"Sound Science" On The Missouri River – How It Should Influence Law and Policy"

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My goal tonight is to describe the challenge we confront in applying what we know about science to the management of our magnificent natural resource heritage, - the Missouri River in particular.

Before I turn to Missouri River issues specifically I will take a few minutes for a more general introduction of an issue that arises every day in our modern society: How are we to apply what science teaches us to the management of our rich heritage of natural resources, including prairie, air, water, forest and wildlife?

There is an inevitable tension between the process by which scientists reach decisions and the process by which public policy decisions are reached. First, consider how science approaches these issues. The scientific method is a process based upon experimentation and proof, followed with verification by independent repetition of the proof, and critique by qualified peers. As rigorous and unforgiving as this process is, it has limits. Scientists view their work as a body of working assumptions, of contingent and sometimes competing claims. Even when core insights are validated over time, the details of these hypotheses are subject to revision and refinement as a result of open criticism within the scientific communities. Scientists regard this gradual evolution of their theories through empirical testing as the pathway to "truth." This science employs a process by which it reaches something close to "truth," while simultaneously recognizing that *uncertainty* is a valid component of that "truth." There is an indeterminancy to science.

In contrast, consider how we make policy decisions. We are a republic. This means that we make decisions involving our governance through elected representatives. The idea is that as the result of open deliberation on the merits, these representatives will deal with competing views (perhaps more typically described as competing special interests) and achieve final decision through compromise. In the hands of the right people, and overseen carefully by a thoughtful public, the process can work tolerably well.

In the policy-making area, however, all of the players are forced to make decisions at a particular moment in time, while the scientific process is going on.

Given the indeterminancy of science as well as its seemingly inconsistent role as the source of most of what we can reliably know, how can the public policy system make the best use of a scientific "fact?" Recent developments in both law and science have conspired to bring increasingly complex scientific issues before courts, legislatures, and administrative agencies for resolution.

The question is *by what process* we ought to make enormously important policy decisions which implicate *scientific knowledge* and *scientific uncertainty*? How are we to deal with tension between the process by which scientists reach decision and the process by which public policy decisions are reached?

In 1753, James Lind, a British naval surgeon, published the results of his studies on the efficacy of fresh lemons and oranges in curing scurvy. Despite the promising results reported it was another 42 years until the British Admiralty formally recognized Dr. Lind's recommendation as the best preventive measure against scurvy and required a daily ration of citrus for all shipboard sailors.

The example presents the challenge of applying what we have learned from science to public policy, and it is far from isolated. News reports on any typical day provide an abundance of examples.

Consider our evolving experience with so-called Mad Cow Disease. Before the one cow in the northwest was diagnosed with Mad Cow, Dr. Stanley Prusiner, an American neurologist who won the 1997 Nobel Prize in Medicine for his work in identifying the protein that causes Mad Cow Disease was quite literally knocking on the door of the U.S. Secretary of Agriculture, hoping to tell her that it was just a matter of time until the disease appeared, and that precautionary action was essential. He was rebuffed.

When, in December, one case of Mad Cow was diagnosed, the Secretary of Agriculture responded by announcing: "[w]e want to make sure that our actions are based on the *best available science*!"

And so, on the one hand, we have the opinion of the scientist most closely associated with knowledge of Mad Cow. On the other hand we have the scientific opinions of employees of a government agency which exists for the specific purpose of advancing the economic well-being of commercial agriculture; they were not speaking with one another. The question I pose is *not* who is correct in this case, but rather *by what process* we make important public policy decisions which rely for their utility on scientific knowledge, including scientific uncertainty?

A second example is provided by an issue that falls under the heading of climate change, or world-wide warming of the Earth's atmosphere. I think it impossible to imagine an issue of more fundamental significance to all of us than that which

results from the warnings we have been given by science. It bears on our very survival. At the least, it threatens turbulence in every world economy, and society. What is more, the scientific community world-wide is speaking with a single voice! This is not a case of a single scientist knocking on the door of a White House official. It is all of science knocking on the door of every government in this world. Yet, considering the utter enormity of the potential consequences – the cost to all human society – we appear to be doing absolutely nothing!! Elected representatives and voters seem to have decided that we will deal with that if it happens!!

Even if you believe that this overstates the case, I again pose the question: By what process shall we make important public policy decisions involving science; how shall we apply what we have learned from science to public policy?

The general point I offer is this: The process by which science reaches decision is uncompromising, based on verifiable proof. The process by which we make policy in our republic is dependent upon compromise, upon a willingness of competing interests to yield. This democratic process is ragged and undisciplined when compared to scientific process, yet there is a fundamental need for a productive dialogue between science and policy.

