

Technical Facilitated Discussion

LeRoy Poff: For question and answer for the panel member, the speakers will comprise the panel, and there's a microphone here if any for those of you who want to ask questions, please come forward to the microphone. In the event you think everyone in the room knows who you are, you still should identify your name and your affiliation. Speak clearly please and we will keep the questions to three to four minutes. Once people start rumbling then we'll move on to the next person, which I know I'm probably doing that right now. All right, so our first and please come forward and make a queue here, I'm sure many of you have questions. Our first questioner.

Tom Annear: Tom Annear, Wyoming Gaming Fish Department. You can say, this only sounds like a self serving question, but it's for Stanford. You made a comment somewhere early in your presentation that, the IFC was very helpful to you when it came to FERC license and permitting and re-permitting. A, is that correct and B, exactly what did you mean? I ask that for people in the audience here who might want to be able to use those same tools to help them with their own FERC licensing.

Stafford Lehr: Thanks Tom. All right, so a little bit of my background, I spent 18 years in hydro wars and water wars, and the history that we had was, licenses that were coming to conclusion, we had approximately 60 major licenses that were entering renewal process. The battle day wars was sitting down with the licensee, they laid their, this is their offer on the table, flat line hydrograph what they determine to be a minimum flow necessary to protect a single life stage for a single season.

You might have heard what I will call a bastardized hydrograph, higher flows during the summer to protect cold water habitat for rainbow trout, and very low flows during the winter. When we got to a point where a group of NGOs called BS, and we sat down at a table and I had to own it. I had agreed to something that I biologically, ecologically could not support. What that caused was a ripple effect within the state of California, where a major operator basically said, "You lied to us," and I said, "I'm sorry, I need to stand up and say what's best for the ecosystem."

They said, "Okay, now what do we do?" I said, "Well, we need to rethink how we did this." We sat down US force service, US fish and wildlife service, the NGOs, the included recreationists and the hydropower licensee was trying to rebrand itself as eco friendly in the state. About that time, we became aware of brands rectors indicators of hydrologic alteration, I probably got that wrong. Then we started to incorporate information from doctor Pop and others that, how do we start to build a hydrograph that can mimic natural flows, yet meet all the competing demands?

Along those lines, we're constantly referring back to the first edition of the council's book, and we just started pull resources out of there. What ended up happening was a paradigm shift in relicensing. We ended up coming into settlement negotiations that use the power of the US force services 4D mandatory conditioning, our state waterboards mandatory conditioning 401. Then the threat of section 18 fish passage with the US fish and wildlife service. All those pressures began to change the mindset of the hydropower licensees that look, we're going to have to give up a little, we can win allies, we can build in, channel maintenance flows where they can be coupled with recreational opportunities. We can establish multi year hydro-graphs based upon five main water year types from critically dry to wet.

We set up certainty with the licensees, so that they could look out, 30, 40, 50 years and say, "What is the economic risk that we're taking by buying this multitude of factors?" Well, one thing I learned was, who was I, this wet behind the ears biologist to challenge some icons that preceded me in relicensing? They worked with the licensees back in the 70s. These people knew what they were doing, but they were always fighting with one hand tied behind their back. Fish and aquatic systems did not have equal standing, first in the mind of a licensee, second in the mind of [inaudible 00:07:25].

What we ended up doing was, reversing that, but the one lesson I learned was, don't assume we know everything today, because there's going to be new methodologies and new approaches. We had to convince the licensees to build an adaptive management bank, and we built in a frequency of monitoring with over five year periods with some trigger points that if flows, temperatures and other conditions were not seeing measurable results based upon clear define smart objectives, that we would have a block of water or a time frame which we could begin to make adjustments within the system and that gave the licensees certainty that they could build into their predictive bank for their stakeholders.

I think in some was what started with the IFC and the taking that and making sure that information was clearly understood and constantly going back to the resources that were provided in the various textbooks and manuals and papers, that we could build a defensible rationale that could withstand Quasi-judicial or judicial scrutiny and convince a majority of the populous that, fish and wildlife were good and that it did not cost the project to be completely economically non-feasible for the licensee.

