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ECONOMIC RESEARCH AND POLICY CONCERNING WATER USE AND WATERSHED MANAGEMENT

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Proceedings for Session 1, Wednesday, April 21, 1999

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Introductory Remarks -- Summarization
by Chuck Clarke, Administrator, US EPA Region 10

Mr. Clarke's opening remarks revolved around four issues concerning economics and EPA's environmental regulations: (1) the need to address compliance problems relating to water quality standards, (2) hydroelectric re-licensing, (3) management of the Snake River and Columbia River systems, particularly with regard to salmon stocks, and (4) enforcement.

The first issue pertains to a national upheaval in water issues over the past four to six years concerning water quality standards. States must now face the question of whether waters will meet water quality standards. Under section 303(d) of the Clean Water Act, each state must publish a list of "impaired waters," and develop a strategy for bringing these waters into compliance with water quality standards. Twenty-one lawsuits have been filed against the EPA for failure to implement section 303(d), all of which EPA has lost.

In dealing with water pollution EPA initially focused upon point sources, as they are easier to identify and regulate. The broader and ultimately more important problem, however, concerns non-point pollution sources. One of the greatest obstacles to regulation that EPA must face is the economics of regulation, not simply the scientific or technical information pertinent to water quality regulation. People in the agricultural industry and the timber industry have aggressively used economics to argue against water quality regulation for non-point sources, and have elevated the economic analysis to a level far above that which EPA has ever had to previously face in connection with water quality regulation.

The problem of bringing water bodies into compliance with water quality standards is daunting enough, but if one combines water quality standards with Endangered Species Act (ESA) requirements, then the impacts can be immense -- over two-thirds of the water bodies in Washington, Oregon and Idaho will not be in compliance with either water quality standards or ESA requirements. Bringing water bodies into compliance with water quality standards and ESA requirements will require the use of economic analysis in two critical ways: (1) using natural resource damage assessments to determine the damages of noncompliance, and (2) determining the impacts on regulated industries of various options for bringing water bodies into compliance. Most resource agencies are poorly equipped to deal with the increasing importance of economic analysis, so in the next several years there will be much more pressure on resource agencies to focus more on economic analysis than has historically been the case. In order for resource agencies to be able to negotiate with regulated industries, it will be imperative that they be able to discuss economics without being at a disadvantage.

The second issue pertains to the impending decisions on the re-licensing of hydroelectric dams. Many hydroelectric systems will expire over the next five to fifteen years. Economics will play a prominent part in the ensuing re-licensing decisions. Economics will answer questions such as:

- Do they continue to operate?
- Can they operate economically under the environmental constraints that will be placed upon their operations?
- What will be the economic impacts, both in terms of the natural resource damages and in terms of the regulated industries?

In re-licensing discussions over the past several years, the EPA has obtained outside economic expertise in order to be able debate the economic impacts of re-licensing decisions with the regulated parties.

The third issue pertains to management of the Snake River system and the Columbia River system, and the impacts on salmon. In virtually all discussions that EPA has had with other federal agencies, the Bonneville Power Adminstration, or any members of the regulated community, a major portion of the discussion has revolved around economics. Issues of electricity rate-setting, impacts on regulated parties and others issues invariably center upon economics. Concentrating on the environmental resources and neglecting the economics has typically resulted in failure to implement EPA's mandates in the end, so being able to use economics in negotiations will continue to be critical.

The fourth issue is the broad issue of enforcement, but has specific applicability to water issues, in that research is needed to ascertain the economic benefits foregone by the states' and EPA's failure to enforce water quality laws. Without some economic basis for determining the damages resulting from water quality violations, EPA cannot determine the appropriate level of penalties.

As an example of how the EPA must increase their commitment to economic analysis, Mr. Clarke noted the example of a discussion he had with the Governor of Idaho, in which they discussed strategies for cleaning up the waters of Northern Idaho. The discussion was primarily economic in nature, in that the impacts on mining industry and the impacts on cities and counties were of concern to the Governor, a much different discussion than would have taken place five or ten years ago. As an example of the need for economic expertise within the resource agencies, one question that EPA needs to answer before negotiating with mining industries is how much can EPA require of the mining industry without compromising their ability to pay for remediation. Further, being ignorant of the economic issues will allow the mining industry to win the political argument and frustrate EPA's regulatory objectives. Mr. Clarke noted in closing that regulatory agencies have done a poor job of dealing with economics in regulatory issues, and failed to anticipate the importance of economics in negotiating with regulated industries. Regulatory agencies in the future must involve economists and make use of economic analysis, or they will be unable to adequately represent the public interest in resource issues.

Introductory Remarks -- Summarization
by Bill O'Neil, US EPA Office of Economy and Environment

Dr. O'Neil's opening remarks pertained to the competitive grant program jointly administered by EPA and the National Science Foundation. EPA will make decisions on funding for proposals submitted in Winter 1999 on May 12. Another request for proposals will be issued in Fall of 1999, which will be due some time in Winter of 2000.

Dr. O'Neil described some of the areas of particular interest to EPA. An area of continuing importance is the valuation of components of ecosystem that are not necessarily consumed by human beings. The components of ecosytsems are still poorly understood, and assessing the importance of these components (in dollar terms or otherwise) will be critical. In economic parlance, it is important to identify the intermediate goods or services provided by the components of ecosystems that contribute to the overall health of ecosystems, which provide more tangible benefits.

EPA is moving away from focusing on traditional pollutants and focusing more upon nutrients and toxic materials, which leads to the exploration of the need to manage, not just control nutrients and toxins. For example, toxins stored in the bottoms of waterbodies might be better left alone than released and stirred up by dredging and removal. Problems with nutrient loading require consideration of non-point sources, including agricultural, construction runoff, and sediment from forestry practices. This in turn requires consideration of best management practices. EPA needs better information about which practices are effective physically, and means of valuing the controls achieved by such practices, so as to be able to assess the cost-effectiveness of different management strategies.

Finally, the need to involve so many different stakeholders and agencies suggests that the division of authority for natural resources at the federal level may be too fragmented. Conflicting and duplicating regulations and overlapping authorities are some of the problems that result from the existence of so many federal agencies. Proposals to look at a better division of responsibility, perhaps even involving the merging of existing agencies or the creation of a new agency, may be of interest to EPA. Integration of the federal, state and local levels of government are necessary as well, so any studies on the proper roles of the different levels might be of interest to EPA as well.

Presentation-- Summarization

by Dennis Wagner, US Army Corps of Engineers, Northwestern Division, and Chair, Drawdown Regional Economic Workgroup

Mr. Wagner opened his presentation by noting that the U.S. Army Corps of Engineers has historically used economic analysis as a key component of its decision-making process, and has expanded the role of economics recently from its traditional role in flood control and navigation studies into environmental issues. The Lower Snake River Juvenile Salmon Migration Feasibility Study is one example of the Corps's use of economic analysis applied to environmental issues. This issue has caused much debate within the region since the listing of the sockeye salmon under the Endangered Species Act in 1991, followed by the listing of the fall, spring and summer chinook salmon in 1992.

In 1995, the National Marine Fisheries Service issued a biological opinion asking for a study of the feasibility of modifying the four dams on the Lower Snake River operated by the Corps to aid recovery of the salmon and ultimately lead to the delisting of the species. Among the alternatives that emerged from the biological opinion were various plans to alter the four dams to achieve free-flowing conditions, including the decommissioning of those dams. The alternatives considered by DREW are 1) maintaining the status quo, 2) making major system improvements such as building surface bypass collectors and guidance structures, 3) removing the earthen bank components of the dams, and 4) conducting a natural river drawdown to simulate free-flowing conditions. Mr. Wagner outlined the process by which the Drawdown Regional Economic Workgroup (the Corps group convened to study the feasibility of different alternatives to aid recovery of listed salmon species, or "DREW") will analyze all of the alternatives, and issue a final report with a recommended course of action sometime in the spring of 2000.

Mr. Wagner identified the four dams on the 120-mile stretch of the Snake River that were included in the study (Ice Harbor, Blue Goose, Lower Granite and Lower Monumental dams), and stated that power generation accounts for 80-90% of the benefits from the dams. The dams have a combined generating capacity of 3000 megawatts, and produce ten to twelve million megawatt-hours of energy in an average water year, or roughly enough to power the city of Seattle. In addition to the large proportion of benefits obtained from power generation, the dams also offer several other benefits. The dams provide navigation benefits: four to six million tons of commodities are shipped down the river, consisting of agricultural products, timber and petroleum. The dams also provide irrigation for 13 farms with 35,000-40,000 acres of cropland behind the Ice Harbor dam. Finally, the dams provide some recreational benefits in terms of boating and other water activities.

Mr. Wagner emphasized that the analysis presented in this workshop is only one of a number of aspects of the dam projects that are being studied, with the economic analysis being contained in the "Socioeconomic Appendix" of DREW's final report. Formally, the economic analysis will evaluate the various economic effects associated with alternative plans to provide for recovery of listed salmon stocks on the Lower Snake River. This

analysis will look at how the alternatives will lead to changes in "national economic development," (changes in goods and services for the nation as a whole), regional employment, and tribal circumstances. Mr. Wagner noted that the Corps is only one of many agencies and organizations participating in the study. This is a divergence from how the Corps has historically performed its economic analysis, which has generally not been in cooperation with other agencies. However, given the great common interest of a broad variety of organizations and agencies in this issue, the Corps believed that a group approach would ultimately be the most effectual. The subjects under analysis by DREW include the effects in the following areas: power, navigation, irrigation, recreation, commercial fisheries, tribal circumstances, implementation costs, cost effectiveness, regional effects, social studies, mitigation requirements, avoided costs, costs allocation, relevant agreements, and uncertainty.

Presentation --Summarization
by Audrey Perino, Bonneville Power Administration

Ms. Perino began her remarks by explaining that Bonneville Power Administration (BPA) markets the power that is generated by the four Lower Snake River dams that are being considered for decommissioning to aid the recovery of the sockeye and chinook salmon. The BPA is the entity that would be most directly affected by removal of the dams. The purpose of her portion of the economic analysis is to value the electricity and other products of the power produced by the four dams. Each dam generates approximate 300 megawatts of power per year, or ten to twelve million kilowatt-hours under average water conditions. To emphasize the uncertainty introduced by water flow variability, Ms. Perino stated that in a dry year, only eight million kilowatt-hours of electricity are produced by the four dams. Along with the electricity produced by the four dams, the dams also support the regional power transmission system and provide other ancillary services.

One method of establishing the cost of decommissioning the four dams is to look at the increase in production costs necessary to replace the lost power generation, typically known as the "production costing method." The increase in costs was calculated by looking at the change in West Coast production costs, since that is the regional power grid that will have to produce the replacement power. A production cost spreadsheet model developed by the Bonneville Power Administration and a U.S. Army Corps of Engineers model called PROSYM were used to calculate the production costs of replacing the lost electricity. The two spreadsheet models demonstrated that loss of the four dams would necessitate the production of 900 megawatts of thermal resources (the best alternative energy source) by the year 2010. Under "medium" market conditions, production costs would amount to $255 million per year, averaged over 100 years. "Medium" market conditions are the use of a set of middle level of assumptions for three potential economic uncertainties: the price of natural gas (an important West Coast resource), the growth of the Pacific Northwest region, and the costs of new resources, such as the cost of building new combustion turbines.

A second method used by BPA to establish the costs of decommissioning the dams was the "pricing method," which calculates the cost of buying replacement electricity from a world-wide market. The prices were developed using the forecasting model AURORA. Historically, only West Coast electricity prices would have been used to calculate power costs, but in light of the deregulation of electric utilities, a world-wide market price for electricity was used. Under "medium" market conditions, the market price multiplied by the generation loss yielded a cost of approximately $220 million over 100 years.

It is also necessary to perform uncertainty analysis. Using the pricing method, the simulations used three pricing scenarios – low, medium and high – of each of the three key economic uncertainties. Three forecasts for each of these uncertainties were included in the simulations. Also, climatic uncertainty was included by using 50 different historical water conditions in the simulations. Assuming an average water year and using different economic conditions, the range of costs is $160 to $360 million annually.

Assuming "medium" market conditions, and using different water conditions, the range of costs is $150 to $300 million annually.

Finally, there is a component of dam decommissioning costs that pertain to the actual costs of decommissioning, the cost of transmission reinforcement, and the loss of ancillary services, which amount to approximately $50 million annually. Thus, assuming medium market conditions, the range of the total costs of decommissioning the four Lower Snake River dams is $250 to $300 million. Also to be included in the analysis (but not included in the estimates reported here) is the cost of a change in air quality resulting from the change in the mix of resources used to produce electricity. Increases in carbon dioxide emissions as well as the costs of conservation measures and renewable energy use will be considered.

Question and Answer Period

Jennifer O'Neal, University of Washington, asked if it was possible to use the models that Ms. Perino used to estimate the costs of decommissioning dams to also estimate the cost of the status quo alternative in terms of ESA compliance costs, or mitigation costs. Ms. Perino replied that it was possible to use these models to analyze many different types of cost scenarios, but was uncertain as to whether the model could be adapted to measure other types of *costs*, since the model is predicated upon the loss of kilowatt-hours as the source increased cost. The problem is that it is unclear as to who ultimately pays for the costs of mitigation.

Tony Prato, University of Missouri, pointed out that if it is the entire country that benefits from the recovery of the salmon, it should be the entire country that pays for its recovery. A second point made by Mr. Prato was that the opportunities to reduce costs through conservation measures are often overlooked. Ms. Perino agreed, and pointed out that DREW was including the possibility of conservation measures in their analysis, but also posed the question of why such conservation measures are not being implemented now, even with the dams in place. Linda Fernandez, University of California at Santa Barbara, followed up by pointing out that along with deregulation has come a freedom on the part of the consumer to choose different electricity sources. Ms. Perino acknowledged the possibility that consumers can opt for cleaner fuel sources, but that in this deregulated atmosphere, there is still an inability to send the correct price signals to consumers for conservation measures. All of the programmatic conservation programs that existed under a regulated economy have now been abandoned because of deregulation.

Presentation -- Summarization
by Phil Benge, US Army Corps of Engineers, Walla Walla District

Mr. Benge presented the progress of the team responsible for analyzing the recreation and tourism component of the economic analysis. The team included the U.S. Army Corps of Engineers, the Northwest Power Planning Council, the Bureau of Reclamation, the National Marine Fisheries Service, and various interest groups. There were twelve members on the team with a variety of backgrounds and experience in recreation and tourism impacts. The team agreed on a number of ground rules, including a team goal of consensus and that the economic analysis would include contingent behavior and existence benefits.

A prior study existed on the recreation and tourism benefits of a drawdown option (i.e., where the dams would be decommissioned and free-flowing conditions restored): the Columbia River Systems Operation Review, completed in 1993, which had a recreation analysis component, but only looked at the existing recreation benefits. The Columbia River review did not address all of the areas of analysis that the Drawdown Regional Economic Workgroup (DREW) wished to address. It lacked an analysis of the changes in recreators' behavior resulting from decommissioning of the dams, and it lacked an estimation of existence value benefits. DREW thus decided to conduct its own recreation and tourism study.

The DREW conducted an inventory of existing recreation facilities, and each was evaluated for suitability of use in a drawdown situation. For example, campground facilities may be less desirable in a drawdown situation, but still usable, while boat launch facilities might become completely unusable. A contractor was obtained to conduct the survey, and assist with development of the survey instruments, which Mr. Benge noted became very political and controversial. The team is currently in the process of reviewing the draft analysis, which had just recently been received from the contractor. The contractors have produced four components of the economic analysis: the existing reservoir general recreation, the existing reservoir angling, the upstream angling above existing resources, and the natural (restored free-flow) river contingent behavior and existence value. The survey evaluating changes in recreators' behavior and existence values will be reviewed by DREW once the team has reviewed it.

Mr. Benge noted that there were several issues and controversies that have occurred thus far in the process of administering the survey. One pertained to the inclusion of existence value as part of the economic analysis. The team agreed to include it, despite the fact that the U.S. Army Corps of Engineers has historically not recognized existence value as valid. A second controversy pertained to the formulation of survey questions to elicit non-hypothetical responses, which was viewed with great concern by the legal counsel for the team, and was ultimately subject to a compromise. A third controversy arose in the context of variations in estimates of use and visitation from different sources, which included some data collected by the Corps, University of Idaho students and some aerial surveys of boating activity. Again, a compromise was struck to resolve a large discrepancy between these estimates.

A fourth controversy arose because the team had originally planned to use an incentive payment in connection with the survey to boost response rates. A $2 bill was planned to be included in the survey, and a $10 reward would be mailed to those who completed the survey. Unfortunately, a misunderstanding on the part of Senator Gorton from Washington that the survey was much broader and costlier than had actually been planned by the team, led to a rejection of the incentive payment plan by the Corps. Senator Gorton's office then also became concerned with the inclusion of existence value in the benefits analysis. Thus, even though the team had decided to include existence values in the benefits analysis, Senator Gorton's opposition led to the ultimate removal of all such questions from the survey. The team decided to use a benefit transfer analysis instead. Other challenges faced by the team included responding to the various political pressures being placed on the team, and maintaining the confidentiality of estimates while distributing draft products to team members.

Question and Answer Period

Jon Goldstein, U.S. Department of Interior, Office of Policy Analysis, asked why existence value is relevant to a recreation and tourism study. Mr. Benge replied that the team was studying the existence value of salmon as a natural resource, not necessarily just the existence value of recreation.

Jennifer O'Neal, University of Washington, asked about the existence value calculation, to which Mr. Benge replied that the existence value estimate was obtained through the benefit transfer calculation. Mr. Meyer stated that he understood that existence value would be treated in stepwise fashion, such that the benefit-cost analysis would be done with and without existence value. Mr. Benge reiterated that the calculation will be mentioned in the report but not included as part of the final benefit-cost analysis.

Edna Loehman, Purdue University, asked if the valuation changes when one considers the possible site substitutions (for boating recreation, for example) that people will make in a drawdown situation. Mr. Benge replied that site substitutions for boating recreationists were considered and will be a part of the study.

Scott Farrow, Carnegie Mellon University, commented that review of the study might be aided if the different impacts were more clearly identified, perhaps in tabular form, in terms of their geographic scope. For example, if one were to ask a question about the fisheries, it is necessary first to identify whether this would be regional issue or just a Snake River issue. Mr. Benge replied that the study area is the Lower Snake area, but conceded that some larger-than-regional issues are important.

Nicole Owens, US EPA Office of Economy and Environment, asked how the recreation and tourism team's benefits estimates compare with Ms. Perino's cost estimates. Mr. Wagner replied that the estimates are not quite complete, but expressed hope that the benefits will be ready in draft form in the next several weeks.

Presentation -- Summarization
by Gary Ellis, US Army Corps of Engineers, Walla Walla District

Mr. Ellis presented the findings of the team responsible for the regional impact analysis for the Drawdown Regional Economic Workgroup (DREW). The charge for the team was to evaluate the various regional economic and social effects associated with the different alternative plans, including jobs created and lost, and impacts on dam operations for the entire 100-year study period. A social impact analysis is being conducted under contract with Foster-Wheeler Corp. The contractor is also performing a regional impact analysis. The regional impact analysis includes estimates of indirect impacts associated with changes in river operations in eight different subregions and covering several different time-periods in the future. The social impact analysis pertains to how communities will be affected by changes caused by decommissioning of the dams, including an analysis of the effect of lower disposable incomes. The complete study will look at changes in all categories, including navigation and irrigation, and the end result will be presented in tabular form, expressed in terms of changes in income and jobs.

The regional analysis will be conducted using various sets of subregions. One set of subregions consists of four states -- Washington, Oregon, Idaho, and Montana. Another set of subregions consists of four different agglomerations of counties: an upriver region, those areas upstream of the dams considered for decommissioning, a reservoir subregion near or around the existing reservoirs, a downriver region below the the dams considered for decommissioning, and a subregion that combines all of these three smaller subregions. The upriver subregion extends into Central Idaho, is a large agricultural and recreational area. This subregion would certainly benefit from increased salmon runs, particularly since the Salmon River (which is in this subregion), is still open for salmon spawning. The reservoir subregion around the existing reservoirs includes many dryland farms and runs from Walla Walla, Washington to Lewiston, Idaho. This subregion would also benefit from increased salmon runs. The downriver subregion extends well beyond the Snake River and almost to the City of Portland, Oregon. This subregion may benefit from increased fishing and also from shipping ports moving from the Snake River to the Columbia River, but may be negatively affected by the loss of approximately 35,000 acres of agricultural production. Finally, one model simulation will combine all three of these subregions, and total the changes in all of the categories.

Mr. Ellis outlined the potential direct spending effects. They include recreational expenditures, capital expenditures for power replacement, changes in household income, changes in transportation costs of farmers who have had their products shipped via barge. The analysis assumes that all of the land that is farmed now will remain in farming after the drawdown, although it is assumed that some of the farmers with higher equity will buy out those with marginal farming operations. Farmers will lose some disposable income as a result of increased transportation costs.

Some change in farmland use will occur, however, and in the area around the Ice Harbor dam, which relies heavily upon the dam for irrigation, some income and jobs will be lost. These farmers will have to make pump modifications to continue to operate their farms.

The capital expenditures associated with decommissioning of the dams should provide a temporary boost to the local economies, for approximately a decade. There should be lower costs of operation and maintenance due to lower maintenance needs of a drawdown alternative.

Mr. Ellis's team is also responsible for the social impact analysis, which pertains to how communities will be affected by and how they adjust to the changes brought on by decommissioning of the dams. How did these communities react to similarly adverse economic developments in the past? One community lost its primary employer, a mill operation, but adjusted by developing a strong recreational rafting industry. Seventeen different communities were chosen to represent a variety of sizes, interests and industries. Focus groups and community forums were conducted by Foster-Wheeler and the University of Idaho in each of these communities. A report summarizing the discussions of these focus groups is forthcoming.

Question and Answer Period

Jon Goldstein, Department of Interior Office of Policy, asked Mr. Ellis if he could discuss some specific problems that have been encountered by his team in the analytical process. Specifically, Mr. Goldstein was surprised to hear that his team assumed that all agricultural land would remain in production after a drawdown, considering that the irrigation and transportation system would be removed. Mr. Goldstein also asked how coefficient estimates were being estimated, and whether or not indirect as well as direct effects were being examined, and what macro-economic multipliers were being used. Mr. Ellis responded that the assumption of agricultural lands was not an important one, since only the 35,000 acres of irrigated land near the Ice Harbor dam will be lost. With respect to the other two questions, Mr. Ellis responded that they were better directed to the contractor, Foster-Wheeler.

Edna Loehman, Purdue University, asked about the structure of the public meetings. Mr. Ellis responded that there was an established four-hour format and a pre-focus group practice meeting. Often, farmers wished to come in and express their opinions, rather than participating in a focus group, but the researchers were able to avoid this problem in the actual meetings. The findings will be part of the social analysis component of the DREW report.

Tony Bynum, from the Yakama Nation, commended the U.S. Army Corps of Engineers on their efforts to study this social aspect of a drawdown alternative. Mr Bynum also asked if there were communities outside of the subregions that were considered in the social impact analysis. Mr. Bynum commented that the drawdown alternative clearly has national implications, and social effects affecting communities and activities beyond those currently under study. In particular, increased salmon runs may result in some new and positive social impacts. Dennis Wagner, U.S. Army Corps of Engineers Northwestern Division, replied that the models using states as subregions are picking up some of these effects. Mr. Bynum suggested that perhaps one or more outside communities might be used as control groups, such that the team could at least calibrate

their study to see how the social impact might diminish further away one moves from the project.

Presentation -- Summarization
by Phil Meyer, Meyer Resources, Inc.

Mr. Meyer commended the U.S. Army Corps of Engineers for undertaking for the first time a consideration of tribal circumstances. Mr. Meyer noted that the Corps has had a history of ignoring tribes' needs, and tribes have had a history of not trusting the Corps.

Mr. Meyer stated that it was important to address methodological issues. Tribal assessments must necessarily be multicultural, and must not rely upon narrowly defined procedures. Assessments must employ a broad framework, and must include "groundtruthing," or the double-checking of the reasonableness of the findings, and the invitation of feedback from the subjects being studied. It is critical to avoid "cultural encapsulation,"[1] or the substitution of model stereotypes for actual characteristics, the disregard of cultural variations, and the use of technique-oriented definitions of process.

Mr. Meyer lauded the federal initiative on environmental justice. The President's executive order on environmental justice requires that people be treated fairly regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies. Moreover, no such group should bear a disproportionate share of the negative environmental consequences from industrial, municipal and commercial operations or the execution of federal, state, local, and tribal programs and policies. In addition, the EPA's Interim Final Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analysis identifies Native American communities as at-risk, and provides more specific guidance where the natural and physical environments of tribes are implicated.

With respect to the Lower Snake River and the Drawdown Regional Effects Workgroup, impacts were considered for five tribes: the Nez Perce Tribe, the Yakama Indian Nation, the Confederated Tribes of the Umatilla Indian Reservation and the Confederated Tribes of the Warm Springs Reservation of Oregon. The report also assesses impacts on the Shoshone-Bannock peoples, who reside further upriver from the Snake River drainage. For all of these tribes except the Shoshone-Bannock, salmon was their most important food. For the Shoshone-Bannock, salmon was also traditionally very important. Mr. Meyer cited some statements from elder tribe members emphasizing the central importance of salmon to these tribes.

Mr. Meyer reviewed the major treaties with the five tribes, which involved the loss of over 40 million acres of land in return for the agreement to move onto 12.2 million acres of reservation land. The right to take fish in all streams, however, was reserved by the tribes, an interpretation that has been upheld in court decisions. Furthermore, the treaties were negotiated when the rivers were biologically functional and fully productive, and the argument can be made that the right to harvest is from a "fully productive" river, not one that has been altered by dam construction.

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[1] Sue. D.W. and D. Sue. (1990) "Counseling the Culturally Different: Theory and Practice." John Wiley & Sons, New York. pp 8-9.

Mr. Meyer reviewed some statistics on the present circumstances of the six tribes. Each had high rates of poverty, ranging from 26.9% to 43.8%, while non-tribal people in Washington, Oregon and Idaho have poverty rates ranging from 9.7% to 12.4%. Unemployment ranges from 19.3% to 26.5% among the tribes and 5.7% to 6.2% among non-tribal people. Per capita income in the tribes ranges from $4,300 to $8,700, as compared to $11,500 to $14,900 among non-tribal people. Mr. Meyer pointed out, however, that tribal spokespersons are uncomfortable with statistical representations of tribal circumstances, as some feel that there is a tendency to place the blame for poverty with the tribal people. However, Mr. Meyer presented some statistics showing that fish harvests have declined precipitously. The Nez Perce annual harvest has declined from 2.8 million pounds in prior to the treaty, to 1.6 million after the treaty in the mid-1800's, to 160,000 pounds today. The Umatilla and the Warm Springs tribes annually harvested 6.9 million pounds before the treaty, 2.6 million pounds after the treaty in the mid-1800's, and 77,000 pounds today. Some initial declines in harvest may have been due to illegal obstructions of access, but in more recent times have clearly been due to the transformation of the rivers accomplished by dam construction. Mr. Meyer stated that tribes have also lost originally reserved lands by force or by ex post facto legislation. Even in the presently depressed circumstances, salmon have remained of central importance for the tribes.

Mr. Meyer reviewed the alternatives being considered by DREW and their effects on salmon harvests. The drawdown alternative would clearly be the one most favored by the tribes, and the only one that moves towards restoring the rights reserved by the tribes under the original treaties. While the non-drawdown alternatives would result in increases of tribal catches of seven or eight percent (a continued violation of the treaties), the drawdown alternative increases present tribal salmon catches by an estimated 29% within 25 years.

In conclusion, Mr. Meyer stated that the drawdown alternative is the only one that is consistent with U.S. treaty obligations towards the tribes, and the only one that can lead to an improvement in tribal circumstances.

Question and Answer Period

Jon Goldstein, US Department of the Interior Office of Policy Analysis, commented that the environmental justice mandate referred to by Mr. Meyer is only an executive order, so is of limited status for enforcement purposes, but the treaties with Native American tribes have a much more binding effect in law. Mr. Goldstein noted the treaties called for a specific percentage of harvest of a "fully functioning river system," a very specific requirement. Mr. Goldstein asked Mr. Meyer how enforceable he thought this requirement was, and whether there is any requirement that this be monetized. Mr. Meyer demurred, noting that he was not an attorney and stating that this was essentially a legal question. Although tribes have generally won cases involving treaties, these cases

have been rare. Mr. Meyer opined that the real question is whether society will opt to choose a policy direction that is less adverse to Native Americans.

Scott Farrow, Carnegie Mellon University, commented that it would benefit Native American tribes if they could provide strong economic evidence of their damages and hardship. Mr. Meyer responded that the problem has been that tribes have trouble monetizing the loss of some goods and rituals that are religious in nature. Mr. Meyer noted that nevertheless, "there may be bills to be paid down the road" in damage claims and lawsuits, but did not wish to present that work in this conference, and added that if one only took the economic aspect, the commercial value of the lost salmon harvest, one would obtain a gross under-representation of the damages.

John Tanaka, Oregon State University, asked a question about a point that Mr. Meyer made about the accuracy of economic estimates versus the reasonableness of estimates, and whether the "ground-truthing" investigations proposed by Mr. Meyer might benefit from social sciences in adding an aspect of reasonableness. Mr. Meyer replied that he felt that he would have characterized the two methods in the exact opposite way, that social sciences could provide accuracy, while ground-truthing could provide some assurance of reasonableness. Mr. Meyer added that because of his experience, he is probably more comfortable with broader ranges of variability in information, and with ordinal ranking of alternatives, rather than cardinal measures. At any rate, Mr. Meyer opined that the suggestion that one can accurately measure tribal values with cardinal measures is a faulty one.

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ECONOMIC RESEARCH AND POLICY CONCERNING WATER USE AND WATERSHED MANAGEMENT

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Adoption of Soil and Water Protection Practices Among Land Owner-Operators in Three Midwest Watersheds

--Working Paper*--

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Adoption of Soil and Water Protection Practices
Among Land Owner-Operators in Three Midwest Watersheds

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Introduction

Erosion of agricultural crop land remains a significant socio-environmental issue within the United States (US) primarily due to the adverse impacts of soil displacement on water quality. While soil erosion can create adverse on-site problems, a large proportion of the negative environmental consequences of soil erosion is associated with off-site damages (Halcrow, et al., 1982; Napier, et al, 1983). Some of the most commonly recognized on-site costs associated with soil erosion of agricultural land are loss of soil fertility, loss of chemical fertilizers, loss of resale value of crop land, loss of aesthetic value of land, and loss of wildlife habitat. Some of the most important off-site costs of soil erosion of crop land are sedimentation of streams and lakes, disruption of transportation systems, costs associated with making water potable, loss of recreation use of water resources, loss of wildlife habitat, loss of aesthetic value of water resources, and threats to human and animal health (Napier and Sommers, 1994; Napier, et al., 1983; Page, 1987).

The major difference between on-site and off-site damages caused by soil erosion is that on-site costs adversely affect owners of eroding land, while off-site costs primarily affect populations that do not own eroding farm land. Land owner-operators are usually concerned about on-site damages and will take corrective action to reduce erosion, if soil loss begins to adversely affect agricultural productivity of land resources and reduce farm income. Unfortunately, land owner-operators frequently ignore environmental degradation caused by soil erosion because they recognize that on-site damages are relatively inconsequential and that the economic costs associated with controlling erosion are quite high. Land owner-operators also know that costs associated with monitoring erosion at the farm level are extremely high which prevents government agencies from forcing land owners to internalize the off-site costs associated with agricultural pollution.

Given the high costs of monitoring nonpoint pollution and the reluctance of land owner-operators to assume the costs of implementing soil and water conservation production systems at the farm level, many farmers continue to employ production systems that contribute to environmental degradation. Without more extensive adoption of conservation production systems by farmers in the US, it is highly unlikely that national water quality goals will be achieved.

While public policies and intervention programs are needed to motivate land-owner operators to adopt and to continue use of conservation production systems at the farm level, such initiatives cannot be effectively implemented without knowing what factors contribute to adoption and/or rejection of such production systems. Unfortunately, existing research does not provide adequate evidence to establish public policies or to implement effective intervention programs. It is clear, however, that failure to adopt conservation production systems at the farm level cannot be attributed to the lack of technological solutions. Technologies and techniques have been in existence for many years to resolve practically any erosion problem (Lal and Stewart, 1995; El-Swaify, et al., 1985). The major barriers to adoption of conservation production systems at the farm level are socioeconomic in nature (Halcrow, et al., 1982, Lovejoy and Napier, 1986; Napier, et al., 1983). Until the socioeconomic barriers are identified and eliminated, little advancement will be made in further reduction of agricultural pollution in the US.

Research conducted since the early 1980s (Halcrow, et al, 1982; Lovejoy and Napier, 1986; Napier, et al, 1999_a; Napier, et al., 2000; Swanson and Clearfield, 1994) strongly suggest that new theoretical perspectives need to be examined because traditional models have been shown to be inadequate for predicting conservation adoption behaviors at the farm level. Existing research basically demonstrates that many variables commonly thought to affect conservation adoption behaviors at the farm level are not useful for predicting adoption behaviors across broad geographic regions. Some of the factors shown not to be good predictors of conservation adoption behaviors at the farm level are as follows: access to various types of information/education programs, characteristics of the farm enterprise, characteristics of the primary farm operator, awareness of environmental degradation, favorable attitudes toward conservation, possession of pro-environmental ethics, attitudes toward the environment, and access to government subsidies (Halcrow, et al, 1982; Lovejoy and Napier, 1986; Napier and Johnson, 1998; Napier, et al., 1999_a; Napier, et al., 1999_b ; Swanson and Clearfield, 1994).

While economic incentives can motivate land owner-operators to adopt conservation production systems, economic subsidies used to encourage adoption often must equal or exceed social and economic costs associated with adoption (Napier, et al., 1994; Napier, et al., 1999_a). Most existing subsidy programs offered by government conservation agencies do not provide sufficient economic incentives to adequately off-set the costs associated with adoption of conservation production systems. When subsidies are sufficiently high to facilitate adoption of conservation production systems, the subsidies must be maintained over time or rejection will occur when they are

withdrawn. Rejection of conservation production systems after subsidies have been terminated nearly always results in loss of conservation investments because most land owner-operators will employ previously used production systems that degrade soil and water resources.

While many socio-economic variables have been assessed in the context of adoption of conservation production systems at the farm level, perceived impacts of adopting conservation production systems on the farm enterprise and the relative importance placed on factors used to make farm-level production decisions have not been examined. The purpose of this paper is to present the findings of a study designed to examine how such factors influence adoption of conservation production systems at the farm level in three Midwest watersheds. Study findings are discussed in the context of conservation programs within the three watersheds.

A Vested Interests Perspective

The theoretical perspective used to guide the investigation was developed from utilitarian components of social learning (Bandura, 1971) and social exchange (Ekeh, 1974) theories. The theoretical perspective was termed the "vested interests" model. The theoretical model basically posits that human beings are reward seeking and punishment avoiding creatures who attempt to achieve net benefits in every social situation. While individuals may not aspire to maximize profits in every decision-making situation, they always seek to balance costs and benefits in a manner that will produce net benefits for themselves. The model argues that many types of costs and benefits are considered in the decision-making process. Social, psychosocial, economic, and environmental benefits and costs of alternative action options are considered.

The vested interests model asserts that human beings evaluate people, places, and things in the context of potential benefits to be derived from contact with them. The model suggests that human beings evaluate things positively that will produce net benefits and will define negatively those things that will result in net losses. The outcomes of these assessments affect actions taken.

Action options that are perceived positively will have a higher probability of being implemented favorably than action options perceived negatively.

Land owner-operators are constantly assessing alternative action options and making decisions about adoption of agricultural production systems in the context of the outcomes of their evaluations. The vested interests

model suggests that farmers will make production decisions in terms of the assessments of benefits and costs associated with alternative action options and that land owner-operators will adopt production systems that will generate the best combination of benefits achievable under constraints of ability to act factors.

Many factors affect the outcomes of the adoption decision-making process. Farmers who perceive that adoption of conservation production systems will result in a decrease in farm output and/or an increase in farm production costs will tend not to adopt such production systems because costs will be increased with no corresponding increase in benefits. Farmers who place higher levels of importance on access to economic and technical assistance when making decisions about adoption of new agricultural production systems will have a higher probability of adopting conservation production systems because economic subsidies and technical assistance are often offered to cooperating land owners to reduce some of the costs associated with adoption. Land owner-operators who place greater importance on costs of new production systems, risks associated with trying an alternative production system, and on demonstrated profitability of alternative production systems when making adoption decisions will have a lower probability of adopting conservation production systems because such systems are usually not profitable in the near-term and often not in the long-term (Batte, 1995; Mueller, et al., 1985; Putman and Alt, 1987). If profits are not expected, farmers will tend to be very reluctant to adopt. Farmers who place higher importance on the threat of agricultural pollution and government regulations governing agriculture when making adoption decisions will have a higher probability of adopting conservation production systems because such systems can reduce agricultural pollution and are more consistent with government regulations designed to protect environmental quality (Halcrow, et al., 1982; Swanson and Clearfield, 1994). Land owner-operators who place higher importance on access to information/education programs when making adoption decisions will have a higher probability of adopting conservation production systems because they will be more aware of the many non-economic benefits associated with adoption.

Research Methodologies

Descriptions of Study Watersheds: Data to examine the merits of the theoretical perspective used to guide the study were collected from 1,011 primary farm operators within three Midwest watersheds. A watershed was selected from each of three states to represent different types of production agricultural systems within different geographical regions of the Midwest. The data were collected in the fall of 1998 and the winter of 1999.

Ohio respondents were operating farms in a watershed located in the central part of the state close to the western suburbs of Columbus. Iowa respondents were operating farms in a watershed in northeast part of the state located west and south of Dubuque. Minnesota respondents were farming land in a watershed in the southeastern part of the state located west and south of Minneapolis.

The study watersheds were purposely selected to provide diversity in terms of agricultural specialization, topography of the land, and the distribution of population throughout the watershed. The watersheds ranged in size from approximately 350,000 acres for the Ohio watershed to over 1.4 million acres for the Minnesota watershed. The topography of the watersheds ranged from flat to gently rolling in Ohio to gently rolling to quite steep slopes in Iowa. The topography of the Minnesota watershed was flat in the flood plain with steep slopes rising to a plateau where the land became flat. The Ohio watershed is being rapidly invaded by suburbs, while the Iowa and Minnesota watersheds have been immune from suburbanization due to the distance to the nearest large city.

Farm operations within the three watersheds were quite different. Farmers within the Ohio watershed specialized in the production of grain, while Iowa and Minnesota farmers produced both feed grains and animals for market. Minnesota respondents were active in the production of dairy products.

Data Collection Techniques: Data were collected using a structured questionnaire that requested information about agricultural production systems in use at the time of the study. The questionnaire also requested information about perceived profitability of conservation production systems and the importance placed on a number of factors farmers commonly consider when making decisions about adoption of agricultural production systems.

The data were collected using a drop-off-pick-up-later technique that consisted of trained field-staff persons selecting every other occupied residence within specified sampling areas within the watersheds.[1] Field-staff persons contacted respondents at the farmer's home and explained the purpose of the study. Questionnaires were left in the possession of primary farm operators who agreed to participate in the study. Field staff persons arranged a convenient time to collect

completed questionnaires. When questionnaires were retrieved, field-staff persons answered all inquiries made about the study instruments to ensure that respondents were correctly interpreting the questions.

The sample distribution was monitored throughout the data collection phase of the project using detailed county maps. Each field-staff person was asked to note the approximate location of each respondent on a map of their sampling area to provide a visual distribution of the study sample. Inspection of the maps provided by each field-staff person revealed that respondents were widely distributed over each sampling area.

A total of 105 primary farm operators in the Ohio watershed, 355 primary farm operators in the Iowa watershed, and 551 primary farm operators in the Minnesota watershed completed questionnaires. The response rate for each watershed was about 80 percent. Given the large sample size, the broad distribution of the sample throughout the study watersheds, the high response rate, and the sampling technique used to select the sample, it is argued that the samples are representative of the farm populations within the three watersheds.

Measurement of Study Variables: Agricultural production systems used at the time of the study were measured using 18 production practices that could be employed on Midwest farms. Primary farm operators were asked to indicate how often **each** farm production practice was used on his/her farm. The production practices evaluated were as follows: fall tillage, fall application of fertilizer, soil testing, no till, chisel plowing with 1/3 ground surface covered with crop residue at planting time (conservation tillage), ridge tillage, deep (moldboard) plowing, winter application of manure, banded (in furrow) application of fertilizer, side dressing of fertilizer during growing season, banded (in furrow) application of herbicides, mechanical weed control, use of nitrification

inhibitor, crop rotation, contour planting, buffer strips, integrated pest management, and precision farming.

Possible responses to each of the agricultural production practices were as follows: never use, once every 5 years, once every four years, once every three years, every other year, use every year. Weighting values for the responses ranged from 0 for **Never Use** to 5 for **Use Every Year** for all of the agricultural practices except fall tillage, fall application of fertilizer, deep plowing, and winter application of manure whose weighting values were reversed. This method of weighting the responses resulted in higher values representing greater use of conservation production systems.