With this as background I now want to turn to the Missouri River, and talk of how we integrate what *science* knows about the River with the political decision-making process. Disputes over decision-making on the River are difficult for most of us to comprehend. The complexity of the situation seems to create an invisible yet impenetrable wall that separates the public from the decision processes. Nonetheless those decisions touch most of us in many ways.

The complexity is understandable. The Missouri Basin itself is the largest in the nation and the River is the longest. It rises in the high mountains, and traverses regions that are, in turn, arid, semi-arid and humid. The River's ecology is unique and subtle. The government agency that manages the Missouri is among the largest in the entire world and its inner-workings are a labyrinth even to the fully initiated, and the engineering on the river is dense as well as spectacular.

Of course, the big moments for the River in human time were 1944 and 1945 when Congress passed the laws which authorized the great dams and the channel. Let's begin there.

Why did Congress decide to build and finance these great works? The first reason is that Congress was aware that the vast armies fighting World War II would be coming home. The soldiers would be restive without work; so the Missouri River dams were first of all a giant jobs program for the returning military.

We also know that Congress was responding to floods on the River which had been severely felt downstream, particularly in Kansas City and Omaha. Congress wanted solutions that would reduce the threat of floods in the downstream stretches of the River.

Reading between the lines of the legislative documents we know also that Congress wanted to provide an economic stimulus to the Upper Basin, which had suffered during the Dust Bowl and depression years. Subsidized electricity and irrigation water were to address that concern.

So motivated, Congress authorized the U.S. Army Corps of Engineers to go forth and build the great dams on the main upstream portion of the River along with a navigation channel from Sioux City to the mouth. These huge engineering structures were to provide for flood control, navigation, hydropower and irrigation.

At this point we can pause and observe. First, the Corps controlled the river agenda, unhampered by competing interests. Second, the only science brought to bear on the River was that of civil engineering, and that science was also controlled completely by the Corps; all decisions, including decisions interpreting relevant science were held by the agency whose single goal was to build engineering structures. The Corps was and remains mission-oriented.

The Corps' management position was strengthened when, during the 1970s, it became apparent that irrigation was not feasible. Waters that had been scheduled to be diverted from the River remained instream to serve other purposes.

Over the years, Congress gradually added to the purposes that the River was to serve. The Corps was authorized to provide municipal and industrial water from the great reservoir and channel as well as cooling water for nuclear and coal-fired power plants. The agency was required to protect from flooding the bottomland farmer along the navigation channel. Recreation was to be a sponsored River purpose, both in the reservoir and the remaining undammed portions. The Corps' river was to be managed to enhance fish and wildlife. Cultural and historical concerns were added to the agency agenda. At the same time Indian tribes for the first time spoke with a strong and effective voice. Their interest in the River – obvious to most people – had been largely ignored by the Corps.

These many purposes intensified the Corps' management duties, and management of the River was made even more complicated for the Corps when an unanticipated fishing industry of surprising economic size developed around the Oahe and Garrison reservoirs. To sustain the fishing in the reservoir the

Corps was pressured to keep higher water levels in the reservoir at the time when it would normally hold the space available to gather potential flood water.

Despite the increasing management pressures, the Corps could succeed in operating the River if that is all there was to it. They could because they were the only decision-maker on the River. They controlled the structures, and the money. More important, they controlled the science. All decisions were made on the basis of engineering science, and that was controlled by the agency. Success was judged by the single purpose of engineering function. The model of an independently reviewed scientific process did not apply. Just as important, there was no role for scientific disciplines such as biology, ecology or wildlife studies.

On a parallel tract, however, there was emerging a series of legislative developments which were inconsistent with the Corps control over river science, and which lead ultimately to today's conflicts. I will highlight a few examples.

In 1954 Congress enacted the Fish and Wildlife Coordination Act. This law requires that federal development agencies such as the Corps consult with the U.S. Fish and Wildlife Service as well as state wildlife agencies, and provide "adequate provision" for conservation and conservation of wildlife resources.

Although the Fish and Wildlife Coordination Act has proved to be largely toothless, it signals the coming sea change. The Corps is located in the Department of Defense. The U.S. Fish and Wildlife Service is in the Department of Interior. The Corps is an engineering agency. The Fish and Wildlife Service's function is closely rooted in the traditional discipline of the scientific method. And here is legislation requiring that the Corps ask these scientists for their advice about the effect the Corps management decisions may have upon conservation!!

Of such small events are revolutions made!! By law, traditional government is required to talk to modern science!! Gradually, the idea has emerged that scientific assessment of potential harms and identification of possible remedies is the best course of action. This idea began to appear more frequently in legislation, and two examples are of prime importance on the Missouri River.