In the end we came out with 30, 40, 50 years of certainty for the licensee and for the agencies.

Brian Ritcher:

Brian Ritcher with Sustainable waters. Thank you all, terrific presentations. My question is for you Matt. In setting up your talk about trying to gaining an understanding of the relationship between ground water and surface water in the upper Colorado River Basin. Part of your setup context alluded to the fact that, there is a lot in the user community that we're interested in the possibility

of increased ground water pumping as being an additional source of supply, was the way that I took it from what you said.

Based on what you found, A, do you think that increased pumping in the upper Colorado River Basin has the potential to further deplete the Colorado and have impacts on the aquatic systems? B, has the possibility further depleting the Colorado flows and injuring surface water rights?

Matt Miller:

Good questions. With respect to A, I think it's certainly possible that further development of ground water resources could impact surface flows. I don't think that we as of now have all the information that we need to fully assess that. I mean what we were able to show with our work was that, although it varies across space, a lot of the surface water flow is dependent upon groundwater.

The question is or I guess one of the unresolved questions is, what is the degree of connectedness between specific parts of the groundwater system and the surface water systems? If you install a well in a part of the groundwater system that either isn't directly connected to the surface water system and/or is connected via very long old flow paths, then I think there's less of a risk. Kind of to summarize that, I think that there is a need for further study to more directly flush out that connection. I think starting with age transit time distributions of groundwater discharge, its specific locations in streams is a necessary step towards that.

The second question with respect to water rights, I don't know that I have a great answer for that. I'm working for the US Geological Survey. I'm trained to not get into the policy side of things, and I think that's good advice. That said, if we can establish this connection between specific groundwater resources and specific surface water resources, I guess I will say that I think then there are implications with respect to water rights certainly.

Lori Buff ????:

I'm going to encourage more people to come ask questions that I know are just eating at you, and I have one of those. Lori Buff, [inaudible 00:12:25] University. It's a followup for you Matt into some extent for you Terry as well. It has to do with this, I'm not sure this was what was being referred to as the Holy Grail earlier, but the modeling the quantitative linkages between groundwater and surface water, and how far you can push models to particular sort of management, relevant spatial scales and temporal scales so that it becomes potentially actionable.

Matt, your Sparrow model was quite interesting, seemed to offer a lot of possibility. It wasn't quite clear to me what scale you sort of special grain you could produce that to, and I'd like to hear you talk about sort of the future you see for that technology in terms of modeling groundwater flows at sort of sub catchment or sub watershed scales or whatever scale you want to talk about. Then, I want to ask if that there's a possibility that that kind of modeling ever

could be linked with things like overgrazing, that was shown by Terry to affect sort of soil moisture retention and of course organic matter degradation or loss.

Seems that somehow if you're really going to have a Holy Grail, then you have to be able to put this down to the level where some management actions could be taken at a sub watershed scale to conserve the integrity of aquatic systems through the kinds of process understanding that Terry is talking about. For you both.

Matt:

Yeah, great. I guess I'll start. I'm sure most of you have heard it George Box's quote, that all models are wrong, but some are useful, that certainly holds here. With respect to Sparrow, Sparrow is, it's a great tool, but it's a limited tool. What I think it's great for is addressing questions that very large spatial scale. For example, the scale of the upper Colorado River Basin to come away with information like what I presented. That is for example, we've got more groundwater discharging the streams at high elevations than at low elevations, but at low elevations the streams are more dependent upon the groundwater discharge streams.

Where it becomes less useful is when you start to get down to smaller and smaller watersheds. The smaller, the spatial scale of the watershed that we're looking at, I think the less certainty that we have on the estimates from the models. I guess I would argue that, if you've got your watershed of interest, that is one 100 square kilometers, whatever size it might be, perhaps you're better off developing a more deterministic process based model, to fully understand the system there.

I wouldn't argue that Sparrow's the right tool to do that, but rather it's the right tool to get a broad scale understanding of what's happening in a regional system and what are the differences among, for example, elevation gradients within that region.

