



Mat-Su Basin.

Visualizing the Flow of Stressors in the Matanuska-Susitna Basin in Southcentral Alaska

by Joseph E. Flotemersch¹, Kelsey B. Aho², Scott G. Leibowitz³, Matthew A. LaCroix⁴, Marc H. Weber²

Rivers are complex adaptive systems. Together, human and non-human components of these systems produce riverscapes. Ecosystem services provided by rivers and depended upon by humans are the backbone of the relationships between these components. Humans extract ‘services’ directly (e.g., drinking water, sanitation) and indirectly (e.g., nutrient and water cycling) from rivers. At times of great human demand, a river’s condition can be compromised which can adversely affect sustainability of a river’s provisioning of services. With little doubt, identifying thresholds of river response to human impacts presents a substantial challenge to managers.

Historically, river condition has been assessed by comparing the system to what it would theoretically look like in the absence of human impact. This theoretical condition, known as the reference condition, can be difficult to define since most watersheds have been altered by humans. As an alternative, managers can identify the type and scale of existing and previous stressors in the watershed to understand observable and measurable conditions.

In support of this approach, a group of researchers developed the “Index of Watershed Integrity” (IWI; Flotemersch et al. 2016, Thornbrugh et al. 2018). Since existing definitions of river

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Executive Director's Eddy

Shifts tip dominoes A departure, not loss is Legacy forward

Change creates opportunity, even when it is catalyzed by loss, and loss for one is often a new beginning for another. The context for 'loss' here is simply a well-deserved retirement for two long-time RMS members, colleagues and friends, for whom we wish the best of opportunities and new beginnings: **Cathi Bailey and Joan Harn**.

Cathi is taking an endless leave from her position as the Wild and Scenic Rivers Program Lead for the Bureau of Land Management. She joined RMS in 1991, spent the majority of her thirty-year career working on and for Wild and Scenic Rivers, and as noted by her supervisor, Sally Butts, "consistently looks out for folks at the local and regional level, making sure they have the tools and guidance they need to effectively manage WSRs." We look forward to seeing Cathi as a Pacific Chapter member and fan of others' work, now that she can take a break from the drill of her demanding job.

Joan Harn leaves us as a mentor, a truly dedicated visionary, and an advocate for RMS and our mission. As the River Program Manager for the National Park Service she has helped RMS grow through her enthusiasm for seeing and acting on synergies between the missions of her agency, RMS and partner organizations. Year in and out, Joan has supported ideas that are strategically sound, even when audaciously large. It is through Joan's smarts, experience and confidence in her instincts that RMS initiated the National River Recreation Database and NationalRiversProject.com for which enhancements will reflect her foresight and commitment for years to come. We'll have more to say about projects she has mentored, later. For now, we simply thank the countless occasions in which she has provided onramps to interaction with many National Park Service programs, professionals, and partners. We appreciate you both, Cathi and Joan!

I'd also like to shout out to **Bob Stanley**, who has been working through the fall and winter to assemble the 2019



Pacific Chapter trip on the Wild and Scenic Tuolumne River. At his side, Christina Wilkinson has volunteered religiously, as well. We held meeting through unorthodox scenarios: seasonal Bob, off duty half way around the world and half a day ahead on the clock, Christina hunkering down during a mid-winter snowstorm without power. As the trip nears, the 150% snowpack has mandated a schedule change to ensure the on-river experience is conducted with all safety precautions taken. Thank you both for your energy, planning and expertise.

Finally, individuals have emailed RMS randomly this spring to comment on aspects of river management that we've passed along to those who might benefit. You are always welcome to share your thoughts or ask questions of fellow members through the RMS Listserve. If you have a 'beef' or nagging curiosity about an issue, you're always welcome to write rms@river-management.org: we'll respond as we can and research or pass your message on, as suits.

Thank you for caring, sharing and improving our awareness about how we are managing and stewarding our precious rivers. Whether you are a brand new or decades 'new' member, in your first-ever job or many years retired, your experience counts. We look forward to learning from you. ♦


Risa Shimoda
Executive Director

RMS President's Corner

Musings...

Continuing Education

For over 30 years, the Grand Canyon National Park Service has partnered with river guides and outfitters for an annual river training seminar. The Grand Canyon River Guides, a non-profit group, takes the lead on organizing the land-based and on-river training sessions. The land-based seminar includes presentations on a variety of park-related topics, NPS regulatory updates, ongoing science, and tribal perspectives. The NPS authorizes and participates in the on-river training that includes stewardship projects such as exotic plant removal and watering restoration sites as well as daily presentations and discussions on relevant topics from the NPS, scientists, tribal representatives and others.

In my former life as a Grand Canyon NPS Outdoor Recreation Planner and Wilderness Coordinator, I often presented on the river planning process and resources monitoring programs. I've been retired for over two years, and I was surprised to be invited as a guest speaker to share the history of Grand Canyon river management. Interestingly, most of the guides on the trip were in middle or high school when the Grand Canyon river management plan was completed 13 years ago, and mostly unfamiliar with the river management history and controversies over visitor use allocation and motors in wilderness. This opportunity to share made me realize that I, too, was a small part of this history, and helped to change some policies that benefit the public's access to a Grand Canyon visitor experience. Putting the past aside, the hard work of protecting the river continues. Many of the same challenges of managing resources at risk remain. The riverine environment is jeopardized by dam operations; the tributary water quality, wildlife and habitat are threatened by mining on adjacent public lands; and wilderness qualities are threatened by proposed developments on neighboring tribal lands. That work is not only on the shoulders of federal agencies, tribes and conservation groups, but requires support and engagement from the river guides and others who care deeply about the canyon

and the experience it offers.

The annual Grand Canyon River Guides gathering serves as a venue to educate and engage the new cohort just as it does the old guard. The learning goes both ways; hanging out with the "new generation" of guides helped me to refresh a long-time relationship with the canyon and embrace the future with renewed confidence – and although I doubt I can match their level of optimism and enthusiasm, I will try.

The Seedskadee

Early last year my partner Kelly took an oar-making workshop at Fretwater Boatworks with Brad Dimock, a master boat builder, doryman and author. Kelly created a beautiful set of 10-foot oars from Port Orford cedar complete with leather oar wraps. Handcrafting the oars was a means to connecting the activities she is most passionate about — woodworking and river running. Then, with a thirst for a greater adventure...let's build a boat?

The Seedskadee was created a few months later. Master Builder Brad and his enthusiastic apprentices Kelly, Janek and Che labored seven days into darkness to

Kelly and Seedskadee on the Green River, Utah.



create a customized McKenzie River drift boat. After the hatches were caulked, the hull stained and oiled, and the handmade oarlocks installed, she was "tested for float" on a local lake. It was fitting that her first river trip was on the Green River, for which she was named. The Crows and Shoshones who lived near the headwaters of the Green called the river Seeds-kee-dee Agie (Prairie Hen River). This name was chosen to honor the Green and its early inhabitants.

Seedskadee offers a new appreciation of rivers, not simply because it's a new boat, but because it is an expression

of talent and passion. In Seedskadee and other craft, we will continue to explore and enjoy the rivers and the landscapes under the care and stewardship of many folks within our RMS community.

Thanks for letting me share. See you on the river! ♦


Linda Jalbert
RMS President

RMS Chapters

Northeast Chapter Adirondacks Trip September 6-8, 2019

Join us for a three-day fall paddling trip in the beautiful Adirondack Mountains of upstate New York! We will paddle a section of the Northern Forest Canoe Trail from Long Lake to Tupper Lake, NY. Paddlers will be exposed to open water paddling on Long Lake and easy river paddling on the Raquette River. If you are interested in participating or would like more information, please contact Trip Coordinator Walter Opuszynski, wopuszynski@gmail.com or Chapter President Emma Lord, emma_lord@nps.gov.

Photo: Emma Lord

Lori, Thank You!



Ms. Lori Potter has recently retired from her practice of law and is stepping back from serving the RMS board as a legal counsel, a role she has played since 2015. A bit about Lori, if you have not had an opportunity to meet her:

A 1980 graduate of Harvard Law School, Lori Potter is regularly listed among Denver's best lawyers, becoming the go-to person for cases involving the recreational use of Colorado and national rivers. When Christo proposed his "Over the River" 42-mile canopy above the Arkansas River in Colorado, he turned to Lori to represent him. Before withdrawing his proposal, Lori encouraged him to fund a bighorn sheep study that resulted in the Union Pacific railroad removing an abandoned line of railroad cars that was blocking wildlife passage to the river.

The Grand Canyon Private Boaters Association hired Lori to challenge the National Park Service for permitting motorized rafts, generators, and helicopters in the Colorado River corridor. The Ninth Circuit Court of Appeals declined, ruling that the plaintiffs had failed to prove the National Park Service acted arbitrarily and capriciously in permitting motors in the wilderness.

When a real estate developer sought to shut down access to rafting companies on the Taylor River in Gunnison County, CO, the Colorado River Outfitters Association hired Lori to challenge the developer, resulting in a compromise that protected their right to float.

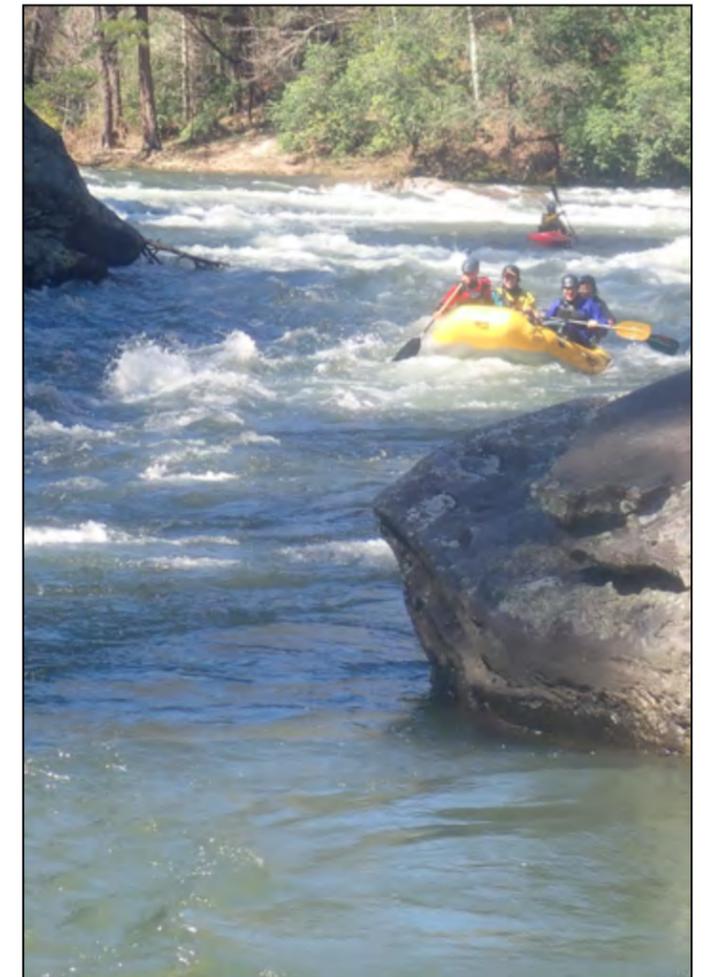
She's revered in Pitkin County for her 1995 test case victory in the Colorado Supreme Court challenging the Aspen Skiing Company for withdrawing too much water from Snowmass Creek for snow making. That victory led to the science-based, stairstep flow regime still in effect. As a legal strategist and mentor, Lori's advice and assistance spans decades from years as regional director of the Sierra Club Legal Defense to service on the Earthjustice national board. Lori's hard work and unparalleled skill has improved river health and access. RMS is fortunate to have benefitted from such a strong advocate for all things wild. ♦

RMS Chapters

Southeast by Jack Henderson

Join the RMS Southeast Chapter on Friday, August 30, for a paddle down Section 3 or 4 of the Chattooga River (water level will determine final selection of section). Trip participants may either help paddle rafts outfitted by Wildwater Outfitters, or bring their own kayak, whitewater canoe, or personal raft. The Chattooga River, forming the northern boundary between Georgia and South Carolina, is a Wild & Scenic River managed by Nantahala, Sumter and Chattahoochee National Forests. Steeped in whitewater history, Section 3 is a scenic class III float, and Section 4 is class IV.

Registration opens soon on the RMS Southeast Chapter webpage. In the meantime, contact Jack Henderson with questions: jack@river-management.org. ♦



Chattooga River, Section 3. Photo: Jack Henderson

RMS Chapters



RMS River Ranger Rendezvous

August 6-8, 2019

Boaters running Skull Rapid in Westwater Canyon on the Colorado River. Photo: Robert Brennan

Colorado River
Ruby-Horsethief and Westwater Canyons
Sponsored by the RMS Southwest Chapter
Cost: \$300 RMS Member (\$330 non-member)

This event is a 3-day, 2-night river trip geared to get individuals that are responsible for the day-to-day management of our nation's rivers together to share leadership and management ideas, and to develop professional relationships. Training sessions and group discussions will take place at camps, lunch spots, and other targeted river-side locations. Maximum: 25 participants.

