Title
Wild & Scenic Rivers: Building a science agenda and community for the US and abroad

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Introduction
2018 marks the 50th anniversary of the Wild & Scenic Rivers Act in the US. A few other countries have some sort of protection of rivers, but usually as a part of some other type of protection, like within National Park or Strict Nature Preserve boundaries. Protecting rivers across jurisdictions is challenge that we have kind of mastered, at least in theory. The US, Canada and Australia are examples of more systematic protection of some rivers and the values they bring to society. The purpose of this presentation/problem description is to lay out some of the high priorities for research to support the US Wild & Scenic Rivers System and to look at our evolving role worldwide.

The Leopold Institute, located on campus at the University of Montana, has existed as an interagency research unit since 1993. Before that it was a Research Work Unit within the Forest Service's Rocky Mountain Research Station, and before that, back to 1967, it started in the Forest Service's Intermountain Forest & Range Experiment Station, which was later consolidated with the Rocky Mountain Research Station. The Leopold Institute has a strategic planning process to define and prioritize wilderness research and administrative studies across the four wilderness management agencies, and sometimes research projects have implications or even focus on rivers, most commonly those contained with Wilderness boundaries.

While the Leopold Institute has not developed a specific Wild & Scenic Rives research initiative in the past, co-sponsorship and active engagement in the Editorial Board of the International Journal of Wilderness has provided opportunity to facilitate publication of river research at the

"wild" end of the spectrum. Two of the Leopold Institute scientists (David Cole and Alan Watson) teamed to produce two special issues of IJW in December of 2000 and April of 2001, which attempted to present some research and protection strategy topics that were important at the time. A combination of peer reviewed and invited articles were an important compilation, and river managers and planners reached out to request more science in response to this compilation. The 50th anniversary of the Wild & Scenic Rivers Act provided the stimulation to again attempt to present some of the latest science and move farther in developing a science agenda for Wild & Scenic Rivers in the US. Reaching farther, this time coordinated by Steve Chesterton (the Forest Service National Wild Rivers Coordinator on the management side) and Alan Watson (the Forest Service social scientist at the Leopold Institute), there was an effort to extend the analysis to an initial worldwide assessment of some of the issues that the US research community could contribute to in a sense of Environmental Diplomacy. The 50th Anniversary issue of IJW focused on Wild & Scenic Rivers was published in December of 2017, with 3 additional articles with international emphasis slated for April 2018.

Putting Wild Rivers into perspective

Also serving as sort of a problem analysis or a proposal for a national Wild & Scenic River research agenda, I hope to also introduce some of the personalities involved in river research. Beyond just developing an agenda - over the last year in development of the special IJW issue, there has also been a sense of developing a community of interest with a stake in the science needed to support the Wild & Scenic River program.

In the special issue, an invited paper by Tim Palmer provided an overview of the history of the Wild & Scenic Rivers System in the US, much of it drawn from a new release of his book about this history, newly released in 2017. A review of this book was contributed by John Shultis of the University of Northern British Columbia in the IJW special issue. Tim's paper referred to the legacy that is our Wild & Scenic Rivers Act, as a bequest, an inheritance, a heritage, endowment or gift from the people of 1968 to future populations.

There were many legacies created in the era of the 1960s that are sometimes forgotten. This context for political action was a unique time in the US and one that many countries have not experienced. Much like my teen-age daughter refers to 1960s and 1970s music as "20th Century music," I think the younger generation must also think of the political actions and the rights movements of the 1960s and 1970s as 20th Century activism. With the Civil Rights Act, the Wilderness Act, the National Trails Act, the Clean Water and Clean Air Acts and extensive social rights movements, our country's consciousness extended across rights for minorities, to all humans, to animals and to the environment itself. I won't go into the history of the WSR Act, as Tim Palmer did in his book, his article, and in a University of Montana lecture that is captured on the Wilderness Institute web site from February 13, 2018. But I will just put up a brief example to make sure we are all on the same track. And I will focus on Montana and the contrast between Montana with only 2 Wild & Scenic Rivers and Idaho with 22.

