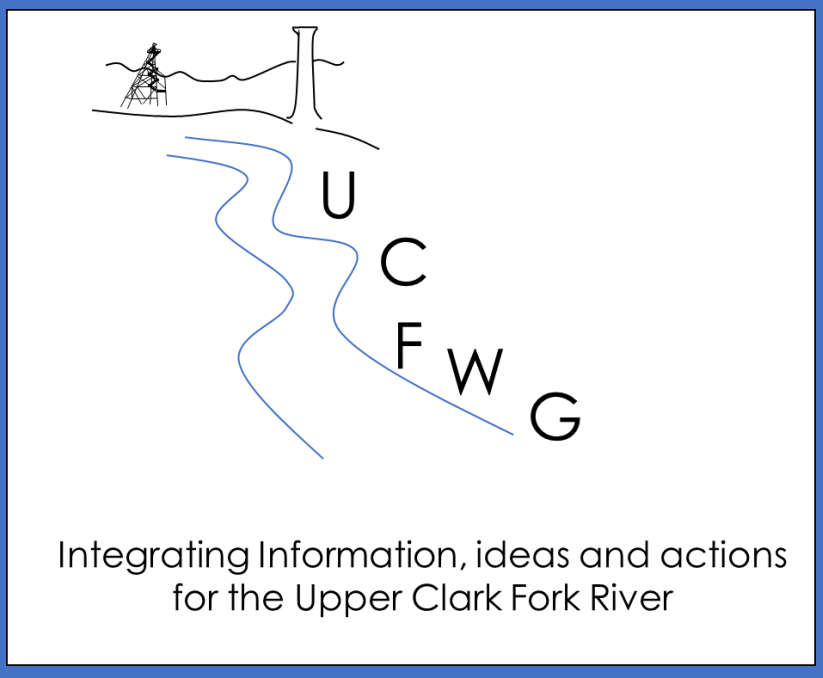
STRATEGIC PLAN: UPPER CLARK FORK WORKING GROUP



H. Maurice Valett

Executive Chair, Ver 3.0 April 2020

UM Co-Director, Montana Institute on Ecosystems

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I) 2019 Upper Clark Fork Working Group – membership

A) UCFWG Participants

Table 1. Contact information for the Upper Clark Fork Working Group (UCFWG)

Name	email	phone	affiliation	Position
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Martin, Doug	dougmartin@mt.gov	444-0234	Natural Resource Damage Program	Restoration Program Chief
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Sowles, Marisa	msowles@geumconsulting.com	363-2353	Geum Environmental Consulting, Inc	Water Resource Specialist
Valett, Maury	maury.valett@umontana.edu	243-6058	University of Montana, Montana Institute on Ecosystems	Professor of Systems Ecology, CREWS Science Lead

B) UCFWG Executive Committee Members 2019

Table 2. 2019 UCFWG Executive Committee Composition and Contact information

Name	email	phone	affiliation	Position
Apfelbeck, Randy	rapfelbeck@mt.gov	444-2709	MT Department of Environmental Quality	Water Quality Monitoring Specialist
Cook, Nathan	Nathan.Cook@mt.gov	210-3872	MT Fish Wildlife and Parks	Fisheries Biologist 2
Martin, Doug	dougmartin@mt.gov	444-0234	MT Natural Resource Damage Program	Restoration Program Chief
Valett, Maury	maury.valett@umontana.edu	243-6058	University of Montana, Montana Institute on Ecosystems	Professor of Systems Ecology, CREWS Science Lead

II) Strategic Plan: challenge, solution, vision, and mission

A) The Challenge

Finding solutions to the complex environmental and natural resource challenges facing the Upper Clark Fork River (UCFR) requires an informed and functional integration of science-driven understanding, stake holder engagement, and agency oversight and direction. The Montana University System (MUS)'s EPSCoR Consortium for Research on Environmental Water Systems (CREWS) has identified the UCFR as a focal fluvial system with water quality challenges to be addressed by a team of interdisciplinary researchers in close partnership with State agencies, non-governmental organizations (NGOs), and private institutions involved in and influenced by the ongoing remediation and restoration activities in the upper reaches of the river. The State and the MUS have worked together on UCFR issues in the past, but research and monitoring along the UCFR is multi-faceted, involving a number of institutions and intentions. There is need for a coordinated effort to align CREWS research and education activities directed at the UCFR with those of the State and other entities to maximize understanding and enrich the knowledge base for effective decision-making.

B) The Solution

With support from the MUS's Institute on Ecosystems (IoE) and the Montana Water Center (MWC), the Upper Clark Fork Working Group (UCFWG) represents a coalition of experts from the CREWS project, representatives of key State agencies, and personnel from NGOs and private industry, with the joint commitment to fostering collaboration and generating fundamental knowledge needed for informed decision making. Sustainable pathways for the UCFR will rely on judicious and coordinated use of available resources through awareness and cross fertilization promoted by the UCFWG's activities. The UCFWG advances solutions for current and future research and monitoring challenges consistent with the State of Montana's extant restoration plans.

