically classified stream reaches in Hawaii. We'll go in to each of these steps a little bit more in just a few minutes but I will say where the StA fellowship really comes in is taking this classification of stream reaches and moving it into management products and this is really through interactions with stakeholders in Hawaii.

The study region overall consisted of the five largest islands of Hawaii and the reason being that these are the islands that contain perennial stream systems. We use all perennial streams in our classification and excluded intermittent rivers. The stream layer I've used is the Hawaii Fish Habitat Partnership stream layer which is a modification of the National Hydrology Data set of 1 to 24,000 stream layer.

The reason we did this is we try to pull out some of the biases associated with unnatural breaks on that layer to create a more robust stream network. The spatial unit that we used for the stream classification was the reach, as I mentioned previously. The reach is actually a small piece of the river network often between confluence flows and also potentially delineated by waterfalls that flow into large bodies of water or the near shore environment.

The individual reaches are often used in classifications. It's a unit that can be useful for management and also scaled up to understand species distributions.

We have 4,732 perennial stream reaches across these five islands. We actually were able to delineate three different spatial extents for use in this classification. The first is the local catchment or the area that flows directly into a given stream reach. The next is the network or upstream catchment which is the entire upstream area that drains and potentially influences that individual reach.

The final is the downstream main channel and this is actually the portion of the river from the terminal point of a reach to the near shore environment. We included the scale essentially to try to capture any potential influences on migration of species into upper reaches.

Spatial framework really allows is that it provides a higher resolution catchment delineation that's been previously available in Hawaii. Once we have the spatial framework established, the next step was to identify, obtain, and attribute data. For species data, we used presence/absence data from 1992 to 2007. It was provided by the Hawaii Division of Aquatic Resources and the Hawaii Fish Habitat Partnership.

These data were attributed to the stream reaches by these groups and accounted for approximately 10 percent of perennial stream reaches across the islands. The species that were included within this presence/absence data set are four species of gobies, an eleotrid sleeper, a native atyid prawn, the ‘Opae Kala’ole which is once again the species I've worked most exclusively on as well as the Macrobrachium prawn, flag tail species and the snail.

These species were identified initially by the Hawaii DAR and staff as important to conservation decisions in Hawaii. Once we have the species data attributed, the next step was to identify natural landscape data that was theorized to be important to stream species. We used both the literature that was available as well as expert opinion to identify our initial set which can largely be classified into the four different types:

Influences on migration which include things like elevation as well as migration through barriers in the form of waterfalls, channel size and slope, multiple spatial extents as well as soil and geological characteristics. Finally, average rainfall and rainfall variability.

I'll just mention that this rainfall data was made available by Abigail Frasier and Tom Giambelluca. It was a monthly rainfall data set of our study period.

The next step was to take these available landscape datasets that were available across all sides of our islands and attribute them to the spatial framework which resulted in over 70 landscape variables with our initial dataset. As you might imagine, this is a bit cumbersome when you're attempting to classify stream reaches. The next step in this process was the actual data reduction of this larger natural landscape data set.

Really what we did here is try to identify those landscape variables that have the strongest relationships to habitat species distribution and therefore allowing the creation of a parsimonious stream classification. It started with a two-step process. The first was for climate or rainfall variables where we calculated hydrological flow metrics for gauges on natural streams with flow data between 1992 and 2007.

We then evaluated correlations between these flow metrics in rainfall variables and selected those that had the strongest relationships to stream flow. These were then included in a larger collection of natural landscape variables and we then implemented a second step known as a fourth collection canonical correspondence analysis.

What this analysis allows us to do is to remove variables that explain little variance in the species distribution and is commonly used in multivaried approach in landscape analysis. After the data reduction step, we ended up having seven landscape variables that were selected for classifying these rivers or river reaches:

Minimum elevation as well as maximum waterfall height, upstream drainage area, downstream slope, local slope, upstream hydrologic soil grouping as well as mean annual rainfall. Using this set of seven landscape variables, we are then ready to actually create the initial reach groupings and we grouped our river reaches using what's called a conditional inference tree.

For those of you who are familiar with card analysis, it is a similar type of approach, although it uses a two-step recursive partitioning technique and allows for the use of both multiple predictor variable and multiple binary responses in the same analysis. What it does, it determines whether any of these landscape variables or the seven landscape variables have a significant relationship with the biological data set.

If they do, it then tries to identify the strongest split value to create the most homogenous grouping of river reaches based on the percent occurrence of these nine species. As we look at the results of the classification, I just wanted to show you an example of what this output looks like.

So you have an individual circle here in the center, that will include a break variable and what that means, it's one of those natural landscape variables that was significantly associated with those species occurrence data, or species presence/absence. Then you have a split value which is the value that creates the most homogenous stream groupings based on species occurrence.