A composite index was calculated from the responses to the 18 production practices in use at the time of the study. Weights assigned to responses to the various production practices were multiplied by values to reflect environmental impacts of each production practice.[2] Fall tillage, deep plowing, and winter application of manure were defined as being the worst types of farm production practices assessed in terms of contributing to environmental degradation. Conversely, no till and chisel plowing with 1/3 ground cover with crop residue at planting time were defined as being the most environmentally benign of the practices assessed. Original weights assigned to responses to these five agricultural practices were multiplied by 2 to give greater emphasis to adoption of these practices (see Table 2). Since the responses had been initially weighted to reflect positive or negative environmental impacts, multiplying by 2 resulted in doubling scores (both positive and negative) for these five practices. The computed values for all of the production practices were summed to form a composite index termed **conservation production index**. The range of possible scores was theoretically 0 to 115, however, farmers tend to specialize in production practices which would preclude farmers from adopting both no till and chisel plowing with 1/3 ground cover at planting time. The index score for each respondent was used as the dependent variable for regression modeling.

The independent variables selected to represent various components of the vested interests model are as follows: perceived changes in production costs, perceived changes in output, required subsidy to adopt, and the importance of 8 factors used to make agricultural production adoption decisions. The independent variables were measured as follows:

"Perceived changes in production costs" was measured by asking respondents to indicate how farm production costs would change if his/her farm was operated in a manner to protect water from being polluted by agricultural

chemicals and to prevent soil erosion beyond replacement levels. The possible responses ranged from **Large Decrease** (weighted -3) to **Large Increase** (weighted 3).

"Perceived changes in output" was measured by asking respondents to indicate how farm output would change if his/her farm was operated in a manner to protect water from being polluted by agricultural chemicals and to prevent soil erosion beyond replacement levels. The possible responses ranged from **Large Decrease** (weighted -3) to **Large Increase** (weighted 3).

"Required subsidy to adopt" was measured by asking respondents to indicate how many dollars per acre would have to be received to adopt conservation tillage systems. The value entered by each respondent was used for the statistical analysis.

Eight factors commonly used by farmers to make adoption decisions about new agricultural production systems were assessed by asking respondents to indicate the importance placed on "Access to government subsidy programs," "Access to technical assistance," "Cost of new production systems," "Level of risk associated with trying new production systems," "Access to information/education programs," "Concern for agricultural pollution," Demonstrated profitability of production practice," and "Government regulations." The possible responses ranged from **Not At All Important** (weighted 0) to **Extremely Important** (weighted 3).

Statistical Analysis: Descriptive and multivariate statistics were used to analyze the study data. Descriptive statistics were used to examine general trends within the study responses, while

stepwise regression analysis was employed to assess the relationships among the predictive variables when all were considered simultaneously.

Missing data for the 18 production practices assessed in the study were assigned the weighting value for "never use." It was assumed that respondents who did not elect to provide information about specific practices did so because they never use the practice. Missing data for the independent variables were attributed the variable mean which has been shown to be the most efficient means of salvaging observations when the number of observations is large, the correlations are relatively low, and the number of missing cases is small (Donner, 1982). All of these conditions were satisfied with the data set.

Study Findings

Descriptive findings are presented in Tables 1 through 5. Characteristics of the study samples are presented in Table 1 and show that respondents in the Minnesota watershed were slightly younger, slightly better educated, and had been engaged in farming their own land fewer years than farm operators in the Ohio and the Iowa watersheds. Primary farm operators in the Ohio watershed reported farming more acres of land than farmers in the Iowa and Minnesota watersheds. Ohio land owner-operators reported owning more land and renting more land for

farming purposes than did farmers in the Iowa and Minnesota watersheds. Iowa respondents reported the lowest percentage of farm income derived from grain, however, they reported the highest percentage of farm income derived from animal production. Minnesota farmers reported the highest level of debt.

Farmers in the Ohio watershed reported the lowest percentage of farm labor contributed by the primary farm operator, even though study findings revealed that primary farm operators in all of the study watersheds contributed a large majority of farm labor. A much larger percentage of land owner-operators in the Ohio watershed reported receiving government financial assistance than farmers in the other watersheds, even though the greatest percentage of farmers in all of the watersheds did not receive financial assistance from the government. Minnesota farmers reported receiving very little financial support and little technical assistance from government sources. A majority of primary farm operators in the Ohio and the Minnesota watersheds reported that they believe their children will operate their farms in the future. A majority of land owner-operators in the Iowa watershed did not expect their farms to be operated by their children in the future.

Respondents in the Ohio watershed indicated that they were operating farms much closer to a city of 50,000 or more than land owner-operators in the other watersheds. This is one of the major reasons that farm land within the Ohio watershed is being rapidly converted to nonagricultural uses (Napier and Johnson, 1998).

Gross farm incomes in the study watersheds indicate that land owner-operators are generating extensive revenues. Approximately 16.2 percent of the Ohio farmers reported gross farm income exceeding $360,000 during the 1997 crop year, while the percentage of farmers in the Iowa and Minnesota watersheds reporting such levels of gross farm income was 7.3 percent and 4.7 percent respectively. One of the reasons for this level of income is that Ohio farmers report cultivating over 826.4 acres of land.

(Table 1 about here)

Findings for the various production practices assessed in the study are presented in Table 2 and show that fall tillage was being used extensively in all watersheds. Fall application of fertilizers was being used by a minority of farm operators in all watersheds with the highest use in the Ohio watershed. Soil testing was one of the most widely used conservation practices assessed and was commonly used in all three watersheds. No till was used extensively in Ohio but not in the other watersheds. Chisel plowing with 1/3 ground cover at planting time was used

frequently in the Minnesota watershed and less so in the other two watersheds. Moldboard plowing was used extensively in Minnesota but not in the other watersheds.

Winter application of manure was frequently practiced in the Minnesota and Iowa watersheds and less so in the Ohio watershed. Banded application of fertilizer was seldom used in the Minnesota watershed, however, a significant minority of farmers in the Ohio and the Iowa watersheds used this production practice. Side dressing of fertilizer during the growing season was not used very often in the Iowa and Minnesota watersheds, however, a significant minority of farmers in the Ohio watershed used this practice. Banded application of herbicides was not used extensively in any of the study watersheds. Mechanical weed control was practiced extensively in the Iowa and Minnesota watersheds but not in the Ohio watershed. Crop rotation was used frequently in all watersheds. Use of ridge tillage, nitrification inhibitors, buffer strips, integrated pest management, and precision farming were not used very often in any of the watersheds assessed in the study.

(Table 2 about here)

Findings for perceptions about how production costs would change if the respondent's farm was operated in a manner to protect water from pollution by farm chemicals and to prevent soil loss beyond replacement level are presented in Table 3. These findings show that primary farm operators in all three watersheds believed that production costs would slightly increase. The

greatest increase was expected by Ohio farmers. The lowest expected loss was reported by Minnesota farmers.

(Table 3 about here)

Findings for perceptions about how farm output would change if the respondent's farm was operated in a manner to protect water from pollution by farm chemicals and to prevent soil loss beyond replacement level are presented in Table 4. The findings show that farmers in all three watersheds expected farm output to slightly decrease if farms were operated in a manner to protect soil and water resources.

(Table 4 about here)

Findings for the importance placed on the eight factors frequently used to make decisions about the adoption of new farm technologies at the farm level are presented in Table 5. These findings show that most of the factors posited to be extremely important to primary farm operators when they are engaged in making decisions

about the adoption of new farm production systems are not as important as commonly thought among farmers in the study watersheds. Access to information/education programs were perceived to be of slight importance in all of the study watersheds and of least importance in the Minnesota watershed. All of the other factors assessed were shown to be slightly important or of significant importance. No factor assessed was reported to be extremely important in the decision making process when evaluated in terms of the mean scores. The highest ranked factor was demonstrated profitability which received a mean ranking of 3.3 among Ohio farmers, 3.2 among Iowa farmers and 2.7 among Minnesota farmers. A value of over 3 indicates that farmers in the Ohio and Iowa watersheds placed significant importance on demonstrated profitability when making adoption decisions about new agricultural production systems. The mean value for Minnesota farmers was 2.7 which indicated a level of importance between slight and significant.

(Table 5 about here)

Multiple regression analysis was used to assess the merits of the theoretical perspective used to guide the investigation. The variance in the **conservation production index** was regressed against the selected independent variables and the findings are presented in standardized regression coefficient form. All coefficients presented are significant at the 0.05 level.

Ohio regression findings:

$Y = 0.344X_1 + 0.283X_2$

Where Y = Conservation Production Index

X_1 = Access to information/education programs

X_2 = Level of risk associated with trying new production systems

Adjusted coefficient of determination (R^2) = 0.190

Iowa regression findings:

$Y = 0.273X_1 + 0.173X_2$

Where Y = Conservation Production Index Score

X_1 = Access to government subsidy

X_2 = Access to information/education programs

Adjusted coefficient of determination (R^2) = 0.110

Minnesota regression findings:

$$Y = 0.168X_1$$

Where Y = Conservation Production Index Score

X_1 = Demonstrated profitability of production practice

Adjusted coefficient of determination (R^2) = 0.024

Conclusions

Study findings basically repudiate the theoretical model used to predict adoption of conservation production systems within the Minnesota watershed and only slightly support the theoretical model within the Ohio and Iowa watersheds. The findings also demonstrated that multiple factors purported to affect adoption of new agricultural production systems at the farm level were not as useful as commonly thought in the decision making process relative to adoption of conservation production systems at the farm level. These findings strongly suggest that use of such factors to develop intervention programs within all three watersheds will result in only minor changes in conservation adoption behaviors of land owner operators.

Failure of the 8 criteria variables to explain adoption of conservation technologies and techniques in this study is very surprising because many adoption studies have reported these factors to be very important in the decision making process regarding adoption of new farm technologies and techniques (Napier, et al, 1999_b ; Rogers, 1995). Study findings strongly suggest that the criteria used to make adoption decisions about conservation production systems within the study watersheds are quite different from those used to make decisions about other types of farm technologies and techniques that could be integrated within the farm production systems presently in use within the watersheds. The failure of the criteria variables used in this study to predict adoption behaviors may be due to the fact that most conservation production practices are not profitable in the near- or in the long-term, while other farm technologies and techniques are nearly always more profitable than what presently exist. Diffusion-type variables, such as those used in this study, may only be effective predictors when the innovation being diffused is more profitable than what is presently in use.

Footnotes

1. Systematic random sampling was abandoned in the Ohio watershed because it became apparent after several weeks of data collection that it would be extremely difficult to locate 105 primary farm operators using the sampling approach initially employed. Most land owners within the watershed rent their crop land to large-scale producers to receive lower taxes associated with agricultural use until they sell the land for development purposes. Given the problems of locating farmers, anyone located within the sampling area who was engaged in production agriculture for a living was included in the study sample.

2. A panel of knowledgeable people were used to determine what practices should be defined as being the most environmentally benign and what practices should be classified as being abusive of the environment. The weights used to compute the composite index were determined using the same approach.

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Table 1: Characteristics of Study Respondents: Ohio (n=105), Iowa (n=355), and Minnesota (n=551)

	Ohio	Iowa	Minnesota
Age			
Mean	48.6 yrs	49.1 yrs	46.2 yrs
S.D.	11.9	11.8	11.1
Education			
Mean	12.7 yrs	12.8 yrs	13.0 yrs
S.D.	2.1	2.4	1.6
Years Farming			
Mean	23.8 yrs	24.9 yrs	21.3 yrs
S.D.	13.4	12.5	12.5
Acres Usually Cultivated			
Mean	826.4 ac	378.7 ac	421.1 ac
S.D.	896.1	470.4	493.9
Acres Owned			
Mean	283.3 ac	265.6 ac	233.7 ac
S.D.	461.1	248.6	187.3
Acres Rented			
Mean	498.8 ac	189.1 ac	316.7 ac
S.D.	610.1	265.2	623.2
Days Usually Worked Off Farm			
Mean	50.8 days	55.6 days	95.2 days
S.D.	94.4	95.8	104.0
Source of Farm Income			
Grain	68.6%	45.0%	62.1%
Animals	16.0%	39.9%	26.3%
Debt-to-Asset Ratio			
0-10	32.4%	20.5%	12.0%
11-20	12.4%	12.9%	9.4%
21-30	9.5%	14.0%	14.9%
31-40	7.6%	9.6%	16.2%
41-50	4.8%	10.4%	11.4%
51-60	6.7%	5.9%	7.8%
61-70	2.9%	1.1%	4.5%
71-80	1.9%	2.2%	4.0%
81-90	1.0%	0.3%	1.1%
91-100	0.0%	0.3%	0.0%
Missing	21.0%	22.8%	18.7%

Table 1: (continued)

	Ohio	Iowa	Minnesota
Percent Labor by Primary Farm Operator			
Mean	68.1%	76.4%	78.9%
S.D	27.0	21.6	20.9
Received Government Economic Support			
Yes	21.0%	15.7%	5.8%
No	79.0%	84.3%	94.2%
Received Technical Assistance			
Yes	27.6%	28.4%	8.7%
No	72.4%	71.6%	91.3%
Distance to City of 50,000 or Higher Population			
Mean	21.6 miles	49.9 miles	45.3 miles
S.D.	9.8	22.6	22.5
Farm Will be Operated by My Children in the Future			
Yes	55.2%	40.7%	52.1%
No	44.8%	59.3%	47.9%
Gross Farm Income			
< 59,999	21.9%	19.7%	8.6%
60,000-119,999	18.1%	23.6%	12.7%
120,000-179,999	12.4%	12.6%	22.5%
180,000-239,999	8.7%	13.2%	27.4%
240,000-299,999	4.8%	5.1%	10.4%
300,000-359,999	2.9%	2.8%	2.4%
360,000 >	16.2%	7.3%	4.7%
Missing	15.2%	15.7%	11.4%

Table 2: Use of Agricultural Production Practices at the Farm Level: Ohio (n=105), Iowa (n=355), and Minnesota (n=551)

	Frequency of Use								
	Never Use	Once Every 5 Yrs.	Once Every 4 Yrs.	Once Every 3 Yrs.	Every Other Year	Use Every Year	MD	X	SD
Fall Tillage *									
Ohio	19 (18.1)	7 (6.7)	4 (3.8)	14 (13.3)	22 (21.0)	36 (34.3)	3 (2.9)	1.8	1.9
Iowa	80 (22.5)	22 (6.2)	17 (4.8)	41 (11.5)	52 (14.6)	115 (32.3)	28 (8.1)	2.1	1.9
Minn.	49 (8.9)	5 (0.9)	0 (0.0)	5 (0.9)	30 (5.4)	454 (82.4)	8 (1.5)	0.6	1.5
Fall Application of Fertilizer*									
Ohio	25 (23.8)	3 (2.9)	3 (2.9)	14 (13.3)	15 (14.3)	37 (35.2)	8 (7.6)	1.9	2.0
Iowa	174 (48.9)	12 (3.4)	13 (3.7)	35 (9.8)	37 (10.4)	48 (13.5)	36 (10.4)	3.3	1.9
Minn.	202 (36.7)	49 (8.9)	19 (3.4)	53 (9.6)	74 (13.4)	133 (24.1)	21 (3.8)	2.7	2.1

	Never Use	Once Every 5 Yrs.	Once Every 4 Yrs.	Once Every 3 Yrs.	Every Other Year	Use Every Year	MD	X	SD
Soil Testing**									
Ohio	9 (8.6)	8 (7.6)	4 (3.8)	34 (32.4)	24 (22.9)	21 (20.0)	5 (4.8)	3.2	1.5
Iowa	8 (2.2)	32 (9.0)	41 (11.5)	164 (46.1)	45 (12.6)	30 (8.4)	35 (10.1)	2.9	1.1
Minn.	62 (11.3)	28 (5.1)	31 (5.6)	177 (32.1)	102 (18.5)	132 (24.0)	19 (3.4)	3.2	1.5
No-Till**									
Ohio	20 (19.0)	2 (1.9)	1 (1.0)	6 (5.7)	15 (14.3)	53 (50.5)	8 (7.6)	3.6	1.9
Iowa	201 (56.5)	16 (4.5)	3 (0.8)	23 (6.5)	24 (6.7)	42 (11.8)	46 (13.2)	1.3	1.8
Minn.	451 (81.9)	30 (5.4)	11 (2.0)	12 (2.2)	4 (0.7)	14 (2.5)	29 (5.3)	0.3	1.0

	Never Use	Once Every 5 Yrs.	Once Every 4 Yrs.	Once Every 3 Yrs.	Every Other Year	Use Every Year	MD	X	SD
Chisel Plowing with 1/3 Ground Surface Covered with Residue at Planting**									
Ohio	26 (24.8)	7 (6.7)	4 (3.8)	13 (12.4)	20 (19.0)	30 (28.6)	5 (4.8)	2.8	2.0
Iowa	88 (24.7)	16 (4.5)	12 (3.4)	39 (11.0)	56 (15.7)	112 (31.5)	32 (9.3)	2.9	2.0
Minn.	127 (23.0)	10 (1.8)	7 (1.3)	23 (4.2)	81 (14.7)	285 (51.7)	18 (3.3)	3.5	2.0
Ridge Tillage**									
Ohio	103 (98.1)	2 (1.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.2	0.1
Iowa	340 (95.8)	2 (0.6)	3 (0.8)	4 (1.1)	2 (0.6)	4 (1.1)	0 (0.0)	0.1	0.7
Minn.	524 (95.1)	5 (0.9)	2 (0.4)	1 (0.2)	1 (0.2)	18 (3.3)	0 (0.0)	0.2	0.9

	Never Use	Once Every 5 Yrs.	Once Every 4 Yrs.	Once Every 3 Yrs.	Every Other Year	Use Every Year	MD	X	SD
Deep (Moldboard) Plowing*									
Ohio	49 (46.7)	12 (11.4)	1 (1.0)	3 (2.9)	8 (7.6)	23 (21.9)	9 (8.6)	3.2	2.1
Iowa	155 (43.5)	56 (15.7)	20 (5.6)	48 (13.5)	18 (5.1)	21 (5.9)	37 (10.7)	3.4	1.7
Minn.	135 (24.5)	22 (4.0)	4 (0.7)	25 (4.5)	49 (8.9)	295 (53.5)	21 (3.8)	1.6	2.1
Winter Application of Manure*									
Ohio	56 (53.3)	4 (3.8)	3 (2.9)	2 (1.9)	1 (1.0)	32 (30.5)	7 (6.7)	3.2	2.2
Iowa	65 (18.3)	4 (1.1)	5 (1.4)	9 (2.5)	17 (4.8)	226 (63.5)	29 (8.4)	1.4	2.1
Minn.	200 (36.3)	10 (1.8)	4 (0.7)	21 (3.8)	40 (7.3)	254 (46.1)	22 (4.0)	2.1	2.3

	Never Use	Once Every 5 Yrs.	Once Every 4 Yrs.	Once Every 3 Yrs.	Every Other Year	Use Every Year	MD	X	SD
Banded (in furrow) Application of Fertilizer**									
Ohio	41 (39.0)	8 (7.6)	3 (2.9)	1 (1.0)	3 (2.9)	42 (40.0)	7 (6.7)	2.6	2.3
Iowa	134 (37.6)	9 (2.5)	6 (1.7)	15 (4.2)	12 (3.4)	143 (40.2)	36 (10.4)	2.6	2.2
Minn.	405 (73.5)	47 (8.5)	4 (0.7)	5 (0.9)	20 (3.6)	70 (12.7)	0 (0.0)	0.9	1.8
Side-Dressing of Fertilizer During Growing Season**									
Ohio	36 (34.3)	4 (3.8)	3 (2.9)	8 (7.6)	7 (6.7)	41 (39.0)	6 (5.7)	2.7	2.2
Iowa	160 (44.9)	12 (3.4)	13 (3.7)	33 (9.3)	23 (6.5)	76 (21.3)	38 (11.0)	1.9	2.0
Minn.	340 (61.7)	21 (3.8)	7 (1.3)	6 (1.1)	32 (5.8)	116 (21.1)	29 (5.3)	1.5	2.1

	Never Use	Once Every 5 Yrs.	Once Every 4 Yrs.	Once Every 3 Yrs.	Every Other Year	Use Every Year	MD	X	SD
Banded Application of Herbicides**									
Ohio	71 (67.6)	1 (1.0)	1 (1.0)	4 (3.8)	1 (1.0)	17 (16.2)	10 (9.5)	1.1	1.9
Iowa	208 (58.4)	6 (1.7)	2 (0.6)	18 (5.1)	21 (5.9)	58 (16.3)	42 (12.1)	1.4	1.9
Minn.	290 (52.6)	15 (2.7)	37 (6.7)	7 (1.3)	38 (6.9)	164 (29.8)	0 (0.0)	2.0	2.3
Mechanical Weed Control**									
Ohio	47 (44.8)	5 (4.8)	14 (13.3)	8 (7.6)	3 (2.9)	28 (26.7)	0 (0.0)	2.0	2.1
Iowa	24 (6.7)	3 (0.8)	6 (1.7)	13 (3.7)	32 (9.0)	244 (68.5)	33 (9.6)	4.4	1.4
Minn.	77 (14.0)	0 (0.0)	1 (0.2)	11 (2.0)	34 (6.2)	404 (73.3)	24 (4.4)	4.2	1.7

	Never Use	Once Every 5 Yrs.	Once Every 4 Yrs.	Once Every 3 Yrs.	Every Other Year	Use Every Year	MD	X	SD
Use of Nitrification Inhibitor**									
Ohio	60 (57.1)	2 (1.9)	3 (2.9)	5 (4.8)	6 (5.7)	17 (16.2)	12 (11.4)	1.4	1.9
Iowa	224 (62.9)	7 (2.0)	5 (1.4)	29 (8.1)	10 (2.8)	26 (7.3)	54 (15.4)	0.9	1.5
Minn.	353 (64.1)	10 (1.8)	11 (2.0)	29 (5.3)	42 (7.6)	63 (11.4)	43 (7.8)	1.2	1.8
Crop Rotation**									
Ohio	2 (1.9)	0 (0.0)	2 (1.9)	6 (5.7)	12 (11.4)	75 (71.4)	8 (7.6)	4.6	0.9
Iowa	10 (3.1)	5 (1.4)	14 (3.9)	81 (22.8)	90 (25.3)	155 (43.5)	0 (0.0)	4.0	1.2
Minn.	57 (10.3)	4 (0.7)	4 (0.7)	17 (3.1)	66 (12.0)	403 (73.1)	0 (0.0)	4.3	1.6

	Never Use	Once Every 5 Yrs.	Once Every 4 Yrs.	Once Every 3 Yrs.	Every Other Year	Use Every Year	MD	X	SD
Contour Planting**									
Ohio	85 (81.0)	0 (0.0)	1 (1.0)	0 (0.0)	2 (1.9)	7 (6.7)	10 (9.5)	0.5	1.4
Iowa	109 (30.6)	6 (1.7)	3 (0.8)	11 (3.1)	9 (2.5)	175 (49.2)	42 (12.1)	3.1	2.2
Minn.	454 (82.4)	0 (0.0)	3 (0.5)	2 (0.4)	5 (0.9)	52 (9.4)	35 (6.4)	0.6	1.5
Buffer Strips**									
Ohio	65 (61.9)	3 (2.9)	2 (1.9)	0 (0.0)	1 (1.0)	21 (20.0)	13 (12.4)	1.3	2.0
Iowa	162 (45.5)	16 (4.5)	11 (3.1)	13 (3.7)	7 (2.0)	99 (27.8)	47 (13.5)	1.9	2.1
Minn.	440 (79.9)	2 (0.4)	2 (0.4)	5 (0.9)	6 (1.1)	60 (10.9)	0 (0.0)	0.7	1.6

	Never Use	Once Every 5 Yrs.	Once Every 4 Yrs.	Once Every 3 Yrs.	Every Other Year	Use Every Year	MD	X	SD
Integrated Pest Management**									
Ohio	73 (69.5)	14 (13.3)	4 (3.8)	2 (1.9)	0 (0.0)	12 (11.4)	0 (0.0)	0.8	1.6
Iowa	218 (61.2)	11 (3.1)	8 (2.2)	8 (2.2)	8 (2.2)	54 (15.2)	48 (13.8)	1.2	1.8
Minn.	420 (76.2)	5 (0.9)	4 (0.7)	3 (0.5)	6 (1.1)	77 (14.0)	36 (6.5)	0.8	1.8
Precision Farming**									
Ohio	90 (85.7)	2 (1.9)	1 (1.0)	0 (0.0)	1 (1.0)	11 (10.5)	0 (0.0)	0.6	1.6
Iowa	297 (83.7)	5 (1.4)	4 (1.1)	7 (2.0)	5 (1.4)	37 (10.4)	0 (0.0)	0.7	1.6
Minn.	422 (76.6)	37 (6.7)	3 (0.50)	2 (0.4)	5 (0.9)	82 (14.9)	0 (0.0)	0.9	1.8

*Weighted 5 through 0 with "never use" receiving a value of 5 and "use every year" a value of 0.
**Weighted 0 through 5 with "never use" receiving a value of 0 and "use every year" receiving a value of 5.

Ohio conservation production index score: mean = 50.0 Standard deviation: 13.1
Iowa conservation production index score: mean = 48.9 Standard deviation: 13.1
Minnesota conservation production index score mean = 38.5 Standard deviation: 13.0

Table 3: Perceptions of How Production Costs Would Change If Farm Operated in an Manner to Protect Water Quality and Soil Fertility: Ohio (n=105), Iowa (n=355), and Minnesota (n=551)

State	Possible Responses								
	Large Decrease -3	Moderate Decrease -2	Slight Decrease -1	NO Change 0	Slight Increase 1	Moderate Increase 2	Large Increase 3	M.D.	$\bar{X}$ S.D.
Ohio	2 (1.9)	3 (2.9)	9 (8.6)	32 (30.5)	20 (19.0)	33 (31.4)	6 (5.7)	0 (0.0)	0.8 1.3
Iowa	4 (1.1)	13 (3.7)	41 (11.5)	105 (29.6)	108 (30.4)	63 (17.7)	21 (5.9)	0 (0.0)	0.6 1.2
Minnesota	10 (1.8)	33 (6.0)	62 (11.3)	190 (34.5)	141 (25.6)	91 (16.5)	24 (4.4)	0 (0.0)	0.4 1.3

$\bar{X}$=Mean
M.D.=Missing data
S.D.=Standard deviation

Table 4: Perceptions of Land Owner-Operators About How Farm Output Would Change If Farm Was Operated in a Manner to Protect Water Quality and Soil Fertility: Ohio (n=105), Iowa (n=355), Minnesota (n=551)

State	Possible Responses									
	Large Decrease -3	Moderate Decrease -2	Slight Decrease -1	NO Change 0	Slight Increase 1	Moderate Increase 2	Large Increase 3	M.D.	$\bar{X}$	S.D.
Ohio	4 (3.8)	12 (11.4)	26 (24.8)	46 (43.8)	14 (13.3)	1 (1.0)	2 (1.9)	0 (0.0)	-0.4	1.1
Iowa	12 (3.4)	52 (14.6)	105 (29.6)	128 (36.1)	32 (9.0)	18 (5.1)	8 (2.3)	0 (0.0)	-0.4	1.2
Minnesota	20 (3.6)	62 (11.3)	115 (20.9)	230 (41.8)	71 (12.9)	44 (8.0)	9 (1.6)	0 (0.0)	-0.2	1.3

$\bar{X}$= Mean
M.D.= Missing data
S.D.= Standard deviation

Table 5: Importance Placed on Factors Affecting Experimentation With New Agricultural Production Systems: Ohio (n=105), Iowa (n=355), and Minnesota (n=551)

Factor Affecting Decision	Possible Responses: Not at All Important 0	Of Little Importance 1	Of Slight Importance 2	Of Significant Importance 3	Extremely Important 4	Mean	S.D.
1. Access to government subsidy programs							
Ohio	19 (18.1)	8 (7.6)	26 (24.8)	27 (25.7)	25 (23.8)	2.4	1.4
Iowa	42 (11.9)	53 (14.9)	101 (28.5)	79 (22.3)	80 (22.5)	2.4	1.2
Minnesota	74 (13.4)	101 (18.3)	173 (31.4)	156 (28.3)	47 (8.5)	2.0	1.1
2. Access to technical assistance							
Ohio	14 (13.3)	7 (6.7)	24 (22.9)	41 (39.0)	19 (18.1)	2.6	1.1
Iowa	45 (12.7)	32 (9.0)	126 (35.5)	113 (31.8)	39 (11.0)	2.3	1.0
Minnesota	61 (11.1)	76 (13.8)	172 (31.2)	182 (33.0)	60 (10.9)	2.3	1.1

Table 5: continued

3.Cost of new production systems							
Ohio	12 (11.4)	4 (3.8)	13 (12.4)	30 (28.6)	46 (43.8)	3.0	1.2
Iowa	53 (14.9)	19 (5.4)	31 (8.7)	143 (40.3)	109 (30.7)	2.9	1.2
Minnesota	68 (12.3)	58 (10.5)	128 (23.2)	169 (30.7)	128 (23.2)	2.5	1.2
4. Level of risk associated with trying new production system							
Ohio	11 (10.5)	3 (2.9)	15 (14.3)	40 (38.1)	36 (34.3)	3.0	1.1
Iowa	43 (12.1)	22 (6.2)	67 (18.9)	130 (36.6)	93 (26.2)	2.8	1.1
Minnesota	77 (14.0)	66 (12.0)	135 (24.5)	181 (32.8)	92 (16.7)	2.3	1.2

Table 5: continued

5. Access to information/ education programs							
Ohio	15 (14.3)	6 (5.7)	34 (32.4)	37 (35.2)	13 (12.4)	2.4	1.0
Iowa	44 (12.4)	31 (8.7)	118 (33.2)	129 (36.3)	33 (9.3)	2.4	1.0
Minnesota	85 (15.4)	131 (23.8)	166 (30.1)	128 (23.2)	41 (7.4)	1.9	1.1
6. Concern for agricultural pollution							
Ohio	9 (8.6)	3 (2.9)	17 (16.2)	53 (50.5)	23 (21.9)	2.9	0.9
Iowa	29 (8.2)	15 (4.2)	78 (22.0)	149 (42.0)	84 (23.7)	2.9	0.9
Minnesota	54 (9.8)	100 (18.1)	148 (26.9)	179 (32.5)	70 (12.7)	2.3	1.1

Table 5: continued

7. Demonstrated profitability

Ohio	10 (9.5)	3 (2.9)	10 (9.5)	34 (32.4)	48 (45.7)	3.3	0.9
Iowa	36 (10.2)	6 (1.7)	33 (9.3)	141 (39.7)	139 (39.2)	3.2	0.8
Minnesota	57 (10.3)	54 (9.8)	92 (16.7)	204 (37.0)	144 (26.1)	2.7	1.2

8. Government regulations

Ohio	15 (14.3)	7 (6.7)	21 (20.0)	36 (34.3)	26 (24.8)	2.6	1.2
Iowa	46 (13.0)	13 (3.7)	71 (20.0)	152 (42.8)	73 (20.6)	2.8	1.0
Minnesota	78 (14.2)	154 (27.9)	116 (21.1)	134 (24.3)	69 (12.5)	2.0	1.2

A National Water Pollution Control Assessment Model

--Working Paper*--

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A National Water Pollution Control Assessment Model

Timothy Bondelid, Research Triangle Institute
Charles Griffiths, U.S. EPA
George Van Houtven, Research Triangle Institute

I. Introduction

A. Good Morning, my name is Charles Griffiths and I am an economist in the Office of Policy at the US EPA.

B. Today I will present some work being conducted on a national water pollution control assessment model

C. I think that it is important that I emphasize my role in this project

1. This is a work-in-progress that has been going on for a number of years
2. I only began working on this project about one year ago and I have primarily worked on sensitivity analysis and goodness of fit
3. The primary water quality modeler is Tim Bondelid
4. George Van Houtven has done most of the economic work up until this point

D. My apologies to my discussant for the length of the paper

E. I will not be able to cover everything

1. I will outline the fundamentals of the model
2. I will illustrate the type of model results obtained
3. I will discuss the work done on sensitivity analysis and goodness-of-fit for the model.

II. The purpose of this research

A. To build a national-level water quality model. It is a major undertaking simply to wire together all of the river systems in the country

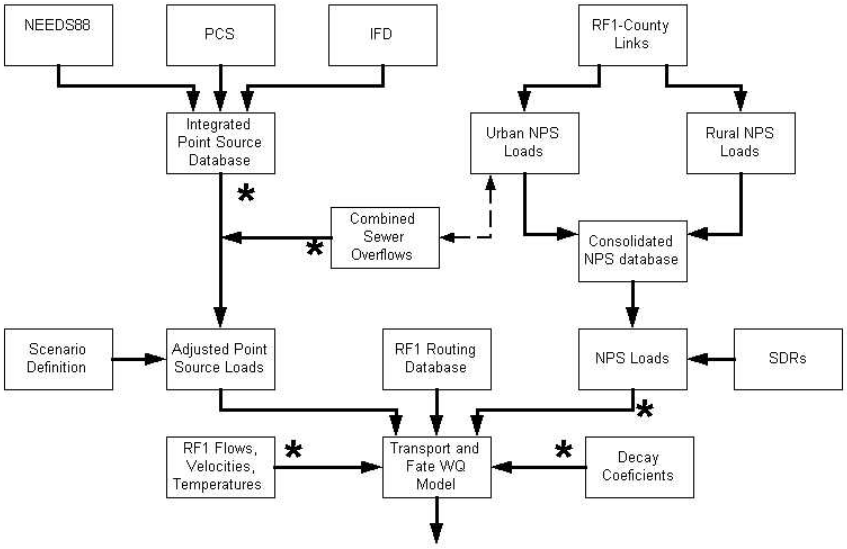
B. To evaluate the effect of water pollution control policies on water quality.

C. To measure the economic benefits associated with water pollution control policies

III. Overview of the Model

A. The National Water Pollution Control Assessment Model, which goes by the unwieldy acronym NWPCAM, can be described as:

1. national-level model of conventional pollutants in the major inland rivers and streams, larger lakes and reservoirs, and some estuarine waters in the lower 48 states.
2. This is done using the EPA's Reach File 1 framework, which covers 320,000 miles of rivers, lakes, reservoirs, and estuaries.
3. The model predicts ambient concentrations of 5 day biological oxygen demand (BOD), dissolved oxygen (DO), total suspended solids (TSS), and fecal coliform along all river reaches.
4. The model controls for loadings from both point and non-point sources, using stream flow and stream velocity data and a first-order decay equation to model pollutant fate.
5. The system includes most waters affected by major industrial, municipal, and CSO point sources.
6. These modeled pollutants form the basis for linking water quality to the Resources for the Future water quality ladder. This ladder is the basis for assigning four categories of beneficial use support (swimming, fishing, boating, and no use support) for each element in the NWPCAM.
7. These use support categories can then be used to measure the economic benefits to persons living near improved waters.

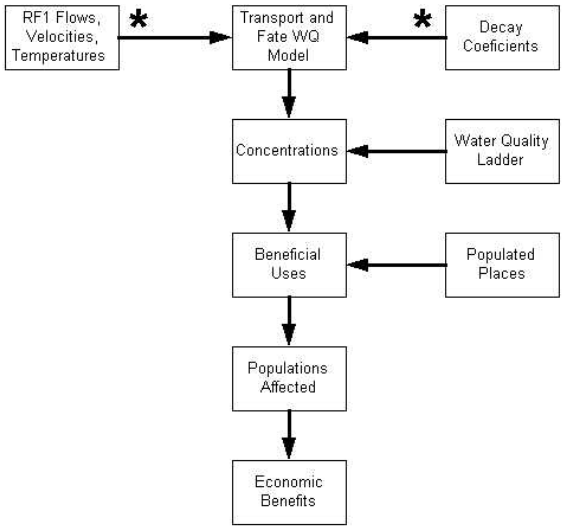


III. Overview of the model, cont'd.

B. Schematic of the model components and processes

1. The central component of the NWPCAM is the RF1 routing model. To this routing framework is added the point source loads from municipal sources, industrial sources, and combined sewer overflows; non-point sources; stream flow, velocities, and temperatures; and pollutant decay coefficients. This allows the fate and transport modeling of pollutant concentrations for each sub-reach.

2. The upper left portion shows the construction of the point sources from the 1988 NEEDS survey, the Permit Compliance System, and the Industrial Facilities Discharger database, and data on combined sewer overflows
3. The upper right portion shows the construction of non-point source loadings from both urban and rural areas. The Sediment Delivery Ratio (SDR) is a coefficient that represents the reduction of pollutant loading as it goes from the field-level discharge to the waterways.



4. The pollutant concentrations are then compared to a water quality ladder to determine the beneficial use of each river reach.
5. The number of households proximate to those reaches can then be used to measure the economic benefit of improvements in water quality.
6. Areas of the model that have been checked for sensitivity have been marked with an *.

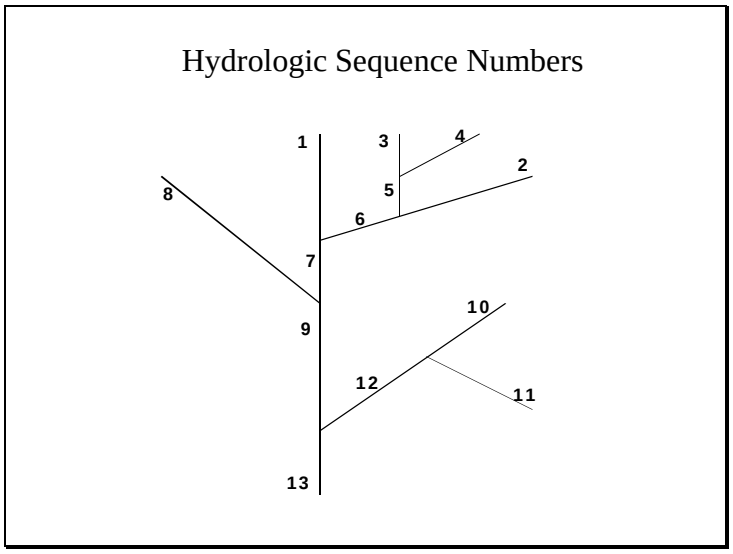
The RF1 System

IV. Reach Files

A. The EPA Reach Files are a series of hydrologic databases created expressly to perform hydrologic modeling and to provide a unique identifier for each surface water feature. This unique identifier is called the "reach code."

B. Reach File version 1, or RF1, contains approximately 632,000 miles of rivers, streams, and larger lakes.

C. RF1 is presently being superceded by RF3 that covers 3.6 million stream miles and includes intermittent, or non-perennial, streams. The reason that the NWPCAM continues to be modeled using RF1 is because crucial data such as stream flow and velocity is not available for RF3.



D. The key to the RF1 routing system is the Hydrologic Sequence Numbers

1. This is a stylized schematic of a river system.
2. Each river reach is an uninterrupted stretch of water, ending at a branch point, and is given a unique hydrologic sequence number.
3. The sequence numbering in the schematic is designed to allow the computer to quickly and efficiently model downstream flow.

E. The RF1 system contains approximate 68.000 reaches, with the average reach about 10 miles long. Since the entire effect of a pollutant discharge could occur in a 10 mile stretch, the NWPCAM is broken into 1-mile or shorter increments call computational elements. The expanded system includes approximately 655,000 computational elements.

NWPCAM Loadings Circa 1990s

All	Count	BOD, ton/yr	TSS, ton/yr
Municipal	14,063	874,262	929,262
Major	2,606	731,952	5,699,736
Minor	47,994	1,119,557	1,639,758
In NWPCAM			
Municipal	9,890	524,005	576,557
Major	2,261	664,056	3,569,373
Minor	24,854	386,760	926,955
On Coast			
Municipal	365	232,716	218,856
Major	194	55,664	838,869
Minor	1319	183,319	119,172
On Great Lakes			
Municipal	96	16,194	17,922
Major	54	2,954	608,593
Minor	135	1,066	20,713
Other Loads			
CSOs	505[a]	1,308,500	4,805,500
Rural NPS	43,097[b]	1,572,500	60,355,500
Urban NPS	16,399[b]	274,500	4,007,000

V. Pollutant loadings

A. Point source loadings data for municipal wastewater treatment plants and major industrial dischargers comes from the 1988 NEEDS survey and the Permit Compliance System.

B. Point source loadings from minor industrial dischargers comes from the Industrial Facilities Discharger database.

C. The table shows that the NWPCAM captures about 70% of the municipal dischargers, almost 90% of the major industrial dischargers, and half of the minor industrial dischargers.

D. Non-point source loadings are estimate by county for rural and non-rural areas, with the final load reaching the river reach dependent upon the watershed specific sediment delivery ratio.

E. These pollutant loadings are calculated for circa 1990 levels, which is the model "baseline."

F. These pollutant loadings can be adjusted for specific scenarios. Of particular interest is the hypothetical scenario of water quality in the absence of the Clean Water Act. This scenario can be modeled by changing the baseline loadings from their current national average, defined as 82% effective removal of influents, to the 1972 level of 62% effectiveness.