In 1969 Congress enacted the National Environmental Policy Act, known everywhere by the acronym "NEPA." Congress came to recognize that the work of mission-oriented agencies such as the Corps assured that environmental considerations – the lessons of science - are systematically underrepresented in short- and long-range decision-making. Congress observed that development agencies such as the Corps tended to overstress the benefits of engineering projects and to insufficiently explore environmentally less damaging alternatives, and to fail to draw into account secondary or indirect project impacts.

I don't want to labor through the detail of this law. What is interesting about it is that it in no way altered the substantive law which governs agency decision-making. Instead it required a new *process* by which an agency, before it makes an important decision that might affect human health and the environment, first *consider* carefully the environmental effects!! It adopts a federal policy that decision-makers "utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences."

Now, the agency may still make a bad decision; NEPA doesn't change that. But, NEPA does require that the agency first ask "what can happen." And, they can only answer that by including unbiased, independent science in their *process*. Among other things, NEPA means that mission-oriented agencies like the Corps must open their decision-making process to the public and to scientific opinion generated outside the agency.

Just a few years after enacting NEPA, Congress enacted the Endangered Species Act in 1973. This made *all* agencies, including the Corps, directly responsible to conserve species of plants and animals threatened with extinction. The *process* established by this legislation is important.

The first step in the protection of a species is the decision by the U.S. Fish and Wildlife Service to list a species as threatened or endangered. Significant for us is the law's explicit requirement that the listing decision be based on "*the best scientific*" data available.

If an agency such as the Corps proposes an action that will take place in an area harboring, or possibly harboring, a listed species, the agency must provide the U.S. Fish and Wildlife Service with the *best available data* in a document known as a "biological assessment." The Fish and Wildlife Service then consults with the agency in forming a "biological opinion" about the extent of possible harm to the species. If the Fish and Wildlife Service concludes that the project will jeopardize a species or harm its habitat, the project *must* be modified to avoid such harm. A failure by an agency to follow this procedure can be enforced by any citizen.

Thus and again, the mission-oriented agency must pause, present its proposal to independent science. It must ask: "What can happen?"

This gradual process of linking science and government has also evolved in economics, which, we will recall, is also a science, said by some to be dismal, but science nonetheless. The existence of NEPA reminds us that when the Corps first planned the great dams and channel on the Missouri, it was not required to consider the potential environmental effects of its design. Similarly, it was not required to consider whether their selected design made economic sense –

whether they were economically feasible; good economics were irrelevant. This too has changed.

Now in planning new projects and in re-evaluating existing projects the Corps is bound by economic Principles and Guidelines which hope to assure that projects make some economic sense, and that they contribute to *national* (not local) economic development consistent with protection of the human and natural environment. The tools are cost-benefit analysis and cost effectiveness analysis. Thus, the science of economics is also brought to bear on river management.

These efforts by Congress to make science relevant in policy decision-making came into view when, in the 1980s, the Corps made a decision which it may now regret. It agreed to reconsider its so-called Master Manual, which is the comprehensive set of rules it follows in its day-to-day management of the Missouri. This review process, which continues as we meet here, would assure that for the first time the requirements of NEPA, the Endangered Species Act, the Fish and Wildlife Coordination Act and the economic principles would be applied to the Corps in its planning for the River. For the first time the Corps would be required to be attentive to outside, independent science in its planning for the River. That is, NEPA requires that the Corps adopt a "systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences." The Endangered Species Act's requirement that there be reference to the "best scientific" data available, and that independent biological science would be a guide suddenly was important as was the relevance of economic analysis.

The Corps stood face-to-face with the growing bond between science and the government in the environmental and resources planning field. *And, it happens that science is able to talk to us about the River*.

What we have learned is that the natural river – the river before the dams – sustained a rich life through a regime of natural disturbances that included periodic floods and attendant sediment erosion and redeposition. These disturbances, in turn, supported a variety of ecological benefits. The ecological processes sustained by periodic flooding in big river floodplain ecosystems are encompassed in the concept known as "flood pulse."

The concept of "flood pulse" summarizes the effects on biota of the connections between the river channel and floodplain. The flood pulse describes for us the predictable rising and falling of water in a natural river-floodplain ecosystem. It is the principal agent controlling the adaptations of most of the life in the River. Central to the flood pulse concept is the notion that floods, rather than representing a disturbance to the ecosystem, are part of the natural hydrologic regime, and that the prevention of floods actually represents an ecological

disturbance. The flood pulse is essential to the health of the river-floodplain ecosystem.

