

**EPA STAR RESEARCH GRANTS PROGRAM AND
NATIONAL EPA-TRIBAL SCIENCE COUNCIL
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Community Based Risk Assessment of Exposure to Contaminants via Water Sources on the Crow Reservation in Montana

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Overview

Dr. Timothy Ford led the presentation on “Community Based Risk Assessment of Exposure to Contaminants via Water Sources on the Crow Reservation in Montana,” the third webinar conducted under EPA’s STAR Research Grants Program/National EPA-Tribal Science Council webinar series this year. Research participants were the Crow Indian Nation; the Apsaalooke Water and Wastewater Authority; Little Big Horn College (LBHC); students; community members; Montana State University (MSU); University of New England; and the Indian Health Service (IHS) hospital.

The research project developed a risk assessment program focusing on the contamination of water sources on the Crow Reservation in Montana. Water, wastewater, and aquatic subsistence foods were collected and analyzed, and contamination from toxic substances in drinking water and surface water sources were evaluated. These data are being combined with an investigation into contemporary and traditional uses of water in the Crow community. LifeLine Tribal risk assessment modeling software will be used to assess the overall risks to the community from contaminated water sources. Potential outcomes from this research include a better understanding of the environmental risks of water sources associated with a subsistence-based lifestyle of Tribal populations. Also, through community-based participation, this research may help improve Tribal capacity to manage and protect environment and health through health education and other risk communication measures.

The webinar consisted of a PowerPoint Presentation by Crescentia Cummins and Mari Eggers, along with comments from other program participants, and a question-and-answer session. Ms. Cummins participated in the project initially as a student, and now as the local Project Coordinator at LBHC, and as a member of the Crow Tribe. Ms. Cummins is able to speak the

Crow language, which enables her to talk to the community elders in their own language, showing them the proper respect, soliciting their input and ideas, and explaining the project and project results to them.

The Crow Indian Reservation

The Crow Indian Reservation is located in south-central Montana and includes the Pryor, Big Horn, and Wolf Mountains. The Reservation, encompassing 2.8 million acres, has a population of about 8,000 people. Although much of the Reservation is rangeland, which is typical of the Northern Plains, it does include a significant amount of agricultural land.

Cultural Importance of Water

Ms. Cummins went to the Elders Committee and asked for the right to discuss the role that water plays in the community. She was granted permission to share stories from the Committee about the cultural importance of water to the Crow Tribe; in fact, the elders encouraged her to talk about the importance of water as much as possible.

Ms. Cummins explained that water has always been a treasured resource in the community, and traditions and history surrounding water are still honored and practiced today. She added that rivers and springs continue to be used in many ceremonial practices and recreational purposes. For example, water is an essential element in the Sun Dance, Native American Church, and Sweat Lodge ceremonies. The water for some of these ceremonies is taken straight from the river.

Ms. Cummins used slides in telling the story of Charles “Chuck” Real Bird, a lifetime rancher—with several prize horses—and a member of the Elders Committee. He is also part of a local EPA/Tribal environmental demonstration project to reduce the impact of livestock on rivers. Mr. Real Bird used to take his horses to the river to drink, but now uses water troughs, leading to less river pollution. Ms. Cummins discussed how important water is to Mr. Real Bird’s life. He participates in the Native American Church where water is brought in at midnight; the water is prayed over to rejuvenate the mind and body spiritually and to ask for good intentions for the next day. Mr. Real Bird named one of his horses Midnight Water in honor of this tradition.

The elders explained to the researchers how water quality on the Reservation has deteriorated over the past 50 years. They told them that the younger Crow people don’t appreciate water the way they used to, when they had to haul it themselves. Now, people can just turn on the tap. The elders told the researchers how important it was to pass down traditions about water to the children.