Part of your question, Lori I think was about kind of moving forward and how if at all do we use that these types of models to do that. Again, depending on the scale of the watershed that you're interested in, if it's a small scale, I would advocate going again with a more process deterministic based model. That said, there's a lot of work being done right now with Sparrow models to make them dynamic, meaning to make them time variable.

What I presented is kind of a long-term average, but we're developing models right now, where we're integrating estimates of transit time distributions, that is, how old is the water that's discharging the streams? Coupling those with historic sources, so if we're talking about groundwater for example, and we know that at a given point in the stream on average, the water is 50 years old, we can say, well, what was the precipitation 50 years ago? How does that match up with what we're seeing in the stream?

We go to another point and it's two years old, we can match it up with the historic record. I think that's a major improvement for sort of the large scale modeling moving forward, but again, that is, it's I would say it's not as applicable as you get to smaller and smaller spatial scales. I'll turn it over to Terry, but I think there is utility in coupling the sort of information that Terry presented with what we've done.

For example, well right now we're working with some folks within the USGS, where we have a dissolved solids parallel. Instead of predicting groundwater discharge streams, we're predicting how much dissolved solids are coming in the streams and where in the watershed are they coming from? We are coupling that with the information on say disturbance in the season range land, so how much grazing is taking place in a range land? We use that as a predictor in a model that predicts dissolved solids. I think something similar could probably be done with the type of work that the Terry is doing if we could come up with these broad scale estimates of how is the landscape changing with respect to grazing for example? What can we then incorporate that into the Sparrow model approach?

Terry Booth:

I think our biggest area of focus, pardon me, needs to be on grazing of the wetlands, rather than upland grazing. That there is an effect of grazing on the uplands, right now I don't perceive that as near as serious as grazing the wetland. We need to understand the connectivity. I show the photo of the PB pasture, the one that had been not grazed or likely grazed for 50 years had 53% organic matter, low surface roughness index.

You notice that it was leaking water through the fence downstream to the dry area, how much water was going out of that mud into the groundwater? Nobody has studied that. There are very few studies. There's one study on the effect of high elevation beaver dams on groundwater recharge, and that doesn't recharge very much, because solid red rock is down there. We need some beaver dams in low elevation areas, in losing reaches of streams, to find out how much recharge we can get there.

There's an ideal need right in Cheyenne, we have the city wells on it losing reach of the Crow Creek. If we could get beaver dams down there, we would recharge that aqua for this, that's getting down low enough, there's some concerns. Mainly we do need the studies, I agree with that.

Norman Johns:

I'm Norman Johns with the National Wildlife Federation office down in Austin, Texas. Generally speaking in Texas we see some efforts if you will to delay or waiver in commitments to environmental flows for endangered species. Would be spring dependent species in the Edward aqua, which you may have heard a little bit about yesterday, and we've got some new species of mussels that maybe wasted soon.

I was wondering Mr. Layer if you could comment on the success of those kind of drastic interventions you had to do, because we see that as a sort of, oh don't

worry, we can intervene with these endangered species put them in aquariums, get them through the worst case droughts and so on. That might be a way of getting around more serious commitments to environmental protection from a proactive point of view from flows.

Stafford Lehr:

I spoke about what working with National Marine Fisheries Service on regulatory assurances. In California we have the California Endangered Species Act and normally, we could create exemptions for take, for scientific research or some other restoration activities that would take place. What we'd never used was a clause set for management purposes, so under the California Endangered Species Act, we looked at the entire take clause and said, well, what if we worked with the private landowner or rancher, an irrigator or someone and said, we're going to work with them under a management scenario, of them allowing them to take water when it was available, yet they forego it. We would not come after them during the period they were taking water if it was an unscreened diversion or there was a potential for take.

