Upper Clark Fork Working Group
Spring 2023 Newsletter

The goal of the Upper Clark Fork Working Group (UCFWG) newsletter is to help members learn more about the group, its meetings and activities, and relevant stories and opportunities. Have ideas and stories for upcoming newsletters? Please contact Madison Boone at madison.boone@montana.edu with your newsletter ideas, feedback, and questions.

2023 Clark Fork Science Forum

The first bi-annual Clark Fork Science Forum will be held on April 20 and 21, 2023 in Missoula, MT. The Clark Fork Science Forum is hosted by the USGS, the University of

Montana, MT NSF EPSCoR CREWS project, and the Natural Resource Damage Program. Participants from federal, state, academic, non-profit, and industry professionals will give presentations and discussions that focus on the "State of the Science" for the Clark Fork River related to hydrology, biogeochemistry, aquatic ecology, and more. REGISTRATION IS CLOSED. To learn more visit the UCFWG webpage and view a draft agenda here.

UCFWG Topic Discussions

November 2022 - "Twenty-Five Years of Walking the Clark Fork: Some Observations"

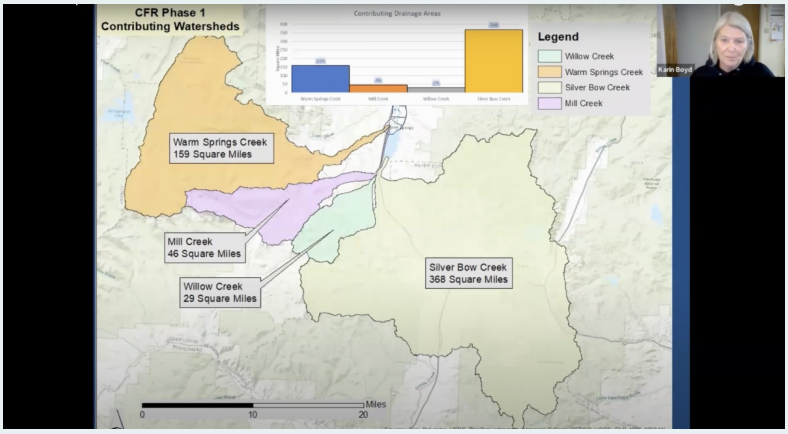
For the November 2022 UCFWG Topic Discussion meeting, Karin Boyd described her twenty-five-year journey of working as a contractor on Silver Bow Creek and the Clark Fork River. She used photos and stories to describe the evolution of fundamental approaches to the restoration and remediation of the river channels and flood plains.

Boyd first got involved in the work being done on Silver Bow Creek in 1997. She explained that their strategies, understanding, and challenges changed over time. Boyd started working at Inter-Fluve, which was a stream design and enhancement group. and they had won a contract to design Silver Bow Creek. When they first went out to subarea 1 near Rocker, MT, they were very overwhelmed by how to even begin making decisions going forward. Ultimately, the Department of Environmental Quality (DEQ) and the Environmental Protection Agency (EPA) agreed that the Silver Bow Creek channel design objective would be "a morphically stable, naturally meandering alluvial system to the degree possible."

On the project, Boyd said that they worked with civil engineers who had done a lot of hydraulics but very little channel design. The Inter-Fluve team and civil engineers got into an argument over what a naturally meandering alluvial system was and whether it was about form or function, which is a dynamic system. At the time, stream restoration was more of a landscaping exercise and less process-based. In 1997, Inter-Fluve was handed the opportunity to do a pilot test on Silver Bow Creek to try different forms of bank protection and embrace a process-based project. Boyd said that she credits the people at Inter-Fluve for how adventurous they were with this opportunity because this was when coir fabric was just starting to get traction. While coconut fiber had been used for hundreds of years, to start using it as woven erosion control was a newer concept and Inter-Fluve was a pioneer of that method. In 1998, Peter Skidmore and Dale Miller at Inter-Fluve published a paper about deformable bank design. The point they were making in the paper was to start wrapping soils with fabric and using alluvial fill to a depth of scour and have woven coir fabric wrap. The idea was that the coir would rot out and at that time you would have established vegetation and a natural streambank.