C) Vision

Our vision is to catalyze collaboration and advance integrated research and monitoring efforts through seamless exchange of information, coordinated formation of the research and monitoring agenda, and collaborative execution, procurement, and production of the data and documentation required to enable informed and agile decision making for remediation, restoration and resource management of the Upper Clark Fork River, MT.

D) Mission

The UCFWG's mission is to facilitate, produce, analyze and share science-based knowledge among key participants involved in the remediation, restoration, research, and monitoring of the Upper Clark Fork River and its tributaries.

III) Sectors of the Strategic Plan

The UCFWG Strategic Plan recognizes four sectors of work focus for the combined personnel and resources prioritized and detailed by this strategic plan including: A) Water quality and biogeochemistry of UCFR waters, B) Biology and habitat issues of the UCFR, C) UCFR hydrology, and D) . Goals, objectives, and activities associated with each sector are provided below.

A) Metal contamination aquatic ecology of UCFR waters

The mining legacy of the UCFR basin has placed heavy metal and metalloid contaminants (Cu, Pb, Cd, Zn, As) as central concerns in terms of aquatic life. Floodplain soils are heavily contaminated and the focus on ongoing remediation efforts. Bed sediments within the channel are not to be removed and retain a contaminant signature with implications for aquatic biota. Furthermore, links between floodplain sources and riverine environments are not well known, but may represent key determinants of the character and location of contaminant hot spots. Because of their central role, this sector deals specifically with heavy metal contamination and its potentail interaction with concomitant water quality threats.

Goal A: Improve knowledge of how metal distribution, abundance, and reactivity influence aquatic species diversity and food web productivity along the UCFR.

Objective A-1: Understand sources, sinks, and spatial/temporal patterns of metals in the UCFR main channel and relevant tributaries.

Activity A-1-1: Maintain and extend metals monitoring programs addressing the UCFR main stem. Focus should be on total recoverable metals integrated with other water quality monitoring projects were possible. Contaminants of interest include metals/metalloids (Cu, Zn, Cd, Pb, As) and monitoring could consider adding groundwater monitoring (LCDC network, other).

Activity A-1-2: Identify, map and characterize waste water treatment plants (WWTPs) in the UCFR including metal loading behaviors over space and time (in conjunction with Activity B-1-2 (see below).

Activity A-1-3: Generate fine-scale measures of metal inputs (i.e., 0.5 km resolution) along Reach A using canoe/raft float trips along the main stem of the river to map and sample water entering the main channel from tributaries and return flows (i.e., irrigation return) from adjacent floodplain fields.

Activity A-1-4: Understand sources of, and controls over, metal loads derived from the Lost Creek Dutchman wetland Complex (LCDC) and their influences on UCFR water quality by addressing groundwater concentrations and contributions as distinct from surface sources as measured by load accumulation along the length of Lost Creek. Superstructure exists for this effort associated with the nitrogen sourcing project in the LCDC (see Objective B-3 below).

Activity A-1-5: Generate budgets metals along Reach A (Warm Springs to Deer Lodge) to assess net changes in material loads over critical stream reaches identified by Activity A-1-3. Combine metal concentrations with river flow data (see Sector II, below) to determine successive solute loads. Employ auto-samplers to quantify diel fluctuations and address sampling implications. Calculate net changes in loads within reaches to generate uptake and production metrics.

Objective A-2: Understand how floodplain land uses interact with irrigation practices, tributaries, and legacy mining to affect metal loads to the UCFR.

Activity A-2-1: Generate a spatially-explicit model of metal sources on the UCFR floodplain and link them to the main river channel via hydrologic transport to assess how land use, irrigation practices, and legacy contaminants sources lead to river metal loading.

Activity A-2-2: Use a socioecological approach to address floodplain residents and the implications of their land-use practices for metal amelioration or exacerbation.

Objective A-3: Determine how biological processes respond to interactions between metals and nutrients over seasonal time frames among and within Reaches A, B, and C.

Objective A-3-1: Address competing hypotheses addressing the influence of enrichment of contaminant transfer with the UCFR food web. The 'contaminant propagation hypothesis' proposes increased metal toxicity resulting from nutrient enrichment because enhanced productivity promotes metal transfer associated with increased organic matter fluxes. In contrast, the 'bloom dilution hypothesis' predicts the opposite effect for nutrient enrichment by proposing that a finite amount of metal is effectively diluted by enhanced organic matter flows as if thus less toxic to higher trophic levels. This effort is a central focus of the Montana NSF EPSCoR award, The Consortium for Research on Environmental Water Systems (CREWS).