Training Topics:

- Invasive Plant Removal and Fire Damage Restoration
- Law Enforcement – Verbal Judo with Difficult People
- Legal Issues in a Drowning Incident
- Best Practices in Outfitter Relations
- Managing Cultural Resources in River Corridors

Pre-trip camping is available at James Robb State Park and BLM River Managers will give an evening introductory talk.

The group will travel through Ruby-Horsethief (~ 25 miles) and Westwater (~17 miles) Canyons for a total of approximately 42 miles. Ruby-Horsethief is a Class II section through scenic, arid canyonlands. Westwater canyon shifts from red sandstone to black kneiss as the gorge narrows and the rapids increase in difficulty, including infamous Skull rapid (Class III+- IV).

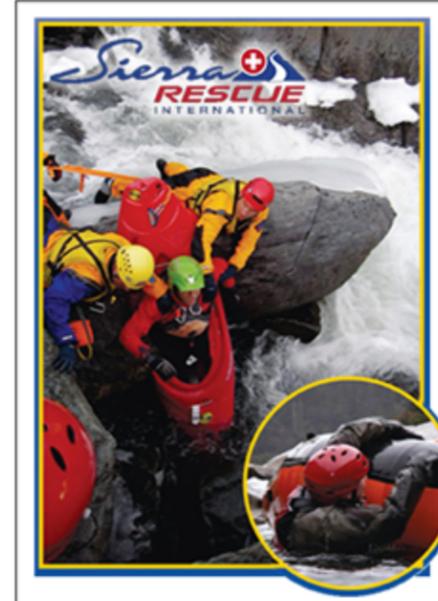
The trip will be operated on BLM motorized rafts. Life jackets and other paddling equipment will be provided. Participants will be responsible for personal clothing, camp chair, and camping equipment. Food for the trip is being catered by Holiday Expeditions so no cooking equipment is required.

Registration is open until July 15 and covers campground fees, on-river meals, and rafting equipment. Visit: <https://www.river-management.org/river-ranger-rendezvous> or contact: Tappan.Brown@state.co.us◆

RMS Chapters

Southwest by Rob White

The Southwest Chapter has been working on three important events this past winter: Swiftwater Rescue Training (right), the River Ranger Rendezvous (left), and potential trips for RMS members, including: 1) Lake Fork of the Gunnison - Early Summer; and, 2) Dominguez-Escalante National Conservation Area - September/October. Stuart Schneider, SW Trip Coordinator (swschneider@blm.gov) is finalizing details. In the meantime, please contact Stuart with other ideas. Enjoy the spring weather and associated run-off! With above average snowpack in most of the western US, the spring/summer whitewater boating opportunities should be excellent! Thanks again to all chapter members for your continued involvement and support!◆



RMS - Southwest Chapter
hosts

River Rescue Certification

A 3-day swiftwater rescue course for river professionals and paddlers instructed by Sawatch Rescue

- Dates: May 22-24, 2019
- Cost: \$300
- Location: Salida, CO

Contact: Tappan Brown, Arkansas Headwaters Recreation Area
 tappan.brown@state.co.us,
 P 719.539.7289 Ext. 4723

Lake Fork of the Gunnison River. Photo: Stuart Schneider



Are You a River Manager? Am I a River Manager?

by David W. Schade, MPA

I would say we all have a role in river management, and many divergent fields of study are an important part of this calling. In 2008, I became the Navigability Subunit Manager in the Public Access Assertion and Defense Unit of the Alaska Department of Natural Resources Division of Mining, Land and Water. So began my 10 plus years of “river management.” Truth be told, I didn’t even know that I was going to be a river manager. Our ANILCA¹ coordinator at that time, Joy Biederman, was talking to me one day and she said, “you should go to the River Management Society meeting with me next week.” It was during lunch, so I thought I’d take the opportunity to get out of the office for a bit. Little did I know this would be the start of a whole new adventure. Very quickly I realized that I didn’t really know anything about river management, but that didn’t matter to this fun, enthusiastic group who were more than willing to mentor the new guy.

Now, many years later, I’m still learning what it means to be a “river manager.” Why do I say this? It’s because I have concluded that river management doesn’t start at the river. It involves all the issues about water from the snow pack in the mountains, to the underground water flows to the sea. River management is an all-encompassing endeavor. I believe that is what makes being a river manager an important vocation, and why the River Management Society membership should be growing in many different directions. Since I have had a unique path to river management, let me share my personal experience, simply to show how and why I have come to these conclusions.

Let’s start with the types of governmental agency staff who

work on rivers. The first group that comes to mind are the hard working federal, state and municipal River Rangers. Their jobs are to be out on the river helping the public have a fun and safe time. They are the front line and the most visible part of river management. For the front line to be successful, they are supported by many people back in the office. The river manager office staff perform necessary functions, such as the land and river use planning, development of the safety plans and protocols, and interacting in developing interagency work plans for different segments (often with differing use parameters) to name a few. I think this

is one reason why our joint symposiums with the Society of Outdoor Recreation Professionals are so popular and successful. There is a lot of cross purpose in the work that each group does and with the River Ranger Rendezvous and other on-river training done by RMS, these groups are key to river staff development.

What about other issues a river manager has to deal with? Well, how about that tricky need to have *water* in the river? Frankly, coming from Alaska, I didn’t even consider the aspects of “water use management” until I became the Water Resources Section Chief and started learning more about hydrology and

David Schade enjoys an RMS Alaska Chapter float trip on the Chulitna River.



the use of both surface and groundwater. It is intuitive that the management of surface water relates to river management, but it has recently come to light that groundwater management is important as well. This has become very clear with the State of California’s recent legislation requiring a plan to develop a sustainable level of water use. But, in the midst of this endeavor, the California Supreme Court ruled that the public trust doctrine applied to the State’s Groundwater Resources. While I will leave it to the lawyers to explain the complex legal points, from my river manager perspective, the court ruled that the over-pumping of groundwater had the impact of violating the public trust doctrine.² So, when I started going to the Western States Water Council³ meetings and Association of Western States Engineers⁴ meetings I was amazed. I learned that every State Engineer (or equivalent) was always looking at the winter snowpack, looking at the predicted weather patterns for the next year, and working to manage dam levels — trying to keep them low enough for flood surges, but as high as possible for recreation and water supply — and, then having to consider all of the ramifications of water curtailment in times of shortage (a routine occurrence in the west over the last 10 years).

These shortages and challenges under the Endangered Species Act (among other things) have led many states to allow for a new kind of water right known as “instream flow reservations” where the right is for water to be left in the river for the fish and other wildlife dependent on the water. This right can also be used to assure enough water is in the river for recreation and other activities. There are also river management professionals who study and work to prescribe flows for fishing, wading, rafting and even for whitewater activities, whether for specific releases from dams for natural waves or for use at designed whitewater parks. My point is that the myriad of folks who study weather patterns, the hydrologists who study the snow pack and flows of water, and the staff who have to manage the different types of water use all are “river managers” or, at the very least, have direct impact on river management. At the recent RMS Symposium in Vancouver, we hosted the President of the American Water Resources Association.⁵ She was delighted to see the myriad of events and

agreed that we have a lot of issues of mutual concern, and we agreed to consider how we could hold a joint symposium/national meeting in the future. This is an example of possible future synergies and an opportunity for a broader understanding of what we do.

Since first passing the Clean Water Act⁶ in 1948, Congress required limits to pollution into “navigable waters.” While there continues to be much litigation and debate over what is a navigable water (aka Waters of the U.S. or WOTUS), there is no doubt that management of different kinds of pollution impact river management. Whether it is point source or non-point source, the whole idea is to restore and keep the river water clean, and I would say most river managers would agree with this concept. The problem is: just what is pollution and where does it come from? How a (potential) pollutant is going to impact the management of the water (river) can be a lot more complicated and from a source not normally considered to have been a threat. A great example of how quickly a problem can arise was from the “Gold King Mine Waste Water Spill” which happened in 2015. An EPA contractor breached rock which was holding water trapped inside the mine, causing an overflow of a treatment pond, thus sending three million gallons of mine wastewater and tailings into Cement Creek, a tributary of the Animus River and into the larger tributaries of the San Juan and Colorado rivers.⁷ This spill went downriver and through Colorado, New Mexico, Utah, and the Navajo Nation, ultimately reaching Lake Powell. The point is that a lot of non-traditional river managers have been working on this problem. The contractors who had to fix the upstream problem, and the scientists and regulators who must respond to and who have worked to mitigate the impacts of this event have become “river managers”. There are many people whose primary duty would not have been thought of as being a river manager and yet, as in this case, they need to understand the implications of and impacts to a river and its ecosystems in order to successfully manage the clean-up.

This was just one newsworthy example, but there are issues of excess nitrogen causing algal blooms which can be toxic to humans and wildlife, as well as other types of run-off which can impact wildlife. I have been involved in

many discussions about farming, and how farmers and other rural residents are now trying a more proactive approach to their activities so that they do not impact the waters around them.

And, on top of all the science and fieldwork, in addition to the legal work done surrounding water-related issues, I believe that river managers have to understand government bureaucracy and political processes. For example, the Wild and Scenic Rivers Act can be an important part of how a river is managed. But the bigger point is that a designation requires political activity, and a river manager must be ready to be a part of many discussions related to the competing uses of water and the rivers themselves. River managers, often later in their careers, will sometimes find themselves in a position to establish policies and procedures and may find themselves pulled into political discussions. Learning how the process works, and who is involved, should be learned prior to being thrown in the hot seat.

So, why have I been struggling with who I think should identify as a river manager? First, as a member of the River Management Society’s Board of Directors (as the Alaska Chapter President), I was challenged to answer this question. As part of developing the RMS River Training Center curriculum, and as part of our planning efforts, the board is trying to see the organization’s future. Second, and a bit more personal, I was wondering whether I should remain involved with the River Management Society, now that I am the “Acting” Director of our DNR Division of Agriculture, a position seemingly unrelated to river management. After much thought, I hope this shows I have decided that I (and all of us) still have a responsibility for river management, both from a professional and personal perspective. So, it seems I am in river management, and RMS, for the long run — no matter what my job description says.

I hope you will agree that our RMS members should be a large and diverse group of professionals who “study, protect and manage North America’s rivers.” If you are not already a member, feel free to reach out to me or any RMS member who can explain why we are part of the RMS family. If you are a member, please think about reaching out to those who either have a professional or personal connection

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The Importance of Swiftwater Safety Training

by Rockford Weber

Many of us have worked and played on rivers for decades. Plus, we know how to swim. So how to rescue one's self from the water is inherent. Isn't it?

Spoiler alert: No. The skills and knowledge needed to execute a successful rescue of yourself or your field partner are not inherent despite the amount of time we have spent on the water.

We learn a lot from experience, some of which would be hard to learn any other way. But self-teaching from books and learning on the job is no replacement for a dedicated safety course that provides a structured curriculum and allows you to physically test yourself in a controlled environment.

The Division of Mining, Land and Water (DMLW), within Alaska Department of Natural Resources,

recognized that staff was not receiving sufficient safety training for tasks they were being asked to execute, including: working adjacent to moving water, stream crossings on foot and by ATV, and operating watercraft on rivers. That recognition led to a multi-year process of training a small cadre of permanent employees to become swiftwater instructors and purchasing the necessary training gear to create a sustainable swiftwater safety program.

Since 2015, the DMLW has offered a two-day training, one day in the classroom and one on the water, that covers the essential elements of self-rescue and buddy-rescue. These are the practical skills staff engaging in fieldwork need to keep themselves safe and not designed to train professionals with river rescue

responsibilities, such as firefighters. The swiftwater safety training has been a tremendous hit with the most common post-course comment being "Can we have a third day?!"

Two days is the bare minimum for field staff who are working adjacent to, crossing, or on moving water. It's just enough to wet their whistle. Depending on the risks and hazards field staff is expected to face; they may very well need additional safety training such as boat ingress and egress or operation of specific watercraft.

When choosing a swiftwater instructor, look for a course that will physically put you in the water and that covers the following skills in the curriculum:

(continued page 12)



Log Drill

Above: Swiftwater instructor Rocky Weber, close to the action, coaches a student caught by a simulated strainer.



Throw-Bag Practice



Stream Crossing



All photos courtesy of the DNR Swiftwater Safety Team

- Water hazards and rescue priorities
- Swiftwater characteristics
- Cold water immersion rescue and treatment
- River swimming, self-rescue and buddy rescue
- Throw bag skills
- Stream crossing techniques

Also, look for some credentials. There are inherent dangers involved with this type of training, but a credible instructor should be able to largely mitigate those risks while still challenging your comfort level.