So, the dams and the navigation channel effectively deprived the River of its central ecological feature – the flood pulse. Development of the River eliminated nine-tenths of the River's sandbars, four-fifths of its aquatic food, and two-thirds of its catfish. It eliminated that other vital feature of all big river ecosystems – river-side wetlands which are re-charged with each flood pulse. It was inevitable that elimination of the central ecological features would lead to extinction of species. Today, the life of the River *itself* is in danger of extinction.

Now, we are a practical people, and application of NEPA and the Endangered Species Act to the River at this time does not contemplate elimination of the dams, which are providing measurable and substantial economic benefits. But, these statutes do require that the Corps ask: "Within these practical constraints, are there steps which we can take to protect species from extinction, and to minimize the great environmental damage that this engineering project has caused?

Curiously, considering all the political dust-kicking that this Master Manual review process has generated, the answer that science, including economic science provided, was simple and feasible; it emerged early in the process.

The ecologists, economists, biologists and wildlife specialists took a look and said: "Yes, There are practical things you can do. Change the pattern of flows. Create ebbs and flows along the stream in order to replicate in a small way the flood pulses which are central to the life of the River. Create some natural flood zones where the flood pulses can spill over and create riverside habitat. These artificial flood pulses along with the overflow areas will allow the Corps to continue to generate hydropower, provide flood control and allow recreation in the great reservoirs. In addition, the scientists asked only that they be allowed to study the process, so that they could learn and make adjustments along the way.

The economists, bless their hearts, concurred, pointing out that although this solution would disrupt summer navigation at times on parts of the River, the harm would be minuscule when measured in economic terms. Even the Corps admits that the upstream recreation interests that would benefit from the more natural flood pulses already generate at least *twelve times* more economic activity than the downstream navigation interests. As one wag has observed, the river's barges carry so little cargo that it would almost be cheaper for farmers to ship their grain by FedEx!

So, sound economic planning and sound environmental planning joined hands and there was a plan. It was agreed upon with the deliberation, caution and conservatism which we associate with our best science

The point I want to make here is that the manner in which Congress designed NEPA and the Endangered Species Act *did succeed* in bringing sound science to the table, and in developing a workable plan. That elusive bond between science and policy appeared to have succeeded on the Missouri. But, the reality is that we are a long way from implementing that sound science solution.

In summary, here is what happened on the "government" side.

I can begin by pointing out that the State of Missouri is a swing state in the general elections. It's senior senator is aligned with the national barge industry, and he began in the late 1980s to crusade for the status quo. Senator Daschle for the upper basin states, sought flow changes. These two fought to a stalemate through the 1990s. Also throughout the 1990s the Clinton administration dragged its feet and kept the U.S. Fish & Wildlife Service from formally issuing a Biological Opinion pursuant to the requirements of the Endangered Species Act.

It was only after citizens threatened to sue that a Biological Opinion was finally issued in 2001. And it was only after election day that the Corps announced that it would follow the requirements of the Biological Opinion.

Sound science was allowed to have its day. In 2001 what was said to be the most complete scientific report ever issued by the U.S. Fish & Wildlife Service directed the Corps to implement flow changes in 2003. With the caution so characteristic of deliberate science, this report was subjected to independent review by a select panel of the National Academy of Sciences, which corroborated each conclusion and recommendation.

But, in the heat of the election the person who was to become the next President visited Missouri and promised to oppose flow changes. So, the Bush administration, through its Secretary of Interior Norton, ordered the U.S. Fish & Wildlife Service to revise the Biological Opinion, based on mysterious "new information." In so ordering the Secretary declared that the next report would "be based on the best available science."

On the policy side, the process has faltered, even failed.

Imagine that this modest proposal of science to restore a small replica of the flood-pulse had been debated openly, on its merits, with proper deliberation. Wouldn't the wisdom and feasibility have become apparent to all? Instead, candid

debate was studiously avoided, and action was forestalled by behind-the-scenes manipulations.

Had this modest proposal to restore a small replica of the flood pulse been adopted when it was first recommended, we would tonight be able to look back upon a full decade of experimentation with the flood-pulse concept. Instead of listening to an old lawyer we might be listening to river scientists report enthusiastically on what they have learned after a decade of experimentation with the flood-pulse. They might even be describing revitalized life in the River!

Now, like the Nobel Prize winning Mad Cow scientist, knocking on the door of the Secretary of Agriculture, our river scientists are still knocking on the door of government, and being rebuffed.

It takes courage to listen to what science has to tell us. It also takes courage to allow our democratic processes to operate as they were designed. We *must* find ways to a more productive dialogue between science and government.

The stakes are high, for it is clear that the life of this River is beyond the crisis stage, and we have *yet* to take seriously what science is trying to tell us.