Under the Federal Endangered Species Act, that got a little more sticky, but National Marine Fisheries Service looked at the broad scale issues and said, "We really need to have collaboration and we've got to have voluntary buy in." That was a major step for us to actually take away the fear of the regulatory agencies at local levels. These things, they took us a couple months or three four months to actually get an agreement that the parties could live with, but it showed goodwill. I think what regulators often forgot was, these people cared about their land and they're stewards of that land. They really wanted to not kill everything in the system.

That was a moment. Now, playing God, I've got to tell you, we had a very long debates well into the night over direct intervention. To save, what did I say, 51 different species. These species were stressed, because of anthropogenic effects. Whether it was historical introductions of non-native fish or whether it was water withdrawals or whether it was just a degraded habitat due to development or whatever. I could spend an hour on each sector that we dealt with, but for, when we went in directly intervened with species, we went through a process. We wanted to leave the critters in their natural environment for as long as possible, but we reached a certain threshold, where everybody sitting around the table said, if this is something that we really care about, it's an iconic species in the state, we have to directly intervene.

What I would say to those that say, "Well we always have the zoo option," really? You've got to care for your environment, and a healthy environment is good for everybody and it's something that everybody can get behind, whether it's clean water, clean air or healthy populations of fish and wildlife. You really, there comes a moment where you've got to have some sort of a realization that animals in their natural habitat are much better than in an artificial environment. What we always said when we brought an animal into captivity, that animal will go back when the habitat recovers.

Unfortunately under the McCloud River redband, it was three years. We went through three breeding cycles, but we finally got the fish back into the environment. Golden trout, we brought them into captivity. We put those back into the environment within eight months. The zoo is never the option.

Jonathan Kohr: Jonathan Kohr, Washington Department of Fish and Wildlife. You just partially answered the question, but I guess I'll get more specific. Did you have like a salvage protocol that when oxygen levels were too low, temperatures were too high something's like a protocol to say, hey, this fish need salvaged and they need replaced?

Secondly, are you doing any post monitoring? We've found so far from the 2015 drought, it looks like our steel head are in the tank.

Stafford Lehr: Yeah, and we did have those protocols established, it was a three step protocol. We always went in, we began monitoring temperatures, flows, condition of the population or all life stages there in insufficient numbers. All the species that are supposed to be there using BMI indicators, so that we begin to establish a baseline. The baseline was late, we get it, we can't be everywhere doing everything for everything.

We would, we prioritized and we basically began to look at geographic areas that we knew were extremely stressed. We sent in strike teams that began to establish monitoring stations, photo points, how far, where was the dry back section starting? In monitoring that, is that track back up to the system? Then we got to a point where there's the last remaining habitat and we're watching the temperature regimes or we're watching the flow regimes and began to say you know, what this is reaching a critical threshold.

We had that all in place and then it was a collective command decision, we convened a call of the regional leadership. I as the deputy director or previously as fish chief was involved and said it's a go. Everybody's of consensus that we've got to go in and do some drastic. Now, putting them back out there, post project monitoring, it all comes down to money. For specific areas, specific species, McCloud River redband, California golden trout, Lahantan cutthroat trout, unarmored three-spined stickleback, Arroyo suckers.

We did go in back and we began to monitor those, where we have not seen a recovery is in our anadromous populations, but we had a confluence of a perfect storm. While we did drastic measures inland, the ocean went sideways on us, so we had ocean acidification, warming. We lost the upwelling, we had harmful algal blooms, so we got the fish out to the ocean, but the ocean couldn't sustain them. That is basically the steelhead and the salmon.

Unfortunately our anadromous fish are in tough order and when you talked about steelhead, I suspect it was probably something beyond our control.

Dean Watts:

Dean Watts, DFO in British Columbia. I just came to realization that Brian Ritcher is not just a giant in the literature world, he's also a giant. Yeah, just a question, and really good presentations. I'm wondering if you could comment a little bit on the back to back and maybe even the back to back to back droughts. You guys have had certainly in California, other states long-term growth scenarios. A

What we're seeing in some parts or actually the Nickel River, Rich McCleary has a post road in the room out there, and so on the Nickel River. One of the things we've seen as well and Nickel River is close to [inaudible 00:29:18] is that, you know that first drought and we had a big one in, back in 2013, the groundwater certainly had a huge influence for fish and fish habitat. Particularly migrating summer ranch chinook salmon.