So, find a swiftwater course that'll put you in the water! You'll develop a whole new appreciation for the river. And, if you are not convinced, find someone you respect who has been through a swiftwater course and ask them their experience. The experience is eye opening, even for us water veterans. ♦

Rockford Weber works for the Alaska Department of Natural Resources and has been instructing swiftwater safety courses since 2015. Contact: rocky.weber@alaska.gov / (907) 269-8693.

(Are You a River Manager? continued from page 9)

to river management. And remember, I'm not just talking about those directly working on the rivers. Everyone is welcome! ♦

¹ Alaska National Interest Lands Conservation Act

² See legal-planet.org; California Court Finds Public Trust Doctrine Applies to State Groundwater Resources, Richard Frank, August 29, 2018

³ Western States Water Council:

<http://www.westernstateswater.org>

⁴ Association of Western State Engineers:

<http://westernstateengineers.org>

⁵ American Water Resources Association: <http://awra.org>

⁶ The Act was rewritten by a new Federal Water Pollution Control Act in 1972, with further amendments by the Clean Water Act of 1977 & the Water Quality Act of 1987

⁷ Kolb, Joseph J (August 10, 2015). 'They are not going to get away with this': Anger mounts at EPA over mining spill.

Recent Supreme Court Decision Affects National Park Service Management of Navigable Waters in Alaska

In late March the U.S. Supreme Court held in a unanimous decision that John Sturgeon, a moose hunter, can use his hovercraft in search of moose on the Nation River, which flows through the Yukon-Charley Rivers National Preserve in Alaska. The suit came after the National Park Service (NPS) told Sturgeon he could not use his hovercraft within the Yukon-Charley because the Park Service bans hovercraft within national preserves and parks.

Sturgeon sued the Park Service in 2011, arguing that the river was non-federal land and that Congress stripped the Park Service of its authority over navigable waters in parks and preserves based on a provision of the Alaska National Interest Lands Conservation Act (ANILCA).

ANILCA, signed into law in 1980, protected over 104 million acres of federally owned public land in the state, including over 56 million acres of new Wilderness. The Act

designated such iconic Wildernesses as Denali, Gates of the Arctic, Glacier Bay, Katmai, Wrangell-Saint Elias, Izembek, Arctic Wildlife Refuge, Kenai, Misty Fjords. The law also contains a number of provisions that affect federal agencies' abilities to manage these areas and require different management than in similar units outside of Alaska.

Both the district court and the 9th Circuit Court of Appeals rejected Sturgeon's argument, and the case went all the way to the Supreme Court twice. The Supreme Court the second time sided with Sturgeon, noting, "If Sturgeon lived in any other State, his suit would not have a prayer of success" because the NPS can ban hovercraft use in parks and preserves regardless of who owns the land and water. The Court found Alaska is "the exception, not the rule."

The full text of the decision can be found at https://www.supremecourt.gov/opinions/18pdf/17-949_6kgn.pdf ♦



Where Can You Float a Boat?

A Basin-wide Approach to Navigability Assessment in Alaska

by Kevin Petrone PhD

As river professionals, including scientists, managers, commercial guides or outfitters, we all have a good sense of what makes a river navigable. Successfully navigating a river requires maneuvering a watercraft through river segments including pools, glides, riffles, or whitewater rapids and avoiding obstructions or hazards such as gravel bars, strainers, or hydraulics. The characteristics of these river features often change with flow so before embarking on a river trip we likely consult local gauges or recreational boating forums to determine whether flow conditions are high, low or just right. While this approach works for many river systems in the contiguous U.S., in Alaska we find that few rivers are gauged and most have no flow data at all.

Since statehood, a central issue for the State of Alaska has

been to determine whether a river or lake is navigable for state title purposes. Given that it is an unrealistic (albeit enviable) task to float every mile or acre in the state, the State of Alaska applies hydro-geomorphic principles at a range of scales—from basin to catchment to river segment and reach—to assess navigability throughout the state.

The basic question is: “Where can you float a boat?” This question might seem straightforward at first, but there are many factors to consider. First are the type of boat used and the volume of water needed to successfully navigate a river segment. Our concern is not large barges or ships, but rafts, poling boats, large canoes, and other watercraft that were commonly used for transportation of people and goods at the time of statehood.

Generally, we define our test boat as an inflatable raft, canoe or other vessel carrying at least 800-1000 pounds, with a displacement of 8 inches. This raft or canoe must be able to travel in a predictable and reliable water column at least 8 inches deep and 8 feet wide for at least a third of the open water (ice-free) season, which typically runs from May to September.

Now, more specifically, we ask how large must a river be in order to successfully navigate our river segment with a raft carrying 800-1000 pounds? To answer this question, we first draw from the well-established hydrology literature that relates precipitation and drainage area size to river flow. In Alaska, the efficiency of a catchment (e.g. stream flow per unit area) depends on climate, elevation, topography, and soil characteristics, as well as glacier coverage. Next, we consider channel geometry and flow conditions. That is, how does channel depth, width, and velocity change with channel flow?

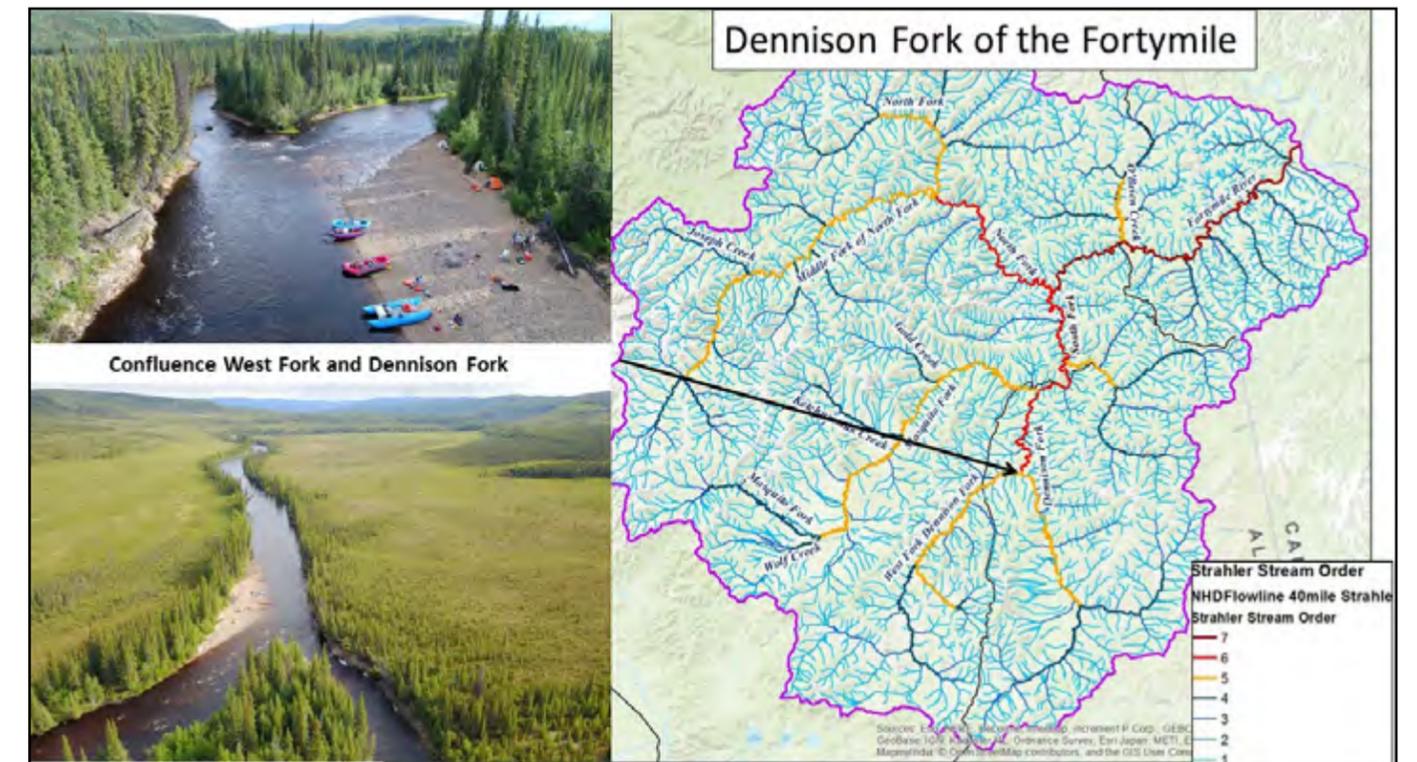
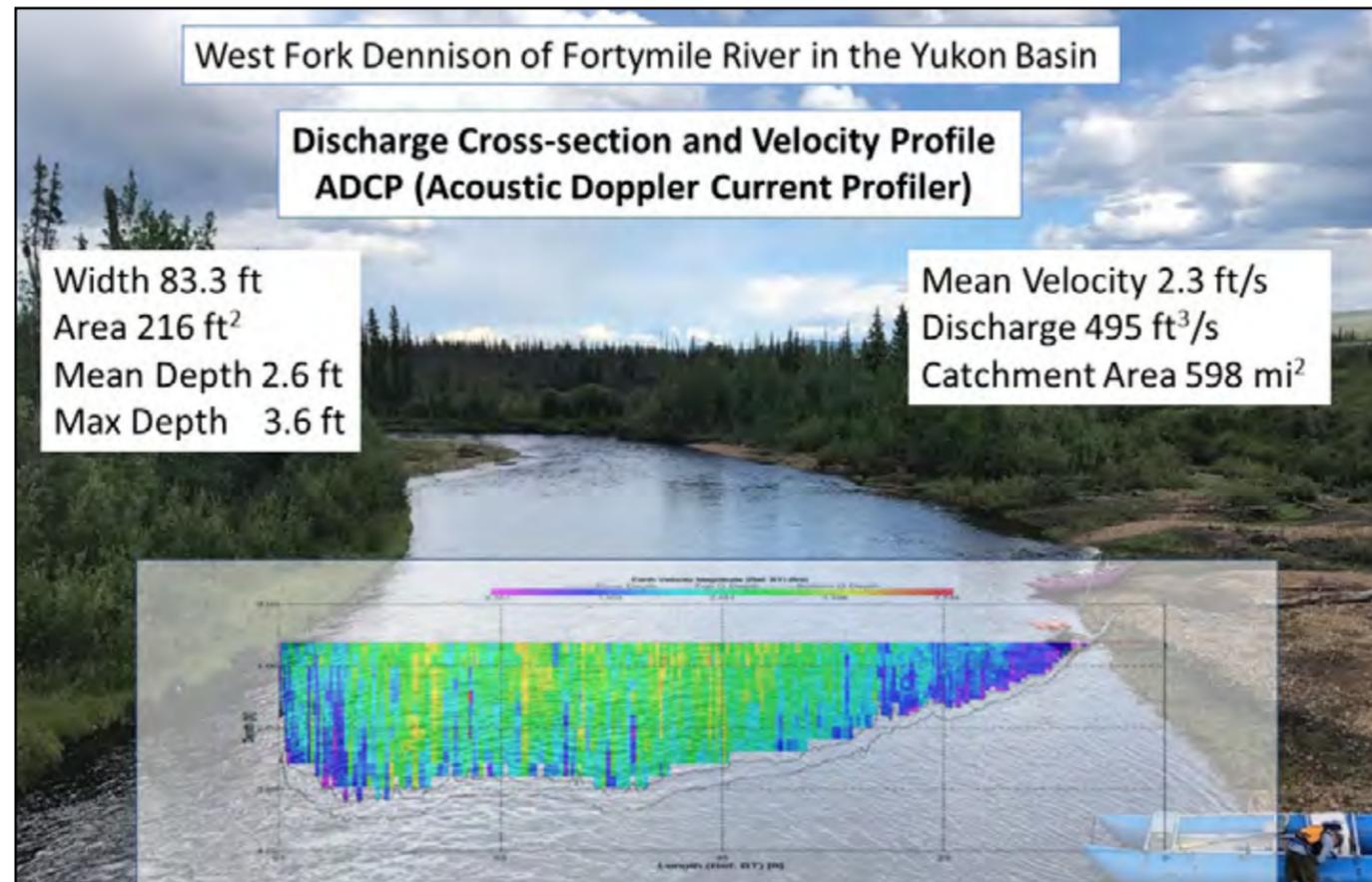
Again, we draw on the wealth of hydraulic geometry literature published since Leopold and Maddock first established the hydraulic geometry equations in 1959.

Technically for our water column example above, 8 inches deep and 8 feet wide at a typical river glide water velocity of 5 feet per second, flow is only 27 cubic feet per second (CFS). We know from experience, however, that channels are irregular and complex and channel width may be two or three times wider than our hypothetical channel, with a corresponding decrease in depth. Further, channels in riffles are spread over large substrate (e.g. cobbles and boulders) and channel depth must be sufficient to allow the watercraft to overcome or avoid these obstacles. Lastly, we must consider geomorphic conditions that affect navigability such as gradient, constrictions, and falls.