Any stream reach with less than or equal to that split value will go to the right and create one stream grouping and any with a split value greater than that split value would go to the...I'm sorry I did that backwards. Left would be less than or equal to the split value and right would be greater than the split value.

Essentially what you end up with are these histograms representing potential species occurrence within a particular stream grouping. I'll say that 80 percent of our data was used for the training or creation of this conditional inference tree, while 20 was withheld for evaluation.

This is the actual output from the conditional inference trees. It's a little bit overwhelming, but I'll try to orient you to what we're seeing.

Along the bottom you'll see a series of histograms ranging from a label from A to I, and those that represent the individual stream groupings that were created and the percent species occurrence within them. The numbers one through nine all relate to a specific species of interest, and while we see those, eight different circles representing individual splits within the tree.

A couple important things to point out. First of all, we see minimum elevation coming up three out eight times within the splitting within the conditional inference tree. This makes sense as minimum elevation, or elevation in general, has been used as a zonation technique for distributions of species in Hawaii and semi-quantitative or qualitative analyses.

What's truly interesting is that two of these breaks, at 22-meters at elevation and 231, are actually very similar to values that have been used in some of those zonation analyses. What we're really seeing is potentially that this is matching some of the ecological understanding that we have about the species distributions in Hawaii.

Additionally, we see that upstream mean annual rainfall is also playing a role, or are associated with significant breaks in species groupings. It's actually within three different groups, G through I, where we see with declining rainfall we have a decline in the percent occurrence of individual species.

This is showing that in some certain types of river systems, or river reaches, you do see upstream annual rainfall playing an important role in shaping species' distributions.

At this point we had our nine initial stream groupings. The next step was to generate what we're calling our final reach types for this classification, so types of different individual reaches.

The process that we went about creating these final reach types was through stakeholder input. We met with individuals from DAR, as well as the Hawaii Fish Habitat Partnership to first make sure that the results matched ecological understanding, but also to try to capture whether we were missing any particular groups or if things could be further delineated based on their knowledge.

We did end up adding three different stream types. The first was reaches with terminal waterfalls that end in the ocean. Those would likely block the migration of any species, minus certain types of climbers.

The second was high-elevation bog streams. We added this stream reach type based on input because at some very high elevations in Hawaii you have low-slope areas that have bog or swamp-like conditions.

I have to say that Dan Pohemoth had a strong influence in the generation of this stream type. I'd like to thank him for his help there.

Finally, the addition of a third stream type, which was headwaters. This is above 750 meters in elevation. At this point it's thought that stream species simply do not make it that high up in the river channel.

At this point we've now created a total of 12 stream groupings that we could then extrapolate and represent across the study region. I won't go into the specific meaning of each individual stream type.

I will say as we move from east on younger islands, such as the Big Island, out to the western portions in Kauai, we do see a shift in the general types of stream types, especially at high elevation, from rivers that potentially have significant relationships with rainfall to those that don't, on the island of Kauai, where there might be potentially increases in groundwater delivery.

Now we have the creation of a stream reach classification. This was finalized in December 2014, about the time I was applying for the Science to Action Fellowship. I received the fellowship in February and was ready to jump right in and try to present this information to stakeholders and identify how it might be used for conservation and with a changing climate.

This started with an initial webinar with stakeholders in March where I discussed the methods used in the classification, as well as the results. Also discussed the Science to Action Fellowship and some of its goals.

I'd like to say thank you to Gordon Smith and the Hawaii Fish Habitat Partnership for helping organize this initial webinar and help bring in a number of representatives from different organizations ranging from state and federal agencies, to watershed alliances, and also national conservation groups.

During this meeting some of the questions that we threw around were what are stakeholder needs related to conservation with the changing climate in Hawaii, can the classification be used to meet any of these needs, and can the classification be integrated to any new products.

One of the big messages that came out of that meeting was that the classification potentially has a role in prioritizing conservation actions, specifically on-the-ground restoration. We'll talk a little bit more about that later.

Following the March webinar, April through June I had a series of follow-up discussions, largely with the planning branch of the Commission of Water Resource Management, as well as the Hawaii Fish Habitat Partnership. During this time we discussed these potential products, or tools, and their potential use and development.

Based on these conversations, and through the support of the Science to Action Fellowship, I was then able to travel to Hawaii in July and have face-to-face meetings with both HFHP and CWRM, as well as representatives from other organizations.

These were held in Honolulu, where we discussed some of these initial products, as well as the potential for new directions or ideas based on what we've seen in the classifications. I'll actually talk about a few of these products in a second.

I will say that these meetings were overall helpful for another reason, because we had so many different people from different organizations that were able to see this project and potentially spawn some new ideas for research or conservation that was separate from some of the projects we were generating.