Activity A-3-2: Link metabolic measures derived from Goal B (see below) to changes in metal loads to address in-stream biological influences on metal transport and incorporation into riverine food webs.

Activity A-3-4: Evaluate potential to modify Warm Springs Ponds management to improve river conditions and downstream restoration outcomes.

B) Nutrient enrichment and biogeochemistry of UCFR waters

Beyond the pervasive metal contamination that is a central threat to UCFR water quality, natural and anthropogenic sources of nutrient enrichment contribute to nuisance algal blooms and potentially degrade riverine fishes. This sector deals with potential threats to water quality related to nutrient enrichment and it modifies, or is altered by, biological processes. Further, it address how both natural and human-driven processes may be of great importance to enrichment of UCFR waters.

Goal B: Improve knowledge of water quality and biogeochemistry effects on aquatic species diversity and food web productivity along the UCFR.

Objective B-1: Understand sources, sinks, and spatial/temporal patterns associated with nutrients and metals in UCFR main channel and relevant tributaries.

Activity B-1-1: Maintain and extend water monitoring programs for the UCFR and select tributaries. Response variables: temperature, dissolved oxygen, specific electrical conductivity, nitrogen (nitrate, ammonium, total N), phosphorus (soluble reactive P, total P), dissolved organic carbon (DOC), and metals/metalloids (Cu, Zn, Cd, Pb, As). Consider adding groundwater monitoring (LCDC network, other).

Activity B-1-2: Identify, map and characterize waste water treatment plants (WWTPs) in the UCFR including material loading behaviors over space and time.

Activity B-1-3: Use river floats to generate fine scale measures of nutrient concentrations and to map and sample water entering the main channel from tributaries and return flows (i.e., irrigation return) from adjacent floodplain fields.

Activity B-1-4: Generate budgets for N and P and dissolved metals in Reach A (Warm Springs to Deer Lodge) to assess net changes in material loads. Combine nutrient and metals concentrations with river flow data (see Sector II, below) to determine successive solute loads. Employ automated nitrate sensors and employ auto-samplers to quantify diel fluctuations and address sampling implications. Calculate net changes in loads within reaches to generate uptake and production metrics.

Objective B-2: Understand how floodplain land uses interact with irrigation practices, tributaries, and legacy mining to affect nutrient enrichment in the UCFR.

Activity B-2-1: Generate a spatially-explicit model of N sources to the UCFR floodplain and link it to the main river channel to assess how land use leads to river enrichment.

Activity B-2-2: Use a socioecological approach to address floodplain residents and their agricultural and land-use practices.

Objective B-3: Understand sources of, and controls over, N concentrations and loads derived from the Lost Creek Dutchman wetland Complex (LCDC) and their influences on UCFR water quality.

Activity B-3-1: Determine hydrologic linkages among surface and groundwater components of the Lost Creek Dutchman Complex by generating a flow net and employing MODFLOW/MODPATH modeling.

Activity B-3-2: Maintain and extend monitoring of surface and groundwater network to characterize nutrient and metal content of LCDC waters.

Activity B-3-3: Use microcosm assays to address N production from peatland and other soils that may serve as N sources to the LCDC complex.

Activity B-3-4: Use nitrate stable isotope composition (i.e., ^{15}N and ^{18}O) to assess nitrification and denitrification and address isotope potential to track N sources.

Activity B-3-5: Work with operators to understand the magnitude and timing of wastewater loading to secondary ponds on the LCDC and to the terrestrial landscape during the growing season. Address implications of operational upgrades scheduled for the WWTP.

Objective B-4: Determine how biological processes respond to and alter water quality over seasonal time frames among and within Reaches A, B, and C.

Activity B-4-1: Deploy automated oxygen sensors and use light, depth, and temperature to generate whole-reach measures of primary production and ecosystem respiration.

Activity B-4-2: Link metabolic measures to changes in nutrient and metals loads to address in-stream biological influences.

Objective B-4-3: Compile relevant literature on Warm Springs Ponds in electronic format within UCFWG information management platform (see Sector D, below) and synthesize current understanding of pond behavior.

Activity B-4-4: Evaluate potential to modify Warm Springs Ponds management to improve river conditions and downstream restoration outcomes.

C) UCFR hydrology

This sector recognizes that river restoration would be aided by more explicit assessment of UCFR hydrology. Key hydrologic features include spatial and temporal resolution of dewatering during the growing season, character of river-floodplain interactions across seasons, and the quantitative and qualitative implications of surface water – groundwater interaction.

Goal C: Characterize hydrologic changes longitudinally (upstream to downstream) over the UCFR with focus on Reach A.

Objective C-1: Characterize hydrologic changes longitudinally (upstream to downstream) over the UCFR with focus on Reach A.

Activity C-1-1: Delineate changes in flow longitudinally from Warm Springs to Deer Lodge over all seasons, with focus on low-flow conditions.