First-order Decay

$$\frac{dc}{dt} = K * c,$$

where

dc/dt = instantaneous change in concentration
K = decay rate (/d)
c = pollutant concentration (mg/L)

$$C_t = C_0 * e^{(Kt)}$$

where

C_0 = concentration at time zero
C_t = concentration at time t

VI. Hydrologic Modeling

A. The fate of BOD, TSS, and fecal coliform is assumed to be driven by a simple, but widely used first-order decay process. The instantaneous change in the pollutant concentration is a function of the pollutant concentration times the decay rate.

B. The closed-form solution of this equation specifies that the concentration at time t is a product of the concentration at time zero and an exponential decay.

C. The trick to this modeling approach is to pick the correct value for k. Using other studies as a guide, the decay coefficient for BOD and fecal coliform are -0.2 and -0.8 respectively.

D. The decay coefficient for TSS is a function of the "settling velocity," set at a default value of -0.3.

E. Dissolved oxygen is modeled differently, as a more complicated interaction of oxygen demand from organic materials, the sediment oxygen demand, reaeration from the atmosphere, and the saturation concentration of DO.

NWPCAM Water Quality Ladder

Beneficial Use	Fecal Coliforms (MPN/100 mL)	Dissolved Oxygen (mg/L) / (% sat.)	5-day BOD (mg/L)	Total Suspended Solids (mg/L)
Drinking	0	7.0 / 90	0	5
Swimming	200	6.5 / 83	1.5	10
Game Fishing	1000	5.0 / 64	3.0	50
Rough Fishing	1000	4.0 / 51	3.0	50
Boating	2000	3.5 / 45	4.0	100

VII. Economic Benefits

A. Use support is calculated using a modified version of the RFF water quality ladder.

1. The original water quality ladder used DO, BOD, fecal coliform, pH, an dturbidity to distinguish five beneficial use categories: drinking, swimming, game fishing, rough fishing, and boating.
2. pH is not modeled so it is not included in the water quality ladder used in the NWPCAM.
3. Turbidity was converted to TSS using standard conversion techniques.
4. Drinking water was dropped as a category.
5. Game fishing and rough fishing were collapsed into one fishing category.

B. Use support is determined for each computational element based upon the most limiting factor among the four pollutants.

C. If any criteria is in exceedence for boating, the element is classified as having “no use support.”

D. Economic benefits are determined by using the Carson-Mitchell household’s willingness to pay values for populations proximate to RF1 waters experiencing changes.

Reaches at or downstream of point sources

VIII. Assessing the results

A. The NWPCAM provides two types of outputs

1. The number of miles meeting the designated uses defined in the water quality ladder.

2. A database containing the use support and pollutant concentrations for each of the 655,000 computational elements.

B. One of the tasks of assessing these results is defining what constitutes an improvement from one scenario to the next. Since the ultimate goal is to provide estimates of economic benefits, we use the change in the number of miles meeting various designated uses, but we should recognize that this is a discreet metric to assess changes in pollutant concentrations that occur on a continuous scale. A policy scenario that decreases pollutant loads from point sources creates improvements, although perhaps infinitesimally, in every reach downstream of those point sources. However, if these changes are not sufficient to move a reach from one beneficial use category to the next, then that reach is considered to have had no improvement using the water quality ladder.

C. Another task is to define the base from which to assess this change.

1. If our goal is to simulate improvements from point sources, then we must limit our analysis to reaches affected by these sources.

2. Of the 632,552 stream miles, only 288,034 are downstream of a point source.

3. Additionally 91,353 miles are already suitable for swimming, so no improvement can be made, leaving 196,681 of improvable miles.

Miles of Use Support Under "No Control" and "Zero Discharge" Scenarios for Reaches that are at or Downstream of Any Point Sources

"No Control" Scenario	"Zero Discharge"		
	Swimming (Miles)	Fishing (Miles)	Boating (Miles)
Swimming	91,353		
Fishing	14,446	81,428	
Boating	3,706	7,856	14,853
No Support	15,203	15,990	5,614

D. Even the 196,681 miles of improvable waters is not the correct base from which to assess changes since some downstream reaches may not improve because of non-point source pollution.

E. to find the base of improvable reaches, it is necessary to compare the scenario without the Clean Water Act, that is using the 1972 level of influent removal, with the scenario of zero discharge.

1. This table shows the reaches that improved if there were no point source pollution at all.
2. The main diagonal shows the miles that did not change in use support. For example, 814,000 miles that were fishable but not swimmable at 1972 removal levels remained fishable but not swimmable with 100% effective point source influent removal.
3. 62,815 miles improved in use support with zero point source discharge.

F. It is to these 63,000 miles that we should compare the effectiveness of using the 1990 effectiveness of 82% influent removal.

Sensitivity Analysis

Variable Changed	Degree of Change	Swimmable (Miles)	Fishable (Miles)	Boatable (Miles)	No Use Support (Miles)
Baseline		238,627	424,712	475,894	156,658
Flow	+25%	258,267	443,217	490,666	141,885
Flow	-25%	214,517	399,813	453,868	178,684
Vel	+25%	233,822	417,225	469,291	163,261
Vel	-25%	245,776	435,508	484,480	148,072
Ybar	+25%	230,629	416,343	471,865	160,687
Ybar	-25%	251,973	434,724	479,962	152,590
P.S.	+25%	236,389	421,575	472,792	159,759
P.S.	-25%	241,458	428,534	478,927	153,625
NPS	+25%	218,968	403,960	459,655	172,897
NPS	-25%	267,243	449,685	494,129	138,423
CSO	+25%	238,383	424,071	475,291	157,260
CSO	-25%	238,886	425,436	476,541	156,010
SOD	+25%	238,627	424,712	475,894	156,658
SOD	-25%	238,627	424,712	475,894	156,658
KTSS	+25%	248,380	432,656	479,214	153,338
KTSS	-25%	228,993	413,657	470,403	162,149
KBOD	+25%	239,553	428,516	480,621	151,931
KBOD	-25%	237,527	419,848	469,418	163,133
KFC	+25%	238,688	424,712	475,895	156,657
KFC	-25%	238,510	424,712	475,894	156,658
AllUse	+25%	340,296	495,597	526,051	106,500
AllUse	-25%	179,420	340,963	405,946	226,606

IX. Sensitivity Analysis

A. The purpose of sensitivity analysis is to

1. Provide a range to bracket the baseline values
2. Determine which variables had the most significant effect
3. Test the model for hypersensitivity

B. Miles of use support

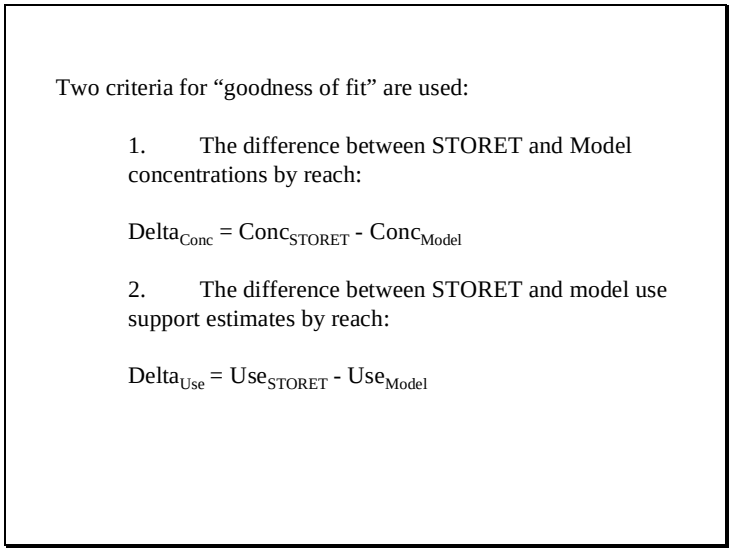
1. This table shows the effect of changing various parameters up or down 25%.
2. The first row shows the number of miles in each use support category under the baseline. Notice that the numbers do not sum to the total 632,000 miles. This is because the 238,627 miles that are swimmable are also fishable, and the fishable and swimmable miles are also boatable. Therefore, the 476,000 boatable miles include the swimmable and fishable miles as well. Note that the boatable miles plus the no use support miles do add to the required 632,552 miles.
3. Each of the other rows represent the model runs with one parameter increased or decreased by 25%. The last two rows show the model results if all of the above parameters were increased or decreased by 25%.

Sensitivity Analysis - Percent Change from Baseline Runs

Variable Changed	Degree of Change	Swimmable	Fishable	Boatable	No Use Support
Baseline		0.00%	0.00%	0.00%	0.00%
Flow	+25%	8.23%	4.36%	3.10%	-9.43%
Flow	-25%	-10.10%	-5.86%	-4.63%	14.06%
Vel	+25%	-2.01%	-1.76%	-1.39%	4.22%
Vel	-25%	3.00%	2.54%	1.80%	-5.48%
Ybar	+25%	-3.35%	-1.97%	-0.85%	2.57%
Ybar	-25%	5.59%	2.36%	0.85%	-2.60%
P.S.	+25%	-0.94%	-0.74%	-0.65%	1.98%
P.S.	-25%	1.19%	0.90%	0.64%	-1.94%
NPS	+25%	-8.24%	-4.89%	-3.41%	10.37%
NPS	-25%	11.99%	5.88%	3.83%	-11.64%
CSO	+25%	-0.10%	-0.15%	-0.13%	0.38%
CSO	-25%	0.11%	0.17%	0.14%	-0.41%
SOD	+25%	0.00%	0.00%	0.00%	0.00%
SOD	-25%	0.00%	0.00%	0.00%	0.00%
KTSS	+25%	4.09%	1.87%	0.70%	-2.12%
KTSS	-25%	-4.04%	-2.60%	-1.15%	3.51%
KBOD	+25%	0.39%	0.90%	0.99%	-3.02%
KBOD	-25%	-0.46%	-1.15%	-1.36%	4.13%
KFC	+25%	0.03%	0.00%	0.00%	0.00%
KFC	-25%	-0.05%	0.00%	0.00%	0.00%
AllUse	+25%	42.61%	16.69%	10.54%	-32.02%
AllUse	-25%	-24.81%	-19.72%	-14.70%	44.65%

C. Percentage change from the baseline

1. The total number of miles is hard to read, so this table shows the percentage of miles changed from the baseline.
2. The parameters that have the largest impact are the flow variable and the non-point source contribution.
    a. The flow variable is calculated from reaches with USGS gauging stations and estimated for other reaches, so it can be checked.
    b. The sensitivity of the non-point source contribution suggests that more attention needs to be paid to this variable.
3. Parameters with moderate impact on the results are the velocity, Ybar (i.e., the average stream depth), and the decay factor for TSS.
4. Note that the effect of point source loadings does not have a significant impact on the use support designation. This is result must be viewed with caution since we are now using all of the river reaches in the model once again. To get the correct effect of the point source loadings, we would have to use the correct base as described previously.



X. Goodness of fit

A. To get a measure of how well the model is predicting, it is necessary to compare it to some known, true values. In this case, the only data that comes close to meeting this criterion is STORET data. This data contains true water quality measures, but it is reported to the EPA by the states and is not checked for correctness nor consistency of methods. It is far from the random sample that we would desire for measuring the predictive capacity of the model. Nevertheless, it is the best data available and so we will treat it as our truth.

B. We use two criteria for goodness of fit.

1. The most obvious is the difference between the STORET concentration levels and those predicted by the model.

2. Since this model ultimately is to be used to measure beneficial uses, we also measure the difference between the STORET and the model estimates of use support.

NWPCAM Results Compared to STORET for DO

	Concentration (mg/l)			Use Support (0, 1, 2, 3)		
Statistic	STORET	Model	Delta	STORET	Model	Delta
N	3,455	3,455	3,455	3,455	3,455	3,455
Mean	7.72	8.46	-0.74	2.75	2.95	-0.20
Std. Dev.	1.59	1.16	1.63	0.60	0.32	0.67
Skewness	-0.63	-1.97	0.22	-2.76	-7.58	-1.11
Kurtosis	2.16	12.75	4.36	7.80	60.5	7.81
90%	9.55	10.21	0.90	3	3	0
75%	8.75	8.92	0.17	3	3	0
Median	7.85	8.42	-0.67	3	3	0
25%	6.90	7.95	-1.63	3	3	0
10%	5.80	7.62	-2.60	2	3	-1

C. DO

1. Note that a negative number implies that the model is over predicting.
2. The model over predicts for DO concentrations, but not by much.
3. We now have to question what is the proper measure of central tendency. Mean is traditional, but it is affected by outliers. Given the degree to which the model spikes after a point source, the median may be a better guide.
4. The model over predicts concentrations using the median as well.
5. The model is very close in predicting use support.

NWPCAM Results Compared to STORET for BOD5

	Concentration (mg/l)			Use Support (0, 1, 2, 3)		
Statistic	STORET	Model	Delta	STORET	Model	Delta
N	2,159	2,159	2,159	2,159	2,159	2,159
Mean	1.91	6.84	-4.92	2.3	2.3	0.0
Std. Dev.	1.49	39.5	39.4	0.9	1.1	1.2
Skewness	4.32	9.62	-9.6	-1.3	-1.3	0.2
Kurtosis	37.27	98.42	99.2	0.9	0.2	0.9
90%	3.6	5.57	1.95	3	3	2
75%	2.3	2.3	1.0	3	3	0
Median	1.45	1.0	0.3	3	3	0
25%	1.0	0.5	-0.6	2	2	-1
10%	0.9	0.4	-3.5	1	0	-1

D. BOD

1. The model substantially over predicts using the mean.
2. The model only slightly under predicts using the median values.

3. Use support estimates in this model are right on.

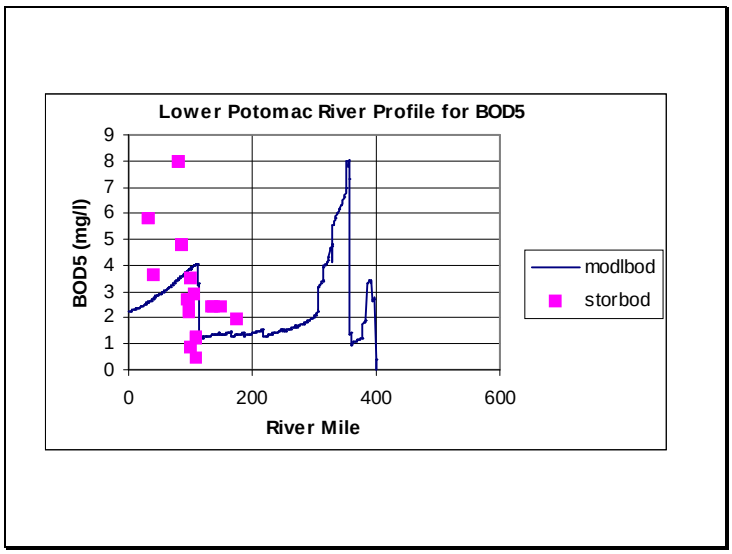
NWPCAM Results Compared to STORET for TSS

	Concentration (mg/l)			Use Support (0, 1, 2, 3)		
Statistic	STORET	Model	Delta	STORET	Model	Delta
N	392	392	392	392	392	392
Mean	445	43	402	1.8	2.2	-0.3
Std. Dev.	5,817	138	5,819	1.1	0.7	1.2
Skewness	19.1	9.3	19.1	-0.6	-1.0	-0.1
Kurtosis	373	112	373	-1.1	0.3	0.3
90%	219	80	165	3	3	1
75%	75	31	42	3	3	0
Median	20	13	2	2	2	0
25%	6	4	-5	1	2	-1
10%	2	1	-38	0	1	-2

E. TSS
1. The model grossly under predicts using the mean
2. The model under predicts using the median
3. The model is fairly close in its predictions of use support
4. This suggests that more effort may be needed with the modeling of TSS.

F. The results for fecal coliform are not reported because of a lack of STORET data.

G. The model may need additional development in its estimates of concentrations, but appears to be a good predictor of use support.



XI. Case Studies

A. A more traditional method of check the predictive capability of a model is the profile plot, where the pollutant concentrations for a stretch of water are plotted on the same graph as the STORET values.

B. Lower Potomac River

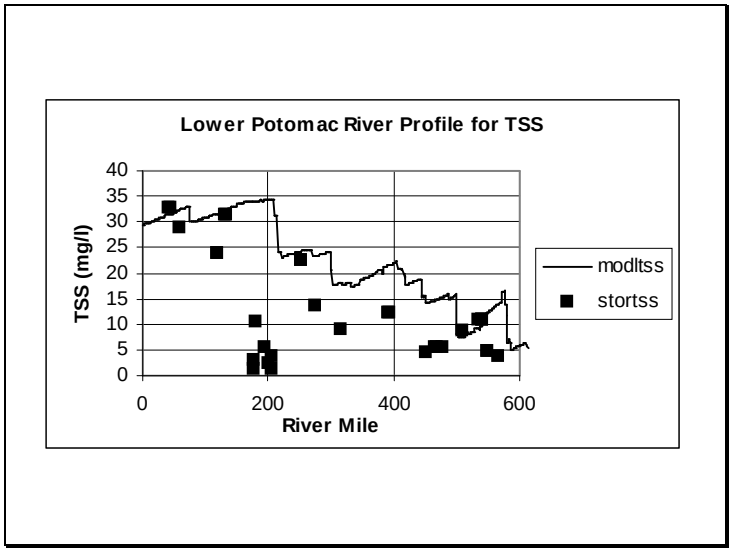
1. BOD

a. The plot is read upstream, with river mile 0 corresponding to the Chesapeake Bay, Washington, D.C. around mile 100, and Cumberland Maryland around mile 350.

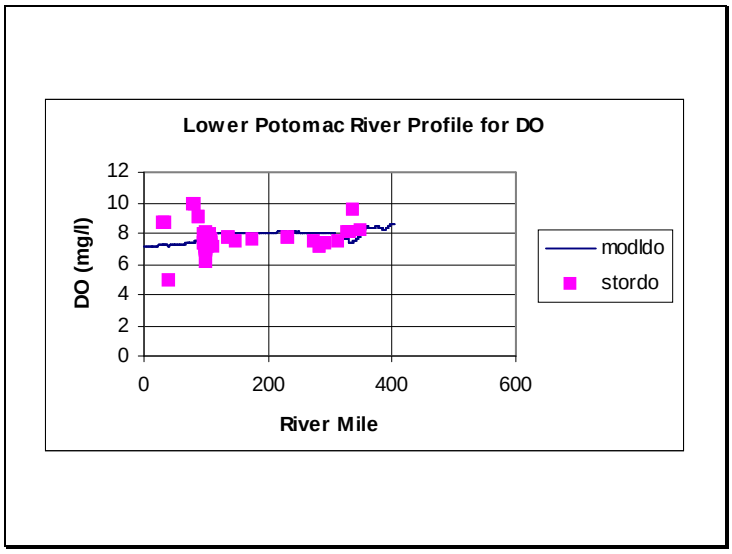
b. STORET values are clustered around D.C.

c. The model captures the rise in BOD around D.C., but misses closer to the Chesapeake Bay.

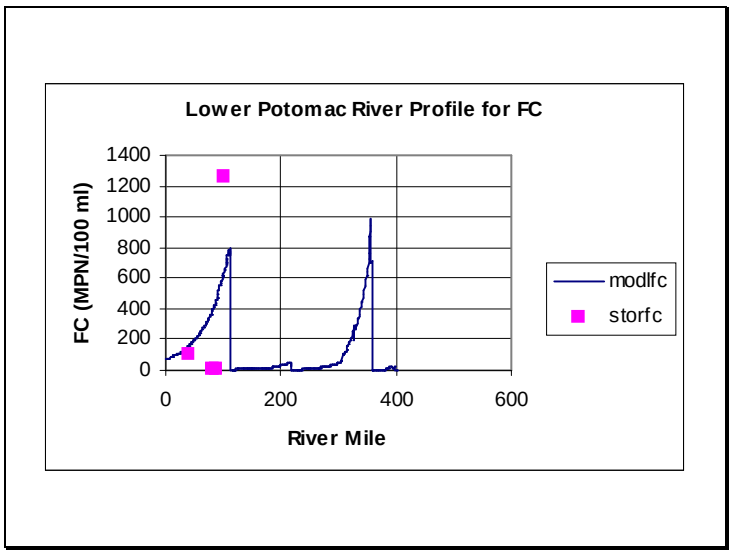
d. Additional estuarine modeling may be necessary.



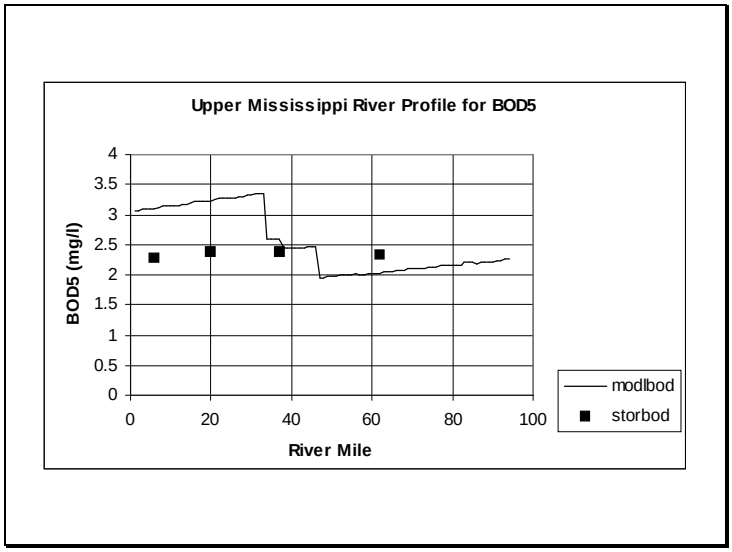
2. TSS
   a. The model slightly over predicts TSS.
   b. The cluster of low values around mile 200 are troublesome and may represent a misclassification of STORET values.



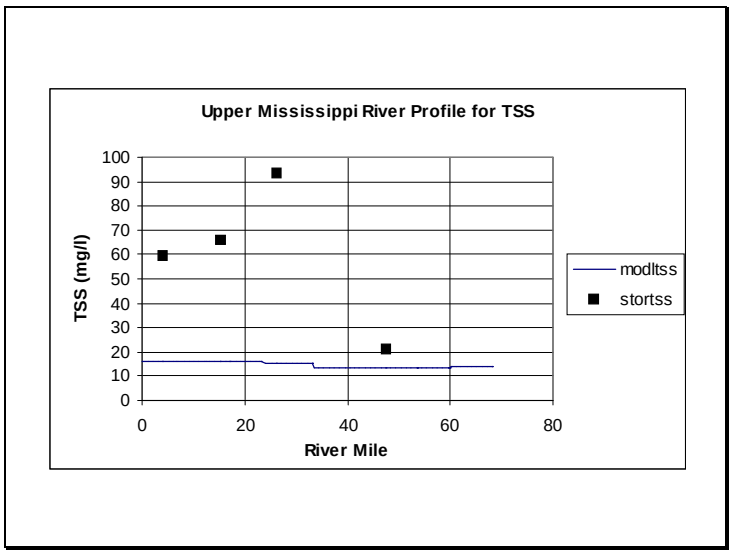
3. DO - The model predicts well for DO



4. Fecal Coliform
   a. The model catches the spike around Washington, D.C.
   b. Notice the absence of data on fecal coliform and the non-random nature of the data, clustered around D.C.



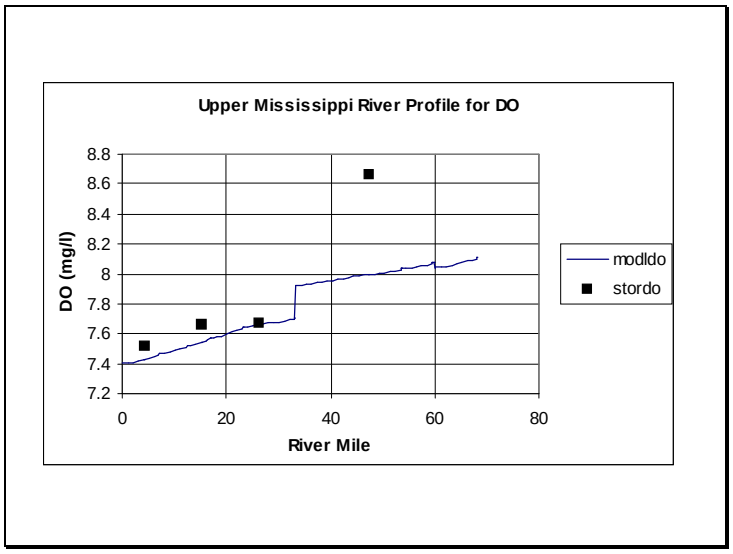
C. Upper Mississippi
   1. BOD
      a. The Wisconsin border is mile 0, at the confluence with the S. Clair River. Minneapolis-St. Paul is around Mile 30.
      b. The model comes close to the STORET values.



2. TSS

a. The model substantially under predicts TSS, particularly around Minneapolis-St. Paul.

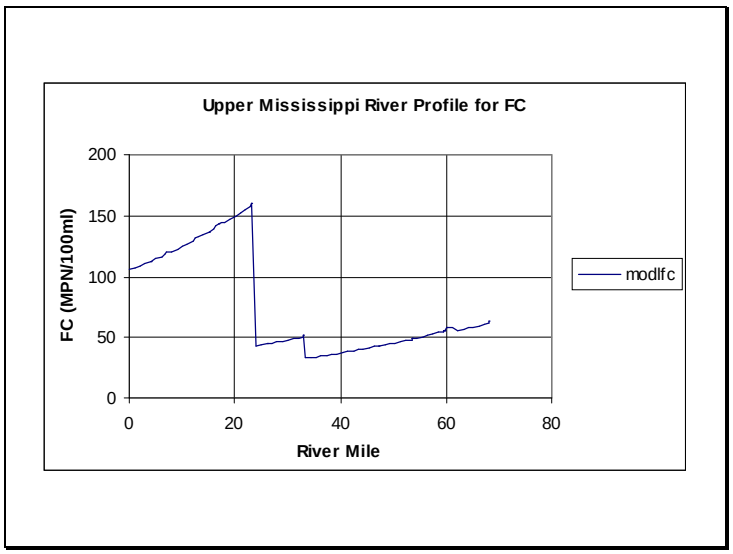
b. This may be due to non-point source loadings from the sediment runoff from the flat landscape. Additional non-point source modeling effort may be necessary.



3. DO

a. The model does well with DO

b. The difference between the model and the one missed point in only 0.6 mg/L.



4. Fecal Coliform - There are no STORET point for fecal coliform for this stretch of river

XII. Conclusions

A. From a modeling perspective, this exercise has been a success. The entire river reach system has been wired together in a reasonable fashion that allows national-level modeling.

B. The model's predictive ability is good

1. The model does not appear to be hypersensitive to any of the parameters
2. The model may need additional effort to more closely model pollutant concentrations
3. The model does well in predictive use support and may be used to predict changes in use support due to policy recommendations

C. Extensions

1. There is a version of the model that includes toxics.
2. Nutrients should be added to the model soon, which will include additional modeling of non-point sources.
3. The model will hopefully be linked to estuarine and coastline models to get a more complete measure of the benefits associated with changes in water quality.

Water Marketing & Instream Flow Enhancement in the Yakima River Basin

--Working Paper*--

PRESENTED BY:
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U.S. Bureau of Reclamation

- This is a working paper developed for the US Environmental Protection Agency Office of Economy and Environment, Office of Research and Development, and Region 10's workshop, "Economic Research and Policy Concerning Water Use and Watershed Management," held on April 21-22, 1999, at the Crowne Plaza Hotel in Seattle, Washington.

***Note**: This paper was not presented at the workshop, as Ms. Yerxa was unable to attend due to illness.*

WATER MARKETING AND INSTREAM FLOW ENHANCEMENT IN THE YAKIMA RIVER BASIN

Introduction

The people of the Yakima Basin are highly dependent upon water from the Yakima River and its tributaries to meet a multitude of economic, environmental and social needs. The state allowed the water of the Yakima River and its tributaries to be over appropriated by the turn of the century. Present rights to water actually exceed the supply during most years. The Yakima Basin is the scene of intense competing demands; there are conflicting water needs for irrigation (both Indian and non-Indian), instream fisheries (both resident and anadromous), recreation, municipal and industrial, and to a smaller extent hydroelectric power.

The inhabitants of the Yakima River Basin, as in other arid regions, are aware of the importance of scarce water. Faced with evidence of shortages of supply to meet growing demand, the typical response has been to: commission a comprehensive study of resources; project the demand on an unconstrained scenario; consider the various supply-augmentation options (ie. build more reservoirs); recommend that which meets projected demand at the least cost (often not including external costs such as degradation to the environment); and implement the scheme through public agencies and at subsidized prices. Water management in the Yakima Basin has followed this traditional supply-side approach. The supply-led approach to water provision, coupled with under-pricing water, guarantees a long-term water problem. However, in the Yakima Basin a promising shift toward emphasizing more careful management of water and related resources is currently underway.

Endangered Species Act & Clean Water Act

Anadromous fish populations in the Yakima River and its tributaries, as well as other areas in the Columbia River system, have been seriously depleted from the historic levels (pre-1900s) when an estimated 600,000 to as many as 900,000 adult salmon and steelhead returned to the Yakima Basin each year. In the Yakima Basin, bull trout and steelhead are listed under the Endangered Species Act (ESA) and spring chinook are proposed to be listed under the ESA. There are also violations of section 303D of the Clean Water Act (CWA) in a number of reaches of the Yakima River and its tributaries. The lack of instream flows is one of the criteria used to determine violations of the CWA in the Yakima River Basin.

The Yakima River Basin Water Enhancement Project

In 1994, Congress passed the Yakima River Basin Water Enhancement Project (YRBWEP), Title XII of Public Law 103-434, in an effort to protect, mitigate and enhance anadromous fish and wildlife and to improve the reliability of water supply for irrigation. The major focus of this legislation is a voluntary Yakima River Basin Conservation Program (Basin Conservation Program). Title XII, Congress directed the

Secretary of Interior, acting through the Bureau of Reclamation (Reclamation), to facilitate water and water right transfers, water banking, dry-year lease options, the sale of lease of water, and other innovative allocation tools to address a host of problems encountered by Yakima River Basin anadromous fish in various life cycles and at various times throughout the year. Sections 1203 and 1205 of Title XII authorizes Reclamation to purchase or lease water, land, or water rights from anyone willing to limit or forego water use on a temporary or permanent basis for the benefit of anadromous fish and wildlife. Title XII authorizes up to $10 million (indexed to $12 million) and provides authority to use funds from the Basin Conservation Program appropriation of $67.5 million to acquire water and land.

Pilot Water Acquisition Program

As a forerunner to the full-scale water acquisition program authorized under Title XII, the Upper Columbia Area Office (UCAO) of Reclamation, in cooperation with the Environmental Defense Fund (EDF), developed and implemented a two-year Yakima Basin Pilot Water Acquisition Program. The pilot program was designed to address the legal, institutional, and public acceptability aspects of acquiring water and transferring to instream flow purposes. The pilot program began in FY 1995 and extended through FY 1996. The pilot program assisted in assuring the viability of the water and land acquisition program authorized under Title XII.

The pilot program was framed around a report written in 1994 by EDF (Zach Willey and Adam Diamant) titled, *Restoring The Yakima River's Environment: Water Marketing & Instream Flow Enhancement in Washington's Yakima River Basin*. The report states that economic value of water leases can be approached from a number of perspectives, but it suggests that Reclamation consider utilizing individually negotiated and auctioning lease solicitation options because these approaches are inherently tailored to the accommodation of the variable individual circumstances faced by potential lessors in the Yakima Basin. During the pilot program the EDF provided Reclamation with economic evaluations for water leases based on income approach.

In 1996, Reclamation leased water rights appurtenant to approximately 460 acres of land irrigated from the Teanaway River, a tributary in the upper Yakima Basin. These lands produced predominately timothy hay with a lesser amount of oat production, and were temporarily fallowed during the period of the lease. As a result of the water leases, approximately 2500
acre-feet of water rights were left in the Teanaway River to enhance instream flows. Reclamation paid between $23 to $40 an acre-foot to lease these water rights. Reclamation sought and received a change in purpose of use from an irrigation water right to an instream flow water right; this was the first time in the state that an irrigation water right was transferred and protected as an instream flow right.

Water and Land Acquisition Program

In FY 1997, Reclamation implemented the Yakima River Basin Water and Land Acquisition Program (Acquisition Program) authorized under Title XII. The main objective of the Acquisition Program is to obtain water or land with appurtenant water rights, through leasing, purchase, or other arrangements (ie. conservation easements), to

provide for enhanced instream flows, flushing flows, and other instream uses and to conserve, protect and restore essential habitat for anadromous fish in the Yakima River and its tributaries.

Reclamation executed five water lease contracts in both 1997 and 1998 on two tributaries to the Yakima River. A total of approximately 1100 acres of irrigated farm land, producing predominately timothy hay, was temporarily fallowed. The associated irrigation water rights of approximately 6,000 acre-feet were transferred and protected as an instream flow. Reclamation paid approximately $23 to $35 an acre-foot for these natural flow water rights.

Reclamation is currently considering a number of water rights and /or lands with water rights for permanent acquisition in the Yakima Basin. Several of these acquisitions are likely to be completed by the end of the current fiscal year, while others are in various stages of the acquisition process. Reclamation will be looking for opportunities to partner with Bonneville Power Administration, Yakama Indian Nation, The Nature Conservancy (Conservancy), or others to acquire water rights and/or lands with appurtenant water rights.

The Nature Conservancy
Reclamation's UCAO entered into a cooperative agreement with the Conservancy in September of 1998. The Conservancy has expertise in the area of land and resource valuation and protection, and is experienced in accomplishing complex land conservation transactions. The Conservancy is providing valuable assistance in development and implementation of the Acquisition Program and is furnishing the land appraisals for the Acquisition Program.

Underlying Science
In the Columbia River Basin over $3 billion dollars has been spent in anadromous fish restoration, with little success. In 1994, the Northwest Power Planning Council (Council) and the Bonneville Power Administration funded a review of underlying science for salmon and steelhead recovery efforts in the Columbia River Basin. The Council's objective was to provide to the region a clear and authoritative analysis conducted by impartial experts. The Council asked that a group of independent scientists (Independent Scientific Group) develop a conceptual foundation for salmon and steelhead recovery efforts. In 1996, the Independent Scientific Group submitted a report, *Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem*, to the Council. The "normative river" conceptual foundation proposed in this report provides the scientific foundation for policy development and has been incorporated into the Acquisition Program.

A Biological study funded by the Basin Conservation Program and the Acquisition Program is on-going in the Yakima River Basin, under the direction of Dr. Jack Stanford (co-author of *Return to the River*), Director of the Flathead Biological Station, University of Montana. The study is directly relevant to the Acquisition Program because it will provide recommendations for actions needed to maintain or restore the environmental

integrity of the most sensitive areas of the river basin in priority order. The study will also provide a protocol and baseline for long-term monitoring of the ecological integrity of acquired floodplains, riparian, and wetlands, thought to be critical to the recovery of salmon and steelhead runs in the Yakima Basin. Dr. Stanford provided Reclamation with a list of "critical river reaches" in the Yakima Basin where acquisition and restoration efforts (possibly water conservation) should be focused. The listing and prioritization of critical river reaches will aid Reclamation in prioritizing proposals, with an eye toward funding those proposals that provide the greatest net benefits, which obviously will include biological benefits.

Umatilla River Basin Water and Land Acquisition Program

A water and land acquisition program for the Umatilla River Basin is authorized under Section 209 of the Umatilla Basin Project Act of 1988, Public Law 100-557. This legislation authorizes $1 million to acquire from willing parties land, water rights, or interests therein for the benefit of fishery resources. Reclamation is working cooperatively with the Conservancy to purchase water rights and land with appurtenant water rights in the Umatilla River Basin. Additional funding for this program is under consideration for inclusion in Phase III of the Umatilla Basin Project Act.

Issues

Over the past almost 100 years, Reclamation programs have evolved from those with an emphasis on irrigation and power development to a much broader range of water resource management. Reclamation must enhance the transition of water from irrigation to other uses, but the internal mechanisms to do so are not necessarily in place. The implementation of the Yakima and Umatilla acquisition programs have been impeded due the following issues:

Economic evaluation of water rights

The traditional way that Reclamation values water rights does not provide an avenue for a willing seller/lessor market based acquisition program. This has been the number one problem in implementing the acquisition programs in the Yakima and Umatilla Basins. We will continue to utilize individuals or entities with expertise in this field.

Land appraisals

Reclamation's history and process of land acquisition by condemnation does not allow us to be competitive in the market. The Conservancy is working with us to provide land appraisals for the Acquisition Program.

Requirements for water acquisition

The requirements followed by Reclamation in acquiring land are not conducive to water acquisition. Reclamation's Denver office has been contacted regarding this issue and agree that the requirements for water acquisition should not follow the same requirements for land acquisition. They will look into this issue but they do not have a set policy.

Discussion of Napier and Tucker paper and of Bondelid, Griffiths and Van Houtven paper --Summarization

by Dr. Scott Farrow, Carnegie Mellon University

Napier and Tucker paper:

Dr. Farrow opened his remarks by emphasizing the need to consider the economic issues raised by the papers. With respect to the Napier and Tucker paper, Dr. Farrow commented on the importance of the question being asked by the authors, i.e., the factors determining the adoption by farmers of conservation practices. Dr. Farrow also complimented the data collection efforts of Mr. Napier's and Mr. Tucker's team, and noted that the data was clearly intended to provide a sense of the importance of perceptions of farmers regarding the costs and benefits of adopting conservation practices. However, the project seemed to be focused upon soliciting the willingness of farmers to accept a subsidy to adopt a conservation practice, and the authors neglected to discuss a very extensive economic literature on contingent valuation. In particular, the literature on survey design, survey instrument choice and the framing of questions was particularly important to address.

Dr. Farrow expressed concern with the choice of the authors' dependent variable, an index of conservation behavior for a farmer which is a rough measure of the conservation value of the way in which the farmer farms the land. The index is a sum, over the various different possible conservation practices, of a product of two variables: a discrete variable representing the frequency with which the farmer employs the conservation practice, with five different values ranging from "never" to "once a year" to "more than once a year," and a variable representing the conservation value of the practice, the values of which were obtained from expert elicitation. Here again, a large literature on expert elicitation should have been discussed, particularly on multi-attribute utility functions. Also, it is not clear exactly what is being measured by this dependent variable. Is it the social cost of the way a farmer practices farming? The authors are correct in stating that the literature on the social costs of nonpoint source pollution is very weak, but there has been some work done in this area by Marc Ribaudo and others that the authors did not reference.

With respect to the regression analysis, Dr. Farrow suggested that the authors might wish to use frequency of conservation practice as a dependent variable, and attempt to ascertain the determinants of frequency. The authors could still used their discrete frequency variable if they employed an ordered probit model, and could still use the same explanatory variables. The authors could even use the expert perceptions of social cost as an explanatory variable to see if the social costliness of a farming practice influences a farmer's decision to adopt a practice. Finally, the authors should have also discussed the economic literature on diffusion of technological change in agriculture (Griliches, Mansfield, and others more recent), and distinguished their paper from this literature. In sum, Dr. Farrow concluded that more economics could have been utilized in this paper, and that some economic literatures need to be discussed.

Bondelid, Griffiths and Van Houtven paper:

Dr. Farrow remarked that the question being asked by the authors, the benefits of water quality improvement, is a highly worthwhile question. Dr. Farrow also noted that this is an interdisciplinary question and expressed hope that this paper will be presented by the authors in a variety of professional audiences.

Dr. Farrow noted that the authors have combined a very large and complex water quality model with a larger economic analysis. However, in a paper that Dr. Farrow had co-authored earlier[1] using a similar economic model (that was less data-informed than the present paper) he had used EPA-mandated state water quality reports for his water quality data, and used contingent valuation data to measure benefits. The conclusion of Dr. Farrow's paper was that better information linking expected water quality improvements with benefits is necessary to plan efficient programs. Dr. Farrow noted that the present paper is a very large improvement on the water quality aspect of the analysis.

The paper suggests two types of policy questions, which Dr. Farrow labeled a "Gore Question" and a "Thompson Question." The Gore Question pertains to environmental efficacy: "is the environment getting better or worse?" It is thus important to ask, "what can the model utilized by the authors (the National Water Pollution Control Assessment Model, or "NWPCAM") tell us about the answer to this question?" The model is aimed at quantifying the economic benefits of the Clean Water Act, and hence utilizes two scenarios – one with the Clean Water Act and one without. This is an important question, but can it also answer the Gore Question? The current model utilizes stream-miles improved in a category as a unit of analysis, but is it the best index? Dr. Farrow proposed an index of water quality whereby:

p_i^0 = the quality level or economic value of water quality at a baseline level for a stream segment *i*

$p_i(Q)$ = the value of water quality level *Q* for stream segment *i*

q_i^0 = a quantity measure of the importance of stream segment *i*, which can either be binary or a weighting measure of the population using stream segment *i*.

n is all of the stream segments in the U.S.

$$\sum_{i=1}^{n} \frac{p_i(Q) q_i^0}{p_i^0 q_i^0}$$

While this is a standard index form, slightly more complex forms such as Fisher's Ideal Index may be used or issues of pollution aggregation may be addressed more directly. Dr. Farrow noted that the water quality ladder used by the authors is compressed from that originally used by Mitchell and Carson.[2] Mitchell and Carson's water quality ladder

1 Lyon, R.M. and S. Farrow. (1995) "An economic analysis of Clean Water Act issues." Water Resources Research 31(1)213-223.