We got a really good performance out of a fully charged groundwater system, right, that eventually that performed quite well in terms of resurfacing down the stream continuum and helping the summer ranch chinook actually checkerboard. There was extremely low flows, surface flows, but they were using the inflows from the ground water, actually checkerboard up the system for migratory purposes, begin to upper reaches where they're spawning. Great, and they were doing this at Nate, strategically and just check boarding where these sites were upwelling throughout the system.

We weren't getting those kind of services in a back to back drought scenario. Just wonder if you sort of have seen these types of, the deterioration of the performance of groundwater surface exchanges for fish, fish habitat as you get into these drought back to back to back in longer scenarios.

Stafford Lehr:

Yeah, I guess I'll take a quick crack at that. Looking good at data where you do have as you mentioned kind of back to back droughts, you do occasionally see situations where your stream flows sustained during the first drought, but then it gets less and less sustained as you move on in time. I think you know that the likelihood of that happening in a given location, is dependent on the specifics of that location.

What is the size of your groundwater reservoir? That's another big unknown that I think would be, provide a lot of valuable information. For example, what's the size of storage of the groundwater reservoir that's contributing the stream flow? If it's very large, perhaps you might not see that, but if it's a smaller reservoir, it could be depleted over a years' time or two years' time, that sort of thing. Getting that sort of information would be valuable.

Yeah. Again, when you look at time series of data, you do see that. You see streams that are perennial that become intermittent, but it depends on the specifics of your watershed. I don't know if anybody else has something to add.

Matt Miller:

I think one thing that really shock the world of California, what people don't realize is that, in the '76, '77 drought, there was flexibility within the AG

community on how they used water. You all read Marc Reisner's book 'Cadillac Desert' when he [inaudible 00:32:18] you know just ripped to shreds corporate firms that were farming alfalfa and cotton in the southern San Joaquin Valley. What we did not have in the 2012, through 16 drought was that flexibility for mag, because they'd converted their crops from a majority of cotton and alfalfa to nut trees.

You're talking about 20 year investment for pistachios and almonds and stone fruit, suddenly you don't have that flexibility, the trees need water. What they did was they basically started drilling the hell out of the aqua fur in the southern San Joaquin Valley and then that just exacerbated groundwater, ground subsidence and then started to put other critical infrastructure at risk, due to subsidence of the land.

Lo and behold what popped out was the surface water ground, I mean the groundwater Management Act subsurface Sigma as we call it, which is the first attempt to regulate groundwater in the state of California. That is a huge war, going after what was always thought was an inalienable right. Now they're beginning to regulate groundwater in California and that will begin to look at that crescendo effect of compound and drought.

Roger Gorke:

Just one other thing to add to that, when we were discussing some of the things that folks in southwest Oklahoma were doing, some of the kind of their action plan, the different parts of their action plan, there's a lot of discussion between the Western States about all of the actions that they were doing, were just proper water resource management. It's not anything necessarily out there that would be just drought specific, but it's just how do you manage your water most appropriately to meet all of the needs that you have?

The message that I took from that is, you need to be doing that whether you're in a drought or whether you're not in a drought. When you have the back to back droughts, you should have yourself set up to be able to manage water depending on how long, regardless of how long that goes out. That was just a huge message for me of when you do water resource management properly, you set yourself up for success during drought situations, regardless of how long those last.

Daniel Cooper:

Okay, I'm Daniel Cooper and I'm with the Leonardo Di Caprio Foundation, I run their legal program. I'm hearing an overwhelming emphasis at this conference on collaboration, collaborative efforts. I'm hearing it typically in the context of safe harbors or regulatory certainty, and so what I'm hearing is, trading away, enforcement of existing laws or existing standards for collaboration from stakeholders, typically water users, AG or municipalities.

I guess my question is that, is that good public policy to trade away those enforcement tools? Why aren't we seeing more classic enforcement of existing laws by resource agencies to achieve the in stream flows we all know are required to sustain fish?

