Moderator: Courtney Chambers ERDC EE-E

February 21, 2011

Edited

Courtney Chambers: All right, good afternoon everyone. We are going to go ahead and get started with our introduction, and I'm sure we will have several others joining us as we go. But, my name is Courtney Chambers and I work here at the ERDC Environmental Lab in technology transfer for ecosystem restoration. I would like to welcome you to our web meeting on HEC-EFM and GeoEFM tools for restoration planning by John Hickey of the hydraulic engineering center. This series of web meetings on ecosystem restoration topics by ERDC and the ecosystem restoration planning center of expertise is designed to address a variety of topics including training, lessons learned, research and development, and emerging issue. The web meetings are recorded and archived and files are posted on the environmental gateway under the learning tab, and I would highly encourage you to go check out that page which is easier to do now with our learning exchange notification system which links you right to the Webinar page. The way the learning exchange system works is everyone receives an initial email notification of a Webinar two weeks in advance from the Corps Lakes address. And then in this e-mail we encourage you to sign up for the Webinar and you can add it to your outlook calendar. Then those of you who register for the Webinar are sent a reminder the day before the Webinar itself. So please continue to work with that system, it’s much more effective and it allows a lot more in the way of scheduling and such.

The next scheduled web meeting we have is going to be the 29th of March on Methods for Assessing Land Change Trends: Examples in the Atchafalaya River Basin and Coastal Louisiana by Yvonne Allen from the Environmental Laboratory. Okay, just a few more notes before we can begin today. We are going to allow time for a question and answer session the last 15 minutes of the presentation. And today we are going to actually be using a shared desktop feature so we are not going to be seeing the chat feature through out the presentation so you could just save your question till the end or speak out with your voice rather than using the chat feature. That way we don't miss the question. Also, please if you are using a speaker phone we need you to keep it on mute while you are listening so we can avoid any background noise and then also remember not to put us on hold with additional background music. Then in order to have a more comprehensive list of attendees, I ask that you list all of the members of your group you're calling in with and you can see an example of how we write that out. This lets us keep track of our participants. Okay, now I'm going to give you today's speaker on the HEC-EFM, and GeoEFM tools for restoration planning. John Hickey is a senior hydraulic engineer at the Hydraulic Engineering Center at the US Army Corps of Engineers with experience as a Bio hydrologist, water manager, oenologist, and fisheries biologist along with being a registered engineer. John also served as a national technical advisor for the Sustainable Rivers Project and as a member of the Corps' Committee on Water Quality. Okay, John I'm going to make you the presenter.

John Hickey: Great, okay. I will share my desktop, project.

Courtney Chambers: Excellent, it's working John.

John Hickey: Okay, great. If there is problem I trust you'll speak up. You should be seeing a cover slide for the presentation right now. If you are not seeing it, it has a series of photos on it, now would be a good time. Okay, I will take that as conformation that everything is working okay. So Courtney should I take it from here?

Courtney Chambers: Yes sir, please do. Thank you.

John Hickey: Okay, so just for everyone's information, I know that - since these are going to be posted online I was instructed to also introduce myself so this will sound a little repetitious but bear with me, it's pretty much just for the record. So, I will start now by saying welcome to today's Webinar on the ecosystem functions model and it's spatial component GeoEFM. My name is John Hickey, I work for the Corps of Engineers at the Hydroelectric Engineering Center, which is located in Davis California. A little bit about me, I have always been fascinated by connections between manmade systems, engineered systems, and natural systems. What are the implications for how humans manage water or make decisions about natural systems? These things have always been fascinating to me and I have been lucky to continue those interest as part of my education whether it was through forest engineering or hydrologic science and engineering, and also in my professional career dealing with software development projects like the Ecosystem Functions Model that does exactly that and tries to understand the natural or ecological responses to decisions that are made by humans. And on this cover photo here you see some images from the Bill Williams River in Arizona which is one of the ongoing applications of EFM and it deals with things like riparian vegetation, what conditions lead to seedling growth and survival, beaver dam dynamics, and also benthic macroinvertebrates, all these things can be looked at by using the Ecosystem Functions Model and its accessories. So, I'm going to start with an outline for today's presentation. We have a few things to think about upfront and then we will get into actually how the EFM works and how it allows users to investigate hydrographs. So first I would like to just talk a little bit about ecosystems that are related to rivers and wetland systems. And this is all information that was pulled together for some communities, natural communities in California, and I'm going to use my pointer here to show, here is a few hydrographs, these are typical river patterns that were just traced into the slide to reflect some hydrologic dynamics that are common in California.