For a test plot, the project team tried many things using many types of fabrics. "Ultimately," Boyd said, "we just went to town with fabric." They used large drums that created the form,

and they would make giant bags of gravel that would become the toe of the bank. After this process, they ended up with columns in the bank toe overlain by lifts. Boyd noted the amount of fabric used and how expensive the project was because of the fabric. They also used fabric-wrapped straw bales on the test plots and did wood treatments using willows with lifts on top that were fairly effective. On Silver Bow Creek, Boyd said that it was important to know that "we were rebuilding the whole channel." But at the time, "this was pretty progressive stuff." They ended up building a mobile stone toe with a coir lift, but it was fairly monotonous. At the time, Silver Bow Creek was driven by remedy, and they were trying to integrate as much restoration as they could. Another point Boyd made about the Silver Bow Creek project was that they made the decision to blade riffle gradation over the whole channel bed top-to-bottom so that there was bed topography with pools. Meanwhile, everyone knew that it should be a sand bed channel but thought it was too risky based on how immensely deformable a sand bed channel would be. Furthermore, due to risk, the team had strict criteria to keep meanders open so that they wouldn't see too much change and could reduce the risk of cut-offs or floodplain scour.



The team then had to return to the question of to what degree Upper Silver Bow Creek was a geomorphically stable, naturally meandering alluvial system. Boyd highlighted that there were many technical, non-technical, political, and non-political decisions that had to be made over the course of the project. They ended up with a large cross-section, big meanders, and a coarse substrate, but the fabric they used was slowly decaying. Boyd went back out at a later point and took a hard look at everything that was built. Then in 2022, Boyd put out a summary of opportunities to incorporate additional restoration elements in Subarea 2 remediation. These elements included increased planform variability, reduced overall width-to-depth ratio, incorporation of a finer substrate gradation in non-riffle environments, increased allowance for pool scour, and increased pool frequency.

Downstream towards Durant Canyon, in Subarea 3, boulders were added to the channel, but they still had the big sweeping plan form that was dominated by lifts. Boyd said that she personally thinks that Subarea 3 is "one of the most impressive [and] neatest sections of Silver Bow Creek" because it is away from the interstate and is a beautiful canyon. However, the area is loaded with transportation infrastructure, including the Milwaukee railroad line and other rail lines. When the team began working in Durant Canyon, it was all about constraints because there was no room to do anything with all the old power poles, contamination, and railways. Ultimately, they had to try to deal with these constraints. Three sections of Subarea 3 were piped in a costly 42-inch pipe. They even had to have someone watch the pipe 24/7 so that no one would come to mess with it. Deformability and function did not play a significant role in Durant Canyon as it was really just a full remedy cleanup.

However, Durant Canyon did provide the opportunity to install a fish barrier at a natural drop in the creek. Montana Trout Unlimited (TU) said that the fish barrier "was working great as we watched non-native trout trying to get over the dam and up the river to where the West Slope Cutthroats are making a comeback to repopulate the river and streams in and around Silver Bow Creek." So, Durant Canyon did allow them to take advantage of this

unique feature and opportunity. Moving north towards Fairmont Hot Springs, everything expands and there is a straightened channel with big berms and tons of room. The floodplain in this area is old and contaminated, and everything is confined so the team had time to think about being a little more bullish with function and doing something different to make the river much more complex. However, in 2010, a year after they had worked on Silver Bow Creek, they lost pretty much the whole creek back out into the original channel, and it was "a mess."

Several people visited the area to figure out what happened, and they found fabric and fences everywhere. Although the area was a mess, it was also a chance to look at what they had done and think about various things from point bar slopes to channel dimensions to plant form. They found that many channels had formed behind the bank treatments, which is why they failed. Water was going everywhere and there was concern about how the EPA and the state would respond to it and to each other. Luckily, repairs on the creek have since been completed. Following this 2010 high-flow event, the EPA expected the DEQ to manage risks "more tightly." There was immense pressure to avoid building something that was risky because it would look bad and would cost money. As a result, Subarea 4 off Highway 2, heading to Anaconda, has the most conservative design and implementation out of any of the subareas. This design was done in response to the 2010 floods and this area of the channel has a very high floodplain that will convey much water and support a very narrow fringe of riparian vegetation.