Typical of the "rivers" admitted into our WSR system is the Flathead River in Montana, it includes what many might think of as multiple rivers and multiple categories (wild, scenic, recreational) that guide protection. Originally brought to national attention in 1957 in an article

by John Craighead, a well-known Montana scientist, the Middle Fork of the Flathead was threatened by the dam building epidemic in post-World War II in the US. But it was not included as one of the original 8 "rivers" that received immediate designation with the Act in 1968. By 1976 it was designated, and it still protects 219 miles of Montana rivers. The other WSR in Montana is about 150 miles of the Missouri managed by BLM, though there are as many as 50 additional rivers and streams that have been recommended for designation by pubic action groups (c.f. http://healthyriversmt.org/our-proposal/ Montanans for Healthy Rivers). Okay, with that brief background let's try to put together some ideas for a coordinated science program to support managers tasked with protecting such a complex system. We've never developed an Institute or a Center for Wild & Scenic Rivers like we have for Wilderness, and we don't really have a coordinated research program with focus on this land classification. Why?

Building a Wild and Scenic Rivers science agenda

I am not going to do an extensive literature review to identify all science associated with rivers. You can imagine it is going to be pretty extensive, spanning a tremendous biophysical range as well as human values associated with recreation, domestic water supplies, subsistence and transportation. But within the Wilderness literature it is pretty easy to see some research that has historically been very closely tied to the scientific and recreation values of wilderness. For instance, in 2000 Luna Leopold wrote a piece where he reviewed some of his times in wild places doing geomorphology and hydrologic cycle research. In his essay he titled "The Value of Fear," in 2000 (he passed away in 2006), this son of Aldo Leopold described a research lifetime to understand relatively undisturbed rivers, and thus the effect humans have on rivers when they are disturbed. The personal story behind his lifetime of geomorphology science was deeply integrated with his lifetime commitment to the concepts his father advanced as an ecologist. He argued that the management of water resources cannot be successful as long as it is naïvely perceived from an economic and political standpoint, much as his father argued about the land resources.

Fish & Fire & Climate

Besides the geomorphology and hydrology research that has been done on wild rivers, I just simply lumped "fish and fire and climate" together as research that is clearly visible and largely attributable to opportunities arising from some of the large wildernesses in the western US. In areas where fires have been able to contribute substantially to the landscape, a great deal of research has been conducted to understand historic patterns of vegetation cycles, woody debris and soil movement into rivers, and their effects on fish populations. Russ Thurow of the Rocky Mountain Research Station in Idaho is very visible and describes some of the research in the FC-RNRW in the current IJW special issue. In fact, he and his co-authors received the Forest Service Chief's award for explaining the value of pristine (relatively untrammeled) wilderness catchments to the understanding of the role of high elevation, large, well connected aquatic habitats in a time of environmental change and threats to biodiversity. Again, without an extensive literature review on this topic, but a very visible one that points out the role of pristine environments and lack of human manipulation to the study of fish, fire effects and climate change.

Invasive plants: "Stewards, Guardians or Gardeners?"

In the 2001 IJW special issue two managers on the FC-RNRW teamed to explain the complexity

of managing a Wild & Scenic River in the war against invasive plants. In a very good presentation of the dilemma of whether their role is as guardians of the wild influences or gardeners to try to intervene in a way that protects natural process based on scientific understanding, the managers pointed to the science available to help them make decisions. Managing invasive plants in wilderness is not exactly the same problem as managing them along a Wild & Scenic river, particularly, if like in Salmon River country, the river flows both inside and outside the wilderness on its journey to distant population centers and the many uses of importance there. For the Main Salmon River, they emphasized that the evidence suggests they can't let off with their invasive management program, they need to think more about restoration and less about treatments, work more with partners to get the work done, expand education and awareness programs, expand inventories and early detection tasks, and extend management planning beyond the borders of the Wilderness or Wild & Scenic River to better coordinate with other entities.

Recreation

The most visible, systematic river-oriented research program among the federal agencies, (that could have evolved into something more like the Leopold Institute), was a river recreation research unit at the Forest Services' North Central Station in St. Paul, Minnesota, in the 1970's and 1980's. Heralded as a new program, it systematically compiled and analyzed results from studies on 45 rivers from 1978 to 1981 and hosted or contributed too many social science conferences, workshops and publications. Their program was simply described as "to determine how rivers are being used for recreation, by whom, and why."