There is definitely a rainy season and then there is also, in the springtime, a very pronounced snowmelt period, and that kind of wraps up over summer and recedes by the time fall roles around. And we went online and looked for information about the life histories for a few different communities or species that used these types of river systems and what we noticed is when you line up the life histories with the hydrologic pattern they really work in concert with one another. Chinook Salmon for instance, grown Chinook come back into the fresh water from the ocean in the fall time and lay their eggs in a gravel bed in the central valley rivers. The young fish hatch and then they rear during these high flow periods where there is a lot of flood plane inundation, a lot of floodage available, you know, ultimately they migrate back to the ocean assisted by this high volume of water that's been generated by that snow melt run off. Cottonwood trees sort of have the same relationship, you know, seed dispersal occurs in the early spring, early summer and the seeds are carried by these high flows on to gravel bar or sand bars where they germinate and begin to grow and their roots grow as the hydrograph that spring hydrograph for seeds. Northern Pintails in California fly very far to the north to do their breeding and rearing. So California is really more of a migratory habitat but they are in California during these very high rain floods where new lands are inundated, creating a lot of floodage available that allow the pintail to build up their energy reserves in preparation for that breeding season. So, these connections between natural systems and hydrologic systems have kind of evolved together and those lessons hold whether you are in California or looking at the bald cyprus seed dispersal or shad migration dynamics in the Savannah River and the South-Eastern United States or in the South West, really these communities have evolved to exist in concert with the natural patterns of flow and stage that occur in river systems or wetland areas.

So, now human influences, I have borrowed these next few pictures from a presentation by Paul DeBoy. Dr. DeBoy works in the Mississippi Valley

Division. When I do this in the classroom setting I always ask the class what they see? What does this image tell you? I would have to acknowledge the boats. They are utilitarian or some type of fishing boat but what's really interesting about these pictures are these structures that are a kind of weighted bars with a lot of strings attached. These are actually mussel fishing boats and to catch the mussels the bars are dragged along the bottom of the river and these weighted lines come into contact with the mussels and mussels as sedentary critters that don't move around much and feeds or, actually are buried in the substrate of these rivers. When these weighted lines hooks come in contact with the open muscle it has a defense mechanism that says I am going to close my shell. These are bivalves so they close their shell and accidentally capture these weighted lines at which time they are pulled up by the muscle fisherman and it looks something like this. This is muscle fishing on the Illinois River near a place called Peru Illinois. And these mussels were used for a number of purposes but this image shows that their shells were harvested and punched to create buttons for clothing for garments, jackets and shirts. Locations like Peru Illinois actually created a whole industry around these things. Mussels are really important for water quality, they are safe and seeders, they take in a lot of water and they function as a filtering mechanism. So there was an experiment that was done. Very simply, take two buckets that are the same size put in the same volume of river water and then add different numbers of mussels to it and see how they are as filtering mechanisms. There are dynamic effects on the quality of water in those buckets. The top bucket after an amount of time had two mussels in it and during the same amount of time the bottom bucket had four mussels with different amounts of water being filtered. Another example for human influence is California example. This is a winter run Chinook Salmon and looking at some of the infrastructure that has gone and version down which is located right here in the system, and these Chinook Salmon would have come from the Pacific winter runs so they would be coming back to fresh water in the winter time, and going up through