On the Upper Clark Fork River (UCFR), the team took a different geomorphic design approach because their goal was to preserve the channel, not rebuild it. The focus of the design was to reconstruct the banks, increase floodplain access, and minimize avulsion risk. At the time, people thought that the Clark Fork would unravel into a braided system. A paper by Smith and Griffin in 2002 said that "at present, the large shrub of the Clark Fork floodplain in the Deer Lodge Valley is so sparse that this floodplain is capable of undergoing a catastrophic geomorphic transformation from a single-threaded, meandering fluvial system to a multi-threaded braided system during a single flood." They also concluded that the "solution to these problems is to re-vegetate the entire meander belt of the Clark Fork through the Deer Lodge Valley with large shrubs."

The project team decided to use the Riparian Evaluation System (RipES) approach to revegetate the floodplain. The RipES approach meant using vegetation to map contamination. The team was then able to use their mapping to remove severely impacted soils (or slickens) and then perform an in-situ treatment of the impacted soils with lime. One of the biggest questions though was whether the in-situ treatment would really support a robust riparian shrub community. This question became quite a discussion, and they developed a demonstration project on a section of the Clark Fork using the in-situ treatment, which included grading, tilling in lime, and using fabric.

However, the team found that they were not meeting the objectives of the Record of Decision (ROD) because there were no dense riparian shrubs on the surface, partly because the river was high and the contaminants were still there. In 2015, the Explanation of

Significant Differences (ESD) determined that RipES alone would not meet the ROD requirements but noted that "achieving geomorphic stability will likely have the effect of lowering the floodplain, which has the added benefit of providing the necessary floodplain function for ROD-required self-sustaining riparian vegetation." This insight revealed that they were going to get more material out so that they could remove tailings and lower the floodplain. They would then be able to replace all the decadent vegetation that was on a decay curve with something more sustainable. Problems kept coming up so they decided that they had to do something so the river wouldn't unravel. The UCFR Conundrum (according to some) was that the vegetation was on a decaying trend, so if the team did nothing, the river would unravel. Alternatively, they could lower the floodplain for long-term vegetation stability, but this would result in periods of raw floodplain so there was concern that if they did do something, the river would also unravel.

The team made the decision to focus on the long-term, which meant that prior to the remedy, there was a 10-year capacity that then went to a 1.5 to 2-year channel capacity. There has also been a widening of the river in recent years, and with this widening comes the question: If there is widening during periods of higher flow, is there a sufficient sediment supply for the river to naturally adjust and narrow up? Silver Bow Creek makes up most of the watershed area for the Clark Fork, and as a result, the sediment supply is essentially cut off by Warm Springs Ponds. The question then becomes, what does that long-term loss of sediment supply mean to the evolution of the Clark Fork? Another restoration factor that Boyd discussed is channel migration. Many berms were put in around the worst slickens, areas that were close to the river. The lifespans of these berms are now ending because the river is getting into them. Because of erosion from the river, a significant rainfall event, and high amounts of copper, the berms were rebuilt as high bails last year. Others have done valuable work on slickens inventories and trying to identify potential risks, but the berms are beginning to lose their efficacy.

Coming full circle, the George Grant Chapter of TU published an article headline that said, "Silver Bow Creek Restoration is AWESOME." Boyd even saw beavers and water coming out of the floodplain near Rocker in 2020. There was still a lot of coarse material in the bed of the floodplain, but there was enough wood to create local scour and capture the material that moved around. The Natural Resource Damage Program (NRDP) said "since 1999, Silver Bow Creek has been transformed from a severely injured, nearly lifeless stream to an ecosystem that is recovering its original character and value. After 16 years of clean up and over $130 million spent, the 25 miles of Silver Bow Creek reached completion in the summer of 2015." On the UCFR, the notion of risk management has been continued. For example, Boyd showed pictures of an avulsion patch that they did special treatments to in order to minimize the risk of unraveling. On several phases, the team saw high water and out-of-bank flows, and from this, kept learning and trying new treatments. The team saw the entire evolution of the river's form: the good, the bad, and the ugly. Boyd said that they just "took a deep breath and said this thing is deformable and we have connectivity, and the ingredients are set up for this thing to recover quite well." They have moved away from a decay curve of the riparian vegetation of the floodplain to something much more sustainable.