Activity C-1-2: Add to the existing USGS stations by generating rating curves for specific locations in Reach A between Warm Springs and Deer Lodge and utilizing pressure transducers for continuous measures.

Activity C-1-3: Work with appropriate personnel (USFS?) to measure runoff flows (i.e., spring flood amplitude) to extend rating curves to include runoff conditions.

Activity C-1-4: Use sequential discharge profiles to identify sites of water loss and gain.

Objective C-2: Characterize critical hydrologic linkages both laterally (via floodplain interaction) and vertically through exchange with the floodplain and alluvial aquifer.

Activity C-2-1: Develop hydrologic model linking river, floodplain, and aquifer components

Activity C-2-2: Network with UCFR research community and Montana University System hydrologist to address the potential of existing or needed hydrologic models to address the appropriate scales and links relevant to UCFR restoration.

Activity C-2-3: Develop a detailed GIS-based map of extractions, canals, and return flows along Reach A in the UCFR to relate water use to instream flows.

Activity C-2-4: Address how existing data on water rights maps onto the network and relate water use to changes in local flow conditions.

D) Biology and habitat features of the UCFR

The UCFWG recognizes the close linkages among river geomorphology, water quality, and biological responses. While biological processes are included in other portions of the Strategic Plan, this sector focuses on the biological populations and communities associated with the UCFR river-riparian corridor.

Goal D: Improve knowledge of UCFR habitat, populations, and biological productivity.

Objective D-1: Understand how riparian and instream aquatic habitat quality varies in responses to changing conditions along upstream-downstream gradients in physicochemical and hydrologic conditions.

Activity D-1-1: Generate spatially explicit map of riparian vegetation assessment including species composition and biomass estimates using combination of NRCS and Lotic Intersite Nitrogen Experiment protocols for ground survey and remote sensing

Activity D-1-2: Map river habitat quality for game fishes following appropriate protocols. Include changes in habitat quality related to periods of algal blooms

Objective D-2: Understand how invertebrate community composition and food web character changes along upstream-downstream gradients in physicochemical and hydrologic conditions.

Activity D-2-1: Use spatially distributed sampling of benthic resources (epilithic biofilms, coarse and fine particulate matter, filamentous algae, allochthonous organic matter) over an annual time course to quantify food availability to macroinvertebrates.

Activity D-2-2: Use spatially distributed sampling of macroinvertebrates over an annual time course to estimate prey composition, abundance, and production.

Activity D-2-3: Use trophic basis of production to address organic matter flows generated by prey and identify primary food supplies to macroinvertebrates.

Activity D-2-4: Use stable isotope tracers (i.e., ^{13}C and ^{15}N) to address trophic level positions and linkages among invertebrates and their food sources.

Activity D-2-5: Assess how landscape position, trophic position, and taxonomic composition tie invertebrates to their food sources and influence metal body burdens (see Activity C-2-1 above).

Objective D-3: Determine density and productivity of stream fishes as they relate to UCFR gradients in biological, physicochemical, and hydrologic conditions.

Activity D-3-1: Use spatially distributed sampling of fishes over space and time in coordination with MT FWP to address population dynamics and characterize fish community composition.

Activity D-3-2: Use a combination of gut analysis, stable isotope tracers (i.e., ^{13}C and ^{15}N), and metal body burdens to address trophic level positions and link fish to invertebrate prey sources.

Activity D-3-3: Use a combination of physiological growth modeling (e.g., Wisconsin model) and the trophic basis of production to address organic matter flows generated by prey and identify primary macroinvertebrate prey species for trout.

Activity D-3-4: Compare fish prey demand to invertebrate production to address potential food limitation over space and time with focus on summer trophic dynamics to address the influences of algal blooms on fish productivity.

E) UCFWG information management

Historical and existing data on the UCFR are varied, dispersed, and sometimes difficult to uncover or obtain. The final sector of the UCFWG focuses on the management of extant information that is identified as relevant and highlighted for joint access. While not proposing to house large data sets already handled by existing entities, goals and objectives here focus on informational resources and needs prioritized by the collaboratory.

Goal E: Improve information management and sharing among the UCFWG and other entities doing research, restoration and remediation in the UCFR basin.

Objective E-1: Enable procurement, storage and sharing of prioritized electronic information among UCFWG participants and relevant partners through a web-based platform that will be maintained through interaction with the Montana Institute on Ecosystems and MT CREWS programs.

Activity E-1-1: Use the web-based platform to share contact and distribution lists, along with information on UCFWG including the Strategic Plan.

Activity E-1-2: Enable the web-based platform to act as a depository for documents, pictures, and transient data sets to alleviate limitations to information exchange among collaborators.

Activity E-1-3: Include within the web-based platform capacity for metadata storage and links to relevant data sets as defined by individual projects.