There was a lot of excitement about this research unit in the late 1970s and early 1980s; everyone wanted to be involved and contribute to an extensive and growing literature on river management issues related to recreation users. They anticipated that with so much research happening they could help people increase enjoyment of river visits and guide managers in development of facilities and programs.

Their commitment to helping managers would have likely led to more complex descriptions of problems they face. While they remained focused on increased use and increased management presence, they acknowledged that the agency managers also have a responsibility to protect the environment. This probably would have led to study of the impact of other threats to rivers than just recreation use, much as it did within wilderness science. Wilderness science also started with an almost complete focus on recreation and its management as the primary threat.

Particularly after the North Central Station river recreation research unit disappeared in the late 1980's, river research certainly continued. However, with less of an emphasis on a coordinated approach to science for our national rivers, and more of a focus on general specific problems or issues that just happened to exist on rivers as well as other areas, particularly wilderness. The Leopold Institute conducted and funded studies on many rivers in the 1990's and early 21st century, but most commonly because managers were trying to apply solutions to rivers within their wildernesses or other wildlands, not due to any major strategic planning to provide science to support a system of rivers.

Future

The future of Wild & Scenic Rivers science will likely continue to include geomorphology and hydrology research that capitalizes on the relative absence of humans and their influences, science to support understanding of fish, fire and climate change will continue particularly where long-term data exists, mostly in western, large, high elevation wilderness, and some sort of recreation research to support planning at specific areas will likely always be in demand. But additionally, from the assemblage of targeted papers in this December 2017 special issue, a strategic approach to defining problems and prioritizing them could emerge. The rest of this presentation/proposal is aimed at a brief overview of 8 research topics that have emerged from this community of interest coming together for this purpose. Historians and scientists from federal agencies, universities and non-profit organizations participated by writing articles, soliciting articles, reviewing articles and reading and discussing these articles. A simple proposal would be to combine the research questions identified within these articles with on-going historically significant science compatible with the Wild & Scenic rivers purpose. This would allow a science program to emerge within the federal science administration or a community of interest committed to protecting the values associated with wild, free-flowing, undeveloped river systems.

- Economic benefits.
- Ecosystem services as outstandingly remarkable values.
- Better ecosystem and social representation.
- Research to support recreation management decisions.
- Monitoring to understand positive and negative effects of restoration through dam removal and re-watering streams.
- Ways to better link protected river designation and management to aquatic diversity.
- Collaboration in worldwide assessments of rivers to understand human health and environmental protection policies globally.
- International collaboration to understand the contribution of river protection to quality of life and the environment.

Economic benefits

Bowker and Bergstrom, a team representing Forest Service Research and the University of Georgia, offered a complex, comprehensive model of the economic benefits of Wild & Scenic Rivers. Their model included both use and non-use values and they reviewed this literature in order to summarize just how much we do know and emphasized how much we don't know. In this model they emphasized that we know Wild & Scenic Rivers can have many revenue functions, not only from visitors, but also from concessionaires, businesses and local residents. Government expenditures to accomplish management objectives also can contribute to economies. Direct sales, trip service expenditures, indirect economic effects, leases, building

facilities and infrastructure all require money to turn over with easily quantifiable benefits.

Our knowledge about these economic effects does not extend across an enormous population of rivers and communities. These economists list a range of expenditure level findings and conclude the average expenditures per person per trip with and without one particular river (the Salmon) can be really different. Simple extrapolation of results would be pretty difficult. Total Industrial Output also varies substantially, but what is demonstrated clearly is that different studies used very different economies to judge the secondary effects. While they argue that in most cases these expenditures are more accurately considered transfers within an economy (such as the US economy), when economic analysis is done on one or several counties, one or two states, or even small riverfront towns, the results are difficult to compare. Lack of standardization for studies that produced existing knowledge limits the application.

