Steve Chainey: Hello. At this symposium of physical scientists and engineers, I'm the sacrificial ecologist, so, be kind.

There are many beneficial uses of rivers that are enshrined in the State Water Code, and held by state law. Citizens of California have repeatedly voted for large bond acts, in large majority, to support many of these beneficial uses.

I'm going to speak on the ecological beneficial uses, but on the lower right you can see that predominantly the delivery of a clean reliable water supply for cities and agriculture and flood protection; voted against one another I think that California water supply would be in first place and flood control in second place, and habitat would be somewhere in the middle, maybe.

I'll focus on primarily the functions of rivers and vegetation; it has many ecological functions -- purposes. It safely [unintelligible] the aquatic zone; it's a great teabag of organic matter and nutrients that feeds the engine that drives the foodweb, that feeds the [unintelligible] that the migratory corridor for [unintelligible] fish and migratory birds. And it's an important source for in-stream woody material -- that's important to fish.

So, why are riparian habitats and floodplain interdependent? I think most ecologists that have learned how to focus on the restoration of these systems, if we had to sum up in one word how we view that -- what we focus on -- it's the floodplains. What are their functions? I'm not talking about theme of floodplains 50 to 100 years, but the frequent two to five-year flooding of natural over-banks, basins and natural higher grounds where the riparian and wetland habitats occur.

Here's a cross-section of a typical floodplain which could occur in the Central Valley; it's predated most of the economic development, and you can see that the river is completely and intrinsically linked to the floodplain -- it would overflow it's banks. Many species, over thousands of years, are adapted in behavior and life-cycle to both the river and its floodplain.

Here's an example of a remnant floodplain of our valley: if we go to the upper Sacramento River, we still have a meander belt; there's private levees and federal levees, but there are still areas you can see where the forests are inside the meander, and flood on a frequent basis. They perform an important function. There are a handful of remnant oxbow channels that are still inside the levee system, and they flood on a frequent basis. And you can see that the water captures that organic material, provides cover for out-migrating fish and forage for terrestrial, but water-dependant, species.

So, here's a contrast that Joe also spoke to: on the left is the green color, dark-green is the riparian forest, some up to several miles wide, and the basin -- the flood basins -- are in the light-green and tan colors that Joe spoke of. On the right is the same scale of what remains of our riparian and wetland floodplains.

So, what have we done to the floodplains? Where did they go? The most important remnant floodplains are the Sutter and Yolo Bypasses, which are actually the basin rim of the historic flood basin. Yute Sink, which is managed for ducks -- it's a historic basin, much smaller. And, the upper Sacramento River meander belt, and occasionally levee breaches expand the floodplain. That's what we try to avoid.

There's one more category, and I'll get to that in a minute. When we built the levee system, we isolated the floodplains and abandoned them to the natural system for our economic development, and our public safety; so all the flows were confined within these levee walls that are higher than the natural floodplain surface. This is what our floodplain looks like today; you can see the brown parallel line along the river, that's the floodplain -- that's part of it; it's on the river side of those lines.

Here's the mighty San Jochaim river, second only to the Sacramento in the Central Valley. The channel is about as wide as the levee, and I can assure you it was much bigger than that historically, and the floodplains were outside those levees. Here's the flood control system. All of our remaining habitat falls within those red lines; the larger blue areas are somewhat deceptive, because they don't flood as frequently as they used to -- the bypasses Yolo and Sutter -- because we harness the hydrology.

So, here's my mystery category: the levee tow with willow scrub. Other than those larger chunks I described to you, those are our substitute floodplain habitats. I thought of a useful euphemism: floodplain elongation. Here's a case where the mature riparian forest, in a historic floodplain, is disconnected from the river Joe [unintelligible] described.

There's a light colored line on the rock, that's the frequent high water of this river; and, there's a band of green, that's the spring and winter floodplain, frequent floodplain, that delivered the seed, that protected the fish; and that's the elevation -- their over-bank elevation -- that's the elevation where riparian species need to germinate. So, reduced flood peaks plus channel incision, that Joe described, in the range of 15 to 20 feet, has isolated our floodplain, and the response of riparian vegetation has been to not regenerate.

I'll focus on one species that's dependant on that habitat: salmonid populations, particularly Steelhead, their spawning habitat losses and their migration and rearing habitat in the riparian system and formerly in the floodplains. You can see the Central Valley rigged, ringed, by large dams. These interacted with the levee to change our physical system. The trees on the upper benches in this cartoon are the historic floodplains that supported the historic forest, and these forests -- I'm sorry to give you this sobering and startling news -- most of the acreage of riparian forest, the big beautiful trees that people love to see and walk through, are not regenerating, because their floodplains are isolated. The seed is not delivered in the spring.

We have new floodplains, but they're much smaller. In the case of Steelhead, the dams block 80 percent of their historic reproductive habitat. Thirty-seven of 50 tributaries of the Sacramento River are completely blocked.

Here you can see before and after: in the tan color we have good to marginal remaining habitat, and the rest is cut off by the dam. And this is their distribution before and after: the aqua is the current distribution. So, that's the adults that spawn. What happens to the eggs and the juveniles that have to move down-stream, get to the delta, through the bay, and out to the ocean? Out-migrating juvenile salmon use predominantly shoreline, shallow vegetation and woody debris as cover from predators, from heat, and to feed.

So, what have we done to our remaining elongated floodplain along our banks and levees? Here's a typical levee improvement along the first 40 years of bank protection. It was effective, except when they didn't put enough rock at the tow, which was common; and now we're- we're spending a lot of money to fix that. This is what it looks like, we did throw a few trees in there -- better than nothing -- but the habitat upstream is more important and beneficial to the juveniles. So, here's the picture with and without that template of bank protection design. There are some remnant trees in the elongated floodplain of the levee.