Using the 330,000 square mile Yukon River drainage as a test case, we have applied many of the hydrologic and hydraulic concepts above to establish a

basin-wide understanding of navigability. Aerial imagery is being used to establish channel width, substrate type, and gradient. USGS Watershed Boundary (WBD) and National Hydrography Datasets (NHD) are used to delineate drainage area and classify river networks using the Strahler stream classification system. Analysis of USGS gage data and the relationships between basin area, discharge and channel width and depth has greatly improved our understanding of navigability for river segments that we cannot readily access. Using this integrated approach vastly increases our efficiency in making navigability determinations within the Yukon River basin and will be applied to other large river basins throughout the state. ♦

Kevin Petrone, Manager of the Water Resources Section's Alaska Hydrologic Survey Unit, works for the Department of Natural Resources, Division of Mining, Land and Water.



Restoring the Jewel of California's Lost Coast

by Zane Ruddy

Thanks to a thriving partnership between the Bureau of Land Management (BLM) and two watershed restoration groups, California's Mattole River just experienced the largest restoration effort in its history. Over the course of six years, 750-ft of estuary slough channel was excavated to create fish habitat, over 400 whole trees with root wads were placed in the mainstem channel to promote complexity, and 15,000 willow cuttings and 17,000 native plants were added to barren river terraces. Large rainstorms and high flows in the winter of 2018-2019 tested the resilience and effectiveness of the projects, along with the nerves of the restoration team. The rain eventually let up, and all signs point to success.

Right: Former Mattole Salmon Group Executive Director Sungnome Madrone meets with Technical Advisory Committee members to discuss project ideas near the mouth of the newly excavated slough channel.

Below: The Mattole River meets the Pacific Ocean near the small town of Petrolia, CA. (Photos: Zane Ruddy, BLM)



The Mattole River is an outlier on the California coast in many ways. Its final three miles meander through BLM's King Range National Conservation Area (NCA), the first NCA established by Congress (1970). There are no homes in the floodplain, no roads or levees constraining the river, and no bridges interrupting the views. The river has no dams or hatcheries. The 300 mi² watershed is the largest along the Lost Coast, the name given to the 50-mile stretch of rugged, earthquake-prone coastline that forced Highway 1 to turn inland. The 2,500 watershed residents travel the area using a winding network of teeth-rattling mountain roads.

The Mattole's isolation spared it from nearly a century of large-scale logging operations in the region. However, in the 1940s heavy machinery capable of building roads and harvesting trees on steep slopes entered the watershed and within a few decades 90-percent of the old-growth forest was gone. The bare hillslopes didn't stand a chance against the watershed's heavy rainfall and record-setting floods of 1955 and 1964, which delivered an overwhelming amount of sediment to the river. A river once known for its cold water, deep channels, and complex fish habitat was now warm, shallow, and simple. Salmon and steelhead populations that had numbered in the tens of thousands crashed at an alarming rate.

The abrupt decline of Mattole River salmon and steelhead motivated a small group of watershed residents to organize a community-based restoration effort in the early 1980s. Over several years the movement manifested itself as two organizations, the Mattole Salmon Group (MSG) and Mattole Restoration Council (MRC), which are often cited as the first citizen-led watershed restoration groups on the West Coast. The MSG focuses on fish population monitoring and instream habitat restoration while the MRC emphasizes upslope restoration and erosion control.

For decades the BLM, MSG, and MRC planned and permitted restoration projects in the lower Mattole River one at a time. This process proved inefficient because each project required a permit or authorization from at least five public agencies, and time and money for project development and implementation was spent on regulatory compliance. In 2012, the BLM and partners decided it was time to take a different approach. "Our team recognized there was a need for a long-term, fully permitted, multi-year plan that would frontload compliance work and provide the regulatory certainty to take on large-scale projects," said Dave Fuller, Planning and Environmental Coordinator for BLM in Arcata. "An added benefit is that these 'shovel-ready' projects attract grant funds."

The restoration planning process was kick-started with the formation of a technical advisory committee (TAC) composed of federal and state agencies, non-profits, watershed restoration consultants, and local landowners. The TAC identified limiting factors for fish in the lower river, formulated the biological and physical objectives of the project, toured potential project sites, shared restoration project ideas, and ensured all potential environmental compliance concerns were resolved. The BLM decided to handle the environmental compliance

and permits, which allowed the MRC and MSG to focus on their strengths — grant writing and habitat restoration. Within a year, the plan was finalized and grant applications for the first suite of projects were submitted.

The restoration plan's biological objective was to provide juvenile salmon and steelhead with suitable summer and winter habitat, and the primary physical objectives were to slow channel migration rates, increase in-channel habitat complexity, increase connectivity to off-channel habitat, and promote topographic diversity. The plan also recognized that flexibility and adaptability (e.g., shifting project locations) was necessary to work in an ever-changing large river environment.

A Chinook helicopter delivers a whole tree to the river channel. The pilot and ground crew worked seamlessly to deliver a new tree to the river every three minutes. (Photo: Sam Flanagan, BLM)





The structure known as “Woodzilla II,” composed of trees delivered by helicopter and naturally accumulated debris, protects an existing mid-channel island. A deep pool on the upstream side of the structure provides complex habitat for salmon and steelhead. (Photo: Zane Ruddy, BLM)

The entire scope of work envisioned in the plan was successfully implemented over six years and was carried out as several distinct efforts: “heliwood”, slough excavation, and vegetation treatments.

Heliwood

Reintroduction of large wood to the lower river was a critical component of the restoration plan. In 2013 MSG’s new executive director, Sungnome Madrone, was committed to going big, which required a helicopter to move massive amounts of wood into the river in a short amount of time. His persistence paid off, and within a year MSG had secured funding, access to trees, and a most importantly, a helicopter.

In the summer of 2013, MSG crews prepared over 180 Douglas fir trees that had encroached into a nearby historic

prairie. Rather than burning the trees as waste or for firewood, they were utilized to create in-stream habitat. Trees were tipped, weighed, and delivered to the river. The Sikorsky helicopter arrived with its extensive crew of mechanics, fuel trucks, boom trucks and ground crew. In two days and 11 hours of fly time, more wood was added to the estuary than the previous ten years combined. The 2013 Heliwood effort resulted in the addition of 180 whole trees, 15 grapple-hauls of slash, 88 15-ft long pine logs, and 44 trees without root wads to the river. The helicopter “built” on-bank and in-stream structures to mimic a system with large quantities of naturally recruited wood. This initial helicopter effort was far more efficient than the prior practice of hauling in trees one at a time by truck and placing them with heavy equipment.

After the trees were flown off the

hillslope, an excavator re-contoured the areas where trees were removed. The MRC, regionally known and respected for their expertise in vegetation management, led the prairie revegetation effort. Their crew mulched and sowed a combination of native and naturalized grasses in an effort to encourage speedy revegetation of all disturbed up-slope areas. “The reseeded, reclaimed pasture is thriving, rich with clovers and perennial grasses,” said Michael Evenson, owner of the property, cattle rancher, and MSG Board of Directors member. “We could never have afforded to reclaim the pastures and create fish habitat with those trees without this important partnership.”

Additional grant funding secured by MSG in 2016 led to the largest single-year restoration effort in the lower Mattole River. In September, a larger Chinook

helicopter was able to lift much bigger whole trees (compared to the 2013 effort) from the nearby prairie restoration lands. Over the course of three days, 250 whole trees were placed in the river. Placement of individual trees occurred in four ways.

First, many trees were loosely placed on the gravel bar, typically lodged against a cluster of vegetation to slow the tree’s downstream transport. For these pieces, the goal was to let the river determine their fate by either remaining in place, or lodging elsewhere downstream to form beneficial habitat. During the initial heliwood effort in 2013, these loosely placed trees often moved downstream and lodged on the bank or against existing large wood and created valuable habitat. Other pieces remained in place and accumulated valuable silt for vegetation colonization. MSG implanted one or more small radio tags into each tree to track their movement through time.

The second placement type was whole trees positioned on the river bank. In this case, individual trees were inserted into the streamside vegetation and pivoted into the river channel. “We didn’t anticipate how skilled and precise the helicopter pilot would be with tree placement — he was able to place a 60-ft tall Douglas fir with the root wad attached exactly where we had flagged out,” said Sam Flanagan, geologist with BLM in Arcata. The bank placement increased the stability of the whole trees and promoted deposition of silt on the floodplain as a growing medium for new riparian vegetation. The portions protruding into the channel scoured pools and accumulated debris that added habitat value. This placement style mimicked what occurs when trees from the adjacent riparian forest fall into the river.

The largest trees were reserved for construction of gravel bar-apex jams. These large trees formed the structure’s foundation and were combined with additional trees to create a hard point in the channel that promoted formation of mid-channel islands and associated vegetation. These structures were built to mimic naturally occurring river islands that are often armored at their upstream end, or apex, by an interwoven mat of wood and live vegetation.

Finally, the smaller trees and tree fragments were reserved for armoring eroding, barren banks. This was intended, in part, to replicate the function of larger, live vegetation naturally falling into

the channel and armoring the bank as the channel slowly migrates across the valley floor. These pieces were buried in trenches using heavy equipment, and left partially protruding from the bank. Willow cuttings taken from nearby sources were woven into the trenched wood to promote vegetation regrowth and naturally anchor the structures. The visions for these structures was not to halt all erosion, but to add hard points for the river to work against as it gradually erodes into adjacent river terraces, thus adding an element of complexity along formerly barren, rapidly eroding banks.

Slough Excavation

In 2014, 250-feet of slough channel was excavated and connected to the Mattole River, and in 2018 the slough was extended upstream 500-feet, this time with the addition of several complex alcoves. The slough provides cold-water summer rearing habitat and allows fish to escape the relatively high, turbid winter waters of the mainstem river and utilize the food-rich floodplain. All three species of threatened salmonids have been documented in the slough, including adult summer-run steelhead, the rarest fish in the watershed. “Extremely high densities of Chinook salmon juveniles have been observed in the early summer, and steelhead juveniles utilize the slough throughout the summer,” said MRC Executive Director Nathan Queener. The slough has also proven to be a favorite destination for birds, river otters, and other native fish species.

Vegetation treatments

The MRC took the lead on planting an incredible amount of riparian vegetation on the barren river terraces. Over 11,000 feet of trenched “willow baffles” comprised of 15,000 large willow cuttings were planted to help stabilize eroding, unvegetated banks while avoiding the construction of “fixed” engineered hard points that halt natural channel migration and are prone to unintended consequences such as adverse bank erosion and structure collapse. Instead, these structures provide depositional environments where finer grained sediment can accumulate and provide areas for new plant colonization. They also provide valuable overhanging vegetation as the willows grow. In addition to willows, MRC planted a diverse array of 17,000 native trees and

shrubs propagated at their Native Plant Nursery.

Based on post-project monitoring and accounts of those that know the river best, it is clear that the project reach responded to the restoration efforts. “When I first started working in the lower Mattole River in 2007 there was little vegetation within the channel and almost no channel stability, it felt like walking through a desert,” said Conor Shea, TAC member and Hydrologist with the U.S. Fish & Wildlife Service. “Now, when I visit the Mattole, I no longer see a desert. I see vegetated islands, new growth coming in, deeper pools, and increased habitat for salmon and steelhead.” Post-project monitoring revealed the number of pools in the project reach has increased from seven to 20, and the average depth increased by two feet, allowing juvenile fish greater opportunities to avoid avian predation.

There is one very tangible reason to be optimistic for the recovery of Mattole River salmon and steelhead. According to MSG monitoring data, approximately 4,000 Chinook salmon spawners returned to the river in 2017-18, which is the highest count since surveys began in the early 1980s. The impressive Chinook salmon run may not be directly attributable to the recent restoration efforts, but it is good to know their offspring, numbering in the hundreds of thousands, had access to the most diverse and highest quality lower river habitat in decades. If the restoration projects function as planned, juvenile salmon and steelhead will grow larger in an increasingly productive estuary environment and have a better chance at surviving the daunting first few weeks following ocean entry.

The BLM, MSG, and MRC are not taking a break anytime soon. The BLM recently finalized a new five-year restoration plan that builds off the success of the previous plan, and MRC and MSG have grant applications in development. We would like to thank the funders and contributors to the project, which include the California Department of Water Resources, California Department of Fish and Wildlife, National Fish and Wildlife Foundation, NOAA Fisheries, and the U.S. Fish and Wildlife Service. ♦

Zane Ruddy, Fish Biologist, works for the Bureau of Land Management, Arcata Field Office.

RMS River Training Center offers...