2 Mitchell, R.C. and R.T. Carson. (1989) Using Surveys to Value Public Goods: The Contingent Valuation Method. p. 345. Resources for the Future, Washington, D.C.

included levels cleaner than "suitable for swimming" and dirtier than "suitable for boating." While this is not likely to be a serious problem, Dr. Farrow expressed curiosity regarding this decision.

Mr Farrow also noted that in his earlier paper he utilized state reports that are required to be filed with the EPA under section 305(b) of the Clean Water Act, which can be viewed as characterizing waters in the same terms as the Mitchell and Carson water quality ladder. Analyzing data at this level is useful for answering the Gore Question on a state basis, and might well be even more useful for a watershed-level analysis.

The economic question, which Dr. Farrow called the "Thompson Question," pertains to the efficiency of water quality regulation: "do the benefits of water quality regulation outweigh the costs?" While it is clear that the model will eventually be able to produce benefit estimates, Dr. Farrow noted that it is not clear that it will produce estimates of cost (little economic information is included in the paper), which is an important piece of information.

There are other economic questions raised by the paper. First, the authors might wish to expand upon the earlier Mitchell and Carson study,[3] which was completed almost sixteen years ago. Given the advances in contingent valuation, a better data set might be used. Second, the local attribution of population is very important in this model, since willingness to pay assumes a representative consumer. Attribution is important not only from a sampling point of view, but in considering the substitution effects for a given population. The fact that a stream reach is within a population boundary does not mean that the willingness to pay to improve that stream reach should be considered in isolation of other stream reaches. Third, discounting is omitted from the model. Fourth, it might be useful to use this study to compare contingent valuation with alternative methods of measuring benefits. Fifth, Dr. Farrow raised an aggregation issue that is characteristic of studies that hypothesize very large changes in environmental quality. He referred to a study that found that Americans were willing to pay, in the aggregate, 20% of Gross Domestic Product for the air quality benefits achieved by the Clean Air Act. If the willingness to pay estimates for this study are similarly large, critics might question the validity of the estimates.

Dr. Farrow lauded the efforts that the authors undertook to validate their data, although he suggested that the water quality inventory could also be tied back to the Clean Water Act section 305(b) state reports. Also, the authors might wish to consider disaggregating their analysis, perhaps down to the state or watershed levels, when attempting to ascertain the expected water quality benefits.

Dr. Farrow suggested some extensions. Including cost estimates might be extremely useful, and may serve to inform policymakers about the possibility of water quality trading. This may be especially useful in the context of looming deadlines for total

3 Mitchell, R.C. and R.T. Carson. (1984) An Experiment in Determining Willingness to Pay for National Water Quality Improvements, Draft Report to U.S. Environmental Protection Agency. Resources for the Future, Washington, D.C.

maximum daily load regulations, which require states to establish the total pollutant load that may be introduced into a stream in order for the stream to meet water quality standards. The authors could also extend their work by introducing uncertainty into their model, as to whether water quality levels could actually be achieved by prescribed policies. Finally, households are not the only beneficiaries of water quality improvements; given the industrial uses of water, the industrial benefits of clean water should not be overlooked.

Dr. Farrow offered four conclusions of his discussion of the Bondelid, Griffiths and Van Houtven paper. First, the authors should not oversell the national coverage of their estimates. Second, the authors could expand their use of economics. Third, the authors should consider exposing the inner workings of their model to critique, in the hopes that some helpful suggestions might be made. Fourth, this paper is a large step forward, although much more can be done as the model evolves.

Note: *Ms. Yerxa was unable to attend the conference due to illness, so these comments were not formally presented by Dr. O'Neil.*

Discussion of Yerxa paper

by Bill O'Neil, US EPA Office of Economy and Environment

General

The premise for the new program managed by Bureau of Reclamation is that water is not being allocated efficiently under traditional water rights allocation systems.

Water is in effect subsidized for irrigation users and no market mechanisms exist to reallocate water to more highly valued uses.

In addition, the services provided by water left in the stream are "public goods" (available to everyone) like aquatic habitat support. These kinds of goods cannot be allocated efficiently by market systems, so it is appropriate for the government to determine the correct allocation of water between withdrawal and in stream uses.

The solution to this problem is to allow a government agency, Reclamation, to use public money to buy or lease water to remain in the stream for provision of public goods.

In theory this program is justified and represents a movement in the direction of greater efficiency in water use. But I would like to learn more about the details of the program.

In order to begin a discussion of the paper I would like to ask a few questions and suggest some possible topics for further work.

Price and Value of Water

This writer suggests that water has been provided at a subsidized price. This is a frequent allegation in the west and probably true since trades of water for use away from the original owner's land has generally been prohibited.

The Environmental Defense Fund used an "income approach" to determine the price at which Reclamation buys or leases water from owners. Could you explain what the income approach is?

I would expect that owners would have to be paid a price at least equal to the marginal value of water in the current use. That is the value added to farming by use of water for irrigation for example.

An additional level of efficiency could be attained if Reclamation paid a price equal to what would occur in a free market. That would be the value of the marginal product of water in its most valuable use, which might not be irrigation. Instead it might be equal

the price urban consumers might be will to pay for water in residential or commercial use. Were these things considered by EDF?

Instream Value

Finally in deciding whether the water provides it the greatest value by leaving it in the stream we should attempt to estimate the value of the services provided by the aquatic habitat that will be supported by instream flows.

These services include the contribution to maintaining stocks of fish for commercial fishing and recreational activities. The Bureau might consider undertaking some investigation into the value of these services to illustrate the importance of instream flow and the willingness to pay by users of instream flow services. An example of this kind of work was included in the morning session yesterday in the analysis of management of the Snake River. Benefits transfer techniques were used to estimate recreation values as well as commercial fishing values for restoration of the salmon fishery in the Snake and Columbia River systems.

In summary, we need to know whether the $23 to $40 per acre foot "price' is above or below the opportunity cost to owners or other prospective purchasers for withdrawal uses of water. And we need to know whether the value to society of instream flows is above or below the stated range and the opportunity cost of withdrawn water. Only then can we begin to determine the efficient allocation of water between instream and withdrawal uses.

WTP and Actual Payments

To the extent that service from the instream flows would actually be used by local residents, it might be appropriate to ask whether there was a willingness to actually contribute money to a fund to augment the budget available to Reclamation for purchasing and leasing water rights. Could a fund be established? Would local recreation associations agree to help raise money? Would the tourism industry participate in fund raising activities? It may be that an achieving an efficient and biologically appropriate level of instream flows takes more money that the political budget process has allowed. Local beneficiaries might be willing to make up the difference.

Water Supply and the Annual Flow Cycle

Is the shortage problem a continuous problem or is it primarily a problem of flow variation and storage? If shortages are temporary then possibly building impoundments is part of the answer. But if demand exceeds supply even after aggregating flows over a whole year or multiyear cycle then we have a more serious problem of rationing. In the latter case it becomes even more important to determine the demand and value of instream flows so the systems can be managed to provide for the public goods of aquatic habitat.

Alternative Solutions

In addition to using price or estimated values as tools for allocating water, it might be useful to investigate methods for extending the use of a given quantity of water.

More efficient irrigation methods to reduce water per unit of crop yield. These might include drip style irrigation, improve return flow systems, better timing in irrigation applications, adoption of crop types that use less water.

Water recycling could also be examined to determine whether water could be treated after residential or commercial use to the point where it was of good enough quality to be recycled for another use. For example wastewater can be treated and reused for irrigation of non-food crops thus reducing the need for new withdrawals from the rivers.

All these types of water saving activities will be investigated by the private sector when they are required to pay a price which is closer to market value including the value of instream services that must be "purchased" or protected by government for provision of public goods.

Question and Answer Period for Session II

Ted Napier, Ohio State University, first offered a response to some of the comments made by Scott Farrow, Carnegie Mellon University, in his discussion. Some of Mr. Farrow's comments were addressed in other papers. Mr. Napier replied that perhaps more thought could have been given to the title which may have misdirected the reader. An important point raised by Mr. Farrow pertains to the measurement difficulty of the dependent variable; however, the study was not intended to predict adoption of specific types of conservation practices (no-till, conservation tillage, ridge tillage, etc.), because it would be impossible to do so for many of the practices.

Mr. Napier emphasized that the importance of the study is to look at the whole package of conservation practices adopted by farmers, and not falling back upon using one conservation practice (say, no-till, for example) as an indicator of whether the farmer was practicing conservation. It is thus important to deal with the numerous complex activities that a farmer may engage in by developing a multi-attribute indicator. If the inquiry were limited to no-till, for example, the Ohio sample would have appeared to be extremely conservation-minded, and the Minnesota sample would have appeared to be indifferent to conservation. However, if conservation tillage were the practice, then the conservation rankings between the Ohio sample and the Minnesota sample would have been reversed. Finally, it is important to acknowledge the environmental problems associated with some individual conservation practices, which is one reason Mr. Napier used the expert-derived indices of the conservation value of each practice.

With respect to the contingent valuation literature, Mr. Napier noted Mr. Farrow's concerns about omitting a literature review, and replied that he has some concerns regarding the methodology. Mr. Napier closed by noting the importance of taking policy actions very soon, otherwise severe regulatory approaches will become necessary.

Charles Griffiths, US EPA Office of Economy and Environment, also expressed appreciation for Mr. Farrow's comments. Mr. Griffiths noted that many of the suggestions that Mr. Farrow made are already being discussed at EPA, such as updating the Mitchell and Carson data set4 and also using the state reports required to be filed under section 305(b) of the Clean Water Act, which EPA is attempting to develop into a more extensive reporting requirement. Laura Palmer, US EPA Office of Water, remarked that states have several different reporting methods from which they may choose, but over a three- or five-year period, states are in fact required to survey each individual site at least once. Mr. Palmer noted that there is now a push to make reporting more consistent.

Linda Fernandez, University of California at Santa Barbara, asked Mr. Farrow and Mr. Griffiths how they might speculate as to how those locality-specific estimates of water quality that Mr. Farrow suggested might be integrated into the model. Mr. Griffiths

4 Mitchell, R.C. and R.T. Carson. (1984) An Experiment in Determining Willingness to Pay for National Water Quality Improvements, Draft Report to U.S. Environmental Protection Agency. Resources for the Future, Washington, D.C.

replied that there are two ways to achieve this: one is to do a national survey and try to elicit more local rather than national responses, and the other is to perform a recreational analysis and a national travel-cost model. Ms. Fernandez noted that the emphasis still appears to be on the national level, not on the local level. Mr. Griffiths replied that this was due to the national scope of the policies which he is required to evaluate at EPA. Ms. Fernandez asked if the model could accept as input localized results from more local or regional analyses. Mr. Griffiths replied that the model could do this.

Edna Loehman, Purdue University, stated that she was involved in the benefits assessment of the Clean Air Act, and expressed concern that the benefits may not exceed the costs, and that this may be due to ignoring some of the different categories of benefits. For example, clean water provides benefits in terms of drinking water and in terms of a balanced pH. In areas where mercury poisoning is a problem, "clean" water may have other properties that are harmful to human health and wildlife. Mr. Griffiths agreed that there are some categories of benefits that are omitted, and some that may never be included in a benefits analysis. Mr. Farrow commented that EPA eventually came through with very positive figures for benefits as compared with costs, but further remarked that in a scientific inquiry, no estimates should be suppressed. Rather, estimates that are flawed should be criticized openly rather than discarded.

Gary Ellis, US Army Corps of Engineers, Walla Walla District, asked what the definition of "nonpoint source pollution" is. Mr. Napier responded that nonpoint source pollution pertains to nonspecific sources of pollution, whereas point sources are specific, identifiable sources of pollution. Ms. Palmer added that examples of point source pollution include storm sewers, or an industrial plant with a single emissions pipe, while an example of nonpoint sources pollution might be agricultural runoff, or runoff from a road that is not collected in a collection pipe but is instead directly deposited into a water body.

Mr. Ellis also asked a question regarding whether there were any contingent valuation questions valuing the benefits of a wetland. Mr. Napier replied that he only knew of one such paper, which calculated benefits by calculating the cost of mitigation, but Ms. Fernandez replied that she had a review paper titled "Economics of Wetlands," published by the American Petroleum Institute in 1991.

Mitchell Mathis, Center for Global Studies, asked Mr. Napier for some conclusions from his study as to what is most effective in inducing farmers to adopt conservation practices. Mr. Napier replied that direct subsidies typically work best, as farmers almost always have a bid price at which they will undertake conservation practices. "Mickey Mouse" subsidies such as technical assistance and information provision do not work very well. Thus, the USDA Conservation Reserve Program, in which farmland can be retired for conservation purposes, has been much more effective. Mr. Napier compares this with policies in Europe, which tend to be more of a command-and-control nature, which would not work as well here, not because of a monitoring issue, but a political acceptability issue.

John Tanaka, Oregon State University, asked Mr. Griffiths how EPA anticipates using the National Water Pollution Control Assessment Model (NWPCAM) to design regulations, given that the unit of analysis is a stream-mile. Mr. Griffiths responded that Mr. Tanaka was correct in noting that EPA could be in a position of imposing non-national standards upon different regulated parties, but Mr. Griffiths did not feel he was in a position to comment upon how these varying standards would be formulated or executed since these are functions beyond his office's powers. Mr. Farrow added, however, that the present push for water-quality-based regulation is one way that such location-specific information obtained from the model might be used to aid in regulation.

Mr. Mathis asked Mr. Griffiths if there was a potential for web-based customizable watershed-based analysis, to which Mr. Griffiths replied that the EPA Office of Water already has a Geographic Information Systems-based system called BASINS, which can ordered on a compact disc, which contains watershed-level data. Mr. Griffiths also pointed out that EPA is headed toward setting up a website with all of the information from NWPCAM and other watershed information.

Note: the remainder of this question and answer period was devoted to questions for speakers from session one.

Mr. Farrow asked Audrey Perino, Bonneville Power Administration, about some of the ecological irreversibilities inherent in the Snake River study, as opposed to the economic irreversibilities discussed by Ms. Perino. Ms. Perino stated that she is not certain if the economic irreversibilities are truly irreversible. The breaching of the dam will be accomplished by removing the earthen portion of the dam, which will not destroy the power-generation facilities of the dam. There is nevertheless an option value of the time and effort required to decommission the dam. Phil Benge, US Army Corps of Engineers added that the Drawdown Regional Effects Workgroup did build in an irreversibility into their analysis.

Mr. Tanaka asked Ms. Perino how much integration is incorporated into their economic analysis. For example, how would dam breaches on the Snake River affect the Columbia River system? How would transportation networks be affected? Ms. Perino stated that this was largely in the domain of the social impact team or the regional effects team. Gary Ellis, US Army Corps of Engineers, Walla Walla District, stated that it was assumed that there are a fixed number of trucks carrying agricultural and other products, and that a dam breach would raise the rental price of those trucks. Ms. Perino pointed out that regionally speaking, integration issues needed to be better addressed. At present, integration of the Columbia River system has not been accomplished in the Snake River study. The Snake River, however, is unique in that if salmon are to be saved, there are not many options available; on the Columbia River, there are many options. Policymakers may ultimately consider decommissioning dams on the Columbia River as well, such as the John Day dam, or the McNary dam. On the lower Columbia, however, there are better power generation facilities, and decommissioning these dams would be very costly. Biologists are advocating the decommissioning of the John Day dam.

Mr. Napier asked Mr. Benge if the Corps attempted to estimate the nonmarket value of a recreational experience. Bill O'Neil, US EPA Office of Economy and Environment, stated that it was indeed possible to measure the value of hiking and boating experiences, for example, by use of travel-cost analysis, and that this and that this was part of the analysis. Ms. Perino also emphasized that there are numerous political factors that will determine how recreational values might be used even if they are monetized. Mr. O'Neil concurred and noted that one senator was adamant about both maintaining the dams *and* saving the salmon (an almost impossible alternative).

Ms. Perino remarked that the Bonneville Power Administration is concerned that the dams may be decommissioned and that the salmon still might not be saved despite the free-flowing rivers, due to other obstacles that the salmon must face. Tony Prato, University of Missouri, pointed out that the same problem exists with respect to global warming. Mr. Prato also posed the question of whether salmon can be saved elsewhere. Ms. Perino replied that the Snake River dams became an issue because of the listing in 1990 of four Snake River-specific species as endangered species. Now, people are beginning to realize that habitat protection is a broader problem, and cannot be solved by Snake River measures alone. There is now a push for more holistic analysis, which has been labeled "Four-H" analysis, looking at issues of hydropower, habitat protection, harvesting (agriculture) and hatcheries. The problem, Ms. Perino posed, is money, which will almost certainly come from the hydroelectric industry. This may be one reason that the focus on habitat restoration has always been on the dams.

Tony Bynum, Yakama Nation, asked: (1) whether the salmon problem might become moot since the Corps is being sued over water quality standards set by the state of Washington; (2) whether the cost-benefit analysis captures the subsidies that are provided for construction and operation of the dams; (3) whether subsidies provided for the generation of hydroelectric power may be affecting the industry for alternative energy sources; and (4) whether the lost hydropower might be recovered by increasing capacity at other dam sites. With respect to Mr. Bynum's fourth question regarding increasing capacity at other dam sites, Ms. Perino responded that it is more appropriate to phrase the question in terms of the least-cost alternative for increasing Bonneville's ability to meet demand, whether it be increasing capacity or adopting conservation measures. Assuming the region will grow in the near future, it may be necessary to increase capacity at the other sites just to keep up with increased demand. Mr. Bynum remarked in response that it is necessary to balance the costs of increasing capacity with the very large costs of losing species. Mr. Prato pointed out that the subsidies provided to dam operation distorts prices. The result is cheap water, cheap power, cheap grazing and cheap access to federal timber lands, all forms of federal subsidies that if accounted for, would make issues of energy conservation and salmon protection moot. Ms. Perino agreed, but pointed out that gasoline prices are subsidized, also, indicating that many other energy prices are distorted. Mr. Prato cited a report produced by World Watch that estimated the subsidy for gasoline amounts to $5 per gallon.

Mr. Bynum returned to the point of considering conservation instead of capacity increases, and reiterated that it seemed incongruous for DREW to consider relatively

inefficient means of providing power, when conservation measures are available and cheap. Ms. Perino replied that DREW was in fact looking at conservation measures very closely, but also considering the capacity-increasing measures that Mr. Bynum referred to. Ms. Perino expressed skepticism that conservation measures can be cost-effective and that consumers would be willing to conserve when power is so cheap in the Pacific Northwest (5 cents per kilowatt-hour).

Mr. Bynum inquired about the problem of sedimentation behind dams, and whether the cost of removing the sediment and the effect on power generation have been considered. Ms. Perino replied that she did not know if these costs were being considered by DREW.

Mr. Tanaka noted that the scenarios that were used by Mr. Ellis's social impact analysis team in their community focus groups were based upon preliminary data, and asked Mr. Ellis how much reliability could be placed upon the findings of the final report. Mr. Ellis stated that preliminary data was close enough to the more recent data to be able to elicit meaningful responses from the community focus group participants.

Note: Ms. Yerxa was absent, but the following discussion concerned her paper.

Edna Loehman asked if Mr. O'Neil might provide some of his planned remarks to the third paper in the session, "Water Marketing and Instream Flow Enhancement in the Yakima River Basin," which was not presented. Mr. O'Neil summarized the paper briefly, noting that it pertained generally to a program whereby the Bureau of Reclamation now has some funding to purchase water rights for the purpose of restoring instream habitat. Ms. Yerxa's paper was to address whether this program would work well, but there was little data in the paper. Maureen Sevigny, Oregon Institute of Technology, noted that in the Klamath Basin's water rights purchase program, only two farmers actually came forward as willing sellers, which was a disappointment. Mr. Bynum added that in the Yakima Basin, rate-setting is problematic because potential sellers are waiting for a better price, leading to a widespread holdout problem. Issues are also raised by leasing alternatives, and outright purchase of the property. Mr. O'Neil noted that the only data in Ms. Yerxa's paper to help the Bureau of Reclamation set set water prices was a study by the Environmental Defense Fund, which estimated water prices by calculating the income generated by using the water for irrigation, and arrived at a range of $23 to $40 per acre foot. Mr. Bynum stated that he thought the figure was to lease the water for a year. Mr. O'Neil agreed that there are many questions regarding the Bureau of Reclamation program that need to be answered. Mr. Ellis remarked that if the price of water is high enough, it might be cheaper to buy the land, to which Mr. Bynum responded that it already is cheaper to buy the land. Mr. O'Neil cautioned, however, that the market price of water is not necessarily bounded on the upper end by the price of the land, since the market price for water may involve transportation to urban areas for residential use, which entails transportation costs.

July, 1999

ECONOMIC RESEARCH AND POLICY CONCERNING WATER USE AND WATERSHED MANAGEMENT

PROCEEDINGS OF THE THIRD WORKSHOP IN THE ENVIRONMENTAL POLICY AND ECONOMICS WORKSHOP SERIES

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MEASURING THE TOTAL ECONOMIC VALUE OF RESTORING ECOSYSTEM SERVICES IN AN IMPAIRED RIVER BASIN: RESULTS FROM A CONTINGENT VALUATION METHOD SURVEY

--WORKING PAPER*--

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ABSTRACT

Five ecosystem services that could be restored along a 45 mile section of the Platte River were described to respondents using a building block approach developed by an interdisciplinary team. These ecosystem services were dilution of wastewater, natural purification of water, erosion control, habitat for fish and wildlife, and recreation. Households were asked a dichotomous choice willingness to pay question regarding purchasing the increase in ecosystem services through a higher water bill. Results from nearly 100 in-person interviews indicate that households would pay an average of $21 per month for the additional ecosystem services (95% confidence interval is $20.50 to $21.65). Generalizing this to the households living along the river yields a value of $30 million to $70 million depending on whether those refusing to be interviewed have a zero value or not. Even the lower bound benefit estimates greatly exceed the high estimate of water leasing costs ($1.13 million) and Conservation Reserve Program farmland easements costs ($12.3 million) necessary to produce the increase in ecosystem services.

IMPORTANCE AND CONTROVERSY IN ECOSYSTEM VALUATION

Valuation of ecosystem services is controversial because of the potential importance such values may have in influencing public opinion and policy decisions. As noted by Costanza, et al. (1998:68) "To say that we should not do valuation of ecosystems is to deny the reality that we already do, always have and cannot avoid doing so in the future". Failure to quantify ecosystem values in commensurate terms with opportunity costs often results in an implicit value of zero being placed on ecosystem services. In most cases, ecosystem services have values larger than zero (Daley, 1997).

Attempts at valuing ecosystem services go back several decades. Notable early examples include energy based approaches of Costanza (1981) and Odum (1983). *Ecological Economics* ran a special issue on the topic in 1995. A recent effort by Costanza, et al. (1997) published in *Nature* to estimate the value of the world's ecosystem services has focused a great deal of attention on this topic (see the 1998 special issue of *Ecological Economics* on The Value of Ecosystem Services for some of

this debate). This ambitious effort by Costanza et al. was partly a challenge "..that ecosystem services are 'big potatoes' and we had better get busy and pay more attention to them—from many different conceptual and methodological perspectives at once" (Costanza, et al., 1998:69).

There were several critiques in this recent special issue of *Ecological Economics* of the analysis by Costanza, et al. (1997). One commentator was concerned that adding up estimates from separate studies on the value of various individual ecosystem services might result in some double counting of benefits (Serafy, 1998:25). However, there can be potentially more than double counting when adding up independently derived estimates of willingness to pay, as substitution effects and budget constraints are often incompletely accounted for, leading to over-valuation even in absence of double counting (Hoehn and Randall, 1989). In addition, Toman (1998:58) notes that for ecosystem valuations to provide more useful information to decision makers faced with trade-offs, that "One needs a specified baseline, a specified measure of changes…"

Our approach attempts to rise to the challenge posed by Costanza, et al. (1998) and these commentators by addressing all three of the above suggestions. First by eliciting a comprehensive value from the public for a set of ecosystem services and thereby reducing the possibility for double counting as well as avoiding the independent valuation and summation noted by Hoehn and Randall. Further we provide respondents a specified baseline and specified measure of change as suggested by Toman. This is done by adapting the contingent valuation method (Mitchell and Carson, 1989) to the valuation of ecosystem services. Such comprehensive valuation critically depends on communicating the nature of ecosystem services to the respondent. This paper reports on an interdisciplinary effort to develop visual aids and text that communicates the ecosystem services of a Great Plains river and the results of nearly 100 in-person interviews with those visual aids. As is obvious, this refinement in ecosystem valuation is far less ambitious than the Costanza et al. (1997) effort in both the number of services that were relevant to value in this ecosystem and the geographic scope of the analysis. We believe future efforts may be able to apply our approach to larger ecosystems with a broader range of the ecosystem services to be valued.

SPECIFIC ECOSYSTEM SERVICES OF A PLAINS RIVER

Rivers can provide many services to humans, including water supply for municipal, industrial and agricultural users, fish habitat and recreation. When demands from all these uses are low, at times these uses can be complementary. However, with excess demand by historic uses resulting in an over appropriated river basin, the uses become competitive. A dynamic society requires monitoring and adjusting the mix of these ecosystem services as society's priorities change (Bromley, 1997) to insure that the highest valued mix of services is produced. Since uses like fish habitat and recreation are not priced, this presents a challenge to water managers.

Like many river basins throughout the world, the South Platte, near Denver, Colorado, has been modified by diversions, adjacent land use and pollution to the point where the river's ecosystem, including its fishes, are severely imperiled. Today the river is operated as a plumbing system with about 500 irrigation ditches and 70% of water withdrawals for agriculture (Strange, et al., 1998). Much of the river's remaining flows are irrigation return flows, with additional inflows from the sewage treatment plant in Denver. Due in part to the lack of riparian vegetation to filter irrigation return flows and feedlot run-off, the South Platte ranks first in contamination by ammonia and nitrates of 20 major rivers in the U.S. and it ranks second among the 20 major rivers in contamination by phosphorous (Strange, et al., 1998). In addition to polluted water, erosion of the streambanks, irrigation return flows, and reduction of instream water by agriculture use has greatly diminished the natural ecosystem of the South Platte River. As a result of these changes in flow regime, habitat, and water quality, six of the remaining native fish species are at risk and are being considered for the endangered species list. Due to the unnatural hydrograph resulting from waterflows timed for irrigation, non-native Russian olive trees are encroaching upon and replacing native cottonwoods. Birds prefer the cottonwood for nesting and the higher abundance of insects. As the number of cottonwoods decrease, bird species are expected to decrease by a third of their present number.

In essence, one ecosystem service from the watershed, irrigation water supply, along with "edge to edge" agriculture has greatly diminished other ecosystem services such as:

- dilution of wastewater
- natural purification of water
- erosion control
- habitat for fish and wildlife
- recreation use

Of course there would be opportunity costs to irrigated agriculture from reducing diversions and replacing cropping and grazing at the river's edge with native vegetation. The question that must often be answered is what are these non-marketed ecosystems worth? It is to answering that question to which we now turn.

WHAT ARE ECONOMIC VALUES OF ECOSYSTEM SERVICES?

Ecosystem services provide many benefits to people. Dilution of wastewater, as well as erosion control and water purification effects from riparian vegetation and wetlands improves water quality. Increased water quality reduces water treatment costs to downstream cities (Moore and McCarl, 1987), increases the aesthetics of water for visitors and supports native fish and wildlife that different people like to view or harvest or simply know exist. Since all of these uses of clean water benefit people, and are scarce, these services have an economic value.

These ecosystem services have characteristics of **public goods**. Specifically, it is difficult to exclude downstream users from receiving the benefits of improved water quality and many of the benefits are non-rival in nature. Many individuals can view the same wildlife or enjoy knowing they exist without precluding others from doing the same thing. Given these public good characteristics, it is difficult for the private sector to market or sell these ecosystem services.

While these ecosystem services are often without prices, they do contribute utility to individuals and therefore have value. In fact, the absence of a price charge increases the individual's consumer surplus. Consumer surplus is also known as the individual's net willingness to pay. It is represented by the area under the individual's demand curve but above any cost to the user of the

ecosystem service.

TECHNIQUES TO MEASURE THE ECONOMIC VALUE OF ECOSYSTEM SERVICES

There are several techniques that can be used to value the benefits of improved water quality or stream restoration. If restoration of water quality or recreation occurs in an urban setting where there are residences nearby the river, the hedonic property method may be applied. The hedonic property method isolates the property value differential paid by a household for having a home along a river with improved water quality as compared to degraded water quality. Research in California, indicates that water quality can increase property values by at least 3% for bank stabilization and up to 11% for improving fishing habitat (Streiner and Loomis, 1996).

If the primary gain in ecosystem services is recreation, the variation in visitors travel costs to the river can be used to trace out the demand curve for recreation at the river. From this demand curve the consumer surplus of recreation with improved water quality can be estimated (Freeman, 1993; Loomis and Walsh, 1997).

When river restoration and water quality improvements result in both on-site recreation and increases in populations of rare or endangered fish, there will often be an existence and bequest value (Krutilla, 1967; Loomis and White, 1996). By **existence value** we mean the amount an individual would pay to know that a particular native fish exists in its natural habitat. By **bequest value** we mean the amount an individual would pay for preservation today, so that future generations will have native fish in their natural habitat. Collectively, existence and bequest values are sometimes called non-use or passive use values. While these benefits are often quite small per person, the non-rival nature of these public good benefits results in simultaneous enjoyment by millions of people. Therefore, the total social benefits can be quite large.

The only methods currently capable of measuring these passive use values of ecosystem services are conjoint, choice experiments and the contingent valuation method (CVM). CVM uses a questionnaire or interview to create a realistic but hypothetical market or referendum, which allows

respondents to indicate their WTP (Mitchell and Carson, 1989). The first part of the survey conveys the description of the resource under current conditions, as well as proposed conditions if the respondent pays. Then respondents are told the means by which they would pay for these proposed changes, e.g., in a higher water bill or taxes. Finally, the respondents are asked whether they would pay a certain dollar amount, which varies randomly across respondents.

The concern with this method is the reliability and validity of the responses. Would these individuals really pay the amount stated in the interview? This question has been subjected to a great deal of empirical testing. The literature finds that CVM passes the tests of the validity involving comparisons of values derived from actual behavior methods such as hedonic pricing (Brookshire, et al., 1982) and travel cost recreation demand model (Carson, et al., 1996). All the published studies to date have shown CVM derived responses of WTP for both use and passive use values to be reliable in test-retest studies (Loomis, 1989; Carson, et al., 1997). CVM has been recommended by federal agencies for performing benefit-cost analysis (U.S. Water Resources Council, 1983) and valuing natural resource damages (U.S. Department of Interior, 1986, 1994). The CVM has been upheld by a federal court (U.S. District Court of Appeals 1989) and was recommended as being reliable enough to provide initial estimates of passive use values by a blue ribbon panel co-chaired by two Nobel Laureate economists (Arrow, et al., 1993).

Nonetheless, CVM derived estimates of public good values such as existence and bequest values may overstate actual cash WTP by a factor of 2-10 in some cases (Brown, et al., 1996). Recent efforts at calibrating stated WTP values show promise at producing equality of stated and actual cash WTP (Champ, et al., 1997).

The only previous application of CVM to the South Platte River involved an in-person survey of 200 residents of Denver and Fort Collins, Colorado in 1976 by Greenley, Walsh and Young (1982). Individuals were asked to pay a higher water bill to reduce heavy metal pollution in the South Platte

River. The average household would pay $4.50 per month in 1976 dollars or $12.50 in 1996 dollars. About half the value was recreation use, with the other half being existence and bequest values.

SURVEY DESIGN

Obtaining accurate benefit estimates using contingent valuation method require detailed descriptions of the resource being valued. This is evident from the name of the method, which produces values, contingent upon, the description of the good and method of payment. Therefore a great deal of effort was expended to carefully define and clearly display the current and proposed levels of ecosystem services to respondents.

During the first year of the project three ecologists worked with two economists to define what the ecosystem services were being provided by the South Platte River and how these could be conveyed in words and figures. Background data was acquired from U.S. Geological Survey and U.S. Fish and Wildlife Service as well as a site visit were conducted. The ecologists have summarized this background analysis of the South Platte in Strange, et al., 1998. The study section of the South Platte River was also selected based on an actual policy proposal (e.g., the Centennial Land Trust). This rural stretch of river extends from Kersey to Fort Morgan, Colorado. The first step was definition of ecosystem services that could be provided by the South Platte River: dilution of wastewater, natural purification of water, erosion control, habitat for fish and wildlife, and recreation.

Once the key ecosystem services were identified, we developed management actions necessary to increase the level of ecosystem services. These management actions included: a ten mile wide conservation easement along 45 miles of the South Platte River, downstream of Greeley. This area is 300,000 acres in size. Next, restoring native vegetation along the river in the form of buffer strips and eliminating cropland and cattle grazing in the buffer strip area. Livestock grazing would be allowed in the remainder of the conservation easement. Finally, water diversions to agriculture were reduced from their current 75% to 50% of the total flow with the corresponding increase in instream flow from 17% to 42%. In terms of acre feet of water, this is an annual gain of 37,820 acre feet of water for instream

flow, wastewater dilution, and aquatic habitat. The payment mechanism was an increase in household water bill.

The interdisciplinary team worked jointly to develop drawings and narrative that conveyed the concept of increased ecosystem services. An initial set of drawings illustrating a natural level of ecosystem services as compared to the current condition of degraded ecosystem service was prepared.

FOCUS GROUPS

To test the validity of these drawings and narrative to convey the desired concepts, we presented them at two focus groups in Denver and one in Greeley. The individuals attending the focus groups were asked to write down their description of what each diagram indicated. We asked them to point out any elements that were not clear. After each focus group, we made modifications to the diagrams and the narrative wording. We found that including a summary diagram that was a composite of all of the ecosystem services presented individually helped to improve comprehension.

PRETESTING OF IN-PERSON SURVEYS

After further revisions following the focus groups, an entire survey script and revised set of diagrams were prepared and pre-tested. We pre-tested the entire script and drawings on four individuals, two of which served as interviewer training. Further changes were made and we believe we have a fairly effective script and diagrams to elicit household willingness to pay for increasing ecosystem services in the South Platte River.

SYNOPSIS OF ECOSYSTEM SERVICES BEING VALUED IN SURVEY

(1) Restoring vegetation buffer strips along streams to increase ecosystem services such as erosion control, water quality, fish and wildlife habitat along with limited recreation opportunities. This is illustrated in Figure 1.

(2) Leaving more water in the South Platte River. This shift in water use was illustrated by comparing two pie charts shown to respondents. The top pie chart presented "Current Water Use" where 75% of water supply is now primarily for agriculture. Respondents were told that additional instream flows in the river can be obtained by: (a) purchasing water rights from agricultural users ; (b) paying farmers to grow crops that use less water ; {c} convert cropland away from the river into fenced pastureland. Farmers would make at least as much income, if not more, from selling the water and growing less water intensive crops or switching to livestock. Respondents were then directed to the lower pie chart which illustrated 50% of the water being used by irrigated agriculture and instream flow increasing from 17% to 42% of the water.

The second action needed to increase ecosystem services is to make changes in land management. Land management actions necessary to restore ecosystem services were illustrated on a schematic map of the study area. Along 45 river miles of the South Platte River shown on the map, the government would purchase conservation easements on both sides of the river over a 10 year period from willing farmers (5 miles on either side for a total of 300,000 acres shown on the map). Respondents were told conservation easements keep the land in private ownership but would pay farmers to manage this land to improve wildlife habitat and water quality. For example, cows would be fenced out of the area along the river banks so vegetation could regrow and the stream banks could be stabilized. This area will be restored to natural vegetation such as grasslands, wetlands and streamside trees (see Figure 1). Some areas would be replanted with native vegetation. The revegetated streamside would: reduce erosion; increase natural water purification by plants; improve water quality and river habitat ; help increase native fish populations so they will not go extinct; provide public access to restored natural areas for wildlife viewing including 5 miles of hiking trails.

These changes were compared to the current condition which is illustrated in Figure 2. Note, all of the figures used in the interviews were in color to better illustrate the change in water quality. The specific wording of the willingness to pay scenario read to respondents was:

"*The purchase of water and 300,000 acres of conservation easements along 45 miles of the South Platte River from willing farmers as well as restoring these areas in natural vegetation costs a great deal of money. To fund these actions a South Platte River Restoration Fund has been proposed. All citizens along the Front Range from Denver to Fort Collins would be asked to pay an increased water bill (or rent if water is included in your rent) to:*
One, purchase water from farmers to increase water for fish and wildlife from 17% shown in the top pie chart to 42% as shown on the lower pie chart (point to).
Two, to manage the South Platte River as shown in the Increased Ecosystem Services (point to Figure 1) along the 45 miles of the South Platte River shown on the map (point to area). The funds collected can only be used to restore natural vegetation along 45 miles of the South Platte River and purchase water from willing farmers to increase instream flow to improve habitat for six native fish so the are not in danger of extinction.

If the majority of households vote in favor of the South Platte River Restoration Fund the 45 miles of river would look like the Figure Increased Ecosystem Services with increased water quality and fish and wildlife (point to Increased Ecosystem Service—Figure 1).

If a majority vote against, these 45 miles of the South Platte River would remain as they are today, as illustrated in Current Management (Point to Current Management—Figure 2).

If the South Platte River Restoration Fund was on the ballot in the next election and it cost your household $__ each month in a higher water bill would you vote in favor or against?
____I would vote Yes ___I would vote No"

The $__ was randomly filled in with one of 12 dollar amounts ($1,2,3,5,8,10,12,20,30,40,50,100).

STATISTICAL MODEL OF WTP

Given that individuals simply respond with a "yes" or "no" response to a single dollar amount, the probability they would pay a given dollar amount is statistically estimated using a qualitative choice model such as a logit model (Hanemann, 1984).

The basic relationship is:

(1) $\text{Prob (Yes)} = 1-\{1+\exp[B_0 - B_1(\$X)]\}^{-1}$

where B's are coefficients to be estimated using either logit or probit statistical techniques and $X is the dollar amount the household was asked to pay. At a minimum, the coefficients include the bid amount the individual is asked to pay. Additional coefficients may include responses to attitude questions or the respondent's demographic information such as age, education, membership in environmental organizations, etc.

From equation 1, Hanemann (1989) provides a formula to calculate the expected value of

WTP if WTP must be greater than or equal to zero (as is logical for an improvement). The formula is:

(2) Mean WTP = $(1/B_1) * \ln(1+e^{Bo})$

where B_1 is the coefficient estimate on the bid amount and B_o is either the estimated constant (if no other independent variables are included) or the grand constant calculated as the sum of the estimated constant plus the product of the other independent variables times their respective means. Confidence intervals around mean WTP were calculated using the variance-covariance matrix and a simulation approach of Park, et al., (1991).

PILOT SURVEY IMPLEMENTATION

Sufficient funds were available to allow for a pilot test of the survey using in-person interviews of about 100 individuals during the spring and summer of 1998. The sample frame were individuals living in towns nearby or along the portions of the South Platte River under study. From February to July 1998, we mailed 462 introductory letters to households in the South Platte River Basin in the following locations: two suburbs of northern Denver (Thorton and Northglenn), Fort Lupton, Fort Morgan, Greeley, Longmont, and Platteville. Thorton and Northglenn were combined into one location identified as north Denver, since both of these since both of these suburbs are suburbs of Denver. To increase the chances for a completed interview, we reminded the participants with a phone call shortly before the interview. As a result, only five people or 5% failed to show for the interview. The disposition of these mailings is indicated in Table 1.

Table 1 Disposition of Initial Contacts

Category	**Number**	**Percentage**
Letters Mailed	462	100
Moved out of area, Undeliverable	89	19.3
Ineligible due to illness, language	54	11.7
No Answer after repeated calls	87	18.8
Net Sample Size	**232**	
Refusals (e.g., no time, lack of trust, etc.)	131	28.4
No Show	5	5
Accepted & Interviewed	**96**	
Response Rate		**41**

Female and Male

Since the majority of the households are listed in the man's name, if a household listed both the husband's and wife's name, the wife's name was given preference. Even so, 56.5% of the letters mailed went to males. However, we had a slightly higher cooperation rate from females, and giving us a nearly balanced sample of male (52%) and female (48%) respondents.

STATISTICAL RESULTS

A full statistical model including all survey demographic and attitude variables was initially estimated. To conserve space, only the model with independent variables significant at the .05 level or better were retained. Demographic variables such as income, education or age were consistently insignificant and these were not included in the final model.

The final statistical model was:

(3) [log(Yes)/(1-Yes)] = Bo - B1(Bid) - B2(Unlimited Water) +B3(Gov't Purchase) +B4(Environmentalist) - B5(Average Water Bill) + B6(Urban)

where:

Yes : Dependent variable records if a person was or wasn't willing to pay the amount asked during the interview. The number 1 records a yes vote, and 0 records a no vote.

Bid specifies the increase in water bill the person was asked to pay.

Unlimited Water "Do you agree or disagree with the statement 'Farmers should be allowed to use as much water as they are entitled to even if it temporarily dries up portions of streams'?" Agree =1 and Disagree = 0.

Gov't Purchase "Do you agree or disagree with the statement, 'Government purchase of land along the South Platte River to increase fish and wildlife is something I would support'?"Agree=1 and Disagree=0.