Stafford Lehr: I'll take that. I think it's a realization that you go into an enforcement action and it can take years to work its way through the system. In a crisis, you need immediate response. Do not think we've turned a blind eye to enforcement action. We took multiple enforcement actions during the drought for the worst of the worst, but often times and when you're talking a landscape level crisis, you've got to use a little bit of sugar to get more people to the table to do the right thing.

Definitely enforcement action was taken during the drought and it was against the worst of the worst.

Roger Gorke: I think to add to that is [inaudible 00:37:09] turn on. I think to add to that, there may not be situations where they're actually outside the law. For example, you might have seen your water users that, how do you help them give up a little bit of their right for folks further down the ladder? I think we've heard today some of the things that are, maybe not on the edge, but not the first tool in the tool box.

I think there's a significant amount of work that happens, that is within and how do you work within the bounds of the law so that there are no losers particularly the environment or in stream flows? The other aspect of what my experience has been is that, folks, if they do the right thing, and they're in compliance with the law, but they might do something that they don't want something to come back to them and be a gotcha later on. Like if they do something now that's voluntary to create something that they'll get stuck with something down the line, will it be outside the law?

I just haven't seen a lot of the, I mean there are a few examples that Stafford is brought up of, we'll give you this for that. The majority of what I see is working within the law and how do you get people to do things where there is no legal hook to make them do things? I hope that helps, but we're continuing, I'm trying to be careful, because this is being recorded. I think there needs to be a lot more creativity on how do we, and whether it's sugar or whatever we use.

Let me put it this way, we've gotten, the EPA has gotten itself into trouble by trying to enforce too much and stretch what we thought we had adequate authority for. When litigated, we went too far and so that has a pendulum swing to the other way, and we lose some tools in the gray area. Especially now, I think we need to be very careful about how we form partnerships, so that it doesn't get there and we do that early, so that it isn't a one of the other enforcement or giving the farm away situation. I hope that helps a little bit, but these are difficult days for enforcement as well.

LeRoy Poff: I just wanted to follow up on that, just a little bit. I think that's a really interesting question and it sort of begs the further question about looking forward in terms of climate change and the increased likelihood of severe drought. It seems like as a society, we're sort of being faced with this, do we

stick with enforcement, which is in some ways limited, because you have increasingly stressed systems and they're going to potentially blink out right?

I mean California did some Herculean efforts to prevent that, but can this experience from California or from the western US, when combined with the forecasts of increasing, changing hydrology is an increasing drought. Can these experiences lead to a much, in my view, a much needed sort of rethinking about how we manage natural resources in the face of increasing population demand for water and climate change? I know we're very legalistic society and we have the rule of law. We have very clear regulations, but I was very encouraged actually to see this sort of collaborative effort emerging in California at the highest levels to try to solve a problem that's real.

I just wonder from your perspectives, with respect to this question about enforcement versus collaboration, what have we learned? Have we learned things that people in this room can take home with them to create a better sort of management environment for natural resources that everybody wants a piece of?

Roger Gorke:

I don't think it has to be one of the other. I think we need to start early and often, whether it's voting or you know collaboration, start early to get that buy in as to how do we all think we can get there most effectively, rather than being crisis driven at the other end. We seem to always be in crisis driven status. It really doesn't work well, because then everybody kind of backs and then you're forced to just use enforcement, which can be limited.

Stafford and I had a brief discussion about the Klamath that might be a good example on how things went from one extreme to the other these days. Not to set you up, but you have the tie.

Matt Miller:

Dr. Poff that was a great sort of introduction. In the peak of the drought, California's water rights are pretty set in history. They go all the way back to Spanish land grant rights, to property rights associated with people living right next to it. To pretty appropriative rights that basically the, what we call pre 14 water right, they can take every drop of water. The only way to solve it is to go into court and make your case, that you're being injured.