Wild & Scenic River

Training Course in Mississippi

by Steve Storck

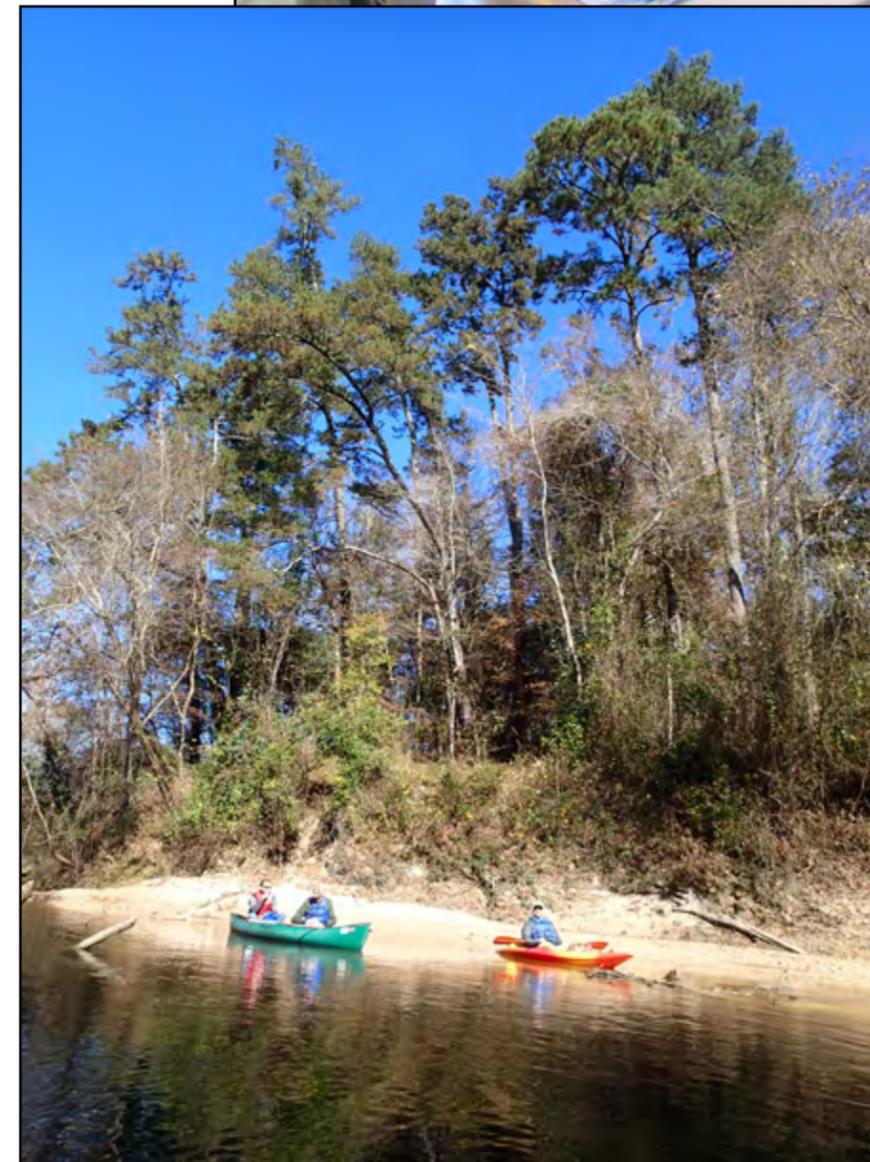
In early December 2018, thirty-two river management professionals and advocates from the Forest Service and local stakeholder groups gathered for a 4-day training focused on building skills to develop Wild and Scenic River Comprehensive River Management Plans (CRMPs). The course, hosted by the DeSoto Ranger District of National Forests in Mississippi, was held in Hattiesburg, MS, and was instructed by Mollie Chaudet and Rod Bonacker, instructors of the fledgling River Management Society - River Training Center. The site was selected to support the planning work of the Forest on a CRMP for Black Creek WSR, Mississippi's only designated Wild and Scenic River. Designated in 1986, Black Creek, as with many Wild and Scenic Rivers around the country, had never had a specific CRMP. Management guidance has been provided within general forest management plans as well as the adjacent Black Creek Wilderness management plan. Workshop sessions provided background on the intent and requirements of the Wild and Scenic Rivers Act, and hands-on work to consider management issues and strategies for local oversight of Black Creek. A unique aspect of the training was the opportunity to work hand-in-hand with the CRMP interdisciplinary team led by Jodi Leingang, of the U.S. Forest Service Enterprise Program, with members from the Enterprise Program, regional and local Forest representatives, and several stakeholder groups. Working sessions on Outstandingly-Remarkable-Value revision (the other ORVs), boundary definitions, ecological protection, user types and capacities, and stakeholder engagement provided a full agenda.

One of the workshop highlights was an opportunity for the group to ground truth some of the documented resource descriptions and ORVs with a paddling trip down 7 miles of this 40-mile Wild and Scenic River. The clear, tannin-tinted river flows swiftly through a heavily forested corridor bordered by

high banks. In stark contrast to the black waters, paddlers visited some of the large white sand beaches that help provide the unique character of this river corridor. Local outfitter Brandon Pearce, owner of Black Creek Canoe Rental, hosted the group and provided insightful perspectives on the transforming use of the river from his 25 years of livery experience. The day was magical and is a true testament to local successes of the 50-year old Wild and Scenic Rivers Act in protecting free flowing rivers and their adjacent corridors. The workshop ended with a hand-off to the planning team and a facilitated action planning session to help them move forward with completion of the CRMP.

The CRMP course is one of four Wild and Scenic River management training courses that were developed by the Interagency Wild and Scenic Rivers Coordinating Council (IWSRCC). The River Management Society, in close partnership with the IWSRCC and our WSR Education team leads — Jackie Diedrich, retired IWSRCC Chair and FS WSR Director, and Molly Chaudet, retired FS WSR Manager — offer these training courses around the country. These courses are designed to improve the quality and consistency of protecting and managing congressionally designated Wild and Scenic Rivers as well as teaching skills to inventory, assess and manage eligible and suitable rivers in the WSR system. As part of the effort to address training needs and build the institutional capacities to manage these rivers, the RMS River Training Center has initiated an instructor development program to develop knowledgeable instructors and resource specialists throughout the country to serve as mentors and advocates. ♦

To find out more about this program or to schedule a course, please contact Steve Storck, RMS Training Coordinator: training@river-management.org.



Above:
RMS River Training Center instructor Mollie Chaudet teaches the group of 32 about the CRMP requirements of the Wild and Scenic Rivers Act. Also in the photo are De Soto District Ranger Anne Casey, USFS WSR Coordinator Steve Chesterton, and USFS Region 8 WSR Program Manager John Campbell.

Left:
Towering pines and white sand beaches border the tannin-stained waters of Black Creek Wild and Scenic River. CRMP course participants take a break on the shore and enjoy these Outstandingly Remarkable Values.

Photos: Steve Storck

National Park Foundation Grant Brings New Features to National Rivers Project!

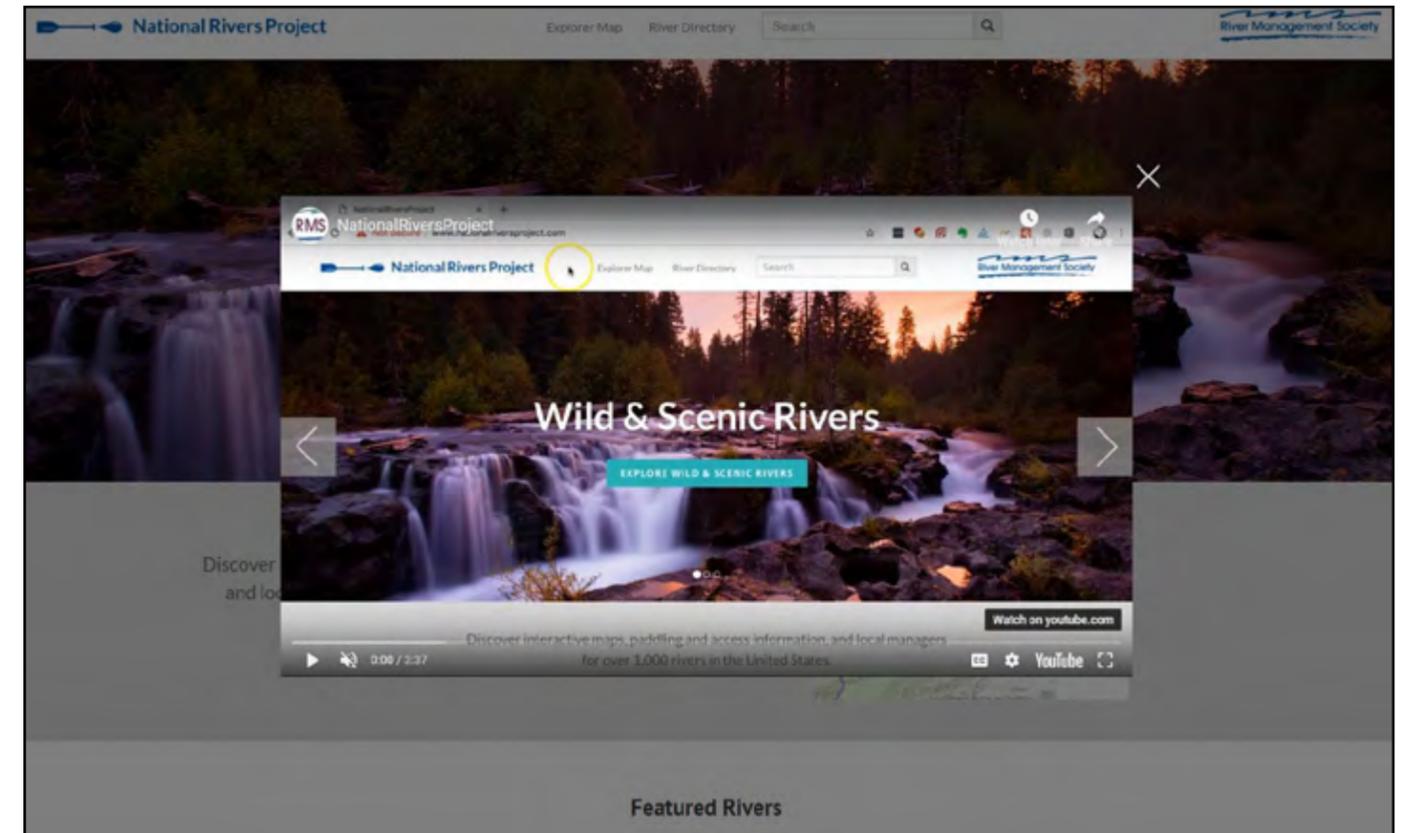
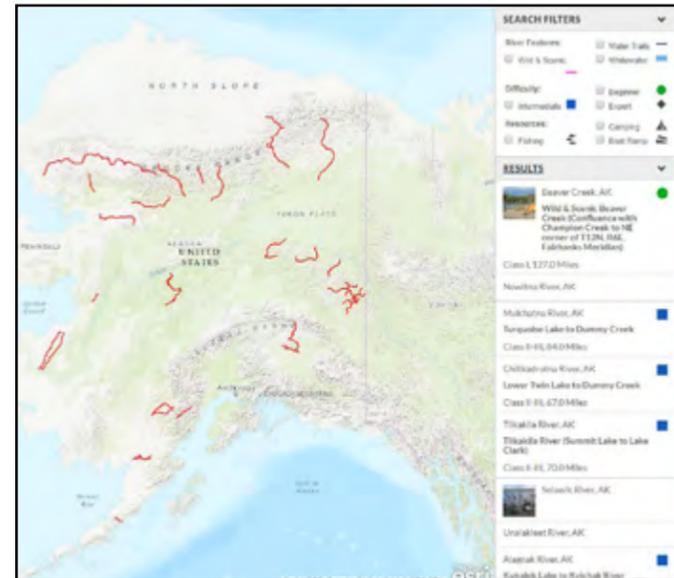
by Jack Henderson

In 2018, River Management Society secured a grant from the National Park Foundation (NPF) to improve the National Rivers Project (NRP) website (www.nationalriversproject.com). This grant was focused on celebrating the Wild & Scenic Rivers Act's 50th Anniversary, and dedicated money towards projects that highlight and/or improve rivers and trails managed by the National Park Service. Eligible projects included Wild & Scenic Rivers in national parks, Partnership Wild & Scenic Rivers, National Scenic and Historic trails administered by the National Park Service, and parks that host sections of national trails. River Management Society pitched the idea to use NPF grant funds to improve the NRP website so that the public can better access information on Wild & Scenic Rivers and National River & Recreation Areas managed by the National Park Service.

The money received from the grant paid for our web developer to design and implement changes focused on: search engine optimization, instructional videos, loading indicators, and more intuitive search result ordering. Additionally, we built out two new pages on the NRP website — directories for rivers by states and managing agency. These can be viewed and explored at www.nationalriversproject.com/directory. We are constantly upgrading the National River Recreation Database to be better suited to utilize these improvements, such as adding photos, ensuring manager information is correct, and providing section details for each river.

New Rivers!