Environmentalist Are you a member of a conservation or environmental organization? Yes = 1 and No = 0.

Average Water Bill The average indoor use monthly water bill for each community.

Urban Equals 1 if lives in urban/suburban area, equals zero if live in rural/farm area.

Table 2 presents the final statistical model.

Table 2. Logit Regression Model of Probability Would Pay Increased Water Bill

Variable	Coefficient	T-statistic	Mean
Constant	2.483	1.48	1
Bid Amount ($)	-.144	-4.32***	14.79
Unlimited Water	-1.485	-2.01**	.452
Gov't Purchase	1.846	2.46**	.78
Environmentalist	3.383	2.868***	.189
Average Water Bill	-.063	-2.05**	35.80
Urban	1.803	2.55**	.747
McFadden R^2	.45		

** significant at the .05 level; *** significant at the .01 level.

Interpretation of the Regression Results

Bid The bid is statistically significant at the .01 level. The negative sign denotes that the higher the dollar amount the respondent was asked to pay, the lower the probability that the respondent would vote for restoration of ecosystem services.

Unlimited Water This variable's coefficient is negative indicating those that agreed with the right of farmers to use their entire water right even if it dries up the stream, were less likely to agree to pay for restoration of ecosystem services.

Gov't Purchase Respondents supporting government purchase of land along the Platte River were more likely to vote for a higher water bill to carry out such a program.

Environmentalist Respondents belonging to an environmental group were more likely to agree to pay the higher water bill.

Average Water Bill The negative sign suggests the higher the household's average water bill the more likely they were to vote against an increase in their water bill for this project.

Urban Suburban and Urban residents were more likely to vote in favor of this program than rural or farm residents.

ECONOMIC BENEFIT ESTIMATES

Using the formula in equation (2), mean WTP was calculated at the mean of the other independent variables. The resulting mean monthly willingness to pay per household was $21 per month with a 95% confidence interval of $20.50--$21.65, for the increase in ecosystem services on this 45 mile stretch of the South Platte River. The resulting logit curve is well balanced and does not exhibit any "fat tail" at the high bid amount. This is evidenced by median WTP being $20.72 nearly equal to the mean. This value is about 1.5 times the inflation adjusted value of what Greenley, et al. (1982) estimated for the benefits of improving just water quality in the South Platte River in 1976.

We make two expansions of these benefits to the population of regional households living along the South Platte River. The first treats our mean WTP as the best estimate of what the average household would pay. The second, is a far more conservative estimate that accounts for the 59% of households that did not respond to the survey. The proportion of households that refused to be interviewed regarding the South Platte River are conservatively treated as having zero WTP.

The counties of the cities interviewed were determined to be the pertinent areas to which the preservation benefits pertain. These counties include: Adams, Boulder, Weld, and Morgan. Mean willingness to pay per household was multiplied by the number of households in this area of the South Platte River Basin. To estimate the more conservative lower bound of WTP assuming the proportion of non-responding households had zero WTP, the mean WTP was applied only to the proportion of households that responded to the survey (41%).

Table 3 Annual Benefits per Household and Along the River

Scenario	WTP	# of Households	Monthly (Millions)	Annual
Apply Mean to all Households	$21.06	281,531	$5.93	$71.148
Apply Mean to only Responding Households	$21.06	115,427	$2.43	$29.171

COMPARISON OF BENEFITS AND COSTS OF RESTORING ECOSYSTEM SERVICES

The annual WTP can be compared to the cost of the conservation easements and water rental necessary to deliver the ecosystem management practices in the study area. The U.S. Department of Agriculture's Conservation Reserve Program (CRP) pays farmers to idle their farmland to reduce erosion and improve water quality. Rental rates in northeastern Colorado average $41 per acre (Page and Skold, 1996). Given the 300,000 acres of easements in our ecosystem management scenario, $12.3 million would be required. Since even the conservative estimate of the amount responding households would pay is $29.17 million, households could pay the CRP rental rate to farmers and have $16.87 million remaining annually to rent the 37,820 acre feet of water needed to increase instream flow, dilution of pollution and aquatic habitat as well as pay any one-time on-site restoration costs such as fencing and replanting native vegetation. Brown (1991) shows market transactions for instream flow in California and Nevada that give annual average values of $9.75 (in 1996 dollars) per acre foot. More recently, Landry (1998) summarized annual lease prices of water for instream flow in the west at $30. Using the more recent higher cost of $30 per acre foot, the annual water leasing cost would be $1.13 million per year. Thus total costs would be $13.43 million, about half the conservative estimate of WTP. Thus, up to $15 million per year could be spent for on-site restoration with native vegetation, riparian improvements and fencing. Therefore, it is clear, that willingness to pay of responding households along the South Platte River far exceeds the typical costs of the conservation easement and leasing the water rights. If one were to include all the households living in the entire South Platte River watershed, WTP would exceed the costs by an order of magnitude.

CONCLUSION

Mean willingness to pay to increase five ecosystem services (dilution of wastewater, natural purification of water, erosion control, habitat for fish and wildlife, and recreation) along 45 miles of the South Platte River was $21 per month in a higher water bill. When the $21 is generalized to households living along the river, this is sufficient to pay for the conservation easements on agricultural land along the river and the leasing of water for instream flow. Thus, the policy to increase ecosystem services meets the economic efficiency criteria that the gaining public could compensate the farmers and ranchers for the conservation easement and water and still come out ahead.

Areas for further improvement include systematically varying the number of ecosystem services to be valued and the level of each ecosystem service to be provided. This can be done using multiple scenarios within a contingent valuation survey or through the use of contingent choice or conjoint analysis (Adamowicz, et al, 1998). In this way the incremental value of specific ecosystem services could be valued and compared to the cost of providing that ecosystem service or higher level of ecosystem service.

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Numbers, Values, and Decisions: Using Constructed Preference Approaches to Value Watershed Management Policies

--WORKING PAPER*--

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* This is a working paper developed for the US Environmental Protection Agency Office of Economy and Environment, Office of Research and Development and Region 10, for their workshop, "Economic Policy and Research Concerning Water Use and Watershed Management," held on April 21-22, 1999, at the Crowne Plaza Hotel in Seattle, Washington.

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A. Introduction

Researchers interested in how people assign values in the context of environmental choices often end up shaking their heads in frustration at the messiness of the venture. The challenges are numerous: identifying the relevant stakeholder groups without omitting any significant parties; defining a manageable set of issues and understanding enough of the relevant context and science to ask meaningful questions of participants; establishing the key dimensions of the problem; deciding whether to work with small groups or large, a random survey or clustered sample; determining how tradeoffs should be addressed, whether in monetary or other units; establishing an appropriate time frame; and speaking effectively to multiple audiences, including interested public and expert and government listeners or readers. The prescriptive basis for addressing any of these issues is often weak and generally controversial, with a variety of approaches in widespread use and few experiments that direct compare alternative methods.

A constructed preference approach to evaluating watershed management policies acknowledges many of these sources of frustration. It is based on insights from cognitive psychology, behavioral economics, and multiattribute utility analysis and, in essence, makes the point that the process of assigning values to the multiple dimensions of many environmental policies is a novel and difficult task that requires help (Gregory, Lichtenstein & Slovic, 1993). Because these values typically are not known a priori, participants in a survey or group are thought to work with available cues and signals to construct a value (Payne, Bettman, & Johnson, 1992). These cues and signals include factual information about the item, the values placed on similar goods, the scale or metric being used for the valuation, and the social and historical context within which the valuation takes place.

A careful construction process should increase the validity of a response; in particular, consideration of the multiple dimensions of a proposed action should improve the fit between the good being valued (by an individual) and the good thought to be under consideration (by policymakers). Careful construction also should decrease the influence of the embedding effect and other judgmental biases, although the success of the construction process will vary across survey or group participants. The perceived precision of a constructed response also will vary across participants; some will think that they can express their value(s) closely, whereas others (more critical of the construction process, or simply less sure of what they believe) will interpret their own response as only a vague estimate or subject to substantial error.

This variation in the precision of responses matters to analysts, because some circumstances call for ballpark estimates of value (either quantitative or qualitative) that can support a defensible decision process whereas others require quite precise numbers to support a more exact evaluation (Gregory et al, 1995). In the former, ballpark category I'd place suggested actions that have significant nonmonetary impacts (e.g., cultural and affective dimensions) as well as those that are either clear winners (i.e., high benefits to costs ratio) or clear losers. In the latter category, I'd place actions that compete closely with other alternatives or ones that have strong support but imply irreversible consequences (e.g., significant increases in the probability of extinction of a species). In general, I believe that the usual economic methods for estimating willingness to pay (including contingent valuation methods) fail to provide a level of precision in value estimates that is sufficient to be much help to the decisions faced by policy makers. In many cases, the resulting number may only be indicative of a general attitude rather than an economic value (as suggested in recent studies such as Ritov and Kahneman, 1994). In these situations, I believe that an explicitly constructive approach can help to refine participants' expressions of preference and thereby increase the usefulness of study results for policy development.

B. Case-study Examples

Consider a hydroelectric water-licensing project on the Alouette River in southern British Columbia, where in 1996 I co-led an expert-public stakeholder Management Committee (with Tim McDaniels). Higher water flows and a more natural hydrologic regime meant better fish habitat and improved recreational opportunities, but also lower electric power production and altered flood risks. Our task was to facilitate a multi-stakeholder committee of about 20 representatives, to consider the pros and cons of alternative water flows across a broad range of impact categories, and to make flow recommendations to the local utility. For some of the actions under consideration, there was no reason to conduct detailed quantitative analyses across impact categories because they were either clear winners (e.g., occasional "flushing flows" to aid salmon habitat) or clear losers (e.g., removing the dam, which would imperil neighboring residents). Stated differently, the values of stakeholders led to a clear decision even though the associated numbers were vague. For other actions, the group quickly focused on consideration of a range of options (e.g., desired water flows of 70 - 100 cfs) but required detailed quantitative analyses to aid in distinguishing the distribution of anticipated benefits, costs, and uncertainties. For these cases, impacts were considered across the five value categories using simplified objectives by alternative matrices, which simultaneously organized the available information on the pros and cons of competing alternatives and served as a reference for coming up with suggestions for mitigation and compensation (McDaniels, Gregory & Fields, in press).

Although it would have been possible to calculate the relative utility of these alternatives, the decision process adopted by the Management Committee instead led to decisions being made on the basis of explicit tradeoffs across key objectives: questions, for example, of the type "Is it worthwhile to decrease electricity production by X mw/year in order to increase salmon production by Y fish/year." Quantitative (including monetary) values were used to help in making these comparisons but only to the extent necessary; power production effects were closely modelled but, for other value dimensions, broad distributions were often sufficient

because at either end of the anticipated impact range the same decision was clearly preferred. Thus, time and money was spent in structuring the decision and in identifying the various impact categories rather than in coming up with more precise numbers to feed into a larger analysis.

A similar approach was used to assist the National Estuary Program in Tillamook Bay, Oregon to develop a community-supported estuary protection plan. In this project (co-led with Katharine Wellman of Battelle Memorial Institute), the focus was again to find a way for local residents and technical experts to consider the multiple components of value that would be affected if any of a set of alternative actions were undertaken. The focus of our project was to evaluate several key consequences of actions proposed in the draft Comprehensive Coastal Management Plan (CCMP) in terms of their associated costs and benefits. This required the use of standard tools of economic and ecological impact analysis as well as the development of new, constructive methods for estimating tradeoffs across multiple components of value. In addition, new approaches were developed for encouraging the broad-based participation of community residents, along with key local and state agencies, in the development and assessment of priority NEP actions. These efforts included a series of structured interviews to help estimate the values placed by community stakeholders on water quality and habitat improvements and, linked to these, the intensity of action (e.g., the amount of resources allocated to an action, or the designated time frame) desired for specific proposed CCMP initiatives.

In some cases, the values information provided by our study is expressed as a dollar measure in terms of social willingness to pay (e.g., is this action viewed as a good use of society's scarce funds, resulting in additional state and/or federal taxes?). In other cases, values are reported in terms of the tradeoffs that participants are willing to make or in terms of the preferences that are implied by their choices. When designing the evaluation tasks, we therefore supplemented the use of dollar-based questions with pair-wise choices and, at other times, asked participants to assign points to each of two or more competing options. As shown in Figure 1, a branching pattern of questions was used to permit participants to address tradeoffs and levels of intensity in the course of considering their responses. Particularly when watershed management policy initiatives involve a mix of economic, environmental, and social/cultural impacts, we believe the quality of information that can be provided by the direct choices and preference judgments of participants often will be higher than if individuals are required to undertake the additional step of translating expressed values into a monetary measure of worth.

A mixture of small-group input, expert interviews, and literature sources were consulted in designing the evaluation tasks. Based on the results of an initial prioritization exercise, we selected three of the most significant and controversial actions proposed by the Tillamook Bay National Estuary Program (TBNEP) for inclusion in an evaluation workbook:

- protecting and restoring tidal wetlands
- limiting livestock access to steams
- upgrading forest-management roads

The final format for each of the actions used a matrix and identifying logos to present the tradeoffs implied by each alternative in terms of three benefits and two costs. Two different levels of intensity were shown for each of these three actions. This focus on options is due in part to the critical nature of decisions about timing and scale for estimating the consequences of actions and, in part, reflects extensive research in judgment and decision making which shows that the quality of a choice typically is improved to the extent that alternatives are offered. Additional questions asked participants to review the proposed plans after further changes had been made and to provide suggestions for desired future communication about, and input to, decisions of this type.

Eight groups were held over the course of two days in mid-January, 1999. A total of 89 people took part in these groups, with 79 surveys (89%) completed and analyzed. Although the number of participants involved in this experimental study is obviously much smaller than the number typically involved in a CV survey, we believe that the care taken in value construction and the additional depth of valuation insight has the potential to result in more useful results. In the Tillamook Bay example, each group was led by a local facilitator, with one member of the project team and one member of the TBNEP staff on hand to answer questions. A one-page information sheet, prepared by the locally-based Performance Partnership, was passed out and discussed briefly at the start of the session to give participants an initial, shared perspective on local environmental and economic issues.

Restore Tidal Wetlands

These results have important implications for the design of the TBNEP initiatives. First, they suggest that linking restoration of tidal wetlands to floodwater storage is likely to increase public acceptance of proposed expenditures (e.g., for the purchase of marginal farmland and the conversion of this acreage to wetlands). Second, they suggest a local willingness-to-pay for these improvements that is quite high, supportive of payments on the order of at least $3 - 5,000 per acre. The upper end of this value is approximately equivalent to the price of medium-quality farmland in Tillamook County (based on an estimated annual value for the services provided by moderate-quality pasture lands of about $500/acre, or -- when capitalized at an interest rate of 10% -- roughly $5,000 per acre), and suggests that the restoration of former (and now degraded) wetlands may be a popular initiative at a scale well beyond the 750 acres of marginal farmland planned for in the current high-intensity Plan B.[1]

[1] There exists an important caveat to this statement: Historically, both the image and economic prosperity of Tillamook County are so closely tied to a healthy dairy industry that proposed reductions in the amount of available pasture land that were sufficiently large so as to threaten the continued well-being of dairy farming would probably be met with vocal and strong resistance.

Limit livestock access to streams
This action is the most controversial of the three key actions under consideration, as demonstrated by the close results between participants selecting the "fencing + 15-foot riparian buffer" lower-intensity plan (13 of 28) and those selecting the "fencing + 50 foot" higher-intensity plan (15 of 28).[2] Both plans are shown to improve the image of the dairy industry significantly. Even though the anticipated expenses to farmers and local agencies could be large (since only 50% of costs are shown to be covered through grants and offsets), answers to the workbook questions reveal that the primary concern was the loss of farmland: a large reduction (from $6.0 to $4.5 million) in the financial costs of the higher-intensity plan had no effect on participants' choice of plans, whereas a 90% reduction in the loss of productive farmland (from 3,000 to 300 acres) resulted in a substantial increase in the number of participants choosing the wider buffer width. Thus, so long as land losses can be kept to a minimum, these results suggest that a strong majority of local residents (14/17 participants in these groups, or 82%) would support the use of substantial public funds (as much as $1.2 million for each of 5 years) as part of a plan to build new fencing and to plant 100-foot (counting both stream sides) riparian buffers.

Upgrade forest management roads
Over two-thirds of respondents (8/11) in this group chose the higher-intensity Plan B option, implying that they support payments of $7 million per year to improve water quality, increase fish passage, and reduce the risks of flooding in lowland areas. When Plan A was improved to include either additional reductions in sediment delivered to streams or higher levels of fish survival, only one person switched their choice. Thus, the majority of participants believe the proposed reductions in sedimentation and increases in fish survival are worth the substantially higher cost of Plan B (an additional $3.8 million per year for each of ten years), which suggests a high level of support among local residents for an enhanced forest road-improvement program.

With modest changes in the instructions and background information provided at the start of the workbook, it would be appropriate to consider obtaining information of this type using a mail survey format rather than the group-based evaluation effort that is reported here. This extension would improve the accuracy of the results and provide for further insights due to the inclusion of additional proposed actions as well as further questions concerning the specific tradeoffs and choices that local citizens are wanting to make in the course of shaping the environmental, social, and economic future of the Tillamook Bay watershed.

C. Research Issues
These examples provide the basis for both a theoretical and a practical argument in support of approaches to evaluating watershed management policies that recognize preference construction. The theoretical argument is that dollar-scaled attributes involved in the decision (as measured by

[2] As explained during the group discussions, these buffer widths refer to only one side of the stream whereas work would be done on both sides; thus, 500 miles of fencing with a 50 foot buffer would translate to 250 miles of fencing on both sides of the stream and a total of 100 feet (50 feet on both sides) removed from pasture land or other current uses.

willingess-to-pay) form only one of several, simultaneously valued components of well-being. Asking community residents to collapse these other values into dollar terms is too heroic a task; as Paul Slovic and colleagues noted in the context of selecting a nuclear repository site, we would be "asking them to tell more than they can know" (Slovic et. al, 1991). The practical argument is that, in the context of this type of social/ecological/economic decision, no survey asking for willingness to pay responses alone would make sense to local citizens (or, in these situations, be permitted by community leaders). Thus, a constructive multi-attribute approach is required to integrate the environmental valuation process with community-based participation.

Would more precise numerical information on benefits or costs help these evaluation exercises? Perhaps, but I expect only a little. The real stumbling blocks are more the framing of the valuation and decision contexts and finding ways to encourage broad-based and informed debate among local citizens about the multidimensional impacts of the actions under consideration.

Despite this overall endorsement of the approach, many questions still remain concerning the application of constructed preference approaches. One of the more interesting issues has to do with selection of either a choice or pricing mode for value construction. If the evaluation question considers different levels of an action (e.g., different levels of stream clean-up), then typically an individual will invoke a set of similar alternatives whose major differences will be at the margin, expressed in terms of peripheral or secondary alternatives. If an action is instead considered in contrast to other, unlike items (e.g., spending money on stream clean-up versus keeping the money for personal use), then the evaluation task is more likely to focus on prominent or central attributes of the choice. For many environmental assets, this latter framing or mode of construction -- emphasizing choice rather than a direct evaluation of worth -- may result in the assignment of a significantly higher value because it emphasizes the more attractive attributes of the environmental alternative (e.g., its ethical foundations or the provision of benefits for future generations). People may want the things they personally can buy but think that they ought to prefer the public good, so the weight of the arguments favoring the environmental option will increase when a choice is required. Although laboratory results on this topic are quite compelling, I haven't yet seen any tests of this hypothesis from community participants involved in real environmental decisions.

Another issue has to do with the time frame for the analysis, since people are being asked now to make choices about the future (in Tillamook, for example, our valuation efforts follow closely a separate community survey to "vision" alternative futures for the region). This requires guesses about the future consequences of present actions, but it also requires (as noted by March, 1978) making guesses about future preferences for these consequences. If this element of additional uncertainty is brought explicitly into the preference construction process, experience suggests that individuals are more likely to adopt a precautionary (risk-averse) attitude. In part, this is due to the heightened salience of responsibility costs: people feel worse about a negative outcome they have had a part in choosing than if it simply occurs. In addition, the act of making uncertainty about future preferences explicit appears to have the result of making the future more

real, which could lower an individual's discount rate or change what a person wants to know and value regarding the range of possible future consequences. I know of very little research about how explicit preference construction affects inter-temporal choices, but I think that the topic is important.

D. Conclusion

In conclusion, I am struck by the complexity of many of the environmental decisions we typically ask individuals to make and the lack of training or insight they are given in how to make these decisions responsibly. The fact that we can obtain a number and attach it to a valuation priority -- $30 for an individual's extra day of freshwater fishing, or $3 million for a community's efforts to clean up a polluted estuary -- means little if the stated context for the decision is either poorly understood or inappropriate. In most cases, I believe that the complexity of the environmental valuation tasks requires a deliberate, thoughtful process of value construction across multiple dimensions and across multiple metrics in order to help individuals arrive at an informed decision.

This comment, however, raises a final issue, which is how little I believe we know about what constitutes a sufficiently "well-formed" value. I might decide to lead a group of stakeholders through a preference construction exercise, asking them to delineate and measure value attributes and even to assign these components priorities (i.e., weights) in the context of the decision at hand, in hopes that their environmental choice will benefit from a "well-formed" expression of value. But who is to say that this value is well-formed? What criteria exist for measuring the progress that has been made on defining the participants' values? Payne, Bettman, and Schkade (in press) have made a start in asking questions such as this, following the analogy of developing a "building code" for the construction of values. But it is only a start.

Currently, I'm wondering whether the universe of values important for watershed management policy decisions might not be divided into two parts. The first is composed of all those things that we assign values to on the basis of readily at-hand cues and social discourse. The second is composed of those things that are fundamental to who we are and to our sense of well-being. It may that that the first set of values can be constructed more or less well but they always will be susceptible to alternative framings; given the informational equivalent of a minor earthquake, these constructed values will either shake a whole lot or fall over. The second set of values may in fact be very solid and may survive the cognitive earthquake with no problem. If this is true, perhaps we want to focus more of our evaluation efforts on understanding and correctly eliciting this second, "bedrock" category of values, so that they can be more fully represented in watershed management policy decisions.

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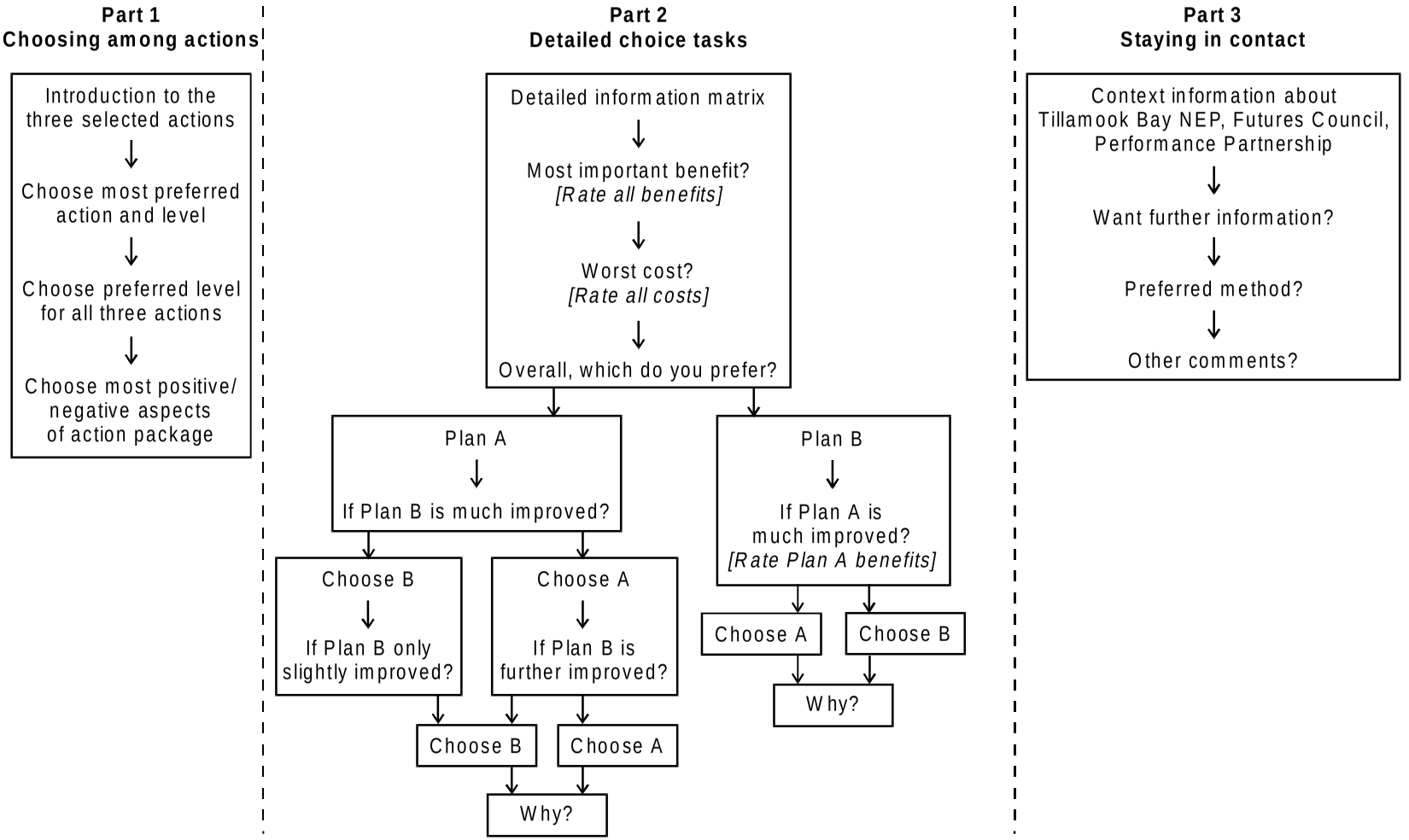

Figure 1. Flowchart for Tillamook Evaluation Workbooks.

Alternatives to Traditional CVM in Environmental Valuation: Applied Research Challenges

--WORKING PAPER*--

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* This is a working paper developed for the US Environmental Protection Agency Office of Economy and Environment, Office of Research and Development and Region 10, for their workshop, "Economic Policy and Research Concerning Water Use and Watershed Management," held on April 21-22, 1999, at the Crowne Plaza Hotel in Seattle, Washington.

Alternatives to Traditional CVM in Environmental Valuation: Applied Research Challenges

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September 17, 1998

Alternatives to the contingent valuation methodology (CVM) to determine the value of natural resources and resource services (especially passive uses) have become more prevalent in applied research in the last three years. Referred to as stated preference methods by some, these models take the form of ratings, rankings, and stated choice. Conjoint analysis, multi-attribute utility theory (MAUT), and attribute based stated choice methods have all been suggested to be superior in one way or another to the more traditional CVM.

From an applied perspective, the taxonomy of alternatives to traditional CVM in environmental valuation shouldn't really matter. These alternative direct elicitation methods should not be viewed as substitutes for CVM or one-another, or competing in terms of their position in the hierarchy of "acceptable" economic practice. Rather, I believe they should be viewed as complementary. Traditional CVM and its alternatives are all based in utility theory and they all involve ordinal and or cardinal rankings. The primary difference at hand is that each method asks respondents to perform a different task. In this light it is important to consider combining methods or choosing the appropriate method depending on the ends one wishes to achieve and the makeup of the group (general population, agency, firm, etc.) whose values are being assessed. The choice of a specific approach should depend on whether one is engaged in policy making, planning, natural resource damage assessment, public involvement, decision making under uncertainty or some combination of the above. For example, under current regulation, CVM is the method accepted in courts of law for the measurement of passive use values in damage assessment cases. While variations to the approach are expected, few lawyers will accept value estimates from an economist that strays far from CVM guidance outlined under the OPA rule. On the other hand, if the goal of some applied research is to involve multiple stakeholders in the prioritization of actions to be included in a watershed management plan, then a pairwise-choice or decision analytic approach may be more appropriate.

What factors come into play in the choice of method(s) to apply in a particular circumstance? Three candidates are outlined below:

- Level of respondent's familiarity with the good or service they are being asked to value.

  Traditional applications of CVM have included the assessment of values for such goods and services as scenic views, marine mammals, and recreational fishing – all fairly specific and relatively well understood. Current applications involve broader questions of ecological functions and services, environmental restoration policies, and conservation and management plans – complex goods with which people are less familiar.

  This factor is one that will not go away with choice of valuation approach.

- Level of Heterogeneity of the Population.

  When dealing with complex environmental issues that involve multiple stakeholders, average willingness to pay estimates across a population may not provide sufficient information to decision-makers who must respond to equity issues and to shifting values based on conflicting objectives and preferences.

  Constructed preference or multi-attribute/decision analytic approaches can offer valuable information about the context of, and reasoning behind, individual values.

- Level of Decision-Makers' and Community Members' Comfort with Researchers "From Away".

  There exists an inevitable tension between local communities' desire for increased participation in resource management decision-making and their frequent need for "outside expertise". Decision-makers and community members involved in complex environmental management issues may be leery of individuals purporting to be able to "help" them deal with difficult decisions. Suspicion or concern may arise as a result of the insider versus outsider or expert versus lay difference in perspectives. In addition, local decision-makers and community members may be concerned about the potential imposition of the outside researcher's values driving the decision process.

  Any approach that distances the researcher from the community (such as a standard telephone or mail CVM survey and analysis) will eliminate this issue, at the expense, however, of valuable information about community objectives, opinions, and values.

Familiarity with the good or level of information has received a great deal of attention in the theoretical and applied literature. The other two factors, heterogeneity of the population and discomfort with researchers, however, have not received much research attention, especially in the context of attempts to involve multiple stakeholders in complex decision-making concerning natural resources.

I wish to illustrate these considerations in choosing a method for environmental valuation using a current case study, the Tillamook Bay Estuary in Oregon State.

Tillamook Bay is located in northwestern Oregon, tucked between the rugged Coastal Range and the Pacific Ocean. It is subject to high rainfalls during the winter months and mild temperatures throughout the year. It supports diverse living resources, including shellfish, runs of salmon and trout, groundfish, and numerous bird species. It is integral to the local and regional economies that are largely based on natural resources, including forestry, agriculture (dairy farming), tourism/recreation, and commercial fishing.

Tillamook Bay, however, suffers from several environmental problems including (1) critical habitat degradation, affecting salmon spawning, increasing stream temperatures, and contributing to bay sedimentation, (2) pathogen contamination affecting shellfish and water-contact uses, and (3) excessive sedimentation in the bay and tributaries affecting fresh and saltwater flows and

living resources. With the support of Governor Roberts in 1992, the U.S. Environmental Protection Agency designated the Tillamook Bay as an estuary of national significance and included it in the National Estuary Program (NEP). As part of the NEP, the Tillamook Bay National Estuary Project (TBNEP) is in the process of developing a Comprehensive Conservation and Management Plan (CCMP) to protect the ecological integrity of the estuary. To achieve this objective the TBNEP has convened a Management Conference, consisting of citizen and government agency stakeholders, that has characterized the estuary, defined priority problems, and is now outlining solutions (actions) in the CCMP.

The goals of the TBNEP are: (1) to achieve water quality standards to protect beneficial uses of the bay; (2) protect and enhance anadromous fish habitats; (3) restore the bay from impacts of sedimentation; (4) develop a comprehensive plan for Tillamook County's economically important industries, while improving and maintaining water quality and living resources; and (5) apply lessons learned there to other Northwest estuaries.

Robin Gregory and I were asked to assist the project in identifying stakeholder (public and expert) values for the Tillamook estuary area, linking these values to specific resource-management actions and ultimately assisting in the prioritization of actions to be included in the TBNEP CCMP. Our strategy has involved a combination of multi-attribute utility theory and decision analytic approaches to identify underlying objectives, define a small set of key CCMP action alternatives, and design and implement a value integration instrument to elicit and compare stakeholder tradeoffs and values relating to these action alternatives. Our goals are: (1) to inform decision-makers of key tradeoffs across conflicting objectives; (2) to estimate numerical values for water quality and habitat improvements in Tillamook Bay; and (3) to lay the foundation for continuing and expanding dialogue among key user groups.

In conducting our work we have faced several challenges. First, the demographic characteristics of the Tillamook Bay area are varied. While natural resource based industries (dairy farming, forestry, and commercial fishing) have driven past socio-demographic trends, in recent years other income sources have substantially affected job growth and the subsequent demographic make-up of the Tillamook Bay community. For example, the number of retirees whose incomes are not dependent on local industries has risen, and tourists or vacationers have become an increasingly important part of the seasonal population and revenue base. There are significant differences, in terms of values and beliefs that define the social and political structure of the area. Clearly, this high degree of heterogeneity of the population makes any decision-making process more complicated and difficult. Our work, accepted as credible and important by some, is viewed as confusing, unnecessary and intrusive by others. We have had to deal with posturing on the part of various stakeholder groups (as opposed to fruitful conversations or interactions) and varying degrees of skepticism and outright hostility; in some cases, discussions about management actions have been cut short by politically induced fears.

A relatively more straightforward mail or telephone CVM approach might have avoided some of these interpersonal conflicts. However, in using such an approach we would not have learned all that we did in terms of individual objectives, how those objectives link to acceptable actions or how the actions link to alternatives, and in general, the fundamental rationale for the tradeoffs expressed. The latter information is all critical to managers (especially those operating in small,

close-knit communities) faced with making decisions that affect a variety of groups in a variety of different ways. No CCMP is likely to be unanimously accepted by all members of the community. On the other hand, if community members are not allowed to be involved in the decision process, it is also clear that any efforts to implement the plan will be fruitless. The result of our approach, however, should be better-informed public citizens and a process that more fully incorporates their views and concerns.

Although a broad cross-section of the community was willing to share ideas, deeply held beliefs, and opinions with each other and with us early in the process, as we moved closer to the actual value elicitation part of the project there developed a clear lack of trust within the community in researchers "from away". Resistance to involvement from outside the Tillamook community was present across all stakeholder groups. There was concern about the amount of time that we, as researchers, were willing to spend on site, and stated desire for local participation or local community member involvement in the implementation phases of our work. In general, it was felt that it was costly to educate researchers from away about local politics, issues and concerns, and participants were wary that the information they provided would be used to make decisions rather than (as promised) to provide insights. This response is understandable. In rural resource-based communities of the Pacific Northwest change has been constant, and generally perceived as negative for the past 15-25 years. Industries have declined, decisions have been made in state capitals and Washington, D.C., and people and ecosystems have suffered. For some stakeholders, our offer of a "place at the table" is seen as too little and as coming too late, feelings that are exacerbated by the need for facing up to tough choices as part of the analysis of plan actions.

A MAUT process can help clarify the values of participating stakeholders and how these relate to action alternatives, allowing affected groups to discuss a broader set of policy options. Community reaction to our work, however, is different than that experienced in corporate or agency settings. This suggests, in part, that the successful application of MAUT/decision process approaches may be situation specific and depend in large part on social and cultural receptivity. Another necessary ingredient to transfer MAUT-based approaches (as an alternative to traditional CVM) to small communities is the leadership of a trusted local group with ties to many parts of the community, and an open and scientific process for collecting information about the consequences of specific policies and decisions. It is critical that the local group has a broad, interdisciplinary understanding of research and decision-making methods and information being used and trusts the process. We had assumed that the TBNEP was that trusted leader, but learned otherwise, eventually recognizing that members of the TBNEP were considered as much outsiders as ourselves. As a result, we recently have begun to coordinate more closely with a respected local group known as the Tillamook Futures Council. Taken as a whole, this 3-way combination of consultant analysis, NEP staff, and the Futures Council link to the community, may result in the elicitation of defensible estimates of public preferences for resource management alternatives, our ultimate goal. We will know more about the outcome of this approach by later this fall.

Discussion of Loomis paper

by Dr. Linda Fernandez, University of California at Santa Barbara

The study offers an important contribution to valuing ecosystems. It is useful to review the quality of the work according to the six fundamental components of a contingent valuation (CV) survey developed by Michael Hanemann.

1) Description of the change (increase) in environmental goods from the proposed ecosystem restoration action. The study makes use of visual aids to help depict ecosystem services under the two scenarios described: (a) the current case with degraded ecosystem services and (b) the natural, healthy ecoystem services from restoration efforts. It would be useful to add more incremental changes to the scenarios that distinguish between different levels of different services (water purification, fish biomass) in order to derive existence values separate from use values and indirect use values. The visual aids and description lend towards the goods bundled into only two levels of the ecosystem, degraded and not degraded. With more levels and distinction between the different services it is possible to distinguish between values and avoid the embedding problem. The description of the management actions to restore the ecosystem is clear and tangible for respondents to understand.

2) Clear means of eliciting value. The survey used in the study presents a plausible payment scheme represented by an increase in the public water bill to all residents. It would be helpful to provide more detail in terms of whether the increase would be a higher fixed amount or tiered and/or block rate pricing. The survey conveys neutrality by explaining various stakeholders and effects (agricultural use, urban water users, instram habitat). It is not likely that there is starting point bias in terms of the range of values for payment to implement the management actions for restoration.

3) Survey Administration. The researchers use a combination of mail, in person, and telephone forms of communicating with respondents to insure the maximum participation for the survey. This is good from the standpoint of maximizing participation.

4) Sample Design. It appears that there is an effort to select a random sample of people to participate in the survey. It would be helpful to provide actual details of the randomness in the sample. What kind of procedure was actually used to select the random sample? Were they stratified or clustered random samples?

5) Experimental Design. The logit model is valid and the variables chosen are useful to account for variation amongst the respondents. It would be helpful to find out more details of possible correlations between key variables. For example, the correlation between the rural dwellers and those respondents favoring unlimited water use by the agricultural sector could be influential. Why not retain the variables of income, education and age instead of dropping them from the model? These seem like they should be included and discussed for interpreting different types of responses. It would be useful to include summary statistics about the respondents.

6) Estimation of Willingness to Pay. The treatment of the non-response data as a value of zero for willingness to pay does not add much to the study so it is probably not worth including. The

comparison of the annual willingness to pay with costs of conservation easements and water diversion purchase is useful for gauging the economic efficiency of policies by a cost/benefit analysis. There is a positive consumer surplus for the public in compensating farmers for conservation easement and water. It would be useful for the study to include some discussion of any substitution effects related to other sites as substitutes for the stretch of the river that the study focuses on.

In summary, the study is useful and well executed. The paper needs to include some details about the components of the contingent valuation components.

Discussion of Gregory paper

by Dr. Patricia Koss, Portland State University

Numbers, Values, and Decisions: Using Constructed Preference Approaches to Value Watershed Management Policies: Comments

This paper primarily discusses the advantages of a constructed preference approach over a willingness to pay approach to estimating valuation. It is asserted that by explicitly asking individuals to make pair-wise comparisons across the multiple attributes of a product, we are more likely to arrive at a much more refined preference ordering than that supplied by a willingness-to-pay study. This is, of course, likely to be the case, but is not surprising since the ***objective*** of a willingness-to-pay study is ***not*** a preference ordering, but a monetary measure of value. These approaches should not be viewed as substitutes for one another. Indeed, it may be appropriate, as indicated in the paper, to use both methods in a single valuation study, depending on the attribute we seek to value.

The paper acknowledges that there is often variation in the precision of responses across respondents: that is, that some people will perceive their own response as a vague estimate, while others are quite sure of their response. It is unclear whether Dr. Gregory is implying that a constructed preference approach is better able to deal with this issue than a willingness-to-pay approach. It would be interesting to consider how the two approaches differ in terms of the variation in the precision of responses across respondents.

The paper points out that the constructive approach itself can help refine participants' expressions of preferences. As respondents are led through a series of pair-wise comparisons, they are forced to acknowledge and understand trade-offs. Large volumes of information are presented in small doses, making it easier for people to analyze options and trade-off consequences. At the same time, this suggests that the researcher must take care not to influence preferences themselves. This can be a particular concern for trade-off analyses. In general, it is not possible to present all possible alternatives, implying that survey bias is unavoidable to some extent.

The paper has acknowledged that offering environmental alternatives in order to determine their place in a preference ordering may bias responses in favor of the alternative respondents feel they "ought to" value. I believe this is a valid concern, but with careful survey design can be tempered. For example, the respondent can be asked to make a pair-wise comparison between two public goods A and B; then between each public good against a private good. We want to ensure that we are truly measuring the value placed on the good itself, not the esteem associated with observed choices.

I am somewhat familiar with an approach called the Analytic Hierarchy Process (AHP) which I believe would be categorized as a constructed preference approach. Under this approach, a valuation exercise is organized as a hierarchy with the overall goal on top, followed by actors/stakeholders, then attributes and subattributes, and finally policy actions. Stakeholders are asked to make pair-wise comparisons across attributes and subattributes. This allows us to derive

a weighted preference ordering for each individual and finally an aggregate weighted preference ordering. Some studies use AHP in conjunction with a contingent valuation, or willingness-to-pay, follow-up study. By enduring the AHP analysis, respondents essentially become familiar with the preferences, allowing them, perhaps, to give better informed contingent valuation estimates.