San Francisco bay through this delta area, and going upstream to their historical spawning ground. In 1967, which is coincidentally when this period where there is data set for the adult returning salmon started, let's see Red Bluff Diversion Dam was build right here and it crossed the Sacramento River cutting off lot of these fish from there historical spawning grounds that was built in 1966. Chaster Dam, which doesn't have any fish passage, built in 1945. So, it would be very curious to see the actual population between 1945 and 1967 how that materialized but you can see that led very much to decline of these adult fish that are coming back into the system to spawn. Ultimately they were listed as an endangered species even 1991 when only 211 returned. It was right in this period at some point I am not sure of the exact year. Since that time there has been other actions, a reparation of Red Bluff Diversion Dam, construction of a temperature control device at Shasta that has allowed these fish to show some signs of rebounding, but again this is a type of human influence through hydrologic alteration. This was a great story in a Sacramento, and really compelling with the population dynamic. So we look beyond California and we look sort of across the whole country, this is a map of ratio of water consumed as compared to how much water is generated as surface flow on average in all these hydrologic units across the country. You see especially in the area west, all these red areas — at least three quarters, over three quarters of the average surface water is actually consumed, this trend is common place all over the globe. And when you look at the numbers at least through 1990 and then projected to 2000, use of water is increasing globally. And I look at it and I think, all right well, what are the ways that humans have enabled this additional use of water, and two things really jump out in my opinion: wells, the use of wells in North America there is over 15 million wells and dams, development of reservoirs to store water. And this is a time past of dam construction, the rest of the story for this slide is that based on data availability that 23,000 plus dams on this image only represent between a half and two thirds of the total number of large dams present in all these different locations now. So, between the hydrologic alteration whether it's an obstruction like the Red Bluff Diversion Dam or reservoirs or transition of habit from agricultural land, any of these things, they have left a legacy of imperiled species and this is a bar chart of the percentage of species that are at risk in North America in the US. And I always think it's important to note that the top four species are all aquatic, those are disproportionately imperiled species. So, that's a little bit about human influences, now hydrographs. I use this slide to illustrate what hydrographs are and also as a transition to the ecosystem functions model. So, here we have a hydrograph. Hydrographs are presented either in terms of river flow or river stage and this is a natural pattern. Also flow regime in a river is a hydrograph. This would be an altered flow regime and when the natural patterns of flow in stage in a river are served or changed it affects the species that depend on those patterns of flowing stage as parts of their life cycle. So you see things like fish that used to access floodplain areas for floodage and spawn in those types of areas are now unable to access them because those big flood events have been changed. They have been reduced to a magnitude or altered in season. This could affect bugs and birds and plants; all respond in different ways to these changed patterns. So some EFM terminology for you, in EFM there are Flow regimes and relationships, these are examples of flow regime. Then the relationships in EFM are these linkages, they are the connections between the national communities and the flow regimes. So two terms there, flow regimes, daily flow and stage in the river or wetland system and relationships, connections between the ecosystem and the hydrology. Fish, birds, bugs all of things can be looked at using EFM.

So that kind of wraps up the introductory material, few key points just to emphasis that ecological systems, communities of plants, animals, critters have evolved in concert with the hydrologic patterns of those water systems.

Humans changed those patterns whether it's through dams or wells, a number of different ways that we affect hydrology, and if they are understood then connections between hydrology and ecology can be used to help, guide water management, ecosystem restoration projects, and decision making that involves water and ecosystems.

So now getting into the EFM, how does EFM allow users to look at hydrographs and consider different scenarios for water management or ecosystem restoration. I think of EFM as a process. The software tools whether a EFM, GeoEFM are designed and provided to enable this process. So it starts with hydrology, we have talked about this, these are the flow regimes and ecology, these are the relationships, the linkages between the natural system and hydrologic system. EFM starts with statistical analysis of those flow regimes to see if the conditions that are required by those ecological relationships or different aspects of the ecosystem are being met or how well they are being met. The statistical level of detail for EFM produces performance measures for each of these water scenarios, restoration projects, and water management decision making. Each one will give performance measures for how the relationship is doing for all those water scenarios.