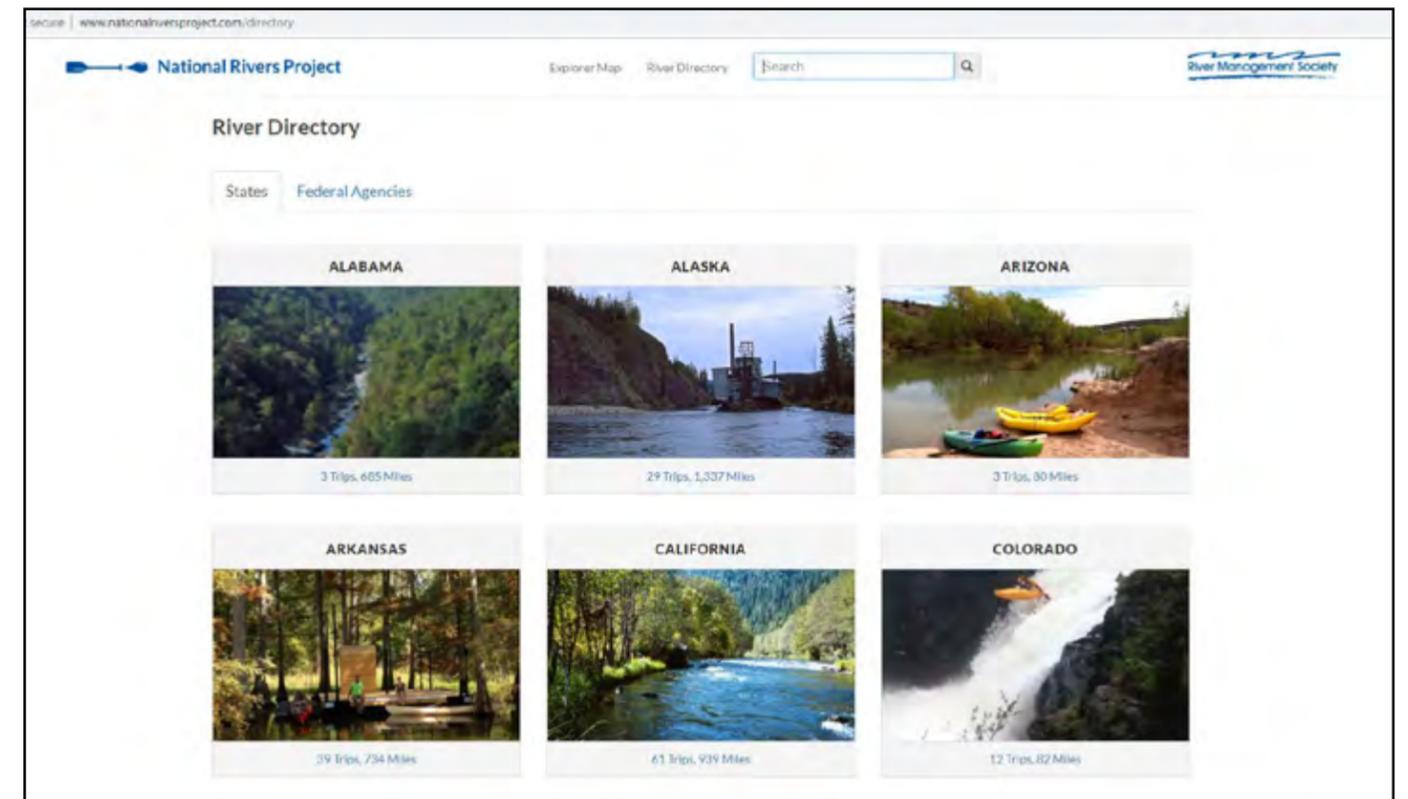
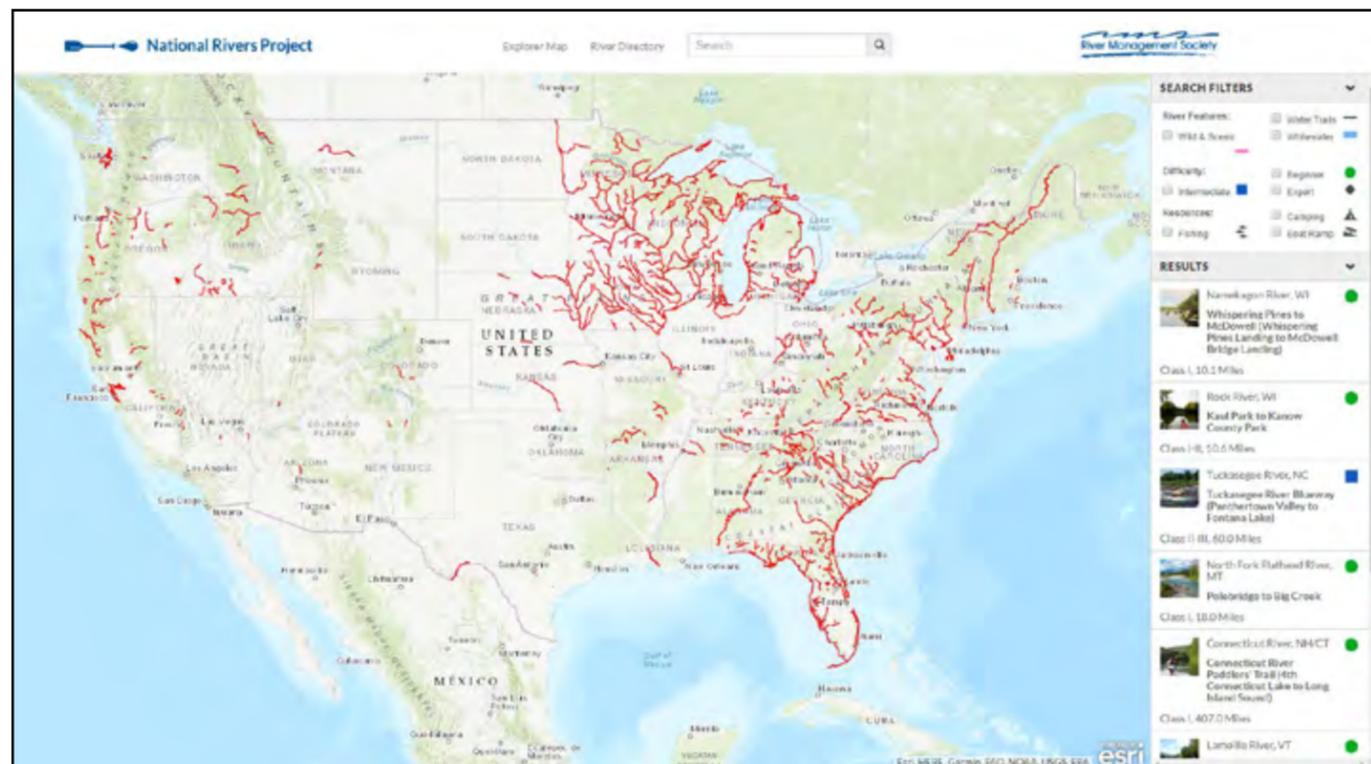
If you haven't already, we encourage you to check out the National Rivers Project website, and contact us to add your rivers! We've been busy adding and updating rivers in Iowa, Florida, and Wisconsin, and are actively working on adding the Bureau of Land Management's Wild & Scenic Rivers, as well as recreational rivers within National Park Service units nationwide.



National Rivers Project's "Take a Tour" Video

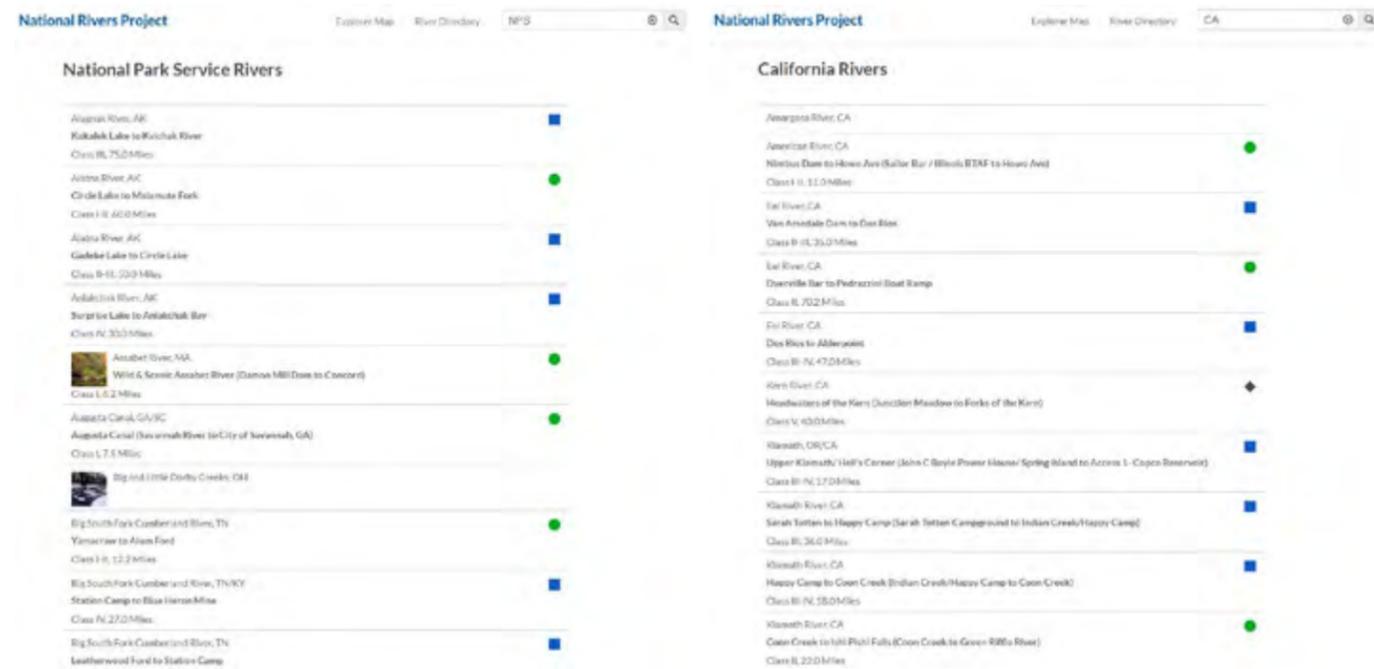
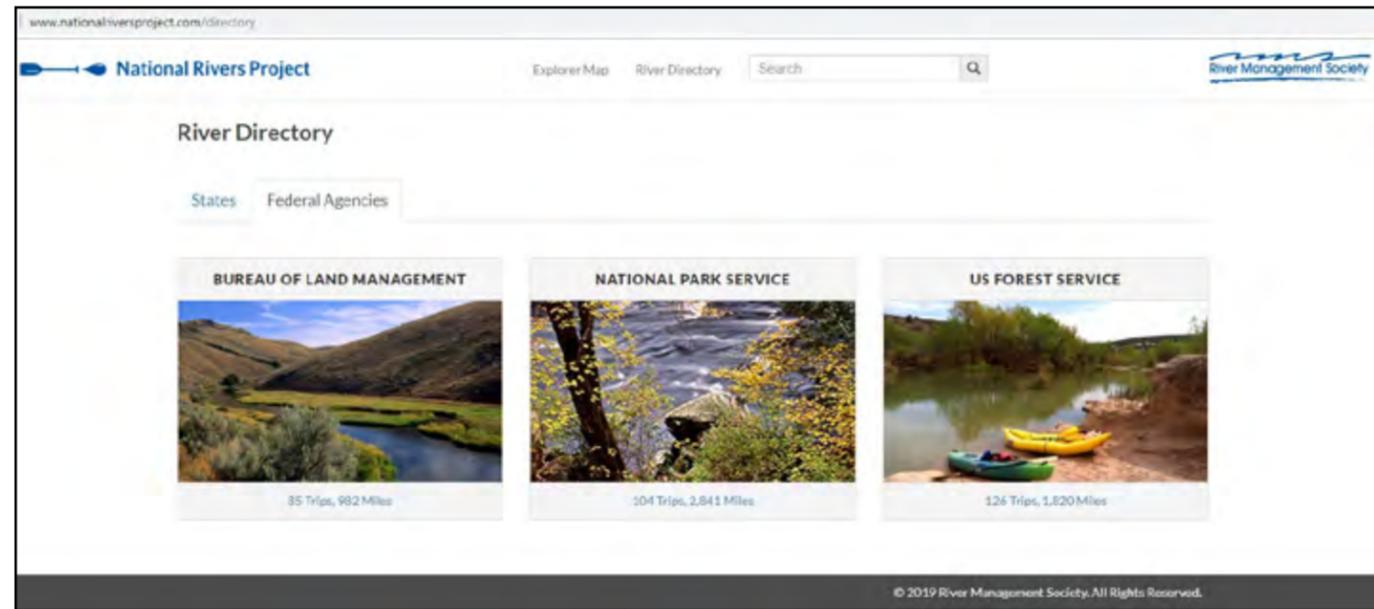
Check out our video! We created and added a new video on our homepage that shows visitors how to use the National Rivers Project website. The 3 ½ minute video efficiently reviews major functions of the website, as well as more detailed nuances of the project.