Then you have appropriative water rights that follow that, and then there's senior appropriative versus junior. What ended up coming out of that was okay, if we looked at the Australian model, okay, just blow up the entire water rights law, start from scratch as zero sum game. You go in, you defend your need and then you build from there. Well, that's going to take decades, okay, and there's going to be litigation no matter what.

What we started to do, was looking at what we did in a small scale effort with an individual rancher or a property owner or a small utility district, and go, what if we went bigger? What if we started talking with the big water right holders in

the Central Valley and started setting up voluntary agreements, where they could provide an ecosystem benefit? Then they get some certainty as it goes up, because in California it's never ending, because if we get one species list, I tell you what, there's six more in the queue. I only have one race of salmon not listed by the federal or state government, and that's our last hope.

What if that species gets listed? What we're trying to do is work at a collaborative environment, where we can set up a regime using these ... We've got modelers and data gurus sitting in dark rooms, working through the data that's then brought to the negotiation table, to start working out some structured negotiation, where we can say, you know what, we're going to come out on a better end with some certainty. To be able to say, you know what, it doesn't necessarily take, and I really appreciate Roger talking about working within the bounds of the law. That is working on those fringes where there might be right up against the edge. There's not an enforcement case, but we need to back it down a little bit, that it could be beneficial.

Let's now face this, in the next probably 15 years, California is going to be a 50 million people. There's not enough water to go around, so we've got to do things smarter, we've got to do things better. We've got to build efficiencies all throughout the system from top a pipe to the end of pipe. Really, the only way is going to do it, is everybody getting around the table trying to figure out a better solution. If it is voluntary agreements that are blown up at a much larger scale, if it is going back to you know what, let's blow up the whole box and start over from a zero sum game, I don't know.

We're trying right now through the negotiation tactic of trying to go back into what are established in very, very set law and precedents of getting them to maybe give up a little bit.

LeRoy Poff: All right thank you for that, I think that's enlightening for food for thought. I know we have at least one other question. We're getting, pushing up a bit against lunch time, so if there's any other additional questions, would you please come and get near the microphone. We'll take at least one more question here.

Gail Cowie: Thank you. I'm Gail Cowie, I'm with the George Environmental Protection Division. I came to the mic with a question, I'm going to add a quick comment, because the agency I'm with is a regulatory agency. I find this discussion of collaboration and enforcement very instructive. In the past 15 years, my agency has increasingly used collaborative approaches as part of our tools. The way I think about it is a necessary and sufficient approach.

Enforcement is absolutely necessary, collaboration as part of the necessary and sufficient set of tools that we have to bring. That echoes a lot of what had been said, but I just wanted to add that perspective from the state level as well, eastern state level. The question I have is for Steve. In your presentation about Oasis, if I heard it correctly, I believe you said that oasis in the Tennessee basin

is being linked to diversity measures. I wanted to ask you to just talk briefly about the data needed to do that and the source of those data. Thank you.

Steve Nebiker:

Yeah, there's a lot of data that goes into forming the relationships. This was an effort spearheaded by Rodney Knight in the Gulf Science Center there. He relied on the TVA fish sampling sites, of which there are many, and then related that flow. It was very detailed study and it applies to the Tennessee River Basin. He's pursuing similar work in the Gulf Coast states, but they're time consuming.

We're doing some work with the National Park Service on the Obed Park in Tennessee to look at alternative water management strategies. We're using that diversity metric as an indicator of successful strategies.

Patrick McCarthy:

All right. I'm Patrick McCarthy. I'm with the Nature Conservancy's Colorado River program. My question is really a follow up to Dr. Poff's question about the possibility of if not changing the paradigm for water management, at least adding a new, maybe a new and different suite of tools that are good at building drought resilience, rather than sort of responding to drought, often in emergency and urgent conditions.

I want to just give the example of the Colorado River system pilot conservation program, which is a proactive, it's an attempt to be proactive in getting more water into the system. I mean one response to drought is to increase storage of course or to increase water availability, not by augmentation or increasing surface water storage, but in this case, managing demand through voluntary compensated reductions in consumptive use, mostly in the AG community.