Questions

Several strategic research questions emerge related to examination of these mostly use-associated values of rivers in the US. First of all, that the existing science is piecemeal and dated. We would assume that the river recreation research initiative in the 1970's and 1980's was more systematic with some level of oversight to assure diversity and some standardization. As well as initial hopes that through replication or long-term monitoring knowledge would remain up to date. The lack of any conclusions by wild/recreation/scenic classification is disappointing, since this classification system is at the heart of the WSR Act and implementation. Making decisions about what to classify within each category could be better informed if this knowledge existed. And while we are going to talk next about off-site values, one conclusion from looking at available science is that there isn't a great deal of knowledge about non-use values, or even off-site use values.

- Science is piecemeal and dated.
- Need to disaggregate any science by wild, scenic and recreation.
- Off-site benefits likely to be at least as significant as on-site, but not assessed well. Most studies have focused on on-site values.
- Valuing based on a more complete estimate of the benefits provided will help ensure that priorities are set such that healthy river ecosystems and appropriate visitor services are provided and maintained to leave these areas available in their exceptional state for future generations.

Ecosystem services as outstandingly remarkable values

In the article by Bowker and Bergstrom, and Perry, it was strongly suggested that it might be appropriate to think of both use and non-use values within an ecosystem services framework. And beyond that, use can be divided into current use and future use. Describing future use (and non-use) values, some of which we have not even realized yet, really captures the essence of the Wild & Scenic Rivers system, and when values are calculated in perpetuity can accumulate really high values to society.

Perry argued that there has been very little use of ecological, botanical, water quality, hydrology and traditional use values in designation of Wild and Scenic Rivers and a more accurate account of values and tradeoffs could be apparent through categorizing ORVs and Benefits by Ecosystem Service Values.

Questions

Some questions come up related to the possibility or the value of incorporating ecosystem service analysis into ORV assessment. First of all, does this approach offer something in terms of the ability of stakeholders to engage more deeply than with a simple listing of ORVs, which may be pretty general and require lots of interpretation at the time of policy development? Second, does an ecosystem services oriented approach help achieve the public purpose of protected rivers by allowing more analysis of costs associated with protection. Methods have been developed and are being applied which not only talk in terms of tradeoffs with the public, but will also allow them to understand how their relationships with these rivers might change due to designation or policy implementation. And third, if we have the ability to understand how well the range of benefits are protected, we might be able to more strategically attempt to protect ones that are not protected extensively now, through designation or simply changes in management approaches.

- How does reframing Wild & Scenic and Outstandingly Remarkable Values into a political-economic framework help stakeholders weigh tradeoffs and inform decision makers?

- Develop methods of highlighting tradeoffs – promise of ecological economics approaches – costs and values.

- How well are ecosystems and their benefits protected?

Better ecosystem and social representation

This question of how well benefits are being protected can lead us to research questions about representation. Representation can be analyzed for eco-regions, as Perry suggests, or across different socio-economic communities or other aggregates of individuals. There are many states and maybe ecosystem types, as well as some social groups that do not have relationships with WSRs. And some (Montana 2, Idaho 22) are quite curious in their distribution if we look at it by political boundaries, but may make sense by eco-region or other criteria.

Questions

There are some systematic research possibilities from this research topic. If we had some sort of strategically selected eco-regions, we would understand the distribution of benefits of our WSR system better. Applying this framework to the 3213 eligible rivers listed in the National Rivers Inventory may give great insight into the benefits of designation beyond local interest. Advocates for ecosystem services approaches to climate change adaptation planning would suggest understanding river protection within some sort of consistent eco-region framework could help guide understanding vulnerability assessments and potential adaptation options. Social justice demands would support better understanding of a combination of ecological and

social representation of benefits and uses of our WSR system. Evaluating tradeoffs in a more complex way than political jurisdiction and influence can improve transparency of public lands stewardship.

- Study ecosystem services by consistent eco-regions.
- Evaluate eligible rivers (3213 – NRI) within eco-regions and the ecosystem services they provide.
- Understand river protection and climate change influences.
- Distribution of benefits across society.
- Evaluate tradeoffs within a sociopolitical stage to identify winners and losers based on relationships with these rivers.