(continued next page)



[National Rivers Project Directory Pages](#)

We added two new pages to the National Rivers Project website! These directory pages organize and outline rivers/sections in the National River Recreational Database by state and federal agency manager. Clicking on one of the tabs brings up another page with the states and agencies listed out, and accessing those pages brings the user to a list of rivers, in alphabetical order. Selecting a river takes you to that particular river/section's respective river detail page. We are currently working on updating and editing all of the rivers in the database to be best equipped to display complete in this awesome new directory structure.



Upcoming projects!

We are always working on adding new rivers all over the country. Here's a quick summary of what's in the works for 2019:

- BLM's Wild & Scenic Rivers and other recreational rivers
- NPS's recreational rivers within National Park Units
- Florida's Designated Paddle Trails
- Oklahoma Scenic Rivers
- Texas Paddle Trails
- Alabama Scenic River Trail
- Nevada's Recreational Waterways
- Carolina Thread Trail ♦

(Stressors, from page 1) ecosystem 'integrity' were focused on the reach or site scale for particular animal groups, such as fish or macroinvertebrates, the development of an operational definition of 'watershed integrity' was a challenge. They eventually agreed to define 'watershed integrity' as the capacity of a watershed to support and maintain the full range of ecological processes and functions essential to the sustainability of biodiversity and of the watershed resources and services provided to society. The team then developed the IWI as an assessment tool.

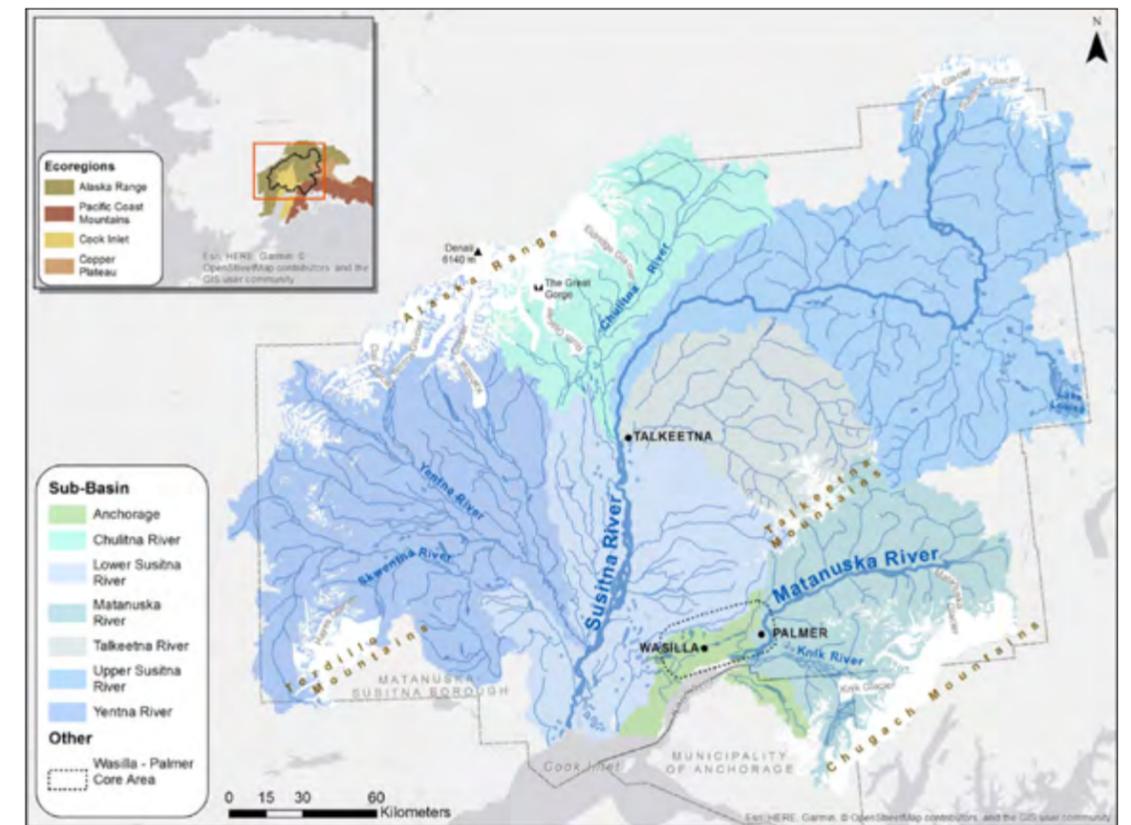
One major application of the IWI assessment tool was to summarize available spatial data for the entire continental United States (CONUS) by catchment (available through EPA's StreamCat dataset; Hill et al. 2016). A catchment (NHDPlusV2 2017) is a sub-unit of a watershed defined as the area of a landscape that contributes flow directly to a stream segment, excluding upstream contributions. Therefore, calculations at the catchment scale reflect the local factors influencing integrity and result in a score referred to as the Index of Catchment Integrity (ICI). However, due to the hierarchical arrangement of catchments, data from upstream catchments can be accumulated and combined with the target catchment to provide an assessment of the entire watershed associated with that catchment, or IWI score. For the CONUS, these catchments average about 3.4 km² in size.

Using this geospatial framework, stressors (i.e., risk factors) were summarized for all 2.6 million catchments (ICI scores). Stressors were also summarized for watersheds of

those catchments (IWI scores), which again consists of the local catchment plus all upstream catchments. To calculate the IWI, a set of stressors are first categorized by their impact to 6 hypothesized functions of unimpaired watersheds or catchments: hydrologic regulation, regulation of water chemistry, sediment regulation, hydrologic connectivity, temperature regulation and habitat provision. The integrity of each of these functions is calculated independently by combining the stressors which interfere with or degrade the function. Resulting values are first used to generate the composite ICI score for each catchment, and then watersheds (IWI). Composite index score can then be mapped by stressor, function, or composite score at the catchment or watershed scale. To identify the drivers of a function score or composite score, results can be deconstructed into the individual stressors, and thereby support local (i.e., catchment) and regional (i.e., watershed) adaptive management. The analysis can be run iteratively and improved as new data and information become available. Generated maps can also be used to identify an emerging risk in a basin, such as changing land use, which may not be visible from the ground or recognized as a risk to the integrity of a stream or river.

To date, the approach has been applied to the CONUS, to four transboundary basins in the Western Balkans, and, most recently, in the Matanuska-Susitna (Mat-Su) Basin in Southcentral Alaska, which is the focus of this discussion (Figure 1). In addition, the performance of the CONUS IWI has been assessed relative to a number of water quality indicators

Figure 1. The Matanuska-Susitna Basin with sub-basins identified.



(Kuhn et al. 2018). It has also been demonstrated how the IWI methodology can be improved by incorporating empirical data on specific functions (Johnson et al. 2019).

The movement of glaciers across southcentral Alaska created the Mat-Su Valley, which today is home to streams and rivers used as spawning grounds by Chinook, Coho, Sockeye, Pink, and Chum salmon. Two large towns in the Valley, Palmer and Wasilla, are the fastest growing in Alaska. The population of the Matanuska-Susitna Borough has doubled in the last 30 years. The development of public and private infrastructure has impacted salmonids, for example, by the increased storm water runoff pollution.

The application of the IWI to the Mat-Su Basin explores 1) use of National Hydrography Database (NHD) Plus High-Resolution (NHDPlus HR 2018) catchments, which average 0.3 km² in area, and 2) the incorporation of locally relevant data identified by those working in the Mat-Su, such as gravel pits, contaminated sites, and Rain on Snow (ROS) Events. The locally

relevant data were incorporated in conjunction with risk factors identified for previous IWI applications. After screening for relevance and redundancy, 21 different risk factors were included in the analysis (Table 1); note that some stressors impact more than one function.

Watershed Integrity of the Mat-Su Basin

The Mat-Su Basin IWI scores are higher than those for the CONUS, as was expected. This indicates lower risk levels in the Mat-Su Basin.

One surprise was the impact of the Rain on Snow (ROS) events. Over the past decade, the number of ROS events has increased in both southcentral and southwest Alaska (Figure 2). Since a single event can occur across tens of thousands of catchments, in comparison to a National Pollutant Discharge Emission Site, which occurs within a single catchment, the ROS events masked other stressors and complicated the interpretation of the ICI, IWI and function values at the catchment and

Table 1. | Functional Components and Stressors of the Index of Catchment Integrity (ICI) and Index of Watershed Integrity (IWI). The stressors used for the ICI represent the catchment itself, while the stressors used for the IWI are accumulated for all catchments in the watershed.