One of the first products that I'll talk about today is using a classification as a region-wide reach layer depicting potential habitat availability for endemics. This product was suggested by the Commission of Water Resource Management.

The Commission of Water Resource Management, specifically their planning branch, focuses on the development and implementation of plans that are proactive in protecting both Hawaii's water resources, as well as their water rights. This often extends into increasing habitats for native stream species.

Their particular question was "In Hawaii, where we have so many diversions of stream systems, in some cases completely draining the river, how could restoration efforts in certain areas benefit habitat downstream, and how much of that habitat might be restored?"

We've been working with the Commission of Water Resource Management to develop this region-wide reach layer using our results from the stream reach classification. Based on the percent occurrence of a species within a particular stream type, compared to its overall prevalence within the study region, we're able to determine whether an individual reach is likely to support a species.

This information, combined with information on the total length of river systems, could potentially be used by CWRM in decisions regarding prioritization of sites for restoration, as well as when we're writing reports on these projects.

The second product that we're working on the development of is an assessment of stream reaches that might actually change in their ability to support stream species with the changing climate. This is working directly with the Hawaii Fish Habitat Partnership.

The Hawaii Fish Habitat Partnership seeks to develop cooperative conservation projects for native aquatic life in Hawaii. One of their goals is to start including a proactive approach to changing climate.

What they're interested in is "will these streams continue to support these species with changes in rainfall, and also which of these regions, therefore, has the highest conservation value under current and future conditions?" These are some pretty complicated questions, but we're beginning to attack it, or we're planning to attack it in a few different ways.

The first is by starting with attributing and aggregating downscaled, projected climate data over multiple time steps and warming scenarios into our spatial framework. We're planning on taking data that's been recently downscaled and attributing it to both the local and network catchments.

This, in itself, represents a useful product in that these data are now available to the Hawaii Fish Habitat Partnership in a spatial framework that they have access to.

Additionally, we're also looking to calculate the total length of change in reach type within given catchments under multiple scenarios to essentially look at how these rivers might change in their ability to support species over time under different climate change scenarios. This is related to identifying regions that might be more or less vulnerable to change.

I'll mention the examples shown here on the North Hill Coast, it's completely hypothetical. This data's not been attributed to our stream types yet.

One final piece, not related to the products directly being developed with the Science to Action Fellowship, but this is about future directions and how the fellowship has led to new opportunities.

During the discussions with the Hawaii Fish Habitat Partnership one thing they mentioned is the need to identify these areas that are highly valued for conservation under both current and future conditions.

What we're looking to do in the near future is account for both the characteristics of the ecological potential of a given reach, its risk of degradation, and potential climate change using data at the reach scale.

What we'd like to do here is in the future come up with some kind of a prioritization, or even a ranking, of which watershed might be in the best condition in 50 or 100 years based under these different scenarios.

With that I'd like to come back to this Science to Action Fellowship experience overall. It definitely has supported me in the development of these management tools that I've been working with these different groups in Hawaii to create.

It's also helped me gain an exposure to NCCWSC and the CSCs. One of the things I took out of this experience, when I was in Reston, Virginia, was about setting and implementing research priorities, how we think about problems that are affecting all parts of the United States and how we can work with these Climate Science Centers to generate new science and information that can affect management.

Finally, I didn't talk much about this today, but this fellowship also offered another opportunity, which was to share my research with a broader audience. Essentially this was done both through webinars, like the one today, but also while I was in Hawaii I was able to attend conferences that included individuals from Guam, as well as from Puerto Rico and other areas, where we talked about the classification and talked about the work going on in that region, and really this has allowed for discovery of potential application and potentially even this approach to other region.

With that, I'd like to say thank you to the National Climate Change and Wildlife Science Center for all their support.

As well as Hawaii Fish Habitat Partnership especially Gordon Smith for all the help with this project. The Hawaii Division of Aquatic Resources, as well as the Commission of Water Resource Management. I would like to also thank the Forest Service, Michigan State University, the National Fish Habitat Partnership, and a number of individuals who have helped with both applying data and working on this project.

Finally, I would like to thank Dr. Shawn Carter, Dr. Doug Beard and Dr. Abigail Lynch who were all great mentors while I was in Reston, Virginia for the two months this spring. I would just say thank you again for attending.

Ashley: Thank you very much, Ralph. I'd like to open up the conference for questions...Yes.

Don Heacock: It does work. This is my first webinar. This is Don Heacock calling from Kauai. Great presentation, Ralph. I'm sorry I wasn't able to meet with you when you were in Hawaii. I was very sick at that time from drinking and not knowing it, atrazine in my spring water for almost 20 years. I got rid of that and all the illness went away.

Ralph: I'm glad you're back on your feet.

Don: Yes. More than that. I just have two questions, Ralph. When you met with the stakeholders, you mentioned that they basically addressed primary needs for conservation. Can you tell me what those were and list them for me?