Question and Answer Period for Session III

John Loomis, Colorado State University, offered some responses to the comments made by Linda Fernandez in her discussion of Mr. Loomis's paper. Mr. Loomis remarked that the juxtaposition posed by his paper and Robin Gregory's paper is the comparison between an individual buildup of willingness to pay versus directly asking for a willingness to pay for an aggregate good. Mr. Loomis stated that their study considered the individual components of their aggregate good, and constructed the aggregate good using focus groups. With respect to the questions Ms. Fernandez raised regarding the use of a higher water bill as a payment scheme, Mr. Loomis responded that the payment was posed as a fixed flat fee to be included with the respondents' water bill. A researcher even obtained the average water bill amount from each town in which the survey was administered to establish a reasonable baseline. Mr. Loomis explained that the sampling was accomplished by choosing communities along the Platte River and randomly choosing names out of phone books. In terms of demographic statistics of respondents, Mr. Loomis stated that income was not included in their model because it was not significant. Since the bid amounts were small, it should not be surprising that income did not significantly influence willingness to pay. There were some correlations among independent variables, but they were small. Finally, in her discussion, Ms. Fernandez had asked what possible substitutes the respondents might have had available. Mr. Loomis noted that like most other places in the arid parts of the West, there are few substitutes in terms of rivers. A paper by Hoehn and Loomis on the willingness to pay for wetland restoration in the San Joaquin valley illustrates this point. Substitution may come into play, however, in the Snake River region.

Robin Gregory, Decision Research, provided some responses to comments made by Patricia Koss in her discussion of Mr. Gregory's paper. Mr. Gregory noted that he is now doing a study on preferences regarding endangered species issues and trying to find ways to ask preference ordering questions so as to capture the increase or decrease of a probability of survival of the species. Mr. Gregory also found that possible commercial exploitation of species creates an emotional response, in the sense that people do not want to pay money to save fish if fishermen are going to catch them for profit. Ms. Koss remarked in her discussion that the goal is not to arrive at a preference ordering but a dollar value. Mr. Gregory responded that the point of the constructed preference (CP) approach is that in order to justify a dollar value, one must address preference ordering issues. CP is thus more precise than contingent valuation (CV). CV has made progress, but asking about attributes is more useful, as making respondents go through the process helps them better understand their preferences. Another reason that CP is more useful than CV to the policymaker is that it examines variation across respondents, rather than simply providing a mean value or a median value for a sample population. Decision-makers often want to understand the preferences of the top 5-10% or bottom 5-10%.

With respect to the remark made by Ms. Koss regarding the Analytic Hierarchy Process (AHP), Mr. Gregory stated that he felt that this technique worked well in structured situations, and was good at producing estimates, but was weak at defining problems. For example, finding and examining preferences for nuclear waste disposal is a policy problem appropriate for AHP.

In sum, Mr. Gregory noted that typically a CP study will only have one-quarter to one-half of the number of respondents that a CV study will have, but will provide different, perhaps more useful information.

John Tanaka, Oregon State University, posed a question to Mr. Loomis regarding his coding non-respondents as having a zero willingness to pay. Mr. Tanaka asked if this led to an underestimate of the willingness to pay, and if it might not be appropriate to provide a weighted average of willingness to pay. Mr. Loomis replied that it is possible that there would be an underestimation in some cases, but he looked at the demographics of the non-respondents, estimated their willingness to pay based on his model, and found that their estimated willingness to pay was in fact quite low.

Mr. Tanaka posed a question for Mr. Gregory regarding participation in the USDA Conservation Reserve Program, whereby farmers are paid to retire farming acreage. Participants are often paid $100-$150 per acre, but farmers in the Tillamook Valley (where Mr. Gregory's study was conducted) often complain that their land was worth as much as $800 per acre. Mr. Tanaka asked if Mr. Gregory separated out farmer responses in his study because of the possibility that they might take a dim view of watershed management plans, especially if they have animal feeding operations. Mr. Gregory replied that he did not, since their sample included only 100 respondents. Mr. Gregory noted that respondents did not have much difficulty working through the survey workbook, and that it might be possible to boost the sample size in the future by not personally administering the survey.

Tony Bynum, Yakama Nation, asked Mr. Gregory how he dealt with the issue of trust on the part of respondents. That is, how did Mr. Gregory deal with the need of respondents to know who else was willing to pay, who they would pay to if they paid, and how this affected respondents' willingness to pay? Mr. Gregory remarked that the question illustrates one of the strengths of the CP approach. As respondents worked through a workbook, it became clear to them what the objective of the survey was, and who the stakeholders were. Mr. Gregory noted that respondents were usually impressed if a client organization (in this case, British Columbia Hydro) was willing to pay for watershed management measures. Mr. Loomis added that this was an issue in CV studies. For example, a survey administered in Puerto Rico, where public trust in government is exceptionally low, failed to obtain usable results. Another manifestation of the issue of trust pertains to concerns about free-riding, which CV researchers have handled by stipulating that everyone will pay for the provision of a public good. There are other mechanisms that can be built into the hypothetical, such as stipulating that contributions must reach a certain provision point or all the money is refunded. The important step is to make sure that the rules for contribution are stated clearly and credibly.

Tom Leschine, University of Washington, commented that estimating willingness to pay functions using demographic variables fails to capture the trade-off that the respondent must make in order to make the payment. A survey that linked willingness to pay not to demographics but to lifestyle changes that need to be made might be more useful. Mr. Gregory agreed that this was a promising direction for CV to take, and that it moves CV towards the CP process by making respondents follow up and forcing them to understand their answers and calculations. This also moves CV away from vague, abstract hypotheticals and into specific lifestyle changes.

Paul Jakus, University of Tennessee, expressed surprise that the mean willingness to pay estimate obtained by Mr. Loomis's study was only $21. Mr. Jakus also asked what would happen if the payment was expressed as a 60% increase in their water bill. Mr. Loomis stated that many residents in the area have had large increases in their water bills, and that he found that those that had experienced increases in water bills in the past had a lower willingness to pay. Mr. Loomis remarked that the sample of 98 respondents was one of the most economically consistent and "best-behaved" samples he has ever used. Another of the factors that was highly significant was the strength of the respondent's belief in the environmental issue posed to them (watershed management) – those that felt strongly about it were willing to pay more.

Edna Loehman, Purdue University, remarked that it was important to keep in mind how policymakers use economic analysis. Benefit-cost analysis is a tool used for welfare analysis, but a common criticism is that it ignores distributional consequences. Ms. Loehman added that CP was therefore promising because it better simulates how a community makes decisions, and asked if it was possible to combine CP and CV in one study. Mr. Gregory agreed that consensus-based decisions were desirable. However, the biggest problem with CV is not with the decision-making process, but that it lacks a structure as to what to do with the information that is provided. Mr. Loomis commented that Ms. Loehman might have been suggesting the use of a CP process to develop a CV instrument, to which Mr. Gregory replied that the weakness is that the information gained from CP can be used more efficiently than as input into a CV process.

Mitchell Mathis, Center for Global Studies, asked about the decision process of the workgroup in Mr. Gregory's study. Mr. Gregory replied that it was decision by consensus, which was a byproduct of the desire of the client (BC Hydro) to obtain the assent of the community. Mr. Mathis posed a second question to Mr. Loomis regarding the upstream/downstream issue, and how one determines the geographic distribution of benefits of a watershed management project. Mr. Loomis replied that this is always a difficult balance to strike. On the one hand, many resources have much more than just a local value. On the other hand, one survey that Mr. Loomis conducted of the willingness to pay of New England residents to preserve the California Spotted Owl was frequently met with the response: "why are you asking us?" Ultimately, a study must have some empirical base for determining the geographic breadth of benefits that accrue from an environmental good.

Mark Plummer, Discovery Institute, noted that one study phrased the hypothetical conservation measure in terms of that which was "necessary to avoid listing" of the species under the Endangered Species Act (ESA). Mr. Plummer asked if this phraseology was meant to avoid triggering a stronger response pertaining to feelings about the ESA. Mr. Loomis acknowledged that his study avoided mention of the ESA in order to avoid stigmatizing the watershed management plan. Mr. Gregory suggested that the effect of the mention of the ESA by splitting the sample into those who are faced with ESA phraseology and those who are not.

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ECONOMIC RESEARCH AND POLICY CONCERNING WATER USE AND WATERSHED MANAGEMENT

PROCEEDINGS OF THE THIRD WORKSHOP IN THE ENVIRONMENTAL POLICY AND ECONOMICS WORKSHOP SERIES

--Session Four--

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Proceedings for Session 4, Thursday, April 22, 1999

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A Protocol for the Elicitation of Stakeholders' Concerns and Preferences for Incorporation into Environmental Policy Dialogue

--Working Paper*--

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*This is a working paper developed for the US Environmental Protection Agency Office of Children's Health Protection, Office of Economy and Environment, and Office of Research and Development's workshop, "Economic Policy and Research Concerning Water Use and Watershed Management," held on April 21-22, 1999, at the Crowne Plaza Hotel in Seattle, Washington.

A Protocol for the Elicitation of Stakeholders' Concerns and Preferences for Incorporation into Environmental Policy Dialogue

Introduction

The formulation and implementation of environmental policy can be challenging under the best of circumstances. This is especially so when the context is fraught with urgency, controversy, uncertainty, distrust, and heightened public interest. In these circumstances, it is unlikely that technocratic policies imposed by agency administrators and experts will find uncritical acceptance by those who perceive a stake in the outcome.

Such is the case regarding the management of impacts in the Illinois River basin in eastern Oklahoma. The river corridor is a popular tourist and recreation attraction and was the first river designated as a wild and scenic river by the State of Oklahoma. Each year more than 180,000 persons float the Illinois River by canoe, raft, or kayak. An estimated 350,000 enjoy swimming, fishing, camping, hiking, birding, and hunting opportunities. The Illinois River provides drinking water for Tahlequah and Watts, irrigates farms and nurseries, and is a habitat for several state and federal threatened and endangered species. (Bality et al. 1998).

Though the economy is based primarily on tourism, a substantial portion derives from agriculture, especially from poultry farming and cattle ranching, and from plant nurseries, forestry, and gravel and limestone mining. The city of Tahlequah, which hosts of University of Northeastern Oklahoma and the tribal government of the Cherokee Nation, also helps anchor the regional economy. (Bality et al. 1998).

Especially since the Oklahoma-Arkansas controversy in the late 1980s and early 1990s over discharges to the Illinois River by the city of Fayetteville, Arkansas wastewater treatment plant that culminated in a 1992 decision by the U.S. Supreme Court, interest by stakeholders and policy makers in protecting the river has heightened. A comprehensive river basin management plan, which had been under development for several years, was just issued in December 1998. However, this plan has not satisfied all parties.

In 1997, the US Environmental Protection Agency, in cooperation with the National Science Foundation, awarded a research grant to a team of collaborators at the University of Oklahoma, Oklahoma State University, and the University of Oklahoma Health Sciences Center to conduct a three year study of impacts in the basin and to test a protocol for policy making that will lead to impact management policy that is simultaneously technically effective, economically efficient, legally compliant, and sociopolitically acceptable. This paper outlines this protocol and presents preliminary findings from its first phase: the baseline sociopolitical assessment.

Description of the Policy Legitimation Protocol

The policy legitimation protocol that is the centerpiece of this study has as its goal the maximization of policy legitimacy. The protocol is divided into three phases. In Phase I, the research team will perform a baseline assessment (*qua* inventory) of extant impacts in the basin. This assessment will be provided to policy makers for their consideration in formulating three distinct alternatives for the management of these impacts. In Phase II, the research team will perform three alternative-specific impact assessments, which will also be provided to policy makers to inform policy deliberation. In Phase III, the revised alternatives will be presented to stakeholders in the basin for their reaction. A basin-wide survey of opinion at the conclusion of the study will serve as the evaluative mechanism to test the efficacy of the protocol to maximize policy legitimacy.

This paper will consider only the Phase I baseline assessment protocol.

Description of the Baseline Impact Assessment Protocol

The baseline assessment is divided into five components, or assessment types.

Physical Impact Assessment. Current impacts from basin activities that can cause erosion, sedimentation, streambank instability, streambed scouring, debris obstruction, channel braiding, river course changes, and other physical impacts in the river corridor form the core of this assessment.

Biological Impact Assessment. Current impacts of basin activities that can affect wildlife habitat, species abundance and diversity, water quality, and human health are evaluated.

Economic Impact Assessment. The current status of the regional economy and the factors that affect it are the subject of this assessment. This includes an evaluation of all economic sectors and the development of an economic model, with multipliers, that can be used to predict changes.

Political Impact Assessment. This assessment focuses on the network of legal requirements and political processes that govern or otherwise affect activities in the basin. In addition, agencies with jurisdiction over basin activities and which administer these laws are evaluated.

Social Impact Assessment. An inventory of the social, cultural, aesthetic, and community resources is conducted. Of primary importance, however, is the conduct of an assessment of the impact concerns and preferences for impact management expressed by stakeholders within and outside of the geographic boundaries of the basin.

The results of these assessments will be used to inform policy dialogue with the goal of maximizing policy legitimacy. The results of first two assessments will be used to ensure technical effectiveness. The third will inform efforts to maximize economic efficiency. The fourth will guide legal compliance efforts. The fifth will increase the likelihood that any policy developed from this process will be sociopolitically acceptable.

At the conclusion of the baseline impact assessments, the results will be integrated and converted into a powerful decision support tool: interactive, multimedia, impact visualization. Aerial and ground-based photography has been obtained and, combined with GIS base maps, will be used as background for the visualizations. These backgrounds will be overlain by the results of the baseline assessments and animated to produce visual images that simulate impacts. Policy makers and stakeholders will be able to interactively query the visualization tool to gain a better understanding of the impacts that currently affect the river corridor.

The remainder of this paper focuses only on the baseline sociopolitical assessment (SPA) protocol.

Description of the Baseline Sociopolitical Assessment Protocol

Like the entire policy legitimation protocol, the SPA protocol is multi-dimensional and multi-faceted. Eight different methodologies are being used to elicit stakeholder and policy maker impact concerns and impact management preferences. This information is essential to policy deliberation to reduce the probability of formulating policy that will not be sociopolitically acceptable. But, before describing the SPA methodologies, it is important to characterize the basin population and participant samples.

Description of the Participant Population, Sample Selection, and Interview Setting

To maximize the representativeness of the sample of stakeholders and policy makers contacted for participation in the SPA, the basin population was divided along two dimensions: geographic and demographic. These dimensions were selected because it is reasonably predicted that opinions regarding impacts and their management may vary by location (due to different activities, cultures, physiography, and so on) and by stakeholder characteristic (primarily occupation).

Geographically, the Illinois River and its two major tributaries (Flint Creek and Barren (Baron) Fork) is 119 miles long and drains a watershed of approximately 900 square miles located in three counties in Oklahoma (combined population = 80,000). To facilitate stakeholder representativeness, the basin was divided into nine regions, as follows.

Region I: Upper Illinois River (from the Arkansas-Oklahoma border to the confluence of Flint Creek at Chewey Bridge)

Region II: Middle Illinois River (from Chewey Bridge to the Highway 51 overpass)

Region III: Lower Illinois River (from the Highway 51 overpass to Etta Bend where the river begins to exhibit lacustrine characteristics)

Region IV: Barren (Baron) Fork (from the Arkansas-Oklahoma border to its confluence with the Illinois River)

Region V: Flint Creek (from the Arkansas-Oklahoma border to its confluence with the Illinois River)

Region VI: Upper Tenkiller Ferry Reservoir (from Etta Bend to Cookson's Bend, which includes about 1/3 of the lake's surface area)

Region VII: Caney Creek (from its headwaters to its confluence with upper Tenkiller Lake)

Region VIII: Outside Users (tourists, recreationists, and other visitors to the region who reside outside of the basin)

Region IX: Policy Elites (policy makers and policy experts working outside of the basin who had jurisdiction over or a professional interest in the basin)

Demographically, the participant population was divided into 15 stakeholder classes. These included agricultural workers (farmers), business owners, animal feeding operators (primarily poultry), nursery operators and employees, foresters, outfitters, recreationists (floaters, hikers, fishers, etc.), general recreation (secondary recreation stakeholders), local government officials, state government officials, federal government officials, Indian tribal government officials, environmentalists, journalists, and residents.

No attempt was made to randomly sample the population or otherwise ensure that the sample characteristics resembled the larger population with respect to sample size (this will be done, however, during the random telephone survey conducted at the conclusion of the study). Rather, the purpose of the baseline assessment is to obtain the maximum range of opinions that exist on impact concerns and management preferences. To accomplish this, participants were selected by either reputation (known opinion leaders, agency representatives, policy elites, organizational heads, etc.) or by "snowballing" (reference by previous interviewees who are known to have different perspectives). Initial contact with potential participants was made by telephone. If the individual agreed to participate, an interview time and place to meet in person was set. On a few occasions, an interview was conducted with a participant who had not been contacted previously (e.g., river basin users).

In all, 330 interviews were conducted with 270 different individuals, not including experts and research team members who participated in preliminary exercises. Every attempt was made to ensure that representatives from every stakeholder class in every region were included. All interview sessions were audiotaped for later transcription (with the permission of the participant) and were conducted at the home of the participant or at a public location of the participant's choosing. Though four interviewers were used, all but 70 were conducted by one person. The length of the interviews varied from 30 minutes to as long as four hours. The mean time of the first round of interviewing (open-ended discussion, cognitive mapping, etc; 150 participants) was about two and one-half hours. The mean time of the second round of interviewing (mental modeling, etc; 60 participants) was about one and one-half hours. The mean time of the third round of interviewing (Q sorting, etc; 120 participants) was also about one and one-half hours.

Baseline SPA Methodologies

The baseline sociopolitical assessment protocol includes both a social and a political-legal assessment. However, only the social impact assessment component related to identifying policy maker and stakeholder impact concerns and their preferences for impact management is discussed below.

Eight methodologies are being used to perform the baseline SPA. The first of these was used in all three rounds of interviews. The second, third, and fourth methodologies were performed in the first round of interviews with 150 participants during the second half of 1998. The fifth and sixth methodologies were conducted in the second round of interviews with 60 participants during the first thee months of 1999. The seventh methodology was conducted

during the third round of interviews with 120 participants during the first four months of 1999. The eighth methodology will be performed during the summer of 1999. Each is reviewed below.

Methodology #1: Statistical Analysis of Demographic Questionnaires

At the beginning of every interview, a brief demographic questionnaire was administered. The questionnaire included questions about gender, race, age, education, occupation, socioeconomic status, length of residence in the basin and in study regions, sources of information about the river, uses of the river, relationships with others in the basin, trust of political institutions, and other relevant information. The results of this methodology are not discussed in this paper.

Methodology #2: Content Analysis of Open-Ended Interviews

Open-ended discussions of river basin impact concerns and management preferences, usually lasting from one to two hours, were conducted in the first round of interviews. These discussions were conducted in a manner that reduced the introduction of interviewer bias. At every opportunity, the participant was encouraged to offer any opinion on any matter related to the river basin and to explain and expand upon whatever was said.

After transcription of the audiotaped discussions, the texts of the interviews were content analyzed to identify the concerns and management preferences contained therein. Weber (1990:9) defines content analysis as: "a research method that uses a set of procedures to make valid inferences from text." Krippendorff (1980:21) emphasizes validity and reliability: "Content analysis is a research technique for making replicative and valid inferences from data to their context."

Ethnographic content analysis stresses interactions between people. Quantitative content analysis is most useful in obtaining data to measure the frequency and extent of messages present (Berelson 1966). The latter method was adopted for use in this project.

Due to budget and time restrictions, only one coder was used (the interviewer), though the coding criteria were developed by the entire SPA research team.

Methodology #3: Statistical Analysis of Likert Scale Responses and Card Ranking Results

Several Likert scale items were incorporated into a brief survey instrument administered at the conclusion of the open-ended discussion that pertained to trust and policy-making procedures. Likert scale items concerned judgments about the certainty of relevant facts; judgments about the salience of both facts and values to decision making; perceived relative controversy; and trust of experts, state government officials, federal government officials, and other stakeholders.

The Likert scale exercise was followed by a card ranking exercise in which the participants were asked to rank, in order of personal preference, eight alternative decision making procedures. These differed across three dichotomies: whether coercive or persuasive strategies were proposed, whether expert-based or deliberative strategies were proposed, and whether the government or an independent neutral made (or facilitated) the decision.

The Likert scale responses were analyzed three ways. First, descriptive statistics were computed basin-wide and by regional and stakeholder classes to assess the levels of trust, controversy, factual certainty, fact-value salience, and decision making procedure preferences. All statistical analyses were performed using SPSS 8.0 for Windows©. Second, cluster analysis using Ward's method of hierarchical agglomerative clustering, was performed on the card ranking data to investigate how participants grouped the decision making procedures and how participants grouped themselves in ranking the procedures.

Third, the Likert scale responses were used to predict which of the eight decision making procedures were preferred. A model developed by the first author guided the predictions. A preliminary assessment of the model's predictive capabilities was conducted.

A discussion of the results of these three analyses is not included herein.

Methodology #4: Statistical and Qualitative Analysis of Cognitive Maps

The final methodology employed during the initial 150 interviews was cognitive mapping. Cognitive maps were used to elicit the schema that participants use to conceptualize river basin impacts about which they are concerned. Cognitive mapping methodology is based on the mapping of active symbols, or schema landmarks, whose identity and spatial relationships reflect the participant's cognitive representation of the phenomenon under study. Cognitive maps provide a unique understanding of how participants think about river basin impacts that no other method accomplishes quite as well.

The technique used to guide the preparation of the maps was adapted from the association-driven issue display procedure developed by Diane Austin (1994). First, the participants were asked to list their river basin impact concerns (many of these had been identified during the open-ended discussions). The participants were given an opportunity to add to their lists by consulting a "master list" of impacts assembled by the research team from documents and prior interviews of experts. Additions from the master list were encouraged only if the participants claimed the missing impacts had inadvertently been omitted. According to Eden et al. (1979), this process of reflective mapping gives cognitive mapping its special utility.

Once the lists of impact concerns were developed, participants were asked to write each concern on an index card. Three sizes of cards were available, depending on the relative importance attached to the concern. Participants were instructed to place those concerns that were judged most important on 5"x8" cards, those of moderate importance on 4"x6" cards, and those of least importance on 3"x5" cards. Participants were then asked to indicate the level of knowledge that they had about each concern by affixing a colored dot on each card: green dots to indicate high perceived knowledge, yellow dots to indicate moderate perceived knowledge, and red dots to indicate low perceived knowledge.

Next, the participants were asked to arrange the cards on a large sheet of paper such that the arrangement represented how they conceptualize river basin impacts. After the cards were arranged, the participants were asked to label each group or cluster of cards in the map by writing a descriptive title on a colored card and placing it next to the group to which the label referred. Grouped concern titles are useful in developing and interpreting both aggregate and congregate maps (discussed later).

Participants were next asked to write the word "self" on colored cards and place them in their maps to indicate how they conceptualized themselves with respect to the concerns identified therein. According to Kaplan (1973), the knowledge of the location of "self" within a map is the crucial starting point for "adaptive behavior."

Finally, participants were asked to articulate the resultant schematic representations by explaining the choices and arrangements of concerns, the relative importance of and perceived knowledge about each concern, and the placement of "self" in the maps. The explanations were audiotaped and transcribed for later use in map interpretation.

The mapping exercise required 30 to 60 minutes to complete. Altogether, 145 usable cognitive maps were obtained during the interviews.

Six analyses of the cognitive map data were conducted: frequency analysis of impacts included on cards, analysis of the relative importance of impacts, analysis of the level of perceived knowledge about impacts, analysis of the relationship between relative importance and perceived knowledge, cluster analysis of impact groups contained within the maps to identify groups shared across maps, and cluster analysis of the shared groups to identify aggregate maps. Each analysis is briefly reviewed below.

1. Frequency analysis of individual impacts. A total of 1112 concerns were identified in the 145 cognitive maps obtained from participants. Given that many of the concerns were identical or nearly so, it was possible to simplify data analysis by combining similar impacts into categories. Categorization was performed by content analysis using two researchers who, by consensus, combined similar impacts. To preserve the integrity of the original data, categorical groups were not formed on the basis of the researchers' beliefs about causal or associational connections, but rather based on participants' own tendencies to group and label similar concerns. At the conclusion of the categorization effort, 87 concern categories were identified. No effort was made to further combine categories that seemed to be similar, since the participants did not do so. Further grouping of

concerns was performed later, however, using cluster analysis (see group analysis below). The impact concern categories were used in computing frequency statistics basin-wide and by region and stakeholder class. These results were later combined with the results of the context analysis of interview texts to add validity to those findings (see discussion later in this paper).

2. Analysis of relative importance. Descriptive statistical analysis of the relative importance of the impact concern categories (based on median card size within each category) was computed basin-wide and by region and stakeholder class. The basin-wide statistics were later combined with the card ranking results obtained during the mental modeling interviews discussed later to increase the validity of those findings.

3. Analysis of perceived knowledge. Descriptive statistical analysis of the perceived knowledge ratings for the impact concern categories (based on the median dot color within each category) was computed basin-wide and by region and stakeholder class. The basin-wide statistics were later compared to the assessed knowledge levels determined during the mental modeling exercise discussed later.

4. Relationship between importance and knowledge. The existence of a statistically significant correlation between relative impact importance and perceived knowledge was investigated. It is conceivable that this relationship exists, either because stakeholders attach more importance to those impacts about which they believe they know more or because they learn more about those impacts about which they are more concerned. These results are also discussed later in this paper.

5. Cluster analysis of impact concern groups. As mentioned above, participants placed related impact concerns into labeled groups. A detailed review of the 145 maps reveals the presence of 416 impact groups. Before these groups could be analyzed for similarity, however, the concerns contained within them were recoded using the 87 concern categories developed previously. After recoding, categorized concerns in the 416 groups were cluster analyzed using Ward's method of hierarchical agglomerative clustering. Forty-five concern clusters were identified. However, 10 of these clusters were used only once and were eliminated from further analysis, reducing the number of eligible clusters to 35. Since cluster analysis combines data sets with similar, but not necessarily identical, attributes, clusters varied in the number of categorical concerns that were shared across member groups. Therefore, it became necessary to establish a membership rule by which concern categories would be included within a cluster: a concern category was included only if 75% or more of the concern groups in the cluster included it (see Table 2 for cluster definitions).

6. Cluster analysis of categorical group clusters. All cognitive maps were recoded using the 35 concern cluster definitions discussed above. Seven of the 145 maps could not be recoded because their concept groups were both dissimilar to the 35 common clusters and unique.[1] The recoded map data were cluster analyzed across participants, again using Ward's method, to identify common (aggregate) maps. Eight distinct aggregate maps were identified. The aggregate maps were interpreted by reference to the concern clusters contained within them and by reference to demographic information of those participants whose maps were members of the cluster (see discussion later in this paper).

Methodology #5: Statistical Analysis of Mental Modeling Exercise

The integrity of the baseline sociopolitical assessment is enhanced if an investigation of the factual knowledge that stakeholders have of actual and potential impacts is performed. Mental modeling is an ideal tool to accomplish this. In fact, mental modeling was incorporated into the SPA protocol for three reasons.

1. The model can be used as a decision support tool. With such a tool, a policy maker can qualitatively estimate the effects of various policy interventions throughout all subsystems. Moreover, if the model's influences were to be quantitatively determined, policy analysts and others could use the model to estimate the *magnitudes* of perturbations to the impact system.

2. The model can be used to design educational programs to correct knowledge deficiencies and misconceptions. Comparisons of lay mental models against an expert model will identify areas that may be amenable to education.

[1] The participants, however, do share meaning in a social system that can be represented by a congregate map. This will be discussed in a later report.

3. The model can be used to assess conflict. By determining what knowledge deficiencies and misconceptions exist, it is possible to identify conflicts that might arise due to differences in knowledge. Moreover, knowledge of misconceptions can be compared against value differences (discovered by using other techniques in this protocol) to determine whether extant conflicts are due to knowledge conflict, value conflicts, or both. This information is essential to fashioning and legitimating a policy that will be widely accepted among stakeholders.

The term mental modeling has been used inconsistently. As used in this research, mental modeling refers to an influence diagram that represents a person's knowledge structure (Bostrom et al. 1992). A knowledge structure is a person's factual understanding of the relationships between and among elements of the phenomenon under study. In this paper, the mental model represents the knowledge structure that a stakeholder has about impacts that may affect the Illinois River basin.

Bostrom et al. (1992) outline four steps in testing lay knowledge structures.

1. Create an expert influence diagram. The expert mental model developed for this study represents the best scientific understanding of Illinois River basin impacts and their inter-relationships available. Each directional node-arrow-node combination in the diagram portrays an influence. The concept in the node at the tail of an arrow influences in some way the concept in the node at the arrow's point. Causality between nodes should not be inferred nor is the relationship between nodes quantified. Rather, the model is intended only to identify impacts to the Illinois River basin and to illustrate how these impacts influence each other.
2. Elicit lay participants' relevant knowledge beliefs. To elicit lay knowledge beliefs, 60 interviews were conducted in which participants were asked relevant questions about the impacts identified in our expert diagram. These questions were asked in a manner that avoided researcher-induced bias in the responses (see discussion below).
3. Map those beliefs onto the expert diagram. During the interview process, participants' responses were coded on copies of the expert model. The coding system used in this study was adapted from the coding system used by Bostrom et al. (1994).
    - *Correct* = participant's response is accurate
    - *Indiscriminate* = participant knows that a node influences a distant node but is unfamiliar with influences between them
    - *Particularistic* = participant has limited knowledge about the relationship between two nodes but fails to connect this relationship to "the big picture"
    - *Incorrect* = participant's response is factually wrong
    - *Peripheral* = participant's response is accurate but irrelevant
    - *Missing* = participant is ignorant of the influence
4. Identify gaps in understanding and misconceptions. Coded responses were analyzed using descriptive statistics to identify gaps and misconceptions. These results are discussed later.

The expert model was developed based on the application of disturbance theory to the polity. At the lowest level of the model (level 0.0), the political subsystem circumscribes four other subsystems. From each of these subsystems, a terminal impact creates a disturbance that, if perceived as severe enough by stakeholders, triggers a political demand. The demand can stimulate a policy response to reduce the perceived subsystem impact. A brief review of each of the five subsystems follows.

1. Physical Subsystem. The smallest of the five subsystems, it includes only 58 influence links. The primary level of the physical subsystem specifies "stream channel deterioration" as the terminal adverse impact (disturbance), which is influenced by stream channel agradation (sedimentation) and degradation (erosion) processes. Both processes are further specified in higher level subsystems. Erosion/sedimentation processes are influenced by a activities such as gravel mining, timber harvest, livestock access to waterways, general vegetation removal, addition of vegetative debris to waterways by beavers, gravel roads construction and maintenance, and the collapse of the dam at Lake Frances.

2. Biological Subsystem. This subsystem is considerably more complex, with 168 influence links. The terminal adverse impact (disturbance) is defined as a threat to public health or the environment. The subsystem is divided into human health and ecologic health, which are both affected by nearly the same activities, though in different ways. In higher level subsystems, details of the biological subsystem impacts are specified. For example, factors affecting water quality include toxic contamination, nutrient loading, sediment load, temperature, and habitat quality. Toxic contamination, in turn, is influenced by urban runoff, pesticide applications and disposal practices, hazardous waste facility runoff and leachate, underground storage tank leachate, animal feeding operations, illegal chemical dumping, industrial point source discharges, and municipal wastewater treatment effluents.

3. Economic Subsystem. The economic subsystem is the largest, with 179 influence links. The specified terminal adverse impact is instability or stagnation of the economy. Influences on the terminal impact include employment, wages, and taxes (which are shown in an integrative relationship) as well as five economic development sectors: tourism and recreation, commercial, residential, industrial, and agricultural. Further details are elucidated in higher level subsystems. For example, each development sector is influenced by consumer demand, which, in turn, is affected by factors such as development costs, developer resources, consumer's net income, population, quality of exploitable natural resources, legal constraints, and public infrastructure.

4. Social Subsystem. The social subsystem is also a large subsystem, with 159 influence links. The terminal adverse impact is dissatisfaction with quality of life. This outcome will occur if stakeholders perceived that their quality of life is less than expected. Factors that influence quality of life judgments are scientific and educational valuation, recreational satisfaction, cultural preservation, aesthetic quality, and the psychosocial state of the stakeholder. Aesthetic quality includes factors such as sights, sounds, odors, and degree of solitude. Cultural preservation includes spiritual valuation and archaeological and historic site preservation. Recreational satisfaction includes type and availability of activities, visitor displacement and succession, and park conditions. The psychosocial state of the stakeholder is influenced by a variety of factors including cultural norms and traditions, community and political values, and demographic characteristics.

5. Political Subsystem. The terminal outcome of the political subsystem is policy that affects the other subsystems. This subsystem has 78 influence links (not including the legal subsystems[2]). Influences to policy include the level of policymaker and stakeholder dissensus, policy maker and stakeholder preferences, legal and knowledge constraints, and interest group pressures.

Representation of the Expert Model

A visual representation of the expert mental model, which represents how various impact processes within the Illinois River basin relate, was developed using Visio Standard 5.0. The model is arranged hierarchically. At its most basic level (model 0.0), the relationship among the five components of the impact management system is depicted: physical (model 1.0), biological (model 2.0), economic (model 3.0), social (model 4.0), and political (model 5.0). Each of the five major subsystems is further specified in higher level influence diagrams (secondary subsystems are numbered 1.1, 1.2, 2.1, etc.; tertiary subsystems are numbered 1.1.1, 2.1.2, etc.; and quaternary subsystems are numbered 3.2.1.1, etc.). Subsystems are not only related to the base and higher levels, but also to each other. Altogether, more than 700 influences are included within 42 subsystems.

Conduct of Mental Modeling Interviews

Mental modeling was conducted during the second round of interviews. The interview began with a description of the types of questions that would be asked; often the interviewee was shown the base model (level 0.0). The

[2] The details of legal subsystems have been specified but have not yet been incorporated into influence diagrams. The legal subsystems will address agencies that regulate land use, water use, and water quality in the basin, as well as agencies that provide incentive programs for establishing vegetated buffer zones along waterways in the basin.

participant was asked not to guess or speculate on an answer, but rather simply relate what they knew. Most participants had no preference on which subsystem to begin, so the order simply followed the numerical order of the subsystems (physical to biological to economic to social to political). Questioning on the physical subsystem began with a generic question. Participants would usually give long responses that covered many of the important topics. More specific questions would follow, as appropriate, about topics participants failed to mention or fully describe.

Response Coding

Measures were taken in coding responses to avoid false positives and false negatives. For example, false positives could occur if questions were too leading. False negatives could occur if participants simply did not happen to recall answers "off the top of their heads" that they in fact knew. False negatives were avoided by giving credit for knowledge on related influences without necessarily asking for descriptions of each influence in the group, if the interviewer believed that the influences were "common knowledge." This was usually only done in assessing knowledge in low level models, which include very general influences. Knowledge credit was also given if it was necessary to disclose the influences in order to proceed with questioning on higher levels (e.g., model 0.0). "Bi-directional" questioning, i.e., asking a question from both the impact and the source ends of an influence, or asking a follow-up question later, was also used to avoid false negatives. Often, these types of questions would stimulate participants to think in a different way about impacts and extract knowledge that had not been previously been revealed. Another technique used to avoid false negatives (and false positives) was to ask opinion questions in place of fact-based questions. In offering opinions, participants may reveal knowledge without feeling pressure to agree with suggestions made by the interviewer. Another method used to avoid false positives was to instruct the participant at the beginning of the interview to refrain from guessing answers, as that would jeopardize the integrity of the research.

Analysis of Responses

Two statistical analyses of mental modeling data were conducted. First, descriptive statistical analyses of participant responses, basin-wide and by region and stakeholder class, were performed using SPSS 8.0. Preliminary results are discussed later.

Second, the basin-wide assessment of knowledge was compared to the perceived knowledge data obtained from the cognitive mapping exercise. To accomplish this, a common set of knowledge areas between cognitive mapping and mental modeling was developed. A careful review of both data sets yielded 30 common knowledge areas. Knowledge scores (perceived and assessed) were computed for each of the 30 areas. These scores were then divided among three levels of knowledge: high, moderate, and low. For perceived knowledge, an average score was calculated based on the color of the dots [1=red (low perceived knowledge); 2=yellow (moderate); 3=green (high)] placed on the cognitive mapping index cards for impact concerns belonging to that knowledge area. Assignment into knowledge levels were made as follows: >2.33 = high, <1.67 = low, and 1.67 to 2.33 = moderate. For assessed knowledge, the percentage of correct responses in each knowledge area was used. Assignments were made as follows: >66% = high, <34% = low, and 34% to 66% = moderate. Of the 30 knowledge areas, perceived and assessed knowledge corresponded perfectly in 15 areas. In nine areas, assessed knowledge exceeded perceived knowledge. In the remaining six areas, perceived knowledge exceeded assessed knowledge. These results are also discussed later in this report.

Methodology #6: Statistical Analysis of Card Ranking Results

Following the mental modeling exercise, participants were asked to rank a series of 16 pollution sources in order of their perceived relative importance to contributing adverse impacts to the Illinois River basin.

Three statistical analyses of the pollutant source ranking data were performed. First, descriptive statistics were computed basin-wide and by region and stakeholder class for the 16 pollution sources. Second, cluster analyses of the pollution source rank scores, using Ward's method, by source and by participant were performed. This provided insight into why participants ranked the sources as they did and who shared similar priorities.

Third, the rank order of the pollution sources was compared with an implied rank ordering of equivalent impact concerns obtained during the cognitive mapping exercise. The implied rank order of impact concerns was computed

in three stages. First, the 87 impact categories that encompassed the 1112 impact concerns obtained from 145 cognitive maps were reclassified to correspond to the 16 pollution sources. Second, an average importance score based on card size [1=small (low relative importance); 2=medium (moderate importance); 3=large (high importance)] for those cards in the impact categories that were assigned to each of the 16 pollutant source groups was calculated. Third, the groups were ranked according to the average relative importance scores computed for each of the 16 groups. The rank orders of the two basin-wide assessments of relative importance were compared using the non-parametric correlation technique, Spearman's rank correlation. The result of this analysis (correlation coefficient, rho = .631??) proved to be statistically significant (at $p<0.05$), adding validity to the pollutant source prioritization finding.

Methodology #7: Factor Analysis of Q Sorts

Q methodology was employed to reveal the broad perspectives that stakeholders hold with respect to IRB impact concerns and their preferences for impact management. These findings can be compared to the findings of the other methods to derive a comprehensive understanding of stakeholders' views regarding the Illinois River basin.

Q Theory and Praxis

Most studies employ R methodology, in which a survey instrument that reflects the investigator's hypotheses is developed, administered to a random sample of respondents, statistically analyzed, and generalized to a larger population. Although this technique has powerful statistical capacity to generalize, it loses data richness because the subject's own definition of the phenomenon under study is subordinated to that of the researcher. The danger of misinterpreting responses according to the investigator's preconceptions, rather than the subject's own views, is always present.

Q Methodology was developed to overcome this limitation (Brown 1980; Stephenson 1978). Q methodology affords a direct measurement of an individual's subjective point of view. William Stephenson, a British physicist-psychologist, invented Q methodology in 1935 and fully articulated its theory and technique in 1953 (Stephenson 1935; 1953). Stephenson's primary interest was to provide a scientific way to reveal subjectivity in any situation, whether about political attitudes or artistic expression. The strength of Q methodology lies in its ability to generate grounded understanding (Verstehen) by abductively revealing subjectivities that are both self-referent and operant.

The factors created from a Q sort are categories of operant subjectivity. These factors are naturalistic because they are naturally occurring events. The statements from the concourse that create the Q sort are a function of an individual's point of view; thereby limiting the researcher's bias.

Q Concourse

A concourse is the flow of communication surrounding a topic (Stephenson 1950; 1953). "Concourse" originates from the Latin "concursus," which means "a running together" – as when ideas run together in thought (Stephenson 1978). The concourse provides a wellspring of creativity and ideas that can be discovered through Q methodology.

Based on the 150 open-ended interview transcripts, more than 3,000 statements relevant to impact concerns and management preferences were identified and included in the concourse. From this concourse, a preliminary sampling 500 statements was obtained by the SPA team. Screening criteria used to select statements were richness (to ensure that each item possesses excess meaning that will inform factor-analyzed perspectives), controversy (to reduce the number of consensus and social desirability items), salience to stakeholders (to ensure that existing perspectives will be revealed in the Q sorts), and representativeness (to capture the full range and diversity of sentiments that exist in the stakeholder and policy maker populations). The 500 item sample was then separated into impact concerns and impact management preferences. The impact concern collection was again reviewed by the SPA team and consensus was reached on the selection of 47 statements for inclusion in the concern Q sample. The management preference collection was reviewed by the SPA team, resulting in a preference Q sample of 58 statements. A balance of items across categories of potential meaning was checked through use of a factorial design, though strict adherence to the 20 categories included therein was not followed in order to ensure maximum representativeness.

Conditions of Instruction

The condition of instruction used to guide sorting of the 47-item impact concern Q sample was "What is your view of human and natural impacts on the Illinois River?" The condition of instruction used to guide sorting of the 58-

item management preference Q sample was "What are your preferences for the management of human and natural impacts to the Illinois River Basin?"