Boyd ended her presentation by highlighting the wonderful people that she has worked with over the years, stating "This has been pretty wild for me, and ultimately it just comes down to working with a tremendous group of people.". Boyd also shared some lessons that she has learned from her work. One is that making many small, incremental decisions to reduce risk can result in a very different outcome than originally envisioned. Another lesson is that increasing risk tolerance to improve long-term function can be highly controversial and it tends to be a moving target. Finally, the bottom line is that deformability is critical because deformable systems adjust. "We never nail a design and so as long as we allow these

systems to adjust be it climate change or sediment loads, then I think that we're doing the right thing with lots of small incremental things that we could get better at."

WATCH THE NOVEMBER 2022 RECORDING

December 2022 - "Open Mic"

The December topic discussion meeting was held in an open-mic format. Participants informed one another about current and future projects in the Upper Clark Fork River (UCFR). The first to share was Nathan Cook, who has been working with Dr. Raja Nagisetty, a Professor at Montana Tech in the environmental engineering department. Dr. Nagisetty has been helping look at how the water quality at Silver Bow Creek relates to the creek's fish population. In the course of the study, Dr. Nagisetty acquired a new drone sensor that can perform high-resolution thermal imagery.

As a proof of concept, Dr. Nagisetty flew the drone on Silver Bow Creek past the confluence of the German Gulch, one of the tributaries to Silver Bow Creek. The German h is cool relative to Silver Bow Creek, and the cool water it provides to the main stem of the creek provides an important thermal refuge for cutthroat trout. This fact makes it the most important thermal refuge for trout on Silver Bow Creek. Dr. Nagisetty flew the drone past this area and captured impressive high-resolution images where one can see the mixing of the creek and the extent of the cold-water habitat downstream of German Gulch, which is a fairly small area. The drone's imaging also picked up cool groundwater coming into the stream. Cook is now working with Dr. Nagisetty to do more of this kind of imaging in places that they think might be important thermal refuges. These refuges include both tributary mouths and areas of groundwater influence. There is a need to do this on the Clark Fork River as well and Cook is hoping to work with Dr. Nagisetty to get the drone out on the river over the coming year. Maury Valett suggested that he could coordinate with Cook in order to accomplish this so that the drone can identify groundwater discharge zones where cool water and water with minerals and such comes into the stream.

Next to share was Claire Utzman, a graduate student in Ben Colman's lab at the University of Montana (UM). Utzman's research focus is quantifying sources of nutrient pollution in the UCFR. The UCFR has a long history of heavy metal contamination and nutrient enrichment. Many studies have been conducted on the basin to identify sources of nutrient pollution, including a comprehensive water quality assessment of the river authorized by amendments to section 525 of the federal Clean Water Act, the voluntary nutrient reduction program (VNRP), and continued monitoring efforts by the Department of Environmental Quality (DEQ), UM, and the Clark Fork Coalition (CFC) from 1998 to the present. The CFC summarizes these reports every five years. Utzman works on quantifying nutrient loads from point sources identified by these projects. She obtained nutrient concentration and

discharge data from various wastewater treatment plants and lagoons across the watershed which she will use to calculate nutrient loads. She will then compare nutrient loads coming into and within the river since 2008. Utzman hopes to characterize any changes in nutrient pollution in the river and see the extent to which infrastructural improvements, like new wastewater treatment facilities in Butte and Deer Lodge, have contributed to reducing those loads. Because there is so much fragmented information about the UCFR, a significant component of Utzman's thesis will be focused on consolidating that information, applying it, and then returning it to people who have ongoing restoration projects or state agencies who may find it beneficial.