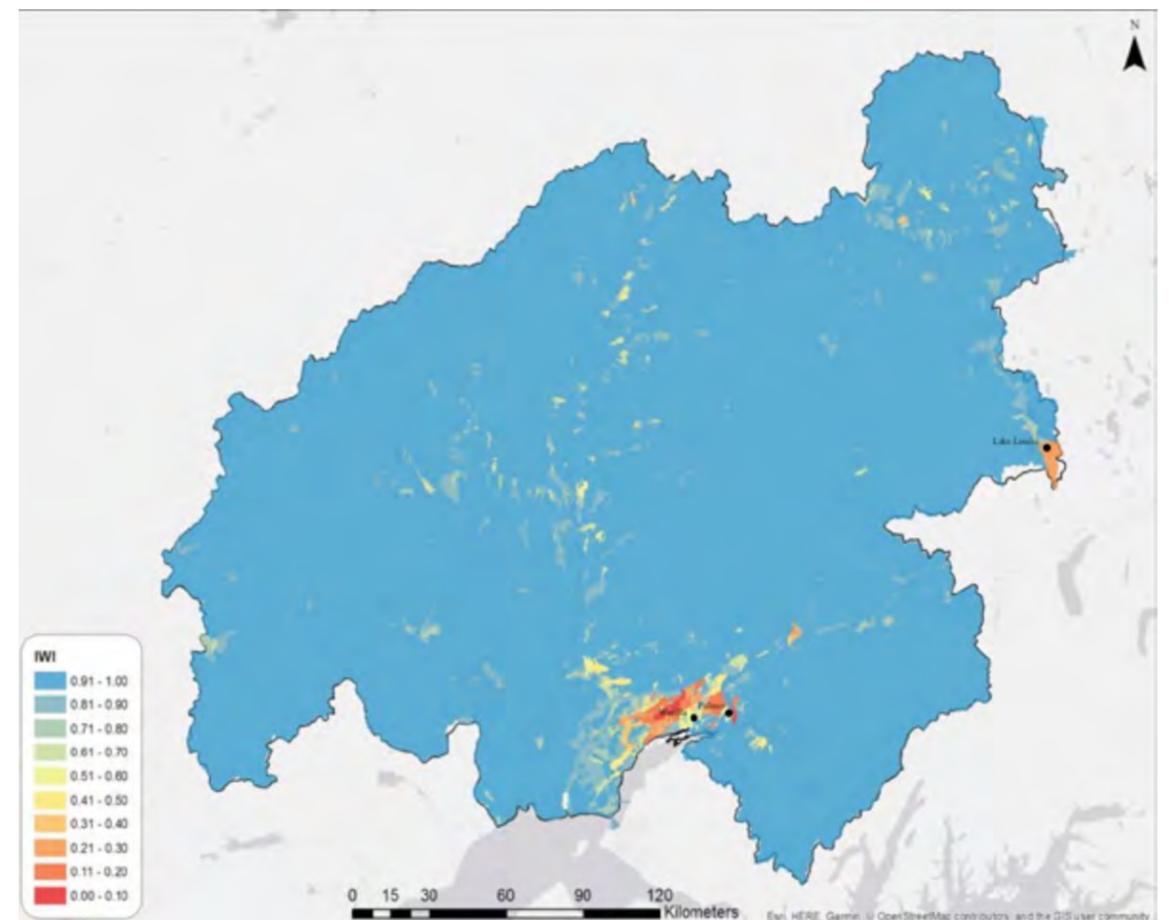
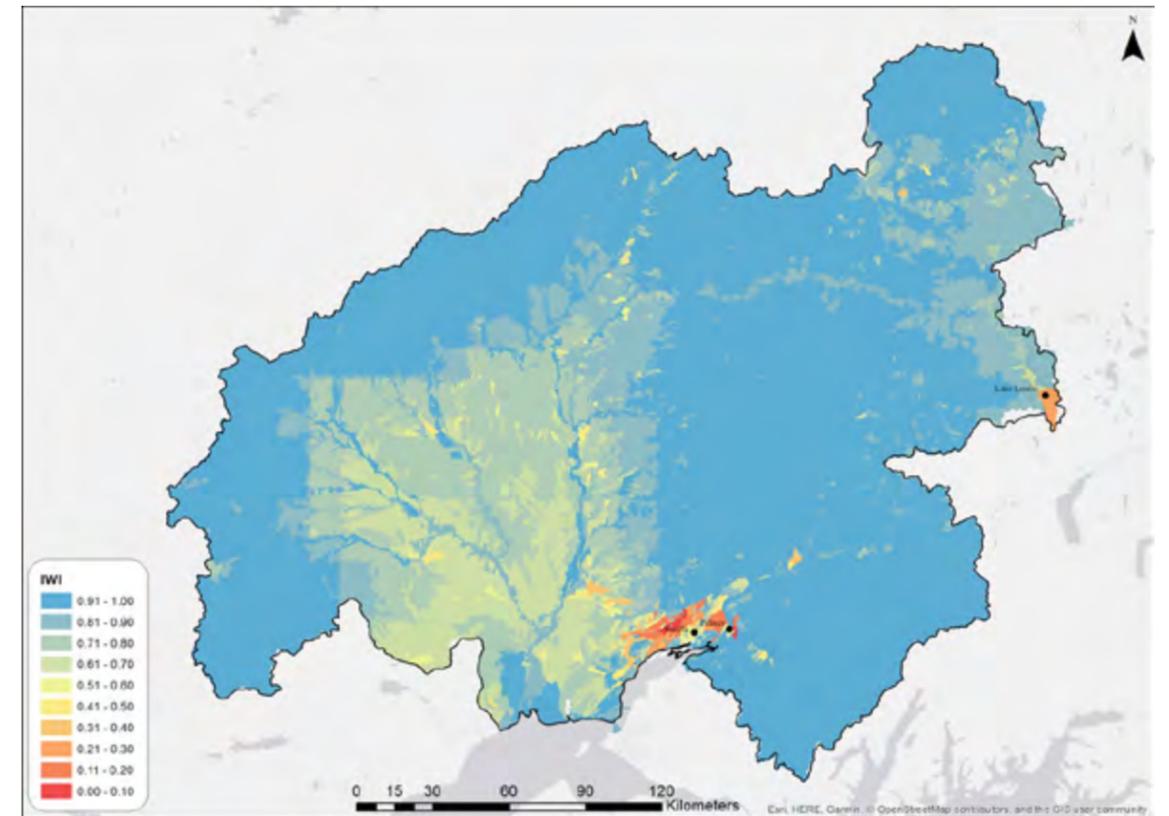
Functional Components					
Hydrologic Regulation	Regulation of Water Chemistry	Sediment Regulation	Hydrologic Connectivity	Temperature Regulation	Habitat Provision
Density of Reservoirs (DenResvr)	Density of Reservoirs (DenResvr)	Density of Reservoirs (DenResvr)	Density of Reservoirs (DenResvr)	Density of Reservoirs (DenResvr)	Density of Reservoirs (DenResvr)
*Density of Culverts (DenCulv)	*Density of Culverts (DenCulv)	*Density of Culverts (DenCulv)	*Density of Culverts (DenCulv)	Percent of Agricultural Land Cover (PctAg)	Percent of Urban Land Cover in the Riparian Zone (PctUrbRp)
Percent of Agricultural Land Cover (PctAg)	Percent of Urban Land Cover (PctUrb)	Density of Mines, Historical Mining Disturbance, State Prospecting Sites (DenMine)	*Density of Septic and Sewer (DenSepSew)	Percent of Urban Land Cover in the Riparian Zone (PctUrbRp)	Percent of Agricultural Land Cover (PctAg)
	Percent of Agricultural Land Cover (PctAg)		*Density of Cadastral Subdivisions (DenSubd)	Density of Contaminated Sites, Wastewater Treatment Facilities, Industrial Facilities (DenPoll)	Density of Railroad, Road, Trail-Stream Intersections (DenTranspStCrs)
Density of Canals, Ditches, and Pipelines (DenCDP)	Density of Contaminated Sites, Wastewater Treatment Facilities, Industrial Facilities (DenPoll)	*Density of Conditional Use Permits for Gravel, Parcels with Material Sales, Timber Sales (DenMat)	Density of Railroad, Road, Trail-Stream Intersections Weighted by the Slope of the Stream Reach (SlopeTranspStCrs)		Density of Contaminated Sites, Wastewater Treatment Facilities, Industrial Facilities (DenPoll)
	*Density of Septic and Sewer (DenSepSew)		Density of Canals, Ditches, and Pipelines (DenCDP)	Density of Housing within the riparian Zone (DenHouseRp)	
Percent Imperviousness of Human-Related Landscapes (PctImp)	*Density of Conditional Use Permits for Gravel, Parcels with Material Sales, Timber Sales (DenMat)	Density of Airports, Roads, Railroads, Trails (DenTransp)	Percent of Urban Land Cover in the Riparian Zone (PctUrbRp)	*Density of Septic and Sewer (DenSepSew)	Density of Airports, Railroads, Roads, Trails in the Riparian Zones (DenTranspRp)
			Percent of Agricultural Land Cover in the Riparian Zone (PctAgRp)		
**Rate of Rain on Snow Events (RateROS)		**Rate of Rain on Snow Events (RateROS)			**Rate of Rain on Snow Events (RateROS)

Stressors identified by Mat-Su Salmon Partnership (MSSP) and U.S. IWI

**Stressors identified by the MSSP*

Stressor Unique to CCH analysis

Figure 2. Index of Watershed Integrity for the Mat-Su (accumulated) with (above) and without (below) Rain on Snow Events.



watershed scales. To remove the masking effect and non-preventable stressors from consideration, the analysis was also run without the ROS events. This does not negate the potential impacts of ROS events, but rather acknowledges the need for more thinking on how best to include data corresponding to large-scale shifts.

The areas with the greatest risk, not including the ROS events, are the Lake Louise area (Figure 2) in the east central extreme of the basin and in the lower parts of the basin near the Wasilla and Palmer Core Area (Figure 3). Looking more closely at the Wasilla and Palmer area, the analysis showed significant impairment to several of the functional components characterized by the IWI; most notably sediment regulation, temperature regulation, and habitat provision. These findings are consistent with what would be expected in areas with high growth rates.

Management Applications

To demonstrate how managers of the Mat-Su Basin could use the IWI tool, a scenario that examined the impact of culvert remediation was developed. The goal of the scenario was to determine which of the six functions would be most improved by removal of stress caused by culverts. At the local, or catchment, scale, Hydrologic Regulation had the biggest improvement. That is, culvert remediation most improved the values of local hydrology. At the larger watershed scale, Hydrologic Connectivity had the biggest improvement. That is, downstream improvement from culvert remediation most improved values of hydrologic connectivity.

The IWI may also have values as a tool supporting

compensatory mitigation, or the “restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances, preservation of wetlands, streams and other aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved” (USEPA 2008). The IWI can be used to prioritize the location of compensation projects by catchment or watershed or to identify specific riverine functions targeted for improvement. As an example, a given development activity may impair integrity of one or more of the functions characterized by the IWI; for illustrative purposes, assume this is hydrologic connectivity. Multiple options might exist for compensatory mitigation activities. In order to better inform decision-makers, IWI scenarios can be developed to demonstrate how the catchment in which an option is located can impact overall functions such as hydrologic connectivity.

Another possible application of IWI data, development of a watershed or catchment risk profile, came from discussions concerning the National Wild and Scenic Rivers System. Once a “Risk Profile” has been developed, managers of aquatic resources with similar profiles can share management approaches. And in locations where condition data exist (e.g., water chemistry, biological community), the success of implemented management strategies can be compared. A “Risk Profile” could also be used in identifying future risk to protected resources, thereby facilitating proactive discussions on how emerging risks might best be mitigated and managed.

At present, there are limitations to expanding the IWI

analysis to all of Alaska. First, the availability of NHDPlus coverage for Alaska, which provides the catchments scale data essential to the IWI process, only exists for the Mat-Su Basin, Anchorage, Juneau, and Port Clarence areas. Yet, data on stressors, required to support the analysis, are generally available for the entire state. Perhaps the most practical approach would be to forego the anticipation of an analysis of the entire State, and rather focus on where there is an interest for an analysis outside of the Mat-Su, such as more populated areas (e.g., Juneau, Fairbanks, Anchorage). Areas of concern to industry (e.g., North Slope), especially those with permanent human populations (e.g., Utqiagvik), could also benefit from NHDPlus coverage and IWI analysis. ♦

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(Note: Readers are encouraged to view this article online, in order to see and better understand the graphics in full color.)

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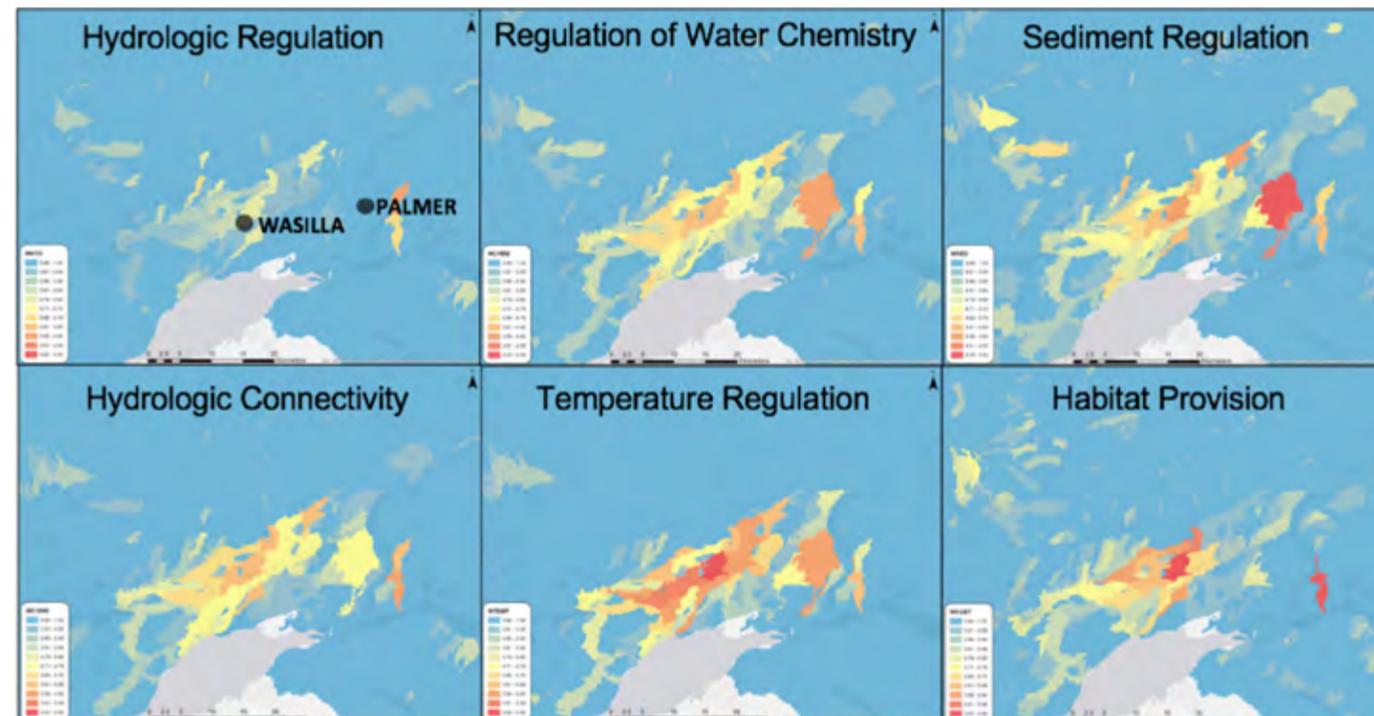
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Figure 3. IWI functional component values for the Wasilla and Palmer Core Area of the Mat-Su basin.



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Save the Date

May 22-24, 2019	<i>Swiftwater Rescue Training</i> , hosted by Arkansas River Headwaters Recreation Area and the RMS Southwest Chapter. Contact: Tappan Brown (tappan.brown@state.co.us)
August 6-8, 2019	<i>River Ranger Rendezvous</i> , hosted by the RMS Southwest Chapter. Contact: Rob White (rob.white@state.co.us)
August 30, 2019	<i>Chattooga WSR Rafting / Kayaking Trip</i> , hosted by the RMS Southeast Chapter. Contact: Jack Henderson (jack@river-management.org)
September 6-8, 2019	<i>Fall Paddling Trip in the Adirondacks</i> , hosted by the RMS Northeast Chapter. Contact: Emma Lord (emma_lord@nps.gov)
October 11-14, 2019	<i>RMS Board of Directors Annual Meeting</i> . Contact: Linda Jalbert (linda@river-management.org)
May 2020	<i>RMS River Management Symposium</i> . Contact: Lynn Crump (lynn.crump@dcr.virginia.gov), James Vonesh (voneshjr@gmail.com), Molly MacGregor (molly.macgregor@state.mn.us), or Steve Storck (training@river-management.org)

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