About the Study

The project began as a community initiative to begin work on water and wastewater issues. Community efforts dated back to 1980, when inadequate, antiquated sewage lagoons were identified as contributing to water quality degradation of the Little Big Horn River. Larry Kindness (LBHC) and Myra Lefthand (IHS) recruited LBHC science faculty member Eggers to help deal with the problem. This led to a Reservation-wide environmental health assessment with the help of Federal experts. The result was a consensus that water quality was the community’s

top environmental health concern. With this information in hand, a local Steering Committee was formed, and with university researcher partners, set out to quantify the contamination in the Reservation's water bodies. Current local Steering Committee members include John Doyle, Larry Kindness, Myra Lefthand, Urban Bear Don't Walk, Ada Bends, William Driftwood, Brandon Goodluck, Vernon Hill, Suzette Nanto Spang, Henry Pretty On Top and Ronald Stewart. MSU researchers include Anne Camper (the NIH P.I.), Sara Young, Steve Hamner, Crystal Richards and Sue Broadway.

The partners were primarily concerned about the quality of the water in the rivers because there was so little information available on water quality in the Little Big Horn and Pryor Creek drainages. Data on the Big Horn River was limited to trace element studies on fish and sediment in sites upstream of the Reservation and a State of Montana 303d listing as an impaired water body because of high lead and mercury downstream of the Reservation. The Big Horn River is susceptible to uranium mining runoff from the Pryor Mountain range, and researchers still consider this an issue for further study. Other areas of concern include:

- Both surface and groundwater are used extensively for irrigated farming in all three major Reservation watersheds. Contamination of water sources with pesticides and other agricultural chemicals is a widespread community concern.
- The Crow Reservation is in range for deposition of particulate and ionic mercury from the nearby coal-burning power plants in Colstrip, Billings, and Hardin, Montana.
- The IHS drills Tribal members' wells to first available water (e.g., into shallow alluvial gravels).
- Declining amphibian populations (e.g., the Northern Leopard Frog, which is an indicator species of deteriorating water quality).

In preparation for its study, researchers reviewed previous data on local water quality. The group identified two studies:

- A USGS groundwater study along the Little Big Horn River in 2003¹ found that EPA Secondary Drinking Water Regulations were exceeded in samples for iron (Fe) and manganese (Mn). EPA maximum contaminant levels (MCLs) were exceeded for beryllium (Be) and radium (Ra). Mercury and organics were not analyzed.
- In 2000, a USGS study² of trace elements and organics in fish tissues and bed sediments in the Yellowstone River basin found that Little Big Horn River brown trout had the highest concentrations of copper (Cu), selenium (Se), and arsenic (As). Furthermore, walleye in Big Horn Lake and the Big Horn River had the highest mercury (Hg) concentrations (3.38 and 3.39 µg/g, respectively), which meant they had the second or third highest rates of all the sites EPA studied across the nation.

¹ Tuck, LK. 2003. Ground-Water Resources along the Little Bighorn River, Crow Indian Reservation, Montana. USGS Water Resources Investigations Report 03-4052.

² Peterson DA, Boughton, GK. 2000. Organic Compounds and Trace Elements in Fish Tissue and Bed Sediment from Streams in the Yellowstone River Basin, Montana and Wyoming, 1998. USGS Water Resources Investigations Report 00-4190.

Research Model

The study employed a Community-Based Participatory Research (CBPR) model, which is defined as “[a] collaborative approach to research that equitably involves, for example, community members, organizational representatives, and researchers in all aspects of the research process.”³

The CBPR approach was selected for several reasons:

Ethics

CBPR provides an equitable partnership in which all parties contribute and benefit. History shows that many Native American communities have been exploited by potential partners who were only concerned with their own interests. Through CBPR, research can be designed so that all partners—researchers and the community— benefit.

Effectiveness

Community expertise on the environment and how it has changed in the last 50 years is invaluable to the research. Community guidance on ensuring culturally appropriate strategies in all phases of the research is essential to the success of the project.

Extends Tribal College Students’ Science Education

When Tribal College science majors are the research interns, the community’s capacity to address environmental health issues is strengthened. The long-term goal is for the students to return to work in their local communities.

The collaborative approach has provided LBHC students with opportunities to:

- Receive training in the MSU lab
- Receive training from the University of Wyoming, J. Craig Venter Institute and Cold Spring Harbor Lab faculty and staff
- Receive training from—and do fieldwork with—the USGS
- Interact in the field with Crow Tribal environmental staff and Rocky Mountain College faculty and students
- Continue to work on the project after transferring to MSU.