After Utzman spoke, Dr. Rafael Feijo de Lima gave everyone a general update on their work regarding the relationships between metals and water and metals and biota, as in algae, in the UCFR. One of the interesting things that they accomplished was performing an experiment in partnership with the USGS that they conducted at their facilities in Helena, with the help of Travis Schmidt and others. In the experiment, they investigated the effects of nutrient enrichment on metal accumulation in algae and bugs that colonized in the CFR as well as the various effects of different size fractions of metal enrichment in these treatments. They are still waiting on the metals results but saw interesting stuff going on and are glad to give everyone a follow-up in the future once they have that data. Another significant update is that the environmental chemistry lab at the University of Montana now has a brand new inductively coupled plasma mass spectrometry (ICP-MS) instrument up and running. There are several studies that have been on the back burner that are being analyzed and will produce a lot of data sets now that they have the capacity to analyze those water samples. Ben Colman shared that this instrument has many capabilities including speciation (which is being set up right now). They will be able to look at the speciation of a whole range of different elements including selenium, iron, arsenic, and mercury. They are looking forward to starting additional analytical approaches.

Dylan White further explained that they have been working on analyzing water samples for metal concentrations from the work that he has been doing, and with the samples that he has collected with members of Maury and Mike's labs. Basically, they are working on catching up on analyzing thousands of water samples for metal concentrations. They also have two upcoming projects: taking a modeling approach with some of this data being generated as well as taking a more detailed look at the speciation of metal in the CFR, specifically at one site at a couple of different time points. Furthermore, White shared that last summer, he took water samples from a few of the lagoons in Milltown State Park and noticed that there were copper slickens in those restoration sites. He says that hopefully, they will have some data about metal concentrations from those ponds. Those samples are currently queued up in the ICP log so that will be something interesting to look for in the future.

Vicki Watson went next and shared an update on the central CFR restoration plan. The central CFR overlaps with the upper river a bit from Flint Creek down to the Flathead. The main reason they carved out the central CFR is that the upper river already has a water restoration plan and so does the river below the Flathead. Additionally, pretty much all the major tributaries of the CFR have watershed restoration plans, but from Flint Creek to the Flathead, the main stem and the small tributaries do not have plans and that must happen in order to apply for certain types of funding. The CFR Task Force was set up to help with the State Water Plan, but they wanted to keep working on other problems, so it reinvented itself as the Clark Fork Kootenai River Basin Council to focus on the fact that the central CFR did not have a water restoration plan. The Council developed a draft and gave it to the DEQ just as COVID hit, so they reviewed the draft and told them that they wanted more detail on the types of projects to be done, their costs, and who the partners would be in helping to pay for those projects. Unfortunately, they didn't have that level of detail yet on all the little

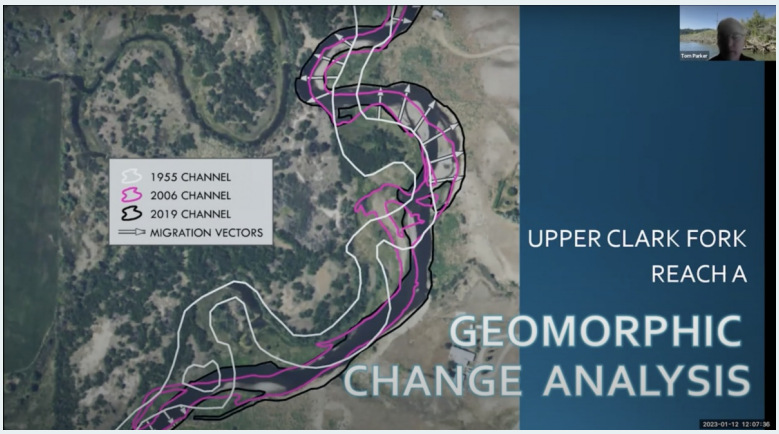
tributaries. In addition to COVID, the 2021 legislature repealed the numeric nutrient standards, which are an important part of a watershed restoration plan. Consequently, those two developments bogged down the planning process. The Council did not survive COVID, and many people had to drop out due to other responsibilities, so those who are still working on this have continued to monitor the nutrient standard process.