Ralph: With the groups that I met with initially, and really these are members of Hawaii Fish Habitat Partnership, as well as the Commission of Water Resource Management. The priorities from those groups specifically for Commission of Water Resource Management was about being proactive in preparing for climate change and essentially the possibility of increasing resilience to the system through restoration.

With the Hawaii Fish Habitat Partnership, the main climate-related piece there was really just about trying to capture how climate change might influence these systems and how we can prioritize on the ground conservation knowing that this climate change will be affecting these streams. Those are the groups that I focused on particularly after the initial webinar.

Because the project that we have generated is really about this broad spatial scale and understanding this broad trends. It has the most applicability at that kind of a scale. Those are the groups that really, we have those defined goals for.

Don: Ralph, just a couple of more questions and I'll let others chime in. Did you meet with or have you spoken with Mike Kido from the Hawaii Stream Research Center who's published works on the stream continuum in Hawaii and the geographical longitudinal distribution of the different species.

Ralph: Actually, Mike Kido sat in on a call during the original creation of the classification which was about two years ago. He had some great input, honestly. He encouraged bringing in the use of distance inland as well as potentially percent stream continuum in some of those initial and natural landscape variables.

I was able to look at some of his work specifically the on northern shores of Kauai with species distribution and the relationships we thought especially on the area of Kauai and Oahu with the distribution of these species to match that kind of thinking especially. And while he worked with density data, the relationship seemeded to be pretty on par. I was pretty excited to see that.

I haven't talked with Dr. Kido in probably a little bit of time since then.

Don: He may or may not be on this conference. He was the one that brought it to my attention. The thing that I'd like to add about what you said about Commission on Water Resource Management is they have no loaded stream biologist on their staff. Their mandate to equitably allocate water resources is a little bit different than the Division of Aquatic resources mandate to protect all aquatic habitats and their living aquatic resources.

You mentioned that CWRM’s primarily concern was to increase the resilience of our stream ecosystems under the pressure of climate change. We all know that biological diversity, the higher it is the more resilient the stream system is. The problems that I would include in these needs for conservation are the fact that we don't even have a definition of stream channel in the Hawaii Water Code.

Similar to what’s in, say the state of Washington's Hydraulic Code. Without recognizing that riparian zones are part of streams and that riparian zones in flood plains are part of rivers, you’re never going to be able to protect them. Period.

The other thing I would do is we need to address for conservation, the restoration of in-stream flows because it doesn't matter how you estimate the distribution of these 90 percent of which are endemic stream animals by various metrics elevation substrate, flows, etc. If there's no water, they're not going to be there.

Lastly, we need to seriously address ways to reduce migratory barriers, for example in Wainiha, the hydropower plant that was built in 1906 has a concrete surface water dam across it that entrains and causes the impingement of many post larvae, larval and adult downstream migrating gobies.

It has serious negative effects as many large hydropower projects do across the nation and around the world. However, if those divergent systems were made sub-surface with low velocity intakes, you can probably reduce the impacts to almost zero. Again, these original systems were designed over a hundred years ago. They didn't have high density polyethylene pipe back then, et cetera.

Some I'll just leave it at that right now. But last comment was where you mentioned identification of areas with high values for conservation. Clearly, the reference quality streams that Mike Kido has identified, and Gordon Smith and myself are already have areas because they have the highest index of biological integrity, clearly are areas that need to be protected and looked at closely as climate change progresses.

Thank you.

Ralph: Thank you very much, Don. I'll just add that I totally agree those reference quality streams are of high conservation value. We're simply trying to bring in the data that's been made available recently and try to bring that into the mix as well. I look forward to working with you on that project and really getting your input as we go along. Thank you.

Don: Just a last comment then I'll be quiet for a while and listen again. Your presentation was very good, Ralph. The other thing, there are many other conservation actions we need. Hawaii, for example, has no comprehensive storm water quality protection program like Washington, Oregon and other places have had for decades.

We still allow increased storm water runoff from urban areas to be dumped right into the closest stream. We're not going to conserve and protect these unique Hawaiian stream biota without taking a whole bunch of steps simultaneously. Lastly, just a question, will you be presenting this presentation at the Sustainable Water Conference coming up in December?

Ralph: I won't be able to make it to that conference, unfortunately.

Don: Because this would be valuable. I will briefly be presenting and hopefully some others will be too. Thanks again, Ralph, for your presentation. It was very well done.

Ralph: Thank you for the comment.

Ashley: Thank you very much. Emily, any closing remarks?

Emily: Just a big thank you to Ralph and to everyone for attending.

Ashley: Thanks, Emily. Ralph, any closing comments?

Ralph: Just thank you to everyone for making it today. I appreciate it.

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