Research was conducted with a 2-year Tribal College for many reasons, primarily to ensure sustainability for the future. Ms. Eggers said that this work would only be sustainable if Tribal members go on to graduate school and return to become local faculty and researchers. According to Ms. Eggers, students are really interested in and motivated by locally relevant, place-based research problems; they know they are doing work important to their community. She also stressed how important it was for the students that their community and elders see value in their work. Furthermore, with this type of research, students learn by watching, listening, and doing, which is more in keeping with traditional Crow education than reading textbooks and writing

³Israel et al. 1998. Review of Community-Based Research: Assessing Partnership Approaches To Improve Public Health. *Ann Rev Public Health*. 19:173-202.

papers.

Lessons Learned

Webinar participants cited the following issues as key to the success of the project:

- The fact that the community identified the environmental health issue as a high priority, and initiated the project, has been critical to the success of the project to date.
- The camaraderie of the Steering Committee is very important; we support one another and keep each other going.
- Our work grows through a collaborative, creative effort. A project like this cannot be controlled by a Principal Investigator in the traditional manner; it requires listening and humility.

Suggestions from the participants on how to keep a project such as this moving forward included:

When designing and conducting the research, ensure that it has value to all partners. The translational component is vital. Explain the project to the community.

- Share data with the community.
- Set up informational booths at community events.
- Explain the project in the Tribe's traditional language to the elders in the communities. (This isn't ancillary to the project, it's essential to the whole program. Community members can't do the surveys without knowing what the researchers are doing.)
- Outreach to younger students (e.g., LBHC conducts several science and math camps).

Use local staff and students who are trusted in the community.

- Use an onsite, full-time, local coordinator and student interns who are local science majors.
- The ability to speak the local language is a real asset.
- Interns are invaluable team members—invest in their training, recognize their contributions, and include them in all activities.
- Ensure reliable transportation for fieldwork; safety is a priority.

Research Methodology

The researchers are performing a risk assessment of exposure to contaminants via domestic and cultural water sources. They hypothesize that shallow wells, which so many people rely on for drinking water; traditional uses of river water; subsistence fishing; and land leasing practices place residents at an increased risk of exposure to environmental contaminants and pathogens via water sources.

They propose to use the LifeLine Tribal™ risk assessment modeling software to analyze an expanding database derived from the following:

- Surface water quality sampling and analyses of the three major rivers and important mountain springs and drinking water sources
- Water quality sampling and analyses of well water throughout the Reservation
- Fish sampling and analyses for mercury contamination

- Home radon testing (because of radiation found in the community)
- Homeowner surveys to assess exposure to chemicals and microbes in homes, and additional exposures from recreational, cultural and occupational activities
- Outreach and risk communication.

Scientific Analyses

River Sampling

All three major rivers were sampled at multiple locations throughout the summer of 2007. Specific conductivity was found to be very high in the Big Horn River. Although conductivity is lower in Pryor Creek and the Little Big Horn River, it increases rapidly with distance downstream—indicating that increased pollution could be a contributing factor. More complete chemical analyses are planned.

Coliform and *E. coli* contamination

Sampling in 2007 found significant fecal contamination of the lower reaches of the Little Big Horn River and Pryor Creek, as well as below an irrigation return on the Big Horn River. The counts are highest in the spring, when it rains more. The lower reaches of the rivers are periodically unsafe for swimming. Livestock, straight piping from homes, and inadequate municipal sewage treatment systems appear to be contributing factors. MSU researcher Steve Hamner and his interns found *Shigatoxigenic* strains of *E. coli* (STEC) in the Little Big Horn River. This bacterium can cause serious and even fatal disease. (Ford pointed out that the presence of this pathogen in the river does not imply incidence of disease).