The EPA rejected the Montana legislature's repeal of the numeric standards by saying that they are based on solid science and because nothing appropriate was proposed to replace them, they rejected the repeal. As of now, the numeric standards still apply so the other factor keeping the central CFR restoration plan from moving forward is the fact that the Council, which was the lead entity, does not exist anymore. They are looking for a new entity to help move it forward, most likely the Clark Fork Coalition and maybe local agencies like Missoula City and County and similar entities that will have to work together to get it going again. Right now, the Clark Fork Coalition is focused on other projects around the basin, especially Grant Creek due to the proposed development around it. They currently have a good start on moving the plan forward but need to update what they have as well as lead entities and stakeholders to push it forward.

Finally, Brian Bartkowiak shared that Trout Unlimited (TU), along with the Cark Fork Coalition, Missoula County, and the tribe put in a grant with the Columbia Basin Toxicity Reduction Program. TU was awarded the grant and will be looking at fish consumption between Butte and Noxon, including on the Flathead. They will mainly be looking at mercury, dioxins, and furans, and in conjunction with the fish sampling, they will be doing passive sampling lures along the way to identify sources. They won't have any results for about a year, but the study will be moving forward.

WATCH THE DECEMBER 2022 RECORDING

January 2023 - "Fluvial Geomorphic Change Since 1955"



The January topic discussion meeting featured several presentations from Tom Parker, Marisa Sowles, and Karin Boyd. All three presenters have expertise related to floodplains and fluvial systems, including how they function and how that should be integrated into responsible restoration. They presented on the geomorphology of the Upper Clark Fork River (UCFR), the insights that they have gained from their experience, and the ideas that they are pushing forward.

Tom Parker, the president and principal ecologist at Geum Environmental Consulting, was the first to present. Parker has been working on the UCFR since 2005, when he worked at Milltown, and then became part of the design team for the UCFR around 2009. He explained that as part of the combined remediation and restoration work on the UCFR they have been using the idea of a channel migration zone, which is a risk-based way to identify a work boundary for remediation and restoration in the reach between Warm Springs and

Garrison. About ten years ago, Karin Boyd developed the original channel migration zone by comparing aerial imagery dating back to 1955 to see how the Clark Fork River channel had changed. Starting in 2021, the state identified the need to develop a strategic plan to determine how to complete remediation and restoration work to Garrison with the remaining funds. As part of that work, the presenters also recognized an opportunity to update their analysis of channel change. Using 2019 imagery, they were able to update the channel migration zone that Karin had previously laid out. The channel migration zone is useful as it helps them look at factors like how much the river will move and how much of the floodplain would erode over a hundred-year period based on historic erosion rates.

Marisa Sowles, who has been working at Geum for the past ten years, was the next to speak. She talked about how when they refer to channel migration, they are referring to channel movement which is occurring on outer bends. This channel movement erodes the outer banks and deposits eroded material on downstream point bars. Over time, willow and cotton ceilings are established on the point bars due to the species-supporting substrate and the right hydrology. The bank is built up by recruiting more sediment because of the vegetation and roughness, which then pushes the channel out onto the opposite bank. The process then repeats itself. There are also avulsions in this process, which is where a channel cuts through the neck of a meander tab.To give more context about outer banks and point bars, which were the main focus of the presentation, Sowles showed pictures and explained them to the group. She said that there are naturally eroding high banks that are clean and then there are banks with impacts like contamination and compaction. Point bars on the UCFR generally have narrow depositional features and after that feature, there is an abrupt jump in elevation. This means that the surface does not frequently see a lot of out-of-bank flows, which otherwise bring seed sources and sediment that support the colonization of woody vegetation. Point bars in remediated phases have been constructed to be very wide and with a shallow slope to create a large surface area for sediment deposition and recruitment of woody species. Over time these will likely steepen up.