Structured Sort Form Boards

Two form boards, corresponding to the two Q samples, were created as a guide to conducting a structured sort. The arrangement of each form board reflected a quasi-normal distribution. This distribution was selected because it is believed that stakeholders feel strongly, either negatively or positively, about fewer items than they would feel less strongly. The 47-item form board utilized a nine column layout of 2, 3, 4, 5, 6, 7, 6, 5, 4, 3, 2. The 58-item form board utilized an eleven column layout of 2, 3, 3, 4, 6, 7, 8, 7, 6, 4, 3, 3, 2.

Q Sort Procedure

The researcher begins Q sorting exercises by asking participants to read each statement and then placing them into one of three piles: (1) those that they most agree with, feel most positively toward, or best reflects their point of view into the rightmost pile; (2) those that they most disagree with, feel most negatively toward, or least reflects their point of view into the leftmost pile, and (3) those that they feel neutral about, feel ambivalent toward, or do not understand into the middle pile. The researcher then encourages further division of the statements in each of the two end piles into two additional piles to indicate a finer distinction between agreement and disagreement. This procedure resulted in the placement of statements into five piles on a continuum from greatest agreement to greatest disagreement that aids the subsequent placement of items onto the form board. The placement of statements are a matter of opinion only; this is important because the participants' subjectivities are the phenomenon of interest (Brown 1993).

Participants were then instructed to place the two most agreeable items from the rightmost pile onto the two rightmost spaces on the form board. Participants continued placing cards in columns on the form board, moving to the left, until all items in the rightmost pile were exhausted. Participants were then instructed to continue placing statements on the form board in similar fashion until the second agreeable pile is exhausted. Participants were next asked to repeat this sorting process from the disagreeable piles. Statements from the leftmost pile, beginning at the leftmost two spaces, were placed first and additional statements were placed, moving toward the right, until all items in the disagreeable piles were exhausted. Last, the statements in the middle pile were sorted from relative agreement to relative disagreement in those spaces remaining in the middle portion of the form board. After the sorts were completed, participants were asked to review the sorts to determine whether the horizontal location of any of the statement should be changed. Usually, participants were happy with the original placement. Finally, they were asked to explain the sorts by narrating their overall perspectives on the condition of instruction. While the narrations were being rendered, the researcher examined the sorts in an attempt to relate the narrations to the sorts. If doubt arose about the placement of items given the interviewer's understanding of the narrations, participants were asked to clarify their perspectives. In such cases, the interviewer's confusion was usually due his misunderstanding of the meaning of one or more statements in the sorts; however, in a few cases, the participants would make minor changes to the sort. When the interviewer was satisfied that he understood the meanings of the sorts and the items included therein, he concluded the sessions.

This procedure was repeated in its entirety in the administration of the second sort concerning impact management preferences.

P Sample

Both Q sort exercises were administered in the third round of interviews to 120 Illinois River basin stakeholders representing all regions and stakeholder classes, a third of which had been interviewed during the first round of 150 interviews. Each interview generally required about two hours. All sorting exercises were audiotape recorded with the participant's permission. These tapes were later transcribed for use in interpreting the factors.

Q Factor Analysis

Item placements on the form boards were entered into a database for factor analysis to determine those perspectives held in common among the participants. The software used to perform the Q factor analysis was a PC version of the mainframe program Quanal (von Turbergen 1980). Factor analysis is performed on an n x n matrix of correlation coefficients that relates item placements between pairs of Q sorts. Q sorts that are highly correlated may be

considered to have a family resemblance (Stephenson 1980). Factor analysis was used to determine how many different families (factors) exist among the population of Q sorts.

The number of factors obtained is dependent on how the participants sorted the Q samples and is therefore purely empirical. Each Q sort has a factor loading among the community of sorts analyzed. The loading expresses the extent to which each sort is associated with each factor. Orthogonal factors were extracted by the principal component method and rotated to simple structure by varimax rotation to minimize unexplained variance.

Seven criteria were used to determine factor retention for later interpretation. A factor was retained if:

(1) it had an eigenvalue greater than one;

(2) it contributed at least 3% toward the total explained variance;

(3) the number of non-significant Q sorts was minimized;

(4) at least two significant Q sorts loaded on it;

(5) it was not simply a bipolar split of a preexisting factor (bipolar splitting criterion = 25%);

(6) the factor solution was stable; and

(7) the factor captured a perspective that has theoretical importance.

Q Factor Interpretation and Validation

Each common factor score array represents an average sort (common perspective) held by those stakeholders whose Q sorts loaded significantly on the factor and thus who sorted the statements similarly. To interpret the meaning of the common perspective, the researcher first examined the common factor score array and then compared it to other arrays.

The development of an interpretation began with an examination of those statements located at the extremes of the arrays (those having the highest importance, whether agreeable or disagreeable). This was followed by an examination of statements lying in the middle of the factor score array to clarify further the potential meaning of the perspective revealed by the factor.

After developing an initial interpretation, the factor arrays were compared to each other to investigate how statements are arranged similarly (consensus items) or differently (discriminating items). After factor comparisons were completed, unique characteristics among the perspectives revealed by the orthogonal factors were deduced and categorized.

The researcher then attempted to interpret each common perspective by developing a paragraph description that reflects its unique characteristics. A descriptive label that captured these unique characteristics was then given to each perspective.

To fine tune each interpretation (and label), the transcripts of those stakeholders whose Q sorts loaded most highly (their individual sorts most closely resemble the common sort) and most purely (their sorts share little in common with sorts defining other factors) on each factor, and therefore hold a perspective that is most representative of the common perspective, were examined.

Once satisfied with the interpretations, the high-pure loaders should be contacted for the purposes of validating the interpretations developed by the researcher. The participant is asked for their reactions to the paragraph descriptions and the proposed labels. Any discrepancies between the interpretation and reaction are resolved by comparing the validator's own Q sort and the common sort. Changes in interpretation and labels are then made, if necessary. The labels and interpretations discussed later have not yet been validated.

Methodology #8: Longitudinal Analysis of Archival Data

Two sources of archival data are available for analysis: newspaper clippings and audiotapes of previous Oklahoma Scenic River Commission meetings. The OSRC Executive Director has accumulated newspaper clippings concerning OSRC activities since he assumed the directorship in 1986. In addition, audiotapes of the bimonthly meetings of the Commission since 1986, including the testimonies of guest speakers and members of the public, were made. These two archives are essential in determining how stakeholder and policy maker concerns about impacts and their preferences for impact management have changed over the past 13 years.

An initial content analysis of newspaper stories over the past three years was conducted in order to develop a coding scheme. Content analysis of the entire collection of newspaper stories will be conducted this summer. The OSRC meeting tapes are being transcribed and will also be content analyzed this summer.

Selected Preliminary Results of the Baseline SPA

A wealth of data has been accumulated over the last nine months and analysis is still ongoing. Nevertheless, some preliminary findings can be reported that will demonstrate the utility of the SPA protocol. Preliminary findings are presented on the identification of concerns and management preferences, the relative importance of preferences, an assessment of knowledge and a comparison of assessed knowledge against perceived knowledge, shared schema on concerns, and shared perspectives on concerns and preferences.

Identification of Impact Concerns and Impact Management Preferences

From the content analysis of open-ended discussion and frequency analysis of cognitive mapping concepts, the following concerns are most frequently identified by stakeholders (only basin-wide results are included).

- Most frequently mentioned are those that are most visible and those that have received most media attention.
- Water quality is the most frequently mentioned concern. Interestingly, most mentioned it as an aesthetic concern; fewer as a health or recreation concern. Almost everyone believed that water quality will get worse if nothing is done to reduce impacts.
- Pollution from animal feeding operations, particularly poultry farms, is most frequently ranked as most important.
- With respect to recreation, unruly behavior, trash, and the lack of restrooms near the river were most often mentioned.
- Property-rights sentiments are most acute among farmers in the upper and middle Illinois River regions. Many farmers oppose any effort to restrict private land use or impose economic burdens from additional rulemaking. Some indicated that they might offer less resistance if they are given adequate consideration and financial assistance in implementing riparian buffer zones and other restrictions on use of property.
- Few stakeholders understand other stakeholders' concerns or their reasons for them. Most agree that there is much controversy about the management plan. Many people in the region distrust each other and the government. In the selection of interviews, many accepted an interview because they wanted to voice their concerns and opinions because they felt that no one was listening to their views.

Impact management preferences discovered include the following.

- Agreement is highest for the management of those impacts that are easily observed, such as recreational trash, unruly behavior, urinating in and near the river, and stream bank erosion.
- Most stakeholders favor management controls on impacts generated by others and disfavor controls on their own operations, usually citing a lack of evidence that their operations in fact generate significant impacts.
- Education is non-controversial in that it is seen as a non-invasive intervention.
- Dissensus exists over the need for and means of regulation of pollution sources and the protection of riparian zones.

Determination of Relative Importance of Impact Concerns

In the card ranking exercise performed after the mental modeling effort, participants were given sixteen sources of pollution to rank in order of importance. An analysis of participants' rankings revealed that three of the four most important sources are Fayetteville sewage, Arkansas animal wastes, and Siloam Springs sewage – confirming the fact that many participants prefer to place the blame for pollution on others. Oklahoma animal wastes are ranked third. All four are sources of nutrient loading to the river. Both animal wastes and Arkansas sources have been highly publicized as sources of pollutants to the river, as has the problem of nutrient loading.

Cluster analysis was also performed on the pollution source data to determine which cards were similarly ranked.

Cluster 1: Nutrient Impacts. Siloam Springs sewage, Fayetteville sewage, Oklahoma sewage (municipal), Oklahoma animal wastes, and Arkansas animal wastes were included in this cluster. These sources cause impacts that had received extensive media coverage; all contribute to nutrient loading. They average a high importance rating, probably due to widespread publicity. It is also possible that the high rating of human and animal waste is triggered by their inherently repulsive nature.

Cluster 2: Toxic Impacts. This cluster contains two smaller clusters: (1) local litter, illegally dumping, and rural septic systems, and (2) untreated sewage, litter/sewage from floaters, agricultural runoff, nurseries, and industrial discharges. The first subcluster includes sources that are small, dispersed, and private. The second subcluster contains sources that are larger, concentrated, and commercial. The reason for their combination in a cluster may be that they are sources of toxic pollution whose precise effects less understood than those sources contained in cluster 1. The average importance score of this cluster is intermediate.

Cluster 3: Physical Impacts. The last cluster contains five cards: forest cutting, urban runoff, highway construction wastes, gravel mining, and accumulated vegetative debris. These cards were generally ranked lowest in importance, since they are least well known. These sources are also the most important sources of physical impacts, which may explain this cluster.

Cluster analysis was also performed on the participants, producing four clusters. The mean importance scores for the pollution sources were recalculated for each participant cluster. These were compared to identify the distinguishing characteristics of each group.

Cluster 1: Arkansas Concerned. The largest cluster consists of 25 participants. They rank sewage treatment plants and Arkansas sources much higher than other groups. This group prefers to blame outsiders.

Cluster 2: Arkansas Considerate. Consisting of 15 participants, they rank sewage treatment plants and Arkansas sources near the middle. They may be less likely to blame Arkansas sources because of their desire to cooperate with them to solve pollution problems (due to their affiliation with the OSRC).

Cluster 3: Chemically Concerned. This group accords most importance to chemical sources such as industrial discharges and nurseries.

Cluster 4: Agricultural Sympathizers. This cluster contains participants who are notable for their low ranking of agricultural runoff.

The card ranking analysis, combined with mental modeling results, shows that participants with a moderate level of knowledge tend to rank issues more highly than do those with low or high levels. Participants with low knowledge may be unaware of the impact source and/or its affects. Participants with high knowledge may be so familiar with the sources and their impacts that they downgrade the source's importance – or they may be engaging in strategic bias.[3] Moderate knowledge may trigger a "I know enough to be afraid but not enough to be comfortable" response in participants.

[3] Evidence was found in reviewing the results of the assessment of lay mental models that some stakeholders may be engaging in strategic behavior that creates spurious results. In other words, stakeholders who have reason to believe that they are responsible for an impact may unconsciously or consciously deny this knowledge. In other cases, these same stakeholders may demonstrate high knowledge about other potential sources of these same impacts, which may indicate blame shifting. The following examples illustrate this finding.

In comparing the relative importance of pollution source results to the cognitive mapping relative importance results (card size), the validity of the importance rankings can be checked.

The order of the 16 impacts included in both rankings was subjected to a non-parametric measure of association known as Spearman's rank correlation coefficient. The rank order correlation coefficient, rho, was found to be significant at 0.68 ($p < .02$). This proves that, for these sixteen pollutant sources, two different techniques produced similar results. The reason, perhaps, that they are not correlated even more closely is that the card ranking includes only sixteen sources of pollution, whereas in cognitive mapping, participants could include any number and type of concerns.

Knowledge Assessment

Physical Subsystem Knowledge. The average score was 43% correct. Those living in areas affected by stream channel degradation are more familiar with these influences. Policy elites, environmentalists, and outfitters scored highest. The performance of the first two is probably due to professional interest, whereas the oufitters' knowledge was probably augmented by an awareness of stream braiding and floaters' comments on low water sections, which impairs floating.

Biological Subsystem Knowledge. The average correct score for this subsystem was 45%. Local policy makers, environmentalists, and the journalist scored highest. High scores by these stakeholder classes are also likely triggered by professional interest.

Economic Subsystem Knowledge. The average score was 86%. All classes scored high in economics, though local policymakers and the journalist scored highest, due largely to the fact that this subsystem is more general than the others and perhaps reflecting the motivation to learn based on self-interest.

Social Subsystem Knowledge. The average correct score was 58%. Again, local policy makers scored highest.

Political Subsystem Knowledge. The average correct score was 50%. Local policy makers, for the fourth time, scored highest.

Local policy makers are the most knowledgeable of all subsystem impacts except physical. Clearly, at least among the participants, local policy makers are well informed and presumably can participate effectively in a policy dialogue. Those stakeholders who prefer to rely on local policy maker judgments are justified in doing so. Environmentalists and the journalist also fared well. Interestingly, federal and state policy elites did not do as well as might have been expected.

Knowledge of impacts, their sources, and the influences between and among them is deficient in all areas except economics. The technical areas of physical and biological impacts were especially challenging. These results suggest that educational programs would likely serve a useful purpose.

One example of widespread misconception concerned the relationship between gravel road construction/maintenance and erosion. The regions scoring highest attained only 39%; two regions scored 0% and

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1. Several participants would avoid questions that related to potential impacts from their operations. More than one agriculture participant avoided questions pertaining to nutrient loading. When asked about nutrient loading, they would respond with, "That's not that big a problem."
2. At other times, participants would blame other sources of impacts to water quality, about which they would have extensive knowledge. For example, animal feeding operators demonstrated high scores about nursery impacts but low knowledge about potential impacts from their own operations.
3. Influence 2.0-24 relates dissolved oxygen to water quality. While 80% of the participants in Upper Tenkiller have correct knowledge about this influence, none of the participants in Flint Creek does.
4. With respect to the same dissolved oxygen to water quality influence, environmentalists, foresters, local policymakers, and nursery people scored very high (80 to 100%). However, participants from agriculture and animal feeding operations, whose activities may contribute substantially to this problem, scored only 60 and 40%, respectively.
5. Influence 2.1-10 relates septic systems to groundwater leachate. Outfitters scored lowest of all stakeholder classes on this influence, despite the fact that most have septic systems.
6. Knowledge of the link between nurseries and fertilizer runoff was highest in the Upper Tenkiller region, the location of a large nursery, as expected. However, outside users, local policymakers, and animal feeding operators also scored highly. Animal feeding operators (who demonstrated rather low knowledge of animal waste runoff from their own operations) may have scored high on this influence due to blame shifting.

two others scored only 5.6%. Though guidelines and best management practices have been promulgated for the building and maintenance of gravel roads within the state of Oklahoma, this finding suggests that an educational program is needed to heighten awareness of this problem, especially given the rate at which residential development is occurring in the area.

On the other hand, educational programs may be not required concerning the link between municipal wastewater treatment and direct discharges to the Illinois River watershed. Two regions - Upper Illinois and Flint Creek – demonstrated prefect knowledge. Both are near the Arkansas border and the relatively large and controversial treatment plants that are located there. Participants in the Caney Creek region also achieved a perfect score. The Stilwell wastewater treatment plant discharges into Caney Creek.

Some knowledge deficiencies could contribute to policy conflict.

- The regional analysis showed that most misconceptions about the relationship between livestock trampling and streambank erosion occurred in the Upper Illinois, Middle Illinois, and Barren Fork regions. This could lead to conflict because the OSRC wants to promote buffer zones along the river in these regions to minimize erosion. Yet, 80% of those working in agriculture, including ranchers, are unaware of this influence. A stakeholder class conflict could also be triggered between agricultural workers and environmentalists, the latter having scored a perfect 100% on this relationship.

- The highest knowledge of the gravel mining to dredging influence exists in the Middle Illinois and Barren Fork regions, where most gravel mining occurs. However, knowledge is much lower in other regions. If policy were formulated to restrict gravel mining in the Barren Fork and other tributaries to the Illinois River and Lake Tenkiller, this lack of knowledge contribute to conflict.

- A localized knowledge conflict also exists with respect to the Lake Frances to sedimentation influence. Participants in Flint Creek have 100% knowledge of this influence and those in Barren Fork average 71% correct knowledge. This finding is not surprising considering the proximity of these regions to the Lake. In contrast, participants in the Caney Creek region, who are least affected by sedimentation from Lake Frances, are unaware of the lake's effects (14%). Surprisingly, however, participants in the Upper Illinois, which directly drains Lake Frances and therefore is most exposed to the impacts, scored only 50%. This highlights a possible basis for the conflict that is known to exist in this region. Some wish to have the dam rebuilt and the lake restored whereas others believe that water quality has improved since the dam broke in 1990 and therefore do not want the dam rebuilt.[4]

Important knowledge deficiencies and misconceptions, as well as areas of knowledge dissensus, were successfully revealed by mental modeling. Though general knowledge of river basin impacts is largely equivalent throughout the basin and among outside users, large differences exist among stakeholder classes and regions with respect to localized impacts.

Perceived Versus Assessed Knowledge

A comparison between assessed and perceived knowledge was accomplished by comparing results from the mental modeling exercise with those from the cognitive mapping exercise. The average knowledge scores for those cognitive mapping concepts and mental modeling influences contained with 30 impact categories were used to generate two separate rank orders. Each rank order was divided into three groups of ten impact categories each. The top third of each ranking was given a high knowledge score, the middle third was given a moderate knowledge score, and the bottom third was given a low knowledge score. As reported previously in this paper, half of the impact categories were matched in assessed and perceived knowledge levels. The remaining 15 did not exactly match. There are several reasons for the discrepancies.

1. Assessed knowledge is greater than perceived knowledge. Nine impacts categories (septic systems, recreation, poultry, cattle, erosion/sedimentation, municipal wastewater, runoff, nurseries, and groundwater) are included in this set. Since assessed knowledge scores are based on participants' responses to terminal influences within

[4] Since there is disagreement among the experts we contacted about the effect that Lake Frances has had on river water quality, our coding of the "effects sedimentation" responses may not be correct.

the appropriate section of the mental model, the assessed knowledge score may be too high relative to perceived knowledge judgments. Participants may have included knowledge of a more complete construction of the impact (including both effects and sources) during the cognitive mapping exercise than they had to do to answer influence-specific questions.

2. Assessed knowledge is lower than perceived knowledge. For two impact categories (ecosystem carrying capacity and point sources), participants believe that they have high levels of knowledge but assessed knowledge levels are rated as moderate. Both of these impacts were mentioned by only a few participants (six and eight, respectively) during the mental modeling exercise. One possible reason for this discrepancy was suggested by an examination of the demographic characteristics of those few participants: the majority are policy elites. Apparently, these professionals are over-confident of their knowledge based on their professional standing. Another possible reason for overconfidence about impacts that are relatively unfamiliar is that participants may be rating their knowledge by comparing it to the knowledge they believe is possessed by others.

3. Assessed knowledge is much lower than perceived knowledge. Three impact categories (noise, odors, and debris removal) are included in this group. The explanation may be found by noting that they were mentioned by only four participants during the mental modeling exercise. Participants did not identify these because they were not perceived as important. However, such impacts were routinely suggested to the participants (through the master list of impacts) during cognitive mapping. It is likely that participants actually have high knowledge of these impact categories but they carry low salience.

Several impacts were rated low for both perceived and actual knowledge – engine waste (from motorized water vehicles), overuse, gravel mining, industrial waste, urination/defecation (by floaters), and animal waste. These are optimal topics for educational programs because participants are not already deluded into believing that they have nothing to learn.[5]

Those impact categories that participants rate their knowledge as high but their assessed knowledge proved to be low present the greatest challenge to educators. They may first need to reduce overconfidence and eliminate entrenched misconceptions before beginning an education program.

For those impacts in which both perceived and assessed knowledge is high, no education is necessary. These include population density, litter, behavior, wildlife, and aesthetics.

Perceived Knowledge versus Relative Importance

When perceived knowledge was compared to relative importance across all 1112 cognitive mapping impact concerns, no significant correlation was found (Pearson's correlation = .031??). Two reasons can be offered. First, participants likely ignored concerns in their cognitive maps about which they attached little importance or had little knowledge. If so, then low importance and/or low knowledge impacts are missing from the rankings, thus skewing the results. Alternatively, participants may have attached different levels of importance to an impact depending on the salience of the concern, as discussed above. A third explanation could be due to an interaction effect between perceived knowledge and perceived importance. For example, low importance may be attached to a low knowledge impact if it is a localized issue such as gravel mining. High importance may be attached to a low knowledge impact if they fear what they do not understand. Low importance may be attached to a high knowledge impact due to familiarity with its effects. Others may attach high importance to a high knowledge impact if they have invested heavily in learning about it.

Identification of Shared Schema on Impact Concern

Eight shared cognitive schema emerged from the aggregate analysis of cognitive maps.

Aggregate Map #1. Eleven participant maps are members of this aggregate. The major impact concerns revealed in these maps are nurseries and their impact on water quality. Specifically, chemical toxicant and nutrient impacts from nurseries were identified. This aggregate is clearly distinguishable from the other seven. Though like other

[5] Of course, education programs are not needed if the assessed actual or potential impact is low.

aggregates, participants in this aggregate are concerned about water quality, they are uniquely focused on chemical and nutrient impacts. Concerns such as animal waste, septic systems, chemical use, nursery pesticides, and herbicides dominated their maps.

Aggregate Map #2. This aggregate also includes 11 participants. The two clustered concerns that defined the aggregate are animal waste and septic systems. These maps center on nutrient impacts from animals and/or humans, though specific animals (e.g., poultry or cattle) were not targeted.

Aggregate Map #3. This aggregate includes 16 participants. The clustered concerns that make up this aggregate include water quality and behavior-induced impacts. Unacceptable behavior by tourists and recreationists adversely impact water quality through littering and overuse. These behaviors deteriorate the river experience by creating visible pollution.

Aggregate Map #4. This aggregate includes 11 participants. Litter, poultry, cattle, government, and septic systems are the clustered concerns that make up this aggregate. Their concern about the role of government parallels the anti-government sentiment expressed by many participants.

Aggregate Map #5. Seventeen participants define this aggregate. Two clustered concerns are dominant, both of which include litter, water quality, and urination/defecation. However, the first cluster also includes behavior, whereas the second cluster includes Arkansas and poultry. These concerns confirm the importance that visible pollution and unacceptable behavior have on participants' perceptions of water quality.

Aggregate Map #6. The second largest group of participants (26) are included in this aggregate. The clustered concerns include water quality, litter, and behavior. Again, participants related their concerns to water quality.

Aggregate Map #7. This aggregate includes 15 participants. This aggregate is defined by clustered concerns of population density and water quality. Population density includes concerns about the increasing number of "outsiders," both temporary (tourists and recreationists) and permanent (new residents). Though their concern about water quality still includes visible pollution, a new dimension is added with the concern about the impacts of new residents on lifestyle changes.

Aggregate Map #8. The largest number of participants (28) belong to this aggregate. Concerns were expressed about water quality as the central concept, with poultry, Arkansas including Siloam Springs and Fayetteville, and litter being related to it.

Participants focused primarily on protecting water quality. Since the entire region, from northwest Arkansas to east-central Texas is witnessing a population growth rate exceeding 6% and approaching 15% in some location, the basin is experiencing the pressures of new demands for increased resources, infrastructure, and services. The cognitive mapping results are instrumental in revealing how stakeholders conceptualize their concerns, which are important to formulating impact management policy that will be politically acceptable.

It appears that a consensus may already be developing within the basin social system, but it can easily be overlooked. The "blame game" that is finding expression in the news media is being expressed by only a few. The quiet majority believes that it is more likely that everyone is to blame and that impacts have been accumulating for a long time. Many also appreciate that it is going to take all stakeholder groups to cooperate to solve the problems that threaten the basin. Very few are under the delusion that problems will be solved in the short term.

Identification of Shared Perspectives on Impacts and Management Preferences

Five shared perspectives were identified from the factor analysis of impact concern Q sorts.

- Pessimistic Perspective. The participants sharing this perspective express concern about chemical and sewage pollution, unruly behavior and drinking, lack of safety, erosion, and over-development, and the damage effects these have on the regional economy and on the environment. Moreover, they believe that the situation is worsening. Recreation is being jeopardized by over-development and contamination; measures to control both are urgently needed to protect the river. They are uniquely sensitive to intrinsic environmental values. They are

convinced that adequate proof exists that the poultry industry, in both Arkansas and Oklahoma, is a large polluter in the basin.

- Stewardship Perspective. Individuals who hold this perspective are unwilling to "pass the buck" in protecting the river and peoples' experience of it. They favor constraints on behavior, land use, and development. They hold Oklahomans as much or more responsible for damage to the river as Arkansans. This perspective is most apt to connect the river's aesthetics with recreation. The perspective reflects a stewardship ethic of responsible use.

- Individualist-Traditionalist Perspective. This perspective is concerned with pollution from elsewhere, not from pollution that may emanate from themselves such as phosphate soaps, septic systems, poultry farms, and cattle. It embraces individualism and resents outsider intervention and restrictions on liberty. Subscribers to this perspective wish to preserve traditional lifestyles. They deny that water quality is dangerous and are least worried about the water quality deterioration.

- Chemically Concerned Perspective. This perspective is most worried about chemical pollutants, regardless of source. Appearance is a visual indicator of pollution. They favor land use, behavioral, and pollution controls to protect the environment.

- Local Recreation Perspective. This perspective is worried about recreation because they directly benefit from it. They are also the strongest proponents for protecting the river to make money. When it comes to aesthetics, they are specifically concerned about recreational aspects.

All perspectives value the environment for more than just making money. They also share a concern about unregulated trash dumping. Finally, they deny that behavior does not impact water quality.

With respect to stakeholders' concerns about impacts, the pessimistic and individualist-traditionalist perspectives most disagree on pollutant impacts. They disagree on property rights, who's to blame for nutrient loading and its affects on water quality, the extent that water quality has deteriorated, the relative importance of human versus environmental values, and the causes of erosion. The latter perspective is most unique of the five perspectives.

Four shared perspectives on impact management preferences emerged from the Q factor analysis.

- Rational Use Perspective. Those sharing this perspective favor a deliberate, rational, and cooperative approach to impact management policy. Policy that restricts activities, even on private land, are appropriate if they result in sustainable use of the river basin. A management plan is desperately needed and should be enforced. Finally, all those responsible for contributing impacts must be held accountable for doing their part to reduce them. They do not trust locals or the Cherokee Nation to manage impacts; but they do trust the Oklahoma Scenic Rivers Commission. These participants are most likely to seek help from outside stakeholders if it would help solve problems.

- Individualist-Traditionalist Perspective. This conservative perspective is resistant to rapid and unfounded change, especially change that is coercive. A "don't rock the boat" and "if it's not broken, don't fix it" element is manifest in this perspective. Those sharing this perspective are more distrustful of those who want change or government intervention, including both experts and outsiders. Property use restrictions are not welcome.

- Conservationist-Green Recreationist Perspective. Those sharing this perspective believe that though more research is needed, an impact management plan and protective action are needed now. They are less supportive of interventions that restrict recreational uses of the river. They recognize that all are responsible for adverse impacts and that all have a duty to protect the river as a resource. However, they also believe that government is captured by special interests and therefore they would likely be skeptical of their motives in implementing a management plan.

- Parochial Perspective. This perspective is primarily concerned with local control. Those with this perspective recognize the need for river basin protection and use restrictions but distrust outsiders, OSRC, and experts to respect local values.

All perspectives condone wise use of the river and that all stakeholders should accept this responsibility.

The greatest difference between stakeholder management preference perspectives is the degree of importance attached to pollution, recreation, and government control.

Conflict Assessment Using Q Methodology

Although Q methodology does not permit an extrapolation of the proportion of stakeholders in the basin who may hold one perspective or another, it does provide insight on the qualitative differences in perspectives shared among stakeholders with respect to impact concerns and management preferences. This information is essential to diagnosing potential conflicts so that a river basin impact management policy that is politically acceptable to all stakeholders can be fashioned.

With regard to impact concern conflicts:

- The pessimist and chemically concerned perspectives accord the environment intrinsic value, the individualist/traditionalist and local recreation perspectives adopt a more utilitarian view, and the stewardship perspective embraces a conservationist ethic – everyone should enjoy the resource and participate in protecting it.
- Much of the individualist/traditionalist perspective conflicts with the other perspectives. First, there is substantial disagreement on the magnitude of farming (e.g., cattle, poultry waste, fertilizer) impacts. They are more likely to blame other sources (e.g., Arkansas). Second, those sharing this perspective resent outsider influence and encroachment on their traditional and individualist lifestyle. Finally, they are not inclined to voluntarily accept government intervention, especially if it restricts property use or imposes economic burdens.
- The pessimist perspective is the only one that is inclined to agree voluntarily to limit access to and use of the basin to protect it. The chemically concerned perspective is most worried about chemicals that can't be seen. Both are worried that the river will degrade to the point that health may be threatened, in stark contrast to the individualist/traditionalist perspective. The local recreation perspective is more concerned about economic threats caused by pollution and other impacts.

Though the participants tended to blame the impacts on others, all but those sharing the individualist-traditionalist perspective recognize that all have a responsibility to protect the basin and must share in the burden. To avoid conflict, it may be prudent to combine an educational program on the types, magnitudes, and sources of impacts with a consensus building approach designed to gain a voluntary commitment to protection and risk mitigation.
With regard to impact management preference conflicts:

- Participants agree that sustainable use of the basin is important, but do agree on how to achieve this goal. For example, those sharing the parochial perspective prefer more aggressive law enforcement to regulate recreationist behavior. However, this policy may be opposed by others; banning alcohol would be particularly controversial.
- Vis-à-vis government intervention, the individualist-traditionalist and parochial perspectives are most insistent that outsiders, including visitors, experts, and government agencies, are not permitted to force their will in policy making if it imposes an economic burden or restricts personal freedoms. This hostility toward and distrust of the motives of outsiders reflects a populist orientation that insists that local people have an inviolable right of self-determination.
- In contrast, the rational use perspective strongly prefers expert-based, rational government intervention that is gradual and deliberate. While the conservationist-green recreationist perspective is not particularly sympathetic to government intervention, they do recognize that enforceable restrictions are necessary. Those sharing this perspective are most supportive of the designation of the Illinois River as a federal wild and scenic river.

These findings confirm that consensus does not exist on the appropriate role that government should play in managing impacts. A split exists between those that favor state and/or federal government intervention (rational use), those that favor local government intervention (parochial), those who are unsure (conservationist-green recreationist), and those who are suspicious of any government intervention (individualist-traditionalist). One resolution of this conflict may be to rely on neutrals to facilitate a policy dialogue among stakeholders, coupled with efforts to maximize the quality of stakeholder participation. No doubt, policy deliberation will need to be

augmented with expert technical analysis and consultation, but factual uncertainty and disagreement seem to be less a source of conflict than do value conflicts.

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Are Bureaucrats and Scientists Members of Advocacy Coalitions? Evidence From an Intergovernmental Water Policy Subsystem

--WORKING PAPER*--

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* This is a working paper developed for the US Environmental Protection Agency Office of Economy and Environment, Office of Research and Development and Region 10, for their workshop, "Economic Policy and Research Concerning Water Use and Watershed Management," held on April 21-22, 1999, at the Crowne Plaza Hotel in Seattle, Washington.

ARE BUREAUCRATS AND SCIENTISTS MEMBERS OF ADVOCACY COALITIONS? EVIDENCE FROM AN INTERGOVERNMENTAL WATER POLICY SUBSYSTEM

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ARE BUREAUCRATS AND SCIENTISTS MEMBERS OF ADVOCACY COALITIONS? EVIDENCE FROM AN INTERGOVERNMENTAL WATER POLICY SUBSYSTEM

For most of this century, many people in the U.S. and Western Europe have assumed that scientific/professional expertise concerning the magnitude of a policy problem, its causes, and the probable consequences of alternative solutions can and should be provided in an objective fashion—that is, uncontaminated by the values of the expert scientist or bureaucrat providing the advice. According to this model, value choices in a representative democracy should be made by elected officials responsible to the voters, and experts such as scientists and bureaucrats should be the sources of objective advice. This model makes a clear distinction between two types of bureaucratic officials: (1) political appointees, who are expected to exercise their values and policy preferences and/or the preferences of the elected officials who appointed them; and (2) civil servants, who are supposed to provide expert advice to political appointees and, once a decision is made, to implement it faithfully even if they disagree with it (Maranto 1993a). This view implicitly assumes that civil servants are "policy indifferent," i.e. that they either have no substantive policy views or, if they have policy belief systems, they don't act upon them.

The classic example is the British civil service. A civil servant should always obey the minister. If the minister is not available, the civil servant's task is make the decision that the minister would have made had s/he been able to make it personally (Brown and Steel 1979, 129; Drewry and Butcher 1988, 157). In the U.S., the argument for neutral expertise was part of the civil service reform movement which began in the latter 19th century and eventually became part of the broader Progressive movement. The Progressives believed that, if professionally trained people were hired and given security of tenure, much of government could be handled in an efficient, neutral fashion—meaning, at the very least, "free of partisan politics" (Knott and Miller, 1987). Despite this faith in the potential of neutral, nonpartisan expertise to solve social

problems, most Progressives acknowledged that elected political leaders had the right to establish the policy goals of bureaucracy and that the bureaucracy's task was to implement the law in an expert, efficient, and rule-bound manner (Goodnow 1900; Rosenbloom 1971). Within the field of public administration, Roberts (1994) has argued that the Rockefeller Charities—which played a major role in funding public administration programs in the 1920s and 30s—didn't want to support anything "political" and thus strongly encouraged the image of a neutral, objective science of administration. There continue to be supporters of the "neutral competence" role model for civil servants (Kaufman 1956; Heclo 1975).

The Progressives' faith in value-free science was, in many respect, a precursor of positivists' belief in value-free science (Brown, 1977). Clearly, many scientists believe that their analyses of the magnitude of the problem, its causes, and the probable consequences of alternative actions can and should be provided in an objective, value-free fashion. And much of the claim for the role of independent scientists in policy disputes rests upon this view of their objectivity (Greenwood, 1997; NIE, 1997).

Many political scientists have long viewed this model of a clear separation between value-laden politics and value-neutral administration as naive (Appleby 1949; Nathan 1983k). Particularly in the U.S., weak political parties and the constitutional separation of powers require agencies to seek political alliances with key legislators and interest groups in order to assure a steady supply of critical budgetary and legal resources. This bureaucratic politics argument is best seen in the work of Wildavsky (1974), Fritschler (1983), and Meier (1985), as well as research on agencies' efforts to organize supportive constituencies (McConnell 1966; Sabatier 1975).

Political scientists have given far less attention to the role of scientists and other professionals in public policy. But there are certainly arguments, first, that technical expertise is an important political resource and source of legitimacy (Rourke, 1976); second, that agency, corporate, and "think tank" scientists tend to reflect the dominant interests or policy views of their organizations (Wildavsky and Tenenbaum 1981; Jasonoff 1987); third, that agencies dominated by a specific profession tend to reflect the policy views of that profession (Kelman 1981; Bell 1985); and , fourth, that divergent paradigms within or between disciplines can contribute to major policy shifts (Eisner and Meier 1990; Hall 1993). The latter two echo recent arguments in the philosophy of science that disciplinary paradigms usually contain all sorts of normative assumptions that belie the image of "value free" science (Brown 1977).

While many political scientists have expressed considerable skepticism concerning the "objectivity" of advice provided by civil servants and scientists, they have not produced any compelling theoretical frameworks of the role of agency officials, outside scientists, legislators, and interest group leaders in public policy-making, particularly in complex intergovernmental systems. The interrelated literatures on bureaucratic politics and policy subsystems generally incorporate relatively simple conceptual frameworks based on resource dependency principles (Pfeffer and Salancik 1978). Individuals are viewed primarily as members of organizations and heavily constrained by organizational rules. Organizations are preoccupied with the acquisition of resources necessary for maintenance and survival: (a) for agencies, budgets and legal authority; (b) for interest groups, budgets (generally perceived to depend primarily upon providing policy outputs that benefit members); and (c), for legislators, reelection. Organizations develop strategies and exchange resources in pursuit of these objectives. In most cases, the optimal strategy is to confine policy-making authority to a small set of legislative

committee members, agency officials, and interest group leaders who share a general set of policy goals and seek to negotiate long-term, mutually-beneficial arrangements—while restricting access of outsiders. Examples include the classic iron triangles in public works, agriculture, and nuclear power (McConnell, 1966; Baumgartner and Jones, 1993).

While these loose resource dependency principles have provided a useful organizing framework for a lot of empirical research, they also suffer from several limitations. First, proponents differ on whether actors have very simple goal structures dominated by material self-interest and survival (e.g. Niskanen 1971)or more complex goals including professional and other conceptions of what constitutes good public policy (Derthick and Quirk 1985). Second, there is a general tendency to assume that the relationship between goals/interests and behavioral strategies is relatively clearcut and that actors' belief systems are quite simple. Relatively little attention is accorded problem definition or technical information concerning problem severity, causes, or impacts. Third, as a consequence, the range of actors has generally been limited to high agency officials, legislative committee members, and interest group leaders, to the exclusion of those interested in policy ideas (journalists, policy analysts) and relatively technical information (scientists and policy analysts in agencies, think tanks, and universities). Fourth, there has been a tendency to focus on relatively simple policy subsystems involving a restricted number of actors. This was fine in the 1950 and early 1960s. But, since the early 1970s, most policy subsystems have become much more complex as actors with entirely different values have become organized (consumers, environmentalists, minorities, religious fundamentalists), decision-making in Congress and some other legislatures has become increasingly decentralized, and as subsystems have become increasingly intergovernmental in

scope. From the vantagepoint of 1997, the Washington-based iron triangles of the 1950s look quaint indeed.[6]

In an effort to address some of these perceived deficiencies in relatively simple resource-dependent frameworks, Sabatier (1988; Sabatier and Jenkins-Smith 1993; 1998) developed the advocacy coalition framework of policy change. It assumes that actors have relatively complex belief systems incorporating multiple values and perceptions of problem severity, causes, and impacts. It specifically deals with the role of scientists and policy analysts in the process. And it is designed to deal with complex intergovernmental subsystems involving large numbers of actors. One of its fundamental arguments is that most agency officials and scientists involved in a specific policy domain (or subsystem) are not "policy indifferent," but instead can be grouped with like-minded interest group leaders and legislators into one or more "advocacy coalitions." Each coalition consists of actors from a wide variety of institutions who (a) share a set of basic and instrumental policy beliefs forming a relatively coherent belief system and (b) engage in some degree of coordinated activity in an effort to alter the behavior of governmental institutions consistent with those beliefs.

In this paper, we first sketch out the basic arguments of the advocacy coalition framework (ACF), including several specific hypotheses. The ACF is then applied to a complex intergovernmental policy dispute involving water policy in the San Francisco Bay/Delta. In particular, we present evidence from a survey of 465 policy elites that (a) university scientists and officials (primarily civil servants) from many federal and state agency have belief systems very similar to interest group leaders from environmental and water development groups; (b)

[6]This is, admittedly, a simplification of a vast literature. In particular, it neglects subsystem dynamics (cf. Fritschler 1983; Worsham 1997). For other attempts to develop conceptual frameworks of subsystem dynamics, see Kingdon (1984) and Baumgartner and Jones (1993).

civil servants have belief systems that are just as integrated (coherent) as more "political" elites; and (c) that both agency officials and university scientists perceive sets of allies and opponents--including interest groups, other agencies, and university scientists—that arguably reflect some degree of coordinated behavior within coalitions. The concluding section discusses the generalizability and some of the implications of these results.

I. The Advocacy Coalition Framework (ACF)

The advocacy coalition framework is designed to understand policy change over periods of a decade or more within a particular substantive domain/subsystem, such as air pollution control or K-12 education. Since one of its goals is to integrate political scientists' traditional preoccupation with socio-economic conditions, political ideologies, and political institutions with policy scholars' concern with the role of policy analysis/scientific information in the policy process, the ACF has to deal explicitly with the factors affecting the behavior of professionals and scientists working in agencies, consulting firms, universities, etc. It does so by developing the concept of an "advocacy coalition."