Research to support recreation management decisions

These authors have some very specific research questions that could be addressed systematically. This sliding scale analysis that is advocated in this interagency effort requires managers to determine the level of uncertainty, risk, controversy and public interest to determine how much effort they put into collecting information and making decisions. The more uncertainty, risk, controversy and public interest places have, the more likely the planners and managers need to take more complex, thorough approaches to making decisions.

Questions

It appears that research could offer assistance with this assessment task and contribute to defensible conclusions about the uncertainty, risk, controversy and public interest in issues at a particular river. If defensible actions are to be developed, research then could contribute substantially to traditional recreation research questions surrounding describing desired conditions, analyzing impacts of different activities, facilities and services, selecting indicators, determining thresholds, establishing capacities and developing monitoring protocols. Much as in the 1970s and 1980s, a major initiative, coordinated with implementation of this Visitor Use Management strategy could be initiated.

- Research to determine uncertainty, risk, controversy and public interest to help make decisions about the sliding scale level of time and resources to invest.
- Research to provide the foundation for visitor use management actions:
    - Defining desired conditions.
    - Analyzing impacts of different visitor activities, facilities and services.
    - Selecting indicators.
    - Determining thresholds.
    - Establishing capacities.
    - Developing monitoring protocols.

Monitoring to understand positive and negative effects of restoration through dam removal and re-watering streams

There are really two topics here that could be expanded to include 1) monitoring of restoration on biophysical parameters, and 2) monitoring of restoration on social uses or changes in ORVs. In this case on the White Salmon, recreation use exploded to the point that biophysical parameter are threatened. On Fossil Creek, a whole new use contingent erupted to the point they had to restrict use, both for biophysical parameters as well as impact on the original ORV of traditional values associated with American Indian meanings and uses associated with the riparian zone. Monitoring suggests recovery of fish species, but with new recreation use, restrictions were needed to protect both the biophysical and social conditions of this WSR. Surrounding dam removal and re-watering activities, there is a need for pre-removal baseline conditions determination and then be set up to capture changes in everything.

Questions

These are some of the suggestions of things that should be monitored after dams are removed or streams rewatered as the uses society values about these rivers changes.

- Monitor restoration and rewilding effects on use, biophysical resources and flow of benefits.
- To obtain stakeholder input and resolve conflict.
- Maintain a multiple ORV focus on all estimates of benefits and costs.
- Determine effects on connectivity.
- Establish impact on hydrology and water quality.
- Determine contribution or threats to cultural values/meanings and traditional uses.

Ways to better link protected river designation and management to aquatic diversity

In this first article, three aquatics researchers illustrated some of the effects on biodiversity, particularly protection as a Wild & Scenic River, aquatic restoration, instream flow provisions, and adoption of more ecologically compatible land use policies on adjacent lands. Linking aquatic diversity and protection isn't as simple as just laying out protection boundaries. It's big and research could help establish these relationships and target priorities for policies and restoration in the US. In the Czech Republic, where there has been some suggestion that protecting wildness will threaten biodiversity by attracting recreation use, there is some evidence that if science is used to monitor ecosystem changes as well as the effect of management policies, biodiversity and human uses can be very compatible.

Questions

To fully gain the benefits to both biodiversity and human uses, risks must be adequately understood. In this case, tying flow levels to user flows and impacts on mussels was critical to obtaining public support for restrictions. Research must contribute to development of methods of controlling introduction of non-native species if there will be human uses, we must be able to understand the effects of water removals and restoration of flow, we need to understand the implications for diversity of categorization as wild, scenic and recreational, we must understand the effects of historical activities, and understand the co-influences of designation and regulation on recreation use and benefits, as well as aquatic species.

- What are the risks/threats to native aquatic species and their habits?

- Can designation protect these species and habitats by addressing these effects?

    - Controlling introduction of non-native species.
    - Effects of dewatering on aquatic species and their habitats.
    - Effects of segmentation based on classification as wild, recreational or scenic.
    - Effects of historical activities.
    - Effects of restoration.
    - Effects of designation on recreation use, visitor management activities and on aquatic species.