Now the statistical results go into hydraulics models, river hydraulics and they compute layers of depth and water velocity, sheer stress, lots of output from those hydraulic models, and they have produced those maps and that gets into the spatial arena where spatial criteria like ranges of suitable depths or velocities can be layered and get maps and areas, this is really habitat areas for each water scenario. But these pictures over here are an example of how the EFM process really thinks and when I present in a classroom setting I - I start by talking about this picture in the middle that has the fish and a little bit of background here, these fish all are the same age. They started from the same hatchery, these are Chinook Salmon, they have started from the same hatchery, the same group of eggs, and when they were very young they were placed into cages in a reverie habitat and then it a wetland or floodplain habitant and after a few months of living in these cages they were collected and measured to determine how they have grown. And I always ask which of these habitat do you think lead to the accelerated growth, the higher growth rate for these fish and I like it because it's not really an easy question, you know, intuitively bigger systems, bigger river support bigger fish.

But in this case this - these Chinook salmon as they are migrating out to the ocean, have evolved to take advantage of wetland habitats. The wet land habitat offer a great storage for these fish, warmer temperatures, which helps with their metabolism and slower water velocities. So they don't have to spend as much of their energy maintaining their place in the system. They can feed and translate the - their - their intake of food to growth. So the answer is this - the bigger fish were growing in this wetland area. Now from an EFM perspective we will start again and we will go, all right well this system is going to have a certain flow regime. It's going to lead to different amounts of availability of these habitats depending on how much flow is generated by that watershed. Ecologically what do we know, we know these fish exists at certain times of the where they want to access the - the floodplain areas on the way of the ocean. So we know seasonality, we know duration, there is a certain threshold of inundation that allows these fish to access that floodplain areas and then get back to the river channel on their way out to the ocean.

These are - this is critical information on the ecological side of things that defines a relationship, the seasonality, the duration, is it a high flow thing, is it a low flow thing, that information guides this statistical analysis of the flow regime that occurs in that river in wetland system. So statistical results we will get a comparison scenario A versus scenario B of how - how much flow it's provided seasonally to support this life stage of critters. Now you will get into the hydraulics, you will take that high flow that is computed seasonally through the statistical analysis and you put it into a hydraulics model. The hydraulics model gives you map - maps of the integrated area, depths, velocities and you can look at these things spatially, you can say well these fish grow back in velocities between zero and one feet - foot per second. They will grow best in depth ranges between zero and two feet, very shallow habitat.

So now you can query those maps that our pictures of the statistical results to figure which areas of inundation need all those criteria. So what you will end up with is the seasonal availability of the - the prime habitat for rearing - for Cottonwood, not for Cottonwood, for a Chinook salmon as they migrated out as the young fish to the ocean so that's the EFM process in a nutshell right there. Here is the interface its tab based so there are lots of tabs along the bottom here, the property tab is where you read in the different flow regimes. So each row has a paradigm series of flowing stage, each one would represent a different management scenario, maybe it's a restoration scenario maybe it's a change in reservoir operation, that's where you will put in the hydrologic information. Up to 37,000 is the design capacity, the most that ever been run an EFM is 341 flow regimes.

The next tab is the relationships tab, this is where the user would enter those linkages between hydrology and ecology. There is a certain season, there is a certain duration, this one is for another California example, this one is for splittail spawning, split tail minnows are a species of concern in the delta area so, kind of in a lower sections of central valley rivers and they are floodplain spawners so much like the Chinook rearing habitat they depend on that over bank in addition to create seasonal opportunities to spawn and they need a certain duration where they go back into these areas, lay their eggs, eggs incubate and then young fish recruit back to channel. But you could define relationship for lots of different species, it's all user defined. And there is also additional features about hypothesis tracking, what would increased flow do, in this case since splittail rely on these vegetated floodplain areas to spawn more flow was hypothesized to be a good thing. The more flow during the season, the more floodplain areas the more opportunities for splittail spawning. Also confidence tracking to see how much scientific support you have for each one of these relationships as they developed. So that's the flow regimes, the - the relationships, there is also geographical queries kind of setting the stage for those spatial investigations. Looking at things like for splittail spawning depth and vegetation are important. Well, why are they important, well depth shallow habitat, zero to three feet vegetation, this, that's require the presence of aquatic plants. Split tail minnows, their eggs they - they fix their eggs to the aquatic vegetation, that provides an anchor for those access to incubate. So these are the interfaces of EFM and you would compute, EFM use for the splittail-spawning example, here is - here is how EFM would think about the hydrograph. Well splittail spawning, there is a beginning of season so it recognizes that end of season, it recognize that then there is a duration interval, it's of eight days and it says all right, over those eight days pick the minimum. This minimum flow is the flow that would support eggs incubation if they relate on this day. This says eight day to take eggs, eight days to incubate so eggs relate on this day, you would look over an eight day period and take the minimum, because anything, any eggs that relate out here would be stranded, they would be desiccated, because the river receded during that, during - during that incubation interval. So EFM would make a mark right there and say that was the flow that supported egg incubation during that interval and then it would advance the day it would go through the same process, pick the minimum. Advance today take the minimum and go through this for the entire season.