Water treatment plant intake

The Crow Agency water treatment plant on the Little Big Horn River serves the largest community on the Reservation. In this past year, the treatment plant monitored *E. coli* levels in its intake water, and found such high levels [> 7000 CFUs/100 mLs on one occasion] that *Cryptosporidium* – an environmentally hardy and disinfection resistant pathogen – is a real concern. UV treatment to kill *Cryptosporidium* oocysts is currently being explored.⁴

Mercury contamination in fish

- The larger-sized fish from the reservoir and rivers had concentrations of mercury high enough to warrant fishing advisories.
- The highest concentrations of mercury were found in the largest brown trout (12–20 inches in length) in the Willow Creek Reservoir.
- Mercury contamination is an issue of concern to the community because of the large number of Crow residents who use the Willow Creek Reservoir and the Big and Little Horn Rivers for subsistence fishing.

Well Sampling

⁴ Data courtesy of EPA, BIA, and the Crow Water Treatment plant operators; analysis conducted by Energy Laboratories.

Physical properties

Initial well results showed that the TDS (Total Dissolved Solids) rate was extremely high, deviating from the satisfactory values of <500 mg/L to as high as 5,980 mg/L.

Inorganics

Initial well results for inorganics showed values exceeding satisfactory levels (i.e., above EPA acceptable levels) in alkalinity, sulfate, hardness, and the sodium adsorption ratio in a significant number of wells, making them unsuitable for drinking.

Metals testing

- Three wells had arsenic at concentrations below the EPA primary standard, but research indicates there is a reason for concern even at these lower concentrations. One of these wells is close to a creek, which also has arsenic in it, possibly from the hot springs feeding the creek.
- Four wells had manganese concentrations above the EPA standard; two of them were above 0.30 mg/L.
- None of the tap water samples contained lead exceeding the EPA primary standard; most were nondetect.

Fecal contamination: coliforms and *E. coli*

- 54% of the wells tested to date (n = 24) were positive for coliforms, which indicates the need for additional testing in case the source of coliforms is from fecal contamination.
- As the wells may have pathogens transmitted with fecal material, such as *Giardia* and *Cryptosporidium*, it is advisable to consider the water unsafe to drink until further testing is conducted.
- None of the well water samples tested positive for *E. coli*, although *E. coli* has been found in some kitchen tap biofilms.

Conclusion of the Presentation

The data from this project has helped the Apsaalooke Water and Wastewater Authority move into Phase 2 of their work, replacing wastewater lagoons and repairing water lines. The Authority is in the process of raising funds for Phase 3, which will include funds for drilling new drinking water wells and expansion of LBHC's health education facility. The community and university research partners are continuing their work, building on what they have learned to date in this project.

Their goals include the following:

- Continue working with the Steering Committee in all areas.
- Continue testing private wells, and springs and surface waters.
- Continue homeowner surveys.
- Test for total PAHs (polycyclic aromatic hydrocarbons), especially in areas with a history of oil spills.
- Compile a geographic information system (GIS) on local water quality, incorporating available EPA, USGS, and Bureau of Indian Affairs data with the findings of this research and local knowledge of contaminant sources.
- Continue community outreach, including planning and conducting risk communication.

- Explore additional methods of data analysis, including the LifeLine Tribal risk assessment modeling software and GIS spatial analysis.

Discussion

The group asked, “Now that we have all this data, what should we do with it?” The group agreed that the data should be put into a risk framework, but the point was made that traditional risk assessment modeling software is not appropriate as it doesn’t apply specifically to a Reservation community. Traditional risk management software assesses exposures that would be found in a typical American city. The risk exposures that are specific to a Reservation, however, should be inherent in any software used to assess risks for this population. The researchers noted that the LifeLine Tribal™ risk assessment modeling software is currently being revised to better account for the uncertainties in Tribal communities, and to be sufficiently flexible to model these uncertainties so the software can be used by other Tribal and rural communities in the United States.

Questions and Comments

Question

Maggie Breville: You told us that you collect water and pray over it. What other exposure routes have you noticed? Are there other practices with water that you have?