To date, that program has only put about \$11 million into, so it's just barely scratching the surface of the three point five million acre feet water deficit supply demand gap in the Colorado River Basin. Which of course is only going to get bigger over time as stream flows decline 10 to 30% over the next several decades. My question is about the scaling up of that kind of approach, which involves proactive agreements, creative innovative agreements, to reduce surface water diversion and consumption, perhaps to reduce, a similar program might reduce groundwater withdrawals or increase groundwater storage in a proactive way.

It requires a lot of forward thinking and a lot of big investment, billions of dollars right? What do you think the prospects are for this sort of, getting out in front proactive thinking and proactive investments in building resilience?

Stafford Lehr:

I'll just touch upon it really briefly and that the other ... In California, fortuitously or not, right before the drought was officially declared, the governor convened three agencies together. We all got together and started looking at a forward thinking proactive water action plan. In that, we identified how could we build resiliency into various systems to address demand. In the high mountain meadows, restoring mountain meadows using them as the continuous sponge

that will retain water throughout the entire season, working with groundwater recharge and making sure that that is fully operationalized and flexible.

Working in restoring habitat and wetlands, so that they can you be used as a filter. Looking at restoration and preservation of Riparian Court, so that we lose, we reduce the warming of water as it comes down. Also, allowing that system to function more properly. It's a very forward thinking plan with distinct deliverables under a five year, but it deals with the mosaic of operations and habitat. It identifies everything from piping systems and reducing losses due to evaporation and things along those lines.

I think it's out there. It's just people need to really put their heads together and start looking at the entire mosaic of the landscape. Setting up clear deliverables with timelines, so that you can have checkpoints back in. Then coupled with that, you've got to have the money to make it happen and a multi-billion dollar bond act was passed to try to implement that. I would say it's all parts and it's only just beginning.

Matt Miller:

Just quickly, I was looking for where you went. I think it's a great idea. The problem, and not to be one that just identifies problems, but the frustrating thing that many of the people that I've come in contact with is, Sam a senior water user or a city or a community and I conserve water. Where does that water go, because as Stafford said in California specifically, there are junior water users. There will never be enough water to meet everyone's use, so are you conserving for the next junior user or how do you conserve to make that water either banked to build that long-term resilience? Or ow do you conserve it specifically for a use?

Is it, I wanted my community conserve and have that water go to in stream flow or for species or for this or for that, and that's kind of the difficulty. It's not just conserving for the next person down the water right pecking order, it's to conserve it for a specific use. I think that has to also be woven into the fundamentals of building that resilience, so that it just doesn't get wasted to the next user.

Terry Booth:

I'd have to give credit to New York City, for a long time they've been way ahead of the curve. They obviously develop supplies, pulling hundreds of miles away. It's basically been an unfiltered supply for the longest time. Recently they've been under pressure to meet the surface water treatment rule, and they've long had infiltration avoidance criterion.

They're pressing against the limits of that, so they spent a lot of money with watershed protection and the cost implications of having to put infiltration or staggering, it's billion dollars or so. They've combined efforts of watershed protection with developing these mathematical models, where they can actually re-operate or move water around between the different reservoirs, and look at the impacts on water supply reliability. That saves them.

Instead of building one hundred, one billion dollar filtration facility, and instead of building a new intake structure on one of the reservoirs, which would be three hundred million dollars, they've been able to accomplish this for a few million dollars in terms of the modeling with this operation support. Then all the watershed protection efforts, so they're very much pro, very proactive on this.

Then the other piece is in a demand forecast often don't get realized, so we can often do a lot more with the systems we have. There's a tendency to overbuild capacity and that's just very expensive. A lot of times that capacity is not, is really not needed and I'm not saying that's not true in California, but a lot of places were saying, you've got a couple of droughts, but a lot of the times you can get through most of the years with no issue at all.

LeRoy Poff:

Any other comments from the panel? Well, I'd like to thank, personally I'd like to thank the panel and I think the audience would like to thank the panel for their stimulating presentations and some interesting discussion here. With that let's clap and go to lunch.