The next setting which is user define and it could be a minimum, a maximum, a mean lots of different statistics here, in this case maximum was picked as the highest flow over the course of that season that supported egg incubation. So this would have been the best-case scenario for splittail spawning. EFM returns these numbers on its tables tab, this is output from EFM, these are the flows and stages that meet all those statistical criteria for splittail spawning, there is a season, a duration, of the minimums the maximums, these are the - the flows from the gauged flow regime or national flow regime, meet all of those statistical criteria, okay. And then these in the EFM process, the statistical results, I should also mention you see this change positive negative, the hypothesis for splittail spawning was more flows the good thing. So in the gauged flow regime the flow that met all those criteria, 18,300 and the natural 36,000 so more flow, what was the change, it was a positive change so EFM this is the first way that EFM communicates how ecosystem aspects are going to respond to those different water scenarios. So, these flows, statistic results are imported into a river hydraulics model, which computes water surface elevations, depth and velocities for all of these results. They can generate maps for depth, velocity and this image over here shows for splittail spawning, we had two flow regimes, one was gauged and wherever you see blue here are the areas that met all those conditions for splittail spawning. Yellow is the habitat that whatever occurred under national conditions. The orange and red, that's - that's a channel habitat so not the floodplain type habitat that the splittail rely on to do their spawning. So you can start to look at maps, you can see locations that offer habitat to different species, and you can also quantify in terms of area, acreage, that's - that's the EFM process right there. From flow regime to relationship to - to statistical and spatial output, so it's been applied in a number of different locations, this is a partial list of EFM applications. It's started the pilot application of EFM and actually where EFM has its routes was for a general investigation done by Sacramento district known as the comprehensive study and it focused on the Sacramento and San Joaquin rivers in California. I think that application had about 15 different relationships. Splittail was one of them also geomorphic processes, recruitment of large woody debris and since that times it's been applied to quite a diverse range of - of projects. Savannah river was a drought contingency study, Truckee river was a - a channel modification so adding (unintelligible) back to a - a previously straightened channel. Mississippi river was a re-operation of a navigation dam, Sandy river delta was a dam removal project, lots of different things that EFM has been applied to.

So we talked about split tail, now the presentation is going to get into a few case studies here, and - and I'm also doing a time check so I know we want to leave time for questions I think we have got about 10 more minutes of presentation material and then we will get into the actual questions. So the other few applications that I would like to talk about are for the Bill Williams River in Arizona and the Farmington River in Connecticut. So first to the Bill Williams, it's very much an arid land river, this is in Western Arizona, it has a core reservoir just located right here called Alamo dam, operated by Los Angeles District of the core and it's been the sight of a lot of scientific study dealing with connections between water management, decisions made at Alamo reservoir and the downstream affects of those decisions, especially from a national perspective related to riparian plants, native fish and some other concerns including water quality concerns like turbidity as it goes down stream into the Colorado river. So Cottonwoods on the Bill Williams, this is the EFM relationship for Cottonwoods like the split tail there is a beginning and end of season, it uses the daily duration and for Cottonwoods the link between the hydrograph and the - the response, this is Cottonwoods seedlings, so recruitment of various small plants just - just starting from seed and getting through their first growing season. Dynamic that's a real concern to those Cottonwoods seedlings, the rate of stage recession.