Sowles then talked about migration analyses, which are completed by digitizing a channel for a specific year in their Geographic Information Systems (GIS) and comparing that year's footprint and bank lines to another year. The three years that she focused on were 1955, 2006, and 2019. Unlike the new analysis, the previous analysis was done by phase, which is generally based on a channel's length and land ownership. In the new analysis, they summarized migration rates by using sub-reaches to help refine the entrainment potential of the contaminated material within a specific phase. For instance, there could be five sib-reaches within a phase, all representing different average rates of migration. Sowles showed results for the geomorphic sub-reaches from Warm Springs to Garrison and the mean migration rate in feet per year for each one of those sub-reaches. Two different time spans were considered: long-term (1955-2019) and short-term (2006-2019). When comparing the long-term average to the short-term average of migration rates, it was clear that with the short-term rates, things are moving a bit more quickly, which piqued a slew of questions and analyses.

To see where channel movement is occurring along the river, they looked at it longitudinally and broke up the migration rates by quartile, with the first quartile representing reaches that are moving very little (the least migration) and the fourth quartile representing reaches that are moving more quickly (the most migration). Upstream sub-reaches are moving very little, and fourth quartiles aren't even represented until phase 11, which is upstream of Deer Lodge and downstream of Sage Lane. The sub-reaches at the beginning are right below Warm Springs Ponds, which retain a lot of sediment. Sediment is a huge component of channel migration in terms of channel movement, so it is more static upstream as opposed to downstream. Sowles then talked about what these migration rates mean in terms of quantity, measured by total acres and cubic yards by sub-reach. The take-

home point is that 70 acres, or 203,156 cubic yards, have been eroded from 2011 to 2019.

Another way to think about channel changes is by looking at channel width, which can be done using the digitized channels and generating cross-sections on each of these channels at 100-foot intervals. The team took the average of those cross-sections and could see that the 1955 channel is similar in width to the average channel width in 2019. However, in between those timeframes, the channel was narrow so there are patterns of narrowing and widening of the river. Sowles said that we can also look at the percent change in channel width (ft) by phase between 2006 and 2019. The remediated phases 6, 5, and 2 are on the higher end largely due to the shallower and wider point bars, which are again meant to capture sediment and facilitate the natural colonization of woody species. Sowles also demonstrated that you can look at channel width with lidar, using two lidar sets from 2011 and 2019. From the lidar data, you can use topography to take cross-sections in the same location and compare the bank lines.

Sowles is also interested in what is happening comparatively in two different locations, like an outer bend versus a straight reach. This analysis isn't comprehensive and primarily exploratory since the team chose only a few phases to start with. In their analysis, the team broke the channel up into straight sections and outer bends to look at the migration data and the reach characteristics related to those sections. For example, they found that outer bends are eroding five times more than deposition is occurring. That same trend is occurring on the straight sections but not to the same extreme. Furthermore, the team looked at geomorphic characteristics in order to try to answer the question of why this phenomenon is happening and to try to see if they can better predict it. They analyzed the sinuosity, or the bend, of the river. They compared sub-reaches that have a sinuosity of greater than 1.5 or less than 1.5. For context, a straight channel has a sinuosity of 1. In terms of mean migration distance, there is not a huge difference. The team also looked at the slope relative to the mean migration difference.

Sowles wrapped up her part of the presentation with a few informal observations that she made by looking at aerial imaging of the UCFR. In the 1955 imagery, there is more deposition and bare ground likely due to tailings. Looking at the 2006 imagery, those areas are now occupied by herbaceous vegetation and some woody regrowth off the channel. In the 1955 imagery, there is more woody vegetation along the banks, right up to the point bar, and all the way around the outer bend. In 2006, there is a buffer of herbaceous vegetation which begs the question of what roles woody vegetation plays on the UCFR. There is literature to support that woody vegetation is a big component of stabilizing and allowing for natural migration rates on the UCFR. Finally, the channel is generally straighter in 1955 and more sinuous in 2006, despite the fact that there have been a handful of meander cutoffs between those two periods of time.

Next, Karin Boyd shared some charts and data about the UCFR. She began by showing a plot of peak flows from the UCFR data at Deer Lodge. The data from this area didn't start until 1979 but the record was extended back to 1899 by using other gauges to develop a dataset. She believes that the peaks are valuable when looking at thresholds. For example, last spring the Yellowstone River hit a threshold with a very short-term peak that caused a major channel change. Typically, what causes the channel form to fundamentally change is work on the channel, which is not so much the instantaneous peak but the duration of those flows.