Collaboration in worldwide assessments of rivers to understand human health and environmental protection policies globally

At the University of Leeds, in the UK, we collaborate with the Wildland Research Institute, a bunch of geographers constantly thinking about how to use existing data and data gaps for evaluation of wildness character around the world. In this case, using some existing data sets, they look first of all worldwide to determine the 10% of wildest rivers based on several parameters, but mostly on the condition of headwaters and basins. Then they go continent by continent, reframing the question based on conditions found in each country. Right now we have an associate at the WRi for the next year, looking at these kinds of parameters or other data sets to allow assessment of wildness of catchments in China.

Questions

From this initial analysis using these existing data sets, Dr. Carver raised research questions about the implications of some of the wildest rivers falling mainly into permafrost or desert environments, how do we improve on global data sets, how do we get more country by country analysis to allow more country to country comparisons with some standardization, what are the most logical definitions of catchment boundaries and attributes and how do we get those adopted, and the importance of national and local assessments to increase validity of conclusions being drawn from these analyses.

- What are the implications of most of the wildest rivers falling mainly into permafrost or desert environments?

- Global data sets are inconsistent, coarse scale and reliant on highly generalized data

sources – how do we improve them?

- Country scale is best, internally most consistent – how do we get more?
- Country to country comparisons are difficult with current data.
- Definitions of catchment boundaries are questionable.
- National and local assessments are important to develop.

International collaboration to understand the contribution of river protection to quality of life and the environment

We have been collaborating with China to understand the environmental history of China and how things have gone in river impacts in the past. People there seem to be thinking things are turning around, with central government and public support. This is a country that has not experienced those great rights movements that we did in the 20th Century, and so they are undertaking proposals to protect the environment and rivers in a very different context than we have. Their science issues may not be all that different, but when they talk about economic and community values of protection, these are much larger parts of the equations than they are in the US. Dr. LiPeng from the University of Yunnan is working with the Ministry of Water Resources and other agencies and universities to float a proposal for a national system of protected rivers. For one specific river in Sichuan Province this coming spring, we will be collaborating to describe the outstandingly remarkable values that need to be protected (we have many options for how to do that), determine the threats to those values that need to be managed or legislated, recommend the appropriate boundaries (across communities, across uses, across elevation and development), obtain input from the communities most affected, and make suggestions about what designation would look like (zones, catchments, categories?) and what a potential management scenario might look like (who would enforce rules, who would do education, who would monitor effects of management, etc.)?

Questions

- How do we make valid recommendations for the right boundaries?
- How do we universally describe outstanding remarkable values?
- What are the primary threats to rivers and how do we assess this?
- What are the best management approaches across different types of PAs?
- What are the designation options for different political and economic situations?
- How do we incorporate desires of local communities?

Conclusion

The US currently has nearly 500 named rivers and tributaries protected under the US Wild &

Scenic Rivers Act. That only means they are designated. We don't really know how they are managed, the emphasis of education programs, the role they play in communities, the effects of the different categories of protection on a variety of potential benefits or who is using them, how they are affecting the river environment or any of the other use and non-use values in any systematic, strategic manner. With over 3000 eligible rivers on the National River Inventory in addition to these 500 rivers and tributaries potentially coming under protection, some indication that restoration may occur on rivers not previously eligible for protection status, and with threats expanding well beyond dams to our nation's remaining free flowing rivers, some systematic, strategic approach to science to support designation decisions, designation specifics (boundaries, allowed uses, etc.), and management is missing.

Science strategic planning may not be considered by most to be an exciting or sexy topic. But with this analysis and description of the range of research topics that could be coordinated into a logical strategy, something must catch almost all scientists' or budding scientists' imagination. There must be ways to describe topics in a less discipline-oriented way, using purpose of the research, common threats or benefits to rally around for science. Think a minute and see which of the topics listed here would be 1) most enjoyable and rewarding to study 2) which is most urgently needed to assure we don't lose opportunities, and 3) which, if any, are worthy of a strategic process to flesh out priorities and potential ways to bring these topics to the public lands research agenda.

We encourage input to ways to describe the importance of not just individual research studies, but to arrive at those studies through a logical, mental map of how we value our rivers, why we value our rivers and what we need to do to leave this legacy in a state that will make our beneficiaries proud.

Questions

- If you could choose, what would be your favorite research topic?
- How important is this science for the future? Why?
- What other science do you think will be important for the designation or protection of rivers?