Woman: Yeah, that would be great.

John Hickey: If the stage recedes too quickly then the routes for these young seedlings they can't grow quickly enough and they become stranded the route desiccate and the - the seedling as well. So an EFM it looks its stage as a rate of change and looks at a following condition and says that okay, the threshold rate for recession is 0.12 feet over the course of three days. So that goes in here three days and here is the threshold recession rate, and what EFM does is it compares the threshold recession to the actual recession, with the logic that if the actual recession exceeds the threshold, then that seedling, any seedlings that are growing are going to be lost because their roots can't grow quickly enough, so on this case, actual is much less than threshold, so the seedlings were fine even today check again. Threshold much greater than actual, fine, today continue to do this testing, and here is one where actual is increasing, but it's still less than the threshold, so any Cottonwoods that are growing on that day would be okay. And then it gets to this point, higher up on the hydrograph, where the actual recession exceeds the threshold recessions. In this case EFM says any Cottonwood seedlings growing at this point cannot survive that three day recession, so we have to revert to the previous successful test and with a logic that growing from this point forward on the recession those Cottonwoods are going to survive the - the rest of their growing season.

What this looks likes spatially and this is actually for an experimental release from Alamo dam, excuse me an experimental release from Alamo dam that was done in 2006. Cottonwoods populous trees could survive the recession up to that point on the stage hydrograph. It's a mixed species, so this is willow trees, so the purple dawn would be where willows and Cottonwoods are growing and surviving their - their initial season, and then also the invasive saltcedar tamarix coming into the mix as well. So to verify this model, we started with Cottonwood seedlings and all of the area that EFM predicted Cottonwoods would be able to begin to grow and survive that first growing season. From that total layer we subtracted out the open water and we were left with this fringe area, where Cottonwood seedlings would begin to grow, and this is a little caddy I always got to check a lot of it myself, but USGS, some scientists there, voted the system after that experimental release in 2006, and they counted patches, so there goes the USGS vote and, you know, they are sitting in a boat going down stream, so there is a certain vital sight, there is certain buffer, where they can't see and count patches beyond we did a series of buffers, 20 meters, 30 meters, 40 meters on either side of the stream centerline, so we also had to clip out the recruitment areas outside of that buffer, which left us with this in terms of Cottonwood recruitment areas. Spatially these were separated into patches, and compared for the entire river system below Alamo Dam, which is up here, and you can see some of those patches up in this thumbnail here. They were compared to the patches the USGS counted when they vetted the system after the 2006 event, and a simple correlation was done, they looked at the number of stimulated patches versus the number of observed patches, and the correlations were found to be very strongly positive, so EFM in this case is doing something right for all of these species.

Courtney, I think I'm going to change the presentation here a little bit, because we are up to the 45 minute mark, and I think I will focus on wrapping up with the GeoEFM and I will sort of bypass this case study that was for the Farmington River in Connecticut, I will just describe it here. It's another application of EFM that focused on plant communities. In this case it was floodplain vegetation and there is a real fascinating study done by Dr. Christian Marks of the Nature Conservancy, where he went all over the Connecticut River watershed. This is the Connecticut watershed here, and he did a series of transects. He had 90 sites with four or five transects a piece or close to 500 cross sections, where on either side of the line, he would go out 10 feet and measure the occurrence of shrub and tree species. And when he came across an individual in any species that was greater than a certain size and just a few inches in diameter, he would get the species of that individual, it's base elevation, perhaps take a soil sample, where it was growing, look at the inundation patterns which let it grow there and really created this dataset that talked about what hydro periods support different floodplain communities. That's the info that went into EFM and allowed us to basically map floodplain plant communities for the Farmington River in Connecticut. Fantastic dataset. I'm sorry, I'm running low on time, so I'm going to go real quick to perhaps the final slide for the Farmington case study and just show you the maps of those different plant communities, there was buttonbush shrub and floodplain forest, each of those translated to a different map. So there is the open water, and this was done with both the Gauged flow regime and the Natural flow regime, so EFM was used to look at a change in acreage. There is about six reservoirs upstream of this location. So there is the open water buttonbushes, its a very water loving species that grows in areas that are pretty much inundated over the course of the entire year. Then there are mixed shrubs and then you get into more of the floodplain forests, which above that it would be transitioning to more of a purely terrestrial species community. So you get change in acreage and you see all the maps that are generated by this EFM process, so that takes me to GeoEFM. It is the spatial component for the Ecosystem Functions Model and it's being developed in partnership with ESRI, they are out of Redland, these are the big arch GIS software developers. So GeoEFM is a toolbar, this is an arc map interface and you would do a right click here and get this list of toolbars, select GeoEFM, and that launches this window, which can be anchored to the interface in a lot of different ways. So what GeoEFM does for you is really three things, it helps manage all these spatial layers associated with your EFM project, and it computes habitat areas, and habitat connectivity, we are still working on a release version for