Boyd then showed the number of days that the channel-forming flows were exceeded at Deer Lodge. Channel-forming flows are the flows that cumulatively move the most sediment. The flow that moves the most sediment over the course of the river's lifespan is what controls the channel morphology. She is also interested in low flows because, during

drought periods, there is riparian encroachment into the channel and a narrowing effect, which increases roughness. Back during the droughts of the early 2000s, there was a lot of contraction of the rivers from vegetation encroachment because of the lack of channel-forming flows and the persistence of exposed areas on the side of the channel. Boyd also discussed sediment mobility by showing data from UCFR phase 7 in which she took the output of a hydraulic model and converted the shear stress to the grain size that would be mobilized from an event.

Lastly, Boyd highlighted factors associated with geomorphic change. There is historic variability in river width, with the current width condition being similar to the width condition back in the 1950s. This latter period also followed a period of relatively high flows. This variability is systemic and seen in both remediated and unremediated phases. There are also altered sediment inputs, but the impact of those inputs decreases as you move downstream. Furthermore, there is a loss of bank vegetation, and the resulting decay curve has increased the differential between the robustness of the bed and the erodibility of the banks. There are also concentrated channel-forming flow patterns and the idea that channel bed armoring is contributing to those patterns. Overall, the team has observed patterns of widening and narrowing on the UCFR, but the narrowing is slower due to fewer flow inputs.

WATCH THE JANUARY 2023 RECORDING

Events and Workshops

Upcoming Topic Discussion Meetings

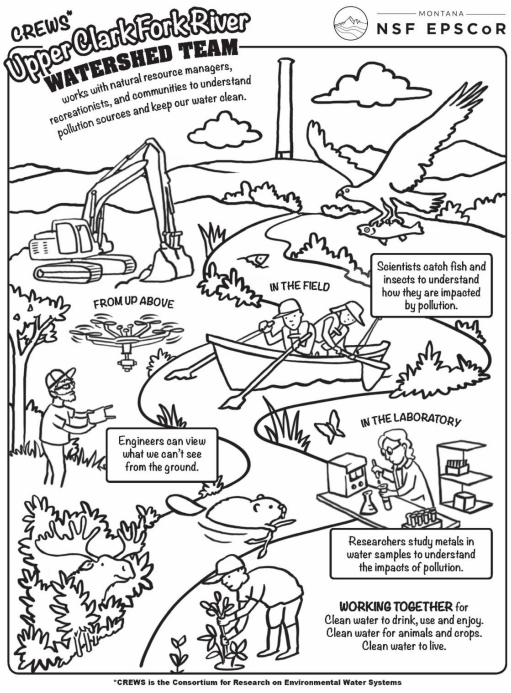
April 2023 Topic Discussion Canceled

News, Education, and Outreach

University of Montana Study Finds Deep Connections in Anaconda to Town's Smelter Stack

A new story from University of Montana News highlights the work of graduate student Megan Moore, whose research on the Superfund cleanup around Anaconda focuses on the town's long relationship with its smelter stack and its history in the state's mining history.

Read the full story on the UM News webpage



New Free Coloring Sheet Highlights CREWS Research in the Upper Clark Fork

A new coloring sheet depicting CREWS research and activities in the Upper Clark Fork River is now available to download for free. The coloring sheet features black and white illustrations depicting CREWS research and the backside features more information about the watershed and the project CREWS.

Learn more and download the PDF on the Montana NSF EPSCoR website

Have a Workshop Idea?

Please take the UCFWG Communication Poll and let us know what you are interested in. We would love to hear from you.

UCFWG Communication Poll

Have an Event you want Advertised to the UCFWG Community?

Send an email to either Madison Boone, madison.boone@montana.edu, or Andrew Hauer, andrew.hauer@umontana.edu, and we will work with you to post your event on our website, newsletter, and send emails to our community.

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