As indicated previously, an advocacy coalition consists of interest group leaders, legislators, agency officials, researchers, and journalists who share a set of basic beliefs (policy goals plus perceptions of important causal relationships and variable states) and who engage in some degree of coordinated activity in order to alter the rules of governmental institutions over time (Sabatier and Jenkins-Smith 1993, 25). In Lake Tahoe environmental policy, for example, Sabatier and Brasher (1993) found two quite distinct coalitions in the 1970s and early 1980s: an environmental coalition composed of environmental groups, federal and state pollution control agencies, university researchers affiliated with the Tahoe Research Group, and several out-of-Basin California legislators; they were opposed by an economic development/property rights

coalition composed of local chambers of commerce, realtors, and property rights groups, most local government officials, most public utility district officials, and most local legislators. Conflict among coalitions is mediated by "policy brokers," i.e. powerful actors more concerned with fashioning an acceptable compromise than with achieving specific policy goals.

The model of the individual—and, by extension, the coalition as a corporate actor—in the advocacy coalition framework assumes that goals are usually complex and that an individual's ability to perceive the world and to process that information is affected by cognitive biases and constraints (Schlager 1995; Sabatier, 1998a). The ACF does not assume that actors are necessarily driven by simple goals of material self-interest, nor does it assume that self-interested preferences are easy to ascertain (Green and Shapiro 1994). Instead, it assumes that actors' goals are normally complex and should be ascertained empirically. In processing information, the advocacy coalition framework assumes that actors suffer from a variety of cognitive biases and constraints. First, their ability to process and analyze information is limited by time and computational constraints, thus providing incentives for simplifying heuristics (Simon, 1985). Second, the ACF assumes that actors weigh losses more heavily than gains (Quattrone and Tversky, 1988) and that they remember defeats more than victories. Third, the ACF assumes—consistent with attribution and cognitive dissonance theories—that, on salient topics, actors' perceptions are strongly filtered by their preexisting normative and other beliefs (Lord et al, 1979; Fiske and Taylor, 1984;).

The belief systems of various coalitions are organized into an hierarchical, tri-partite structure, with broader levels generally constraining more specific beliefs (see also Peffley and Hurwitz, 1985; Sabatier and Jenkins-Smith 1993,221). At the broadest level, the "deep core" of the shared belief system includes fundamental normative beliefs, such as the familiar Left/Right

scale, which operate across virtually all policy domains. At the next level are "policy core" beliefs which represent a coalition's basic normative commitments, causal perceptions, and preferred institutional arrangements across a policy domain or subsystem. Finally, the "secondary aspects" of a coalition's belief system within a specific policy domain comprise a large set of narrower beliefs concerning the seriousness of the problem or the relative importance of various causal factors in specific locales, policy preferences regarding desirable regulations or budgetary allocations, the design of specific institutions, and the evaluations of various actors' performance.

This model of the individual and of belief systems has important implications for coalition dynamics. First, policy core beliefs—because they are fairly general in scope yet very salient—prove more efficient guides to behavior over a wide variety of situations than do either deep core beliefs (which give insufficient attention to domain-specific parameters) or secondary aspects (which are too narrow). This, in turn, contributes to the ACF's assumption that the policy core provides the principal "glue" of coalitions (Zafonte and Sabatier 1997). Second, since the ACF assumes that coalition actors use selective perception and a variety of other devices to screen their beliefs from challenge, particularly at the deep core and policy core levels, such beliefs are resistant to change, and the composition of coalitions is hypothesized to be stable over periods of a decade or more. Third, actors in different coalitions will perceive the world through different "lenses"and thus often interpret a given piece of evidence in different ways. This contributes to in-group cohesion. It also produces distrust of people (including experts) in other coalitions who, since they come to conclusions so different than ours, must be either incompetent or motivated by nefarious interests. When combined with the tendency to remember losses more than victories, it becomes easy in high-conflict situations for a mutual "devil shift" to

develop, as each coalition views the others as more evil and more powerful than they probably are (Sabatier et al, 1987). As a result, conflict resolution among coalitions is more difficult than classic rational actors models would predict, and coalitions tend to remain differentiated and stable over time [in contrast to Riker (1962)].

The advocacy coalition framework explicitly rejects the assumption that most bureaucrats and researchers involved in a policy area will be policy indifferent. Instead, it contends they will have policy belief systems that are about as internally coherent as, for example, interest group leaders. There are at least four reasons. First, people usually choose a career because it is consistent with their underlying values and norms (Friedson, 1994). Second, researchers and agency officials with advanced degrees will generally accept the paradigmatic assumptions of their discipline (Brown 1977), including its normative assumptions about what topics are worthy of interest and whose welfare is critical, e.g. in the analysis of risks.[7] The normative assumptions behind welfare economics and benefit-cost analysis, for example, have been widely discussed (Rhoads 1985; Jenkins-Smith 1990). There also appear to be rather systematic differences between civil engineers and wildlife biologists.[8] The former generally assume that nature exists

[7] For example, Barke and Jenkins-Smith (1993) provide evidence that biologists perceive significantly greater risks from nuclear waste disposal than do physicists, chemists, and engineers. The latter accept a certain degree of background radiation as "natural" and think in terms of dose-response curves, while biologists are more wary of the effects of *any* dose on living organisms.

[8] Following are the data from the 1992 survey of San Francisco Bay/Delta water policy elites discussed later in this paper. We present the mean values for respondents from five disciplines on two primarily normative scales, one indicating a Utilitarian View of Nature, the other a Concern for Bay/Delta Fisheries:

Discipline	Utilitarian View of Nature	Concern for Fisheries
Engineering (n=74)	3.26	4.72
Physics/Chemistry (11)	3.40	4.86
Earth Sciences (109)	2.85	5.44
Social Sci/Humanities (109)	2.46	5.50
Biology (101)	2.15	5.82
Overall mean	2.61	5.40

for human purposes and that they can mitigate virtually all negative impacts arising from their projects. In contrast, most wildlife biologists tend to view virtually all species as having intrinsic worth and are very skeptical of the ability of humans to manipulate natural systems without unforeseen adverse consequences on one or more species. Third, long-standing, high-conflict policy disputes tend to be rather nasty, with lots of misrepresentations and *ad hominem* attacks. University scientists and even many agency officials who do not have a strong interest in solving the problems at hand tend to depart, creating a selection bias in favor of those with tough hides and committed points of view.[9] Fourth, most agencies have clear missions and their personnel will generally come to believe in the importance of that mission because of self-recruitment, indoctrination, and interaction with the agency's supportive constituencies (Kaufman, 1960; Kelman, 1981).

We can summarize these arguments in a set of hypotheses. The first two are simply a restatement

of the basic contentions of this paper:

> Hypothesis 1: Most agency officials, including civil servants, involved in policy disputes will be members of advocacy coalitions, i.e. they (a) will have coherent policy belief

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F-value (one way ANOVA) 10.4*** 8.72***

As can be seen, engineers and biologists were on opposite ends of both scales and the differences were significant at the .001 level. By the way, over 60% of the civil servants responding to our survey had advanced degrees.

[9]For somewhat similar arguments, see Nelkin (1971), Primack and von Hippel (1974), and Mazur (1981). We're not arguing scientists manipulate or falsify data. Instead, disciplinary paradigms, the values underlying their discipline, and their desire to solve particular problems affect the topics they choose to research, the variables they focus on, the methods they utilize, where they place the burden of proof in situations of uncertainty, and how quickly they present various results. For example, wildlife biologists are much more likely than engineers to look for species in trouble because their disciplinary norms define species extinction as a serious problem. They are more likely to look to human technological interventions as a likely explanation because they tend to respect the beauty of natural systems. In contrast, engineers assume they can improve on nature. Members within each discipline will readily present results congruent with these assumptions, while incongruent results are likely to be interpreted as tentative and in need of further verification.

systems[10] similar to those of relevant interest groups and (b) they will engage in some non-trivial degree of coordinated behavior with interest group leaders and other people with similar beliefs.

Hypothesis 2: Most researchers, including university researchers, involved in policy disputes will be members of advocacy coalitions, i.e. they (a) will have coherent policy belief systems similar to those of relevant interest groups and (b) they will engage in some non-trivial degree of coordinated behavior with interest group leaders and agency officials with similar beliefs.

The advocacy coalition framework does not, however, assume that university scientists and agency officials will be indistinguishable from interest group leaders. Instead, agency officials will usually be more moderate in their beliefs—particularly in the public expression of those beliefs—because they must be cautious about offending their multiple principals/sovereigns upon whom they depend upon for legal and budgetary resources (Jenkins-Smith et al 1991; Sabatier and Jenkins-Smith 1993, 213).

Hypothesis 3: Agency officials will express beliefs that are more moderate than, but similar in structure to, their interest group allies.

Similarly, university researchers should be more willing than their professional colleagues in agencies and interest groups to alter important perceptions in the policy core and secondary aspects because they are not constrained by the official position of their organization on such topics. That same lack of constraint—"academic freedom"—would also predict greater variation among university researchers in their beliefs than officials from specific interest groups or administrative agencies.

[10]A coherent policy belief system is one which contains a logically-consistent set of beliefs pertaining to a given policy domain/subsystem from the three ACF levels: deep core, policy core, and secondary aspects. It should contain general normative commitments, perceptions of system parameters and causal relationships, and more specific policy preferences. In this paper, then, we need to examine both ranges of beliefs.

Hypothesis 4: University researchers involved in a policy dispute will demonstrate greater variation in beliefs than officials from interest groups and administrative agencies.

All the above hypotheses are consistent with the advocacy coalition framework, although the first two are clearly more critical than the latter two. As a contrast, we'll use the "policy indifference" argument as a null hypothesis:

Policy Indifference Hypothesis: Agency officials (especially civil servants) and university researchers do not have coherent policy belief systems.

The rationale is that people who don't care about substantive public policy have no incentive to develop coherent *policy* belief systems relating general values, perceptions of causal relationships and state parameters, and policy preferences. Instead, agency officials will be preoccupied with procedural due process, administrative efficiency, and obeying superiors—e.g., "neutral competence" (Kaufman 1956; Heclo (1975)[11]—while university researchers will be preoccupied with pursuing good science for its own sake. In both cases, their policy beliefs should be somewhat randomly related, rather than similar to those of specific interest groups.

The remainder of this paper explores these arguments with respect to water policy involving the San Francisco Bay/Delta. After briefly providing some background on that policy dispute and our data base, we examine the views of agency officials, university scientists, and interest group leaders on a variety of different beliefs, in addition to their perceptions of allies and opponents.

II. Background

A) **Case Selection: San Francisco Bay/Delta Water Policy**

[11]This is only one interpretation of the concept of "neutral competence." Another interpretation includes professional norms. Since the latter, however, involve normative assumptions, we would not regard them as value neutral.

The advocacy coalition framework seeks to understand "wicked problems" (Hoppe and Peterse (1993)—i.e. those characterized by (a) a large number of actors from multiple levels of government, (b) substantial technical complexity and uncertainty, and (c) high political conflict. These are the types of situations simpler resource dependency (Pfeffer and Salancik, 1978) and institutional rational choice (Scharpf 1997; Ostrom 1998) frameworks have difficulty with because of the large numbers of actors and the uncertainties of preference formation. Water policy in the San Francisco Bay/Delta clearly meets these criteria.

In addition, the San Francisco Bay/Delta is one of the most important bodies of water in the United States. It is the defining characteristic of "The Bay Area," home to 7.5 million people. The Bay/Delta constitutes the most valuable wetlands area in the Western U.S. and a critical link on the Pacific Flyway. In 1980, its fisheries were valued at $27 million, but have declined substantially in recent years. Most importantly, the Delta is the hub of the state's major water delivery system which transfers water from the Sacramento and other Northern California rivers to the South Delta, where massive pumps from the Federal Bureau of Reclamation's Central Valley Project (CVP) and the California Department of Water Resource's State Water Project (SWP) deliver it though hundreds of miles of canals to farming areas in the San Joaquin Valley (which supplies 45% of the nation's fruits and vegetables) and to over 15 million people in Southern California (San Francisco Estuary Project 1992).

[Insert Figure 1 about here]

San Francisco Bay/Delta water policy has witnessed a series of major controversies over the past thirty years. In the 1960s, the major issue was the filling of San Francisco Bay by land developers, ports, and airports. This led to the creation of the Bay Conservation and Development Commission (BCDC) in 1965 and its strengthening in 1969. In the late 1960s and throughout the 1970s, the major focus switched to water pollution from municipal treatment

plants, industries, and surface runoff. Then, in the late 1970s, attention shifted upstream to the Delta and particularly to the relative importance of various factors—water diversions, pollution, overfishing, and the 1984-92 drought—on the precipitous decline of most Delta fisheries. This is an issue of tremendous economic and political importance, since most efforts to protect specific fish populations will adversely affect water supplies to San Joaquin Valley agriculture and Southern California urban areas.

Over the past twenty years, there have been at least five major attempts to deal with water flows and fisheries in the Delta. In 1978, the State Water Resources Control Board (SWRCB) proposed water quality standards for the Delta which substantially affected diversions, but these were subsequently brought into question by a 1985 Federal appellate decision. Second, in 1980-82 Governor Jerry Brown sought an engineering solution—building a "Peripheral Canal" around the Delta with strong environmental protections—but this was defeated in a 1982 statewide referendum by a strange alliance of environmental groups, San Joaquin farmers, and Southern California fiscal conservatives (Munro 1993). Third, two of the critical fisheries, the winter run salmon and the Delta smelt, were listed as threatened under the Federal Endangered Species Act in November 1991 and April 1993, respectively. Fourth, in 1992 Congress approved the Central Valley Project Improvement Act (CVPIA), which seeks to substantially enhance the BOR's and U.S. Fish and Wildlife Service's role in fisheries enhancement within the CVP and to encourage the CVP to engage in water marketing with Southern California cities. Finally, in 1994 informal negotiations among water agencies, agricultural water districts, and environmental and fishery organizations (both agencies and interest groups) resulted in the Bay/Delta Accord, which established a new set of water quality standards to protect Delta fisheries at reasonable costs (Sabatier 1998b).

B. Data Base

The data base for this paper comes from responses to a 14-page questionnaire mailed in the winter of 1992-93 to our estimate of the set of actors who in 1992 were informed and actively seeking to influence some aspect of Bay/Delta water policy (e.g. fisheries, water quality, water supply, fill) The names were obtained from three sources: 1) people active in the San Francisco Estuary Project or in SWRCB hearings on the Bay/Delta; 2) the major actors in critical agencies and interest groups concerned with some aspect of Bay/Delta water policy, and 3) people nominated as influential by the advisory committee to our project.[12] This produced a census of 779 names, of whom 427 responded, for an overall response rate of 55%. [13] In addition, 20 people were added from a companion 1984-92 elite panel survey when they said they were as active in 1992 as they had been in 1984. Finally, since we are primarily interested in comparing the responses of elites from different institutions, 18 people are counted twice because they held

[12]The majority of names came from the various policy and technical advisory committees associated with the San Francisco Estuary Project, a mammoth forum of agency, interest group, and research leaders that attempted to compile assessments of various Bay/Delta resources and to suggest policies for alleviating identified problems (SFEP, 1992). Many others came from the boards and critical staff of agencies and interest groups playing important roles in various Bay/Delta issues. To fill in the holes, 20-30 names—primarily mid-level staff in state and federal agencies--were added by our advisory committee. We are quite confident this represents virtually the entire list of important Bay/Delta water policy elites. One of the items in our questionnaire asked respondents to name the individuals or organizations they relied upon most heavily for advice and information. Of the 1260 authorities listed by our respondents, all the organizations and all but two of the 378 individuals were included in our survey.

8Following are the number of respondents and the response rate for various categories of actors:

Category	Number of Respondents	Response Rate
Federal & state govt. (includes 3 legs.)	96	60%
Bay local & regional govt. & public dischargers	98	52%
Central Valley govt. & interest grps.	32	56%
Southern California govt. & interest grps.	22	65%
Bay business, ports, & private dischargers	56	44%
Environmental and sportsmen's groups	47	58%
Consultants, univ. researchers, educ. fora	62	55%
Journalists and misc.	6	33%
Unknown (removed ID)	8	dk
	427	55%

two elite positions: one on the board of a regional agency, the other as a state or local government official.[14] Thus our data set consists of 465 respondents.

III. Results

In order to test these hypotheses, we must first group our 465 respondents into a reasonable number of organizational affiliations. We then examine the distribution of opinions among officials from a variety of organizational categories on several deep core, policy core, and secondary beliefs. Next will come several regression analyses to see if civil servants have belief systems which are as coherent/constrained as those of other actors. Then we shall look at various actors' perceptions of their allies and opponents to see, on the one hand, if agencies and university researchers were perceived by interest group leaders as active political actors and, on the other, if agency officials and university researchers viewed each other as allies and opponents.

A. Categories of Organizational Affiliation

Cluster analysis using individuals as the unit of analysis would be the ideal way to test the ACF hypotheses concerning similarity of belief systems. Unfortunately, a cluster analysis of our 465 respondents is simply unmanageable—at least from a presentation standpoint. The individuals must be aggregated in some fashion. So we first do so by organization, on the assumption that individuals within an organization will have *relatively* homogeneous beliefs because of the self-selection and indoctrination processes discussed previously. Even this, however, is insufficient, since our 465 respondents come from about one hundred private groups and local, state, and federal agencies that play a recurring role in Bay/Delta water policy. In

[14] Of the 18, 14 were members of the BCDC Board who were also local or state government officials; 3 were members of the Board of the Central Valley Regional Water Quality Control Board (as well as leaders of water districts or major agricultural organizations); and 1 was with the Aquatic Habitat Institute (as well as the San Francisco Regional Water Quality Control Board).

order to reduce these to a reasonable number, we have further aggregated them into the following twenty categories of organizational affiliation. Different organizations have been collapsed into the same affiliation category (a) if they have similar functions and/or locale (e.g. Bay local governments) *and* (b) if their respondents expressed similar views on our attitudinal scales.

Agencies

1) *U.S.BOR/CA DWR* (n=20). These are officials, primarily civil servants, from the U.S. Bureau of Reclamation and the California Department of Water Resources, the agencies that operate the CVP and SWP water projects that send water from the Delta to the San Joaquin Valley and Southern California.

2) *U.S. Army Corps* (n=8). These are civil servants from the U.S. Army Corps of Engineers, the federal agency primarily responsible for regulating dredging and construction in wetlands.

3) USFWS/NMFS (n=13). These are officials, primarily civil servants, from the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, the two federal agencies responsible for fisheries and endangered species.

4) *CA Fish and Game* (n=11). These are officials, primarily civil servants, from the California Department of Fish and Game. While their views generally parallel those of their biologist colleagues in the two federal wildlife agencies, state agency personnel differ on the Peripheral Canal and thus are kept separate.

5) *EPA/Misc. Resource Agencies* (n=30). About a third come from the U.S. Environmental Protection Agency, with the rest coming from a variety of federal and state natural resources agencies, including the State Lands Commission, the California EPA, and the U.S. Soil Conservation Service; almost all are civil servants.

6) *SWRCB* (n=11). These are officials, primarily civil servants, from the State Water Resources Control Board, the state agency primarily responsible for both water quality and water rights/flows. Under the state board are several regional boards, including two in our survey; respondents from the three organizations expressed different enough views that we decided not to aggregate them.

7) *San Francisco RWQCB* (n=13). These are board members and senior staff (most of the latter, civil servants) from the San Francisco Regional Water Quality Control Board which has jurisdiction over San Francisco Bay and a portion of the Delta.

8) *Central Valley RWQCB* (n=10). Similarly, these are board members and senior staff from the Central Valley Regional Water Quality Control Board, the board with jurisdiction over the Sacramento Valley, the San Joaquin Valley, and the remainder of the Delta.

9) *BCDC/Misc. Regional Agencies* (n=29). These are primarily board members and staff from the Bay Conservation and Development Commission (BCDC), which regulates building and fill along the Bay shoreline; also a few people from other Bay Area regional parks/planning agencies.

10) *Bay/Delta Local Govt* (n=43). These are elected officials and senior staff from general purpose local governments and water supply agencies in the Bay/Delta.

Interest Groups

11) *Southern California* (n=22). These are elected officials and senior staff from water agencies in Southern California who either testified at Bay/Delta hearings or are on the boards of the SWP or CVP Contractors Associations. They are treated here as interest groups because they have no formal governmental authority in the Bay/Delta (Salisbury 1984).

12) *San Joaquin Valley/Statewide Ag* (n=25). These are primarily elected officials or senior staff from water or irrigation districts in the San Joaquin Valley who testified at Delta hearings or were on the CVP/SWP Boards. It also includes 7 representatives of statewide agricultural organizations, such as the Farm Bureau, Grange, and Agricultural Chemicals Assn., who testified at the SWRCB hearings and whose responses were very similar to those from the San Joaquin Valley.

13) *Sacramento Valley* (n=10). These are officials from general purpose local governments slightly upstream of the Delta or from water districts in the Sacramento Valley (i.e. north of the Delta) who testified at the Delta Hearings or were active in the Estuary Project. They are treated as interest groups because they have no formal governmental authority in the Bay/Delta.

14) *Private Dischargers* (n=28). These are primarily water quality specialists with industries that discharge wastes either directly or indirectly (via sewer systems) into the Bay/Delta.

15*) Public Dischargers* (n=27). These include board members and senior staff from the five publicly-owned sewage treatment works (POTWs) in the Bay Area or the association of such dischargers.

16) *Business/Ports* (n=27). This includes 14 representatives from business associations (primarily the Bay Planning Coalition) and 13 from ports and airports—all in the Bay Area. These groups tend to have similar views, in part because of their common interest in development along the Bay shoreline.

17) *Environmental/Sportsmens Groups* (n=54). These are the senior staff and critical board members from the principal environmental and fishing/ hunting groups concerned with the Bay/Delta.

Researchers (and Misc)

18) *University/Misc. Researchers* (n=32). These are primarily university faculty who have been active in Bay/Delta research; it also includes a few researchers from institutes in the Bay Area, such as the Tiburon Center. Most were taken from the lists of technical advisors to the Estuary Project.

19*) Consultants* (n=23). These are researchers in consulting firms who have been active on Bay/Delta water issues, either as advisors to the Estuary Project or as participants before SWRCB hearings.

20*) Other* (n=28). This is a miscellaneous group composed of journalists, leaders of educational fora, union leaders, a few state legislators, and anonymous respondents. This category is not mentioned in most of our analyses, although its members are included in the overall means.

This diverse set of actors from agencies and legislators at multiple levels of government, interest groups, and researchers is typical of many policy subsystems—except perhaps for the relatively large number of university scientists (Marin and Mayntz 1991; Heinz et al. 1993; Knoke et al 1996).

B. Attitudes of Policy Actors

This section provides the mean scores for each organizational category for a variety of attitudes ranging from very broad ideological orientation to specific perceptions and preferences. Each figure also provides the overall mean, standard error bars for each organizational category, and an indication of whether the means for specific organizational categories are significantly different from the overall mean.[15] For most agency categories, there is no statistically

[15] We used a two-tailed t-test to determine if the mean for a specific organizational category was significantly different from the overall subsystem mean. If the variance for the organizational category differed significantly ($p<.05$) from the population mean, we used an unequal variance test. If it didn't, we used an equal variance test.

significant difference between civil servants and elected/appointed officials.[16] In cases where there is—chiefly involving the San Francisco and Central Valley Regional Water Quality Control Boards—these will be noted.

In general, the advocacy coalition framework predicts that agency officials and university researchers will have views similar to, but somewhat more moderate than, their interest group allies and that the same patterns will persist across all levels of their belief systems. The policy indifference hypothesis predicts that university researchers and agency officials (particularly civil servants) will cluster around the overall subsystem mean, as the easiest and safest point of view.

1)Deep Core: Conservatism Scale. Figure 2 presents the data on a 6-item Neo-Classical Conservatism Scale representing support for markets and property rights (see Appendix A for details). This scale is at the deep core since it applies to a wide variety of policy domains.

[Insert Figure 2 about here]

At the upper-right portion of the figure, representing the most conservative positions, were officials from San Joaquin Valley/statewide agricultural groups, Bay businesses and ports, Southern California water districts, and private dischargers from the Bay Area. All were significantly different from the overall subsystem mean. The two water export agencies (the BOR and DWR) were also on the conservative side of the spectrum, although not significantly

[16] We compared the views of civil servants versus elected officials and political appointees for six categories of agencies (BOR/DWR, EPA et al, BCDC et al, Bay local govts., Southern California water districts, and San Joaquin Valley water districts) on 10 attitudinal and perceptual items. There were statistically significant differences at the .05 level on 4 of those 60 relationships, or almost exactly what would be expected by chance. At the .10 level, there were differences on 7 of the 60 relationships. On the Central Valley and San Francisco Regional Water Quality Boards, however, there were significant differences ($p<.05$) on 8 of the 20 items, primarily in the deep core and policy core, plus the policy item concerning listing the Delta smelt as an endangered species. In both regional water agencies, the boards were more conservative and less environmental than the staff, which is what one would expect given that the boards were appointed by a Republican Governor politically indebted to San Joaquin farmers while the staff were primarily water quality engineers.

different from the mean. At the bottom-left, liberal end were environmental/sportsmen's groups, EPA and misc. federal/state resource agencies, BCDC and other Bay regional agencies,[17] university researchers, and, marginally, the two federal fisheries agencies ($p<.10$). Several agency categories, including Bay local governments and the water quality agencies, were near the overall mean, consistent with the policy indifference model. In the cases of the Central Valley and San Francisco Water Quality Agencies, however, this "indifference " was simply the average score between a conservative board (PA=political appointees) appointed by a Republican Governor and a relatively liberal staff (CS=civil servants) composed primarily of water quality engineers and biologists. University researchers were clustered at the liberal end of the scale, suggesting that not much has changed since the 1960s (Ladd and Lipset 1975).

2) Policy Core: Flows and Fisheries Scale. Now let's look at a scale containing a variety of normative and perceptual items related to fisheries and flows in the Bay/Delta (see Appendix A for details). We treat it as policy core because it deals with an extremely important aspect of Bay/Delta water policy that has ramifications for most other aspects (Zafonte and Sabatier 1997).

[Insert Figure 3 about here]

The results in Figure 3 support the advocacy coalition framework. At the pro-environmental end were officials from the two federal fishery agencies, environmental/sportsmen's groups, EPA et al, California Fish and Game, university researchers, and BCDC et al., as well as civil servants from the San Francisco Regional Water Board[18] At the

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[17] In this case, the 13 civil servants were not quite significantly different from the mean, while the 15 political appointees--and the category as a whole--were.

[18] Again, however, BCDC civil servants were not quite significantly different from the overall mean, while political appointees and the organizational category as a whole was.

other end of the scale—indicating skepticism that Bay/Delta environmental quality and fisheries were declining and opposition to strong measures to protect them—were officials from San Joaquin/statewide agricultural groups, Southern California water districts, the BOR/DWR, and political appointees from the Central Valley Regional Water Board. All had means significantly different from the overall mean. These patterns are quite similar to those seen previously on the Conservatism Scale.[19] They provide evidence for two distinct coalitions, each comprised of interest groups and officials from several different types of agencies, with the attitudes of university faculty placing them clearly in the environmental coalition. The data here (and elsewhere) also suggest that some aggregated categories, namely consultants and Bay Area local governments, tend to hold positions close to the overall mean.[20]

3) Critical Causal Perceptions. We now pass to a purely perceptual item involving a critical aspect of Bay/Delta fisheries. Figure 4 presents respondents' perceptions of the importance of water diversions (including the CVP and SWP pumps, but also upstream diversions) on the decline of Bay/Delta fisheries. In ACF terms, this is important enough to be labeled a policy core perception because it deals with Bay/Delta fisheries as a whole, and fisheries are a critical aspect of Bay/Delta water policy.

[Insert Figure 4 about here]

The results on diversions in Figure 4 are virtually a mirror image of the previous policy core scale. The federal and state fishery agencies, EPA et al, university researchers,

[19]The results are similar to those from several other deep core and policy core scales that could not be presented here because of space constraints (see Sabatier and Zafonte 1995, Tables 1-2).

[20]Of course, *specific* local governmental officials and consultants were sometimes members of various coalitions. Our practice of aggregating officials across similar organizations into categories of organizational affiliation represents a conservative test of the advocacy coalition framework since there will be some regression toward the overall subsystem mean for different organizations in the same category.

environmental groups, BCDC et al, and, marginally, SWRCB officials ($p<.10$) are at one end; the San Joaquin/state agricultural organizations, Southern California water districts, and BOR/DWR are at the other. Public and private dischargers, Bay businesses/ports, and Central Valley Regional Water Board officials occupied positions on the water development side of the overall mean, but did not attain the .05 significance threshold (except for Central Valley RWQCB political appointees).[21]

4) Specific Policy Proposals. Finally, Figures 5 and 6 present the positions of our organizational affiliation categories on two of the most important and controversial policy proposals affecting Bay/Delta fisheries: (1) the listing of the Delta smelt as a threatened species and (2) the construction of a Peripheral Canal around the Delta to provide water supplies to Southern California and the San Joaquin Valley while hopefully reducing the impact of the export pumps on Delta fisheries.

[Insert Figure 5 about here]

The lineup on the Delta smelt listing in Figure 5 provides further evidence of our familiar coalitions: an environmental coalition composed of the two federal fisheries agencies, environmental/sportsmen's groups, university researchers, EPA et al, BCDC et al, and California Fish & Game. At the other end was the familiar water development coalition composed of San Joaquin/statewide agricultural groups, Southern California water districts, and the BOR/DWR,--together with Bay businesses and ports, and public dischargers. The boards of both regional

[21] We also looked at different groups' perceptions of the importance of (a) entrainment of fish in CVP/SWP pumps and (b) overfishing/poaching as causes of the decline in Bay fisheries. The distribution of perceptions on the pumps were very similar to those for diversions. Those on overfishing were, as expected, basically the *reverse* image of the results on diversions (i.e. those ranking diversions high deemphasized the importance of overfishing, while those wishing to deflect attention from diversions pointed to overfishing as a cause). The most notable exception on the latter were university researchers, with a mean virtually identical to the population mean. Finally, elsewhere (Sabatier and Zafonte 1995, Tables 4-5) we have presented data indicating that these differences persist—albeit in somewhat attenuated form—regarding interpretations of a specific graph depicting fluctuations in Delta smelt populations over time.

water quality agencies favored the water development coalition, while staff were either neutral or favored the environmental coalition.

[Insert Figure 6 about here]

The lineup on the Peripheral Canal in Figure 6 has some familiar elements but also several anomalies. In strong support, as one would expect, were the BOR/DWR, Southern California water agencies, and San Joaquin/statewide agricultural groups. But also in strong support were officials from the California Department of Fish and Game and the SWRCB. These agencies had adopted the position in the early 1970s that (a) the export pumps were here to stay and (b) the best way to minimize their impact on fisheries was to build a canal from north of the Delta directly to the pumps. The defeat of the Peripheral Canal in the 1982 statewide referendum did not change their views.[22] At the opposing end of the scale were the familiar environmental groups, BCDC et al, university researchers, and officials from federal fisheries and resource agencies (although the latter were significant at only the .10 level). In addition, environmental groups were joined on this issue by an unusual ally, private dischargers. The probable explanation is that dischargers were worried the Canal would divert so much water around the Delta that not enough would be left to dilute pollution concentrations.

The results throughout this section indicate substantial support for the basic ACF propositions (Hypotheses 1 and 2) that most agency officials and university researchers will not be grouped around the overall subsystem mean (as suggested by the policy indifference hypothesis) but instead will consistently have positions close to their interest group allies. On

[22] The Peripheral Canal would obviously meet the needs of San Joaquin agriculture and Southern California cities. F&G and SWRCB officials argue it would also improve Delta fisheries by the pumps' effects on the Delta. At present, the pumps not only "entrain" (chew up) millions of fish but also alter flow patterns in the Delta, thereby confusing migratory fish such as salmon. The risk, which these groups feel is acceptable while environmental groups do not, is that the Canal could greatly increase the amount of water diverted south. We wish to thank Jerry

most issues, there were two coalitions with positions significantly different from the overall subsystem mean: An environmental coalition composed of environmental/fisheries interest groups, federal and state fisheries agencies, EPA and other federal/state resource agencies, BCDC and other Bay regional agencies, and university researchers. They were opposed by a water development coalition composed of San Joaquin/statewide agricultural groups, Southern California water agencies, the two major water export agencies (the Federal Bureau of Reclamation and the California Department of Water Resources), and the politically-appointed board of the Central Valley Regional Water Quality Control Board. On the other hand, consultants (as an aggregate category) and several agencies—including the U.S. Corps of Engineers, the SWRCB, and Bay Area local governments (as an aggregate category)—were *not* part of discernible coalitions, but instead seemed to be either near the subsystem mean or to approximate the positions of different coalitions on different issues.[23]

What about the hypothesis (# 3) that agency officials—particularly civil servants—will express more moderate beliefs than their interest group allies? Table 1 provides the means for various agencies and interest groups involved in the water development coalition and the environmental coalition on all the attitudinal items presented in this paper, together with an indication of whether the means of agency officials (in the aggregate) were significantly different from their interest group allies.

[Insert Table 1 about here]

In the water development coalition, on four of the five items BOR and DWR officials held more moderate views than their allies in San Joaquin and Southern California water districts

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Johns (SWRCB), John Budd (U.S. BOR) and Randy Brown (DWR) for their comments regarding the Canal on a previous version of this paper.

and these differences were statistically significant.[24] Within the environmental coalition, the specific agencies usually had more moderate views than their interest group allies, and these differences were significantly different in the aggregate on three of the five items. Note, however, that on two of the items—diversions as a cause of fishery decline and support for listing the Delta smelt as a threatened species—officials in the two federal fishery agencies held more extreme views than their interest group allies. On the whole, however, these results present fairly strong support for Hypothesis 3.

With respect to university researchers, the data in Table 1 indicate that, on four of the five items, their views were significantly more moderate than those of their interest group allies (although not necessarily more moderate than officials from specific agencies). The standard errors from Figures 2-6 do not, however, support the argument in Hypothesis 4 that university researchers in a policy dispute will demonstrate greater variation in beliefs than officials from interest groups and agencies. [25]

C. Do Civil Servants (and University Faculty) Have Coherent Policy Belief Systems?

The policy indifference hypothesis predicts that, since civil servants and university faculty are indifferent to policy issues, they should have poorly integrated policy belief systems. In contrast, the advocacy coalition framework predicts that, since most civil servants and university faculty involved in policy disputes are members of coalitions, their belief systems

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[23]Recall that specific individuals within these groupings might be members of coalitions, even if the overall mean for the category approximates the subsystem mean.

[24]If one runs a two-tailed test, the differences on the Delta smelt item cease to be marginally significant. Otherwise, the results for both coalitions are identical. We present the results from the one-tailed test because the moderation hypothesis posits a direction.

[25]Although the standard errors do not seem to suggest less variation among university researchers than within other categories, we should probably run F-tests on the standard deviations

should be as coherent/constrained as those of other policy elites, such as interest group leaders or legislators.

In order to test these competing hypotheses, Table 2 presents the results from two sets of multiple regression equations. The first set attempts to explain support for the Peripheral Canal and the second for listing the Delta smelt as a threatened/endangered species. The independent variables are two deep core scales, two policy core scales, and several relevant perceptual items.[26] For each policy proposal, we ran the same equation twice: once for the entire set of respondents (composed largely of interest group leaders and political appointees), and then only for civil servants.

[Insert Table 2 about here]

On both sets of equations, the results for civil servants are similar to those for the total set of respondents in terms of the percentage of variance explained (adjusted R2), as well as the sign and magnitude of the regression coefficients. In both cases, the Chow F-test for structural difference in all parameters was *not significant* (Greene 1993). These findings suggest that civil servants involved in Bay/Delta water policy in 1992 had belief systems which linked normative positions, causal perceptions, and policy preferences in about as coherent or constrained a manner as those of other policy elites—thus providing additional support for Hypothesis 1.

We ran the same equations for university faculty and, again, the Chow F-test revealed no significant differences between them and the population as a whole. [27] We don't present the

[26]Because of space constraints, data on some of these items has not been presented in this paper although they have been mentioned in the footnotes. See Sabatier and Zafonte (1995)—a paper written primarily for Bay/Delta policy practitioners—for details. We here present the results for the full model, although we strongly suspect that a truncated model would produce very similar results.

[27]For the Peripheral Canal equations, the Chow F-test=0.906 (p=.5114). For the Delta smelt listing, Chow F-test = 1.298 (p=.2440).

regression coefficients because of problems with multicollinearity and small degrees of freedom. But these results provide at least a little additional support for Hypothesis 2.

D. Perceptions of Allies and Opponents

Thus far we have presented evidence that the officials of most federal and state agencies—as well as university researchers—involved in Bay/Delta water policy have coherent belief systems that are fairly close to, although somewhat more moderate than, their interest group allies. Thus they have met the first of two conditions for being "members" of advocacy coalitions. But what about the second condition, i.e. engaging in "a non-trivial degree of coordinated activity over time" (Sabatier and Jenkins-Smith 1993,25)?

Although we lack direct measures of the behavior of agency officials and university researchers, our questionnaire does provide systematic data on who respondents perceived their allies and opponents to be. These are relevant in at least three ways. First, the advocacy coalition framework would expect agency officials and university researchers to admit having "allies" and "opponents"—at least to the extent that they admitted being members of coalitions. In contrast, the policy-indifference model would expect neither bureaucrats nor university researchers to have "allies" and, even less so, "opponents." Thus the policy indifference model would expect the non-response rate to these items to be much higher for agency officials and university researchers than for other policy elites. Second, the advocacy coalition framework would expect to find both interest groups and other agencies among the allies and opponents of both agency officials and university researchers, since all would be regarded as potential members of coalitions. In contrast, the policy indifference model would expect that, even if bureaucrats and university researchers admitted having allies and opponents, these would be limited to interest groups. It would make little sense to think of other agencies and researchers in

these terms, since the vast majority of such actors would, according to this model, be policy indifferent. Third, perceptions of allies and opponents are presumably based in part on the past behavior (rather than simply the private attitudes) of officials in those organizations. While our 1992 survey did not explore this assumption, a very preliminary analysis of a similar question in a 1997 survey of Bay-Delta water policy elites suggests this is, in fact, a reasonably valid indirect indicator of several types of coordinated behavior.[28]

One part of the questionnaire gave respondents a list of 20 types of organizations (roughly the same as our organizational affiliation categories) and asked them to indicate up to three "with whom you identify or regard as allies" and up to three "which you regard as your principal opposition." Table 3 indicates, for respondents from organizations in the two potential coalitions, their perceived allies, grouped by type of organization and coalition. Table 4 does the same for perceived opponents.

[Insert Table 3 about here]

[28]In response to Edella Schlager's (1995) criticism that our measures of perceived allies and opponents were not actually measuring coordinated behavior, our 1997 Bay/Delta questionnaire attempted to address this deficiency. For each ally listed by a respondent, it asked for the frequency (never, occasionally, often) with which they engaged in four types of activities: (a) share information, (b) voluntarily modify my behavior to assist them, with the expectation of future reciprocity, (c) voluntarily modify my behavior to assist them because we share similar goals, and (d) develop a joint policy position or stratery. Since the survey is still ongoing, we have only very preliminary data. But an analysis of 25 respondents (selected from the middle of a pile of 300 thus far) who listed a total of 66 allies reveals the following frequency distributions:

	Share Info	Modify b/c reciprocity	Modify b/c goals	Joint Strategy
Never	0%	36%	8%	21%
Occasionally	44%	44%	58%	41%
Frequently	56%	20%	34%	38%
Occasionally or more:	100%	64%	92%	79%

In sum, in 100% of cases, listing a person/organization as an ally involved at least occasionally sharing information; in 92% of cases, it involved at least occasionally modifying behavior because of shared goals; in 79% of cases, it involved at least occasionally developing a joint policy position or strategy; and in 64% of cases it involved at least occasionally modifying behavior in expectation of future reciprocity. Thus listing a person as an "ally" does appear to be an indirect indicator of several types of past and future coordinated behavior.

Looking first at the bottom row of the two tables for the percentage of non-respondents from each affiliation category, 0-15% of agency officials refused to list any perceived allies, compared to 4-8% from the various interest groups and 16% of university researchers. None of these differences among agency officials, interest groups, and university researchers were statistically significant at the .05 level. The percentage of agency officials refusing to list any opponents increased slightly (particularly for the BOR/DWR and EPA et al), but, even so, over 85% of federal and state agency officials listed at least one opponent. University faculty were comparable (19%), while respondents from interest groups were slightly more willing to acknowledge having opponents, but the differences between agency, interest group, and university personnel were, again, *not* significant.

Turning to various actors' perceptions of their allies and opponents, the results provide fairly strong support for the advocacy coalition framework.. In Table 3, for example, among BOR/DWR officials, 75% cited each other as allies, while 35% cited agricultural interests and Southern California cities. Generally only about 5% cited various members of the environmental coalition, with the exception of 30% citing the various fishery agencies and 15% citing university researchers. The data were similar for agricultural groups and Southern California water agencies. Both cited themselves and the BOR/DWR as allies about 75% of the time, while citing each other about 20%. Very seldom did either cite members of the environmental coalition as allies, with the exception of 23% Southern Calfiornia representatives citing environmental groups as allies. These anomalies reflect the politics of the recently-passed Central Valley Project Improvement Act, in which Southern California cities switched allegiance from San Joaquin agricultural interests to