GeoEFM, but it does have some functionality that I will describe here. This is the viewer where the different map layers are associated with the combinations of flow regimes, for instance experimental floods and relationships like Cottonwoods or willows or saltcedar. So there is already the structure that was made in the EFM application, that's adopted for use in GeoEFM.

Here is the interface that looks at area, so you would have your tabulate feature here, it would launch this interface and the user would say, I would like to generate a report called habitat area, it's for the Bill Williams River application. I would like to see results expressed in terms of area and also a change in area, units, acres, square meters, square miles, lots of options there, and then picking the flow regimes that you would like to see tabulated. So the flow record, then in experimental flood, for what relationships and you click okay, EFM, GeoEFM, would go and query all the layers, for these flow regimes in relationship and compute the acreage of Tamarix populous that's generated by these different flow regimes. That's the habitat area feature and there is also a habitat connectivity feature known as the patch analysis that allows users to define areas of interests like this red polygon and look at layers within those areas of interest to see how patchy the habitat is, how many patches are there, what are the size of these different patches. With the logic that if you were to build a bridge here and cut through polygon one or patch one and two that decision would fragment the two largest patches of habitat within your area of interest. So perhaps there is a better choice for the location of that project. So, that's the - the gist of GeoEFM, its used down in this spatial mode of the EFM process and, you know, just to revisit it flow regimes relationships, these are the different water management ecosystem restoration scenarios, here the different aspects of the ecosystem that you are concerned with for your project Statistical analysis would be performed to get performance measures that are purely statistical and then you get into the hydraulics, in the spatial you would end up with time series analysis and I will put in terms of flowing stage for the statistical side of things, and I will put in terms of maps and acreage and connectivity for the spatial side of things.

So wrapping up here, now we talked about flow regimes and relationships, a few points about EFM. It is a generic software tool applicable to a wide range of river system wetland systems. It can be used to test many different types of relationships. We talked about split tail minnow a fish spawning relationship and Cottonwood trees, a riparian plant relationship. But also mussels, geomorphic processes, things like that can be looked at with EFM. It's powerful, 37,000 is the conceptual limit for the number of flow regimes. I Thought about ways to kind of make that number real and I thought about it for the Missouri River, it's the longest river system in the United States, and if you took its complete length and divided it by the number of flow regimes or locations of interest that EFM could analyze, the spacing would be one location every 110 meters along the shores of the Missouri River. What do you get out of EFM? You get that statistical output, how are the ecosystem relationships are responding under different scenarios. And you get spatial output, statistics go into the hydraulic models and come out as maps. They can be queried for habitat areas, connectivity, or looked at to see about the habitat preferences of those relationships.