What's the statistics? In the upper Sacramento River, three-quarters, 50 miles, a 120 bank miles; three-quarters has been armored with rip-wrap. The entire Sacramento River system, nearly 200 miles, is nearly half, and with all the bank protection we've done since 2003, we're pushing 60 percent.

So, this is what it's supposed to look like: the green on this is herbaceous vegetation that's colonized a depositional wedge of sediment that the river has delivered to the upper portion, middle and upper portion, of the rip-wrap. This would easily support trees, but we don't allow that. So, now we have the Corps' new policy to enforce old regulations in the white paper.

We've spent most of this symposium talking about trees on the crown of the levee, on the slopes and in the 15-foot areas where no trees are allowed, as well as beyond the 15 feet where no canopy is allowed into the 15, therefore you remove the tree. But, I'm more concerned about something else; I'm more concerned down in the lower right, where the regulations call for a continuous three-to-one downward projection of the levee slope through the natural floodplain deposits, down to the bed of the channel, and anything that gets near that line is in conflict with the regulations; including that lower, regenerating, elongate floodplain.

I can see that the big oak on the left, on the levee's crown, is unacceptable. The crown is 25 feet wide, but that topples, or its roots grow through: it's a risk, I hate to say it, but it's got to go. There's one in the middle, I'm not sure; if it's above the phreatic zone is it the same level of risk? I don't think so.

Here's a mature riparian forest; a very effective windbreak from tree fall, a very effective energy-dissipating canopy protecting the levee from waves and high-velocity. Should we take this out too? What a Herculean task! Here is something I think about a lot; again, at this symposium we talked, almost exclusively, about that top prism: the levee fill on top of the historic deposits. That's 15 to 20 feet tall, 10 to 20 depending where you are on the river system.

The lower bank is the natural floodplain deposit; it's typically 18 to 20 feet high; pretty darn consistent on the Sacramento River. I've surveyed hundreds of miles of river in the Central Valley, and those patterns are very consistent. Historically the floodplain, the natural floodplain, would have been about two-thirds lower in height. So, down below, those are the trees that are the most interactive with the aquatic zone, with out-migrating juvenile salmon. I can see that this tree has to go, but down there on the shoreline where trees are typically stunted in their growth because of prolonged inundation in aerobic soil, they don't grow much, two to three feet above the summer water surface. They tend to be much smaller in stature, but they provide the most valuable aquatic habitat.

Here's the Sacramento metropolitan area, you can see that in the lower river, because of bank migration that Joe described, because we didn't anticipate the effects that the alteration of sediment transport would have on the widening of the channel following incision. Most of these trees, most of that canopy is in conflict with those old regulations and new policies. They would all have to be removed to be certified, because they're growing in the three to one projection; because that's what's left of the floodplain.

So, how will it affect our ability to restore rivers and mitigate for habitat loss of bank and levee projects? In California, we've learned ways to incorporate habitat, particularly over the last decade, and it's been gratifying to collaborate with design engineers and physical scientists to find ways to do this.

These trees were staked as live stakes through the rip-wrap after it had been placed; through labor, hard labor, and they're doing well. The engineers that designed this believed this was a safe design, and they put their engineer's liability stamp on the plan to stick.

Here's some of the innovative design that engineers, after listening to biologists, try to describe the physical requirements of fish, wildlife and vegetation. Once we got quantitative in describing to engineers -- who by nature are committed to solving challenges of, particularly, physics -- have learned that massive rock at the tow, the submerged tow, and a few feet above the bank, addresses the primary failure mechanism in our river system. Above that where we have primarily wave and wake erosion, not velocity erosion until you get on much higher gradient stream, we've learned ways to incorporate vegetation, recreate artificial floodplain. They're pretty modest: 10, 15, maybe 20 feet wide if we get lucky; if it's shallow and it doesn't require as much rock. And the engineers figured out a way to put a wedge of soil; and we've aimed the canopy at the boat wake and the wind wake, and that canopy is very effective at dissipating their energy.

We've placed organic material, "root wads," that juvenile fish tuck into to feed and hide. And you see those blue, thin lines? Those are the three, the four, average, quarterly, frequent closed stages that the fish biologists have determined are critical to the population of out-migrating salmon.

How much time do I have?

Male voice: [unintelligible].

Steve Chainey: Oh, really? Well, you didn't tell me.

Here's the case of a design where the engineers had to work with a two to one slope, so the vegetation entrenching is in violation of the three to one policy. My last example: we used woody piles in an innovative design by engineers, in that wave erosion zone, where the fish need the habitat. And we placed it on a bank, on top of a rock bench. We didn't rock the back-slope; we filled it and we planted it densely.

The following year there was a big flood; it was prolonged and it had characteristically high sediment. We had -- see the beaver fence? -- four feet. We had four feet of deposition, some were deeper; so, a net-losing bank became a net-depositional bank because of the design, which is in conflict with the old regulations that the Corps policy has decided to enforce.

In spite of all these years of collaboration, and innovation, by geo-technical engineers, design engineers, hydraulic engineers, and biologist and ecologists -- true, sometimes conflictive collaboration and sometimes very productive collaboration; so, let's not throw that out. Let's find a way to incorporate that into our regulations and policy, and use multiple objective flood management priorities and structures to solve the problems we've begun to solve thanks to our engineers and physical scientists here in the Great Central Valley.

Thank you.