Crescentia Cummins: The Big Horn River is the drinking water for the Crow community and the wells connected to it are shallow and probably under the influence of contamination by groundwater. We already mentioned the Sweat Lodge, but sometimes the elders heat up the same water after the sweat and bathe in it, and some even use that same water for drinking. Also, both spring water and river water are used in Native American religious practices. Water has been an important recreational activity for generations. Kids are swimming in the water all the time—that’s the recreation in the summer and it has been that way for generations. When we were gathering samples, there were three little boys always in the water. They asked what we were doing and we told them we were checking for *E. coli*, but they didn’t care. They kept swimming and spitting water out of their mouths even after we told them it wasn’t safe to swim in the river.

Question

Representative from Chippewa Indians, Northern Minnesota: How did you pay for the well water funding?

Mari Eggers: That is being funded through the INBRE program, which is a National Institutes of Health grant.

Tim Ford: This is the statewide, biomedical networking program, but it was also very much focused in two areas: infectious diseases and environmental health. The environmental health programs were all targeted toward Reservation communities and provided small amounts to obtain pilot data on water quality and other environmentally associated health risks.

Question

Monica Rodia: Is this study also going to look at the correlation between the contaminants in the wastewater system and the impacts on the pilot community? Have you noticed any types of sickness that would be associated with water contamination, such as *E. coli*?

Crescentia Cummins: The Indian Health Service (IHS) has been contacted and they're willing to provide us information on rates of gastrointestinal illness. We're talking about comparing our data with these rates and see if there is a spike in gastrointestinal illness at those swimming holes.

Tim Ford: I think this speaks to us building the task. I now think we're at the point where the IHS will share information with us so we can start doing the basic epidemiology, correlating exposure with disease outcomes. A good example is Crow Fair. A large population will be congregating at the river, and many people will be using the river—and perhaps we could follow up afterward to see if there is an increase in gastrointestinal infections. Obviously, there will be confounding factors, but we might be able to tease out the water as an exposure route in this case.

Mari Eggers: Recently, there was a community-wide meeting with the IHS, Bureau of Indian Affairs, and Senator Baucus' office that brought together all the people in the community who work on water or health issues. So we now have a connection in the IHS who is going to provide that data for us to see what the gastrointestinal illnesses look like in relation to time of year and what kind of illnesses are occurring in that community. Also, IHS has well water data that I think they will provide and we're going to take all this information and overlay it onto one GIS to see if a particular aquifer or river is correlated with higher rates of gastrointestinal illnesses.

Question

In terms of risk management, what types of intervention are you going to do once the community is fully aware of the problem, and how are you going to improve the water?

John Doyle: We are hoping to implement a method of improving the quality of the river by using setbacks, for example. We tried it once before, but there wasn't enough data available to encourage enough interest in the community. It has been at least 5 years since we made that attempt. Hopefully, the Tribe will initiate the process next time and bring the County on board, and maybe we'll be able to deal with some of the agricultural issues creating part of the problem as well.

Question

Stanly Holder, Tribal Program, EPA Region 7: Has there or will there be any studies about communities that have toxins in their berries?

Crescentia Cummins: We don't know, but the Elders Committee was told not to pick berries along the agricultural areas where fertilizers and pesticides are sprayed.

Mari Eggers: We are asking in our survey, "What kinds of berries do you pick and where do you collect them?" Almost everyone says they pick their berries in the mountains now. There's definitely community awareness about the berries. It's sad; it's a loss, really, that you can't just go down along the road and pick the berries anymore.

Tim Ford: If the community wants us to analyze toxins in the berries, we will. We count on the Environmental Health Steering Committee to inform us on what are considered to be the greatest health risks, so it's a case of prioritizing, and at the moment, we're primarily focused on water, but we'd like to move on to subsistence foods.

Christine Chaisson, The Lifeline Group

Unless there is an amendment stating otherwise, right-of-ways are exempt from the Human Health Risk Assessments. It never occurred to the department that people would be harvesting anything in these right-of-ways. You might want to follow up with EPA's Office of Pesticide Program and tell them there are opportunities for human exposure.

Mary Munn, Fond du Lac Reservation, MN: Our Reservation has agreed with the State Department of Transportation not to spray.

Closing

Maggie Breville closed the webinar with the following:

“As long as the grass will grow and the river will flow, we hope to help in bringing about the healing of the waters that you seek on this reservation.”