So, I would like to take this opportunity just to say thank you for attending the web meeting. Thank you to the environmental lab for setting it up. And to acknowledge that EFM has been developed with support through Corps research and development dollars, the SWWRP research program supported development and release of version one of EFM that was released to the web in July 2008. EMRRP supported version two, that was released last November or excuse me the previous November 2009. And since the initial release of EFM to the web, the Web sites has had 40,000 visitors close to that, 4000 downloads. So we are seeing use in EFM not only in the Corps but in consulting firms and other governmental agencies. It's an exciting time for EFM so thank you very much for the support there. Just some resources here on this final slide and then we can open it up to questions. Websites for EFM, EFM plotter is the display mechanism for the statistical output. GeoEFM is the spatial component that will be coming soon. And a series of articles that focused on or mentioned EFM and how it can be used in these types of studies. And with that I will conclude open it to questions, Courtney, should I turn off the sharing, did anything come up in the chat?

Courtney Chambers: I can go to your last slides so people can continue to see the contact information that you have provided.

John Hickey: Okay, great.

Courtney Chambers: And then yes at this point feel free to ask your questions, you use the chat feature back in your screen or you can just speak out, just remember to take your phone off of mute. Any questions for John, you must have really wowed them John and answered all the questions.

John Hickey: Yeah. That was a lot of information. Yeah, and I know we just have a few minutes left here too Courtney.

Courtney Chambers: Yes. You did do a great job sharing an impressive tool. Give everybody a few more minutes to think.

John Hickey: Sure.

Courtney Chambers: Hey there's one, it says John can you talk a minute about data requirements?

John Hickey: Yeah. Data requirements, good question it's just related to the level of detail you want to perform with EFM, you know, to start with EFM all you need is that flow regime and basic understanding of how the ecosystem connects to those patterns that are in the flow regime really you can get this statistical output from EFM within a matter of minutes and download flow regimes from USGS Web site, put in a relationship that you would like to test really quickly weather it's a fish or a riparian tree or whatever is of interest to you and click that recalculate button in EFM. When you get into the spatial arena then the amount of data and pretty much level of effort generally goes up. You need to geo reference hydraulic model, any other layers that are relevant for your ecological investigation, things like that.

Courtney Chambers: Okay. Thanks, Valerie Seawall says how is headquarters responded and accepting these models and is there a case study written upon application for ecosystem restoration?

John Hickey: Yeah. There are case studies written up for sure related to restoration. Bill Williams was one of the big publications. EFM use has been documented for the restoration project on the Truckee River where the meander was put back into the river system. So there is a growing number of documents that talk about EFM use, the headquarters response I would say has been very supportive in EFM’s role and place in a research and development program. EFM hasn’t been formally certified yet there is documentation, a certification package that’s probably 80% prepared, but hasn’t been submitted for certification yet. So I think those two things kind of connect.

And I saw the - the question pop up - is the model certified? Yeah, you know, it's been online for since 2008 it certainly getting some use, it's not formally certified yet, it's something that HEC would definitely like to do and we have got a lot of the materials, we just haven't had funding source that would allow that group of outside experts to really take a look at it and give it to a solid critic.

Courtney Chambers: Thanks John. There is one more from the EL out there that says what sort of stage and flow are needed? period of record? or anything about land user topography?

John Hickey: Yeah, the only limitation on the stage and flow is that EFM thinks in terms of daily time series. So any daily average time series would be fine in EFM. Land user topography, in my opinion that really comes into play when you get to the spatial side of things. So once you had your maps, what's the topography that is underlying the inundation patterns, how does land use also factor into the different habitat provision for all the relationships that are looked at with EFM? So there is really no constraints to the type of land user topography, it's just left up to the user to determine what's of interest to their application.

Courtney Chambers: Excellent. Are there any other last minute questions? Oh there is one.

John Hickey: Yeah, thanks for now, I see it - the question is does it is a matter if it's a 1D or two-dimensional model? Not at all, EFM doesn't think about hydraulics for itself, it relies on external tools to do that. So as long as the hydraulics model, 1D, 2D, or 3D can produce the maps, whether it's depth or velocity or whatever, the user would like to look at for different aspects of the ecosystem, EFM is fine with it. It doesn't really factor into the EFM process. Yeah.

Courtney Chambers: Okay, well with that, I think we will go ahead and wrap up. We are right at our time limit and we want to let you all get back to work but John we do want to thank you very much for sharing today. It was a very good presentation.

John Hickey: Thanks everybody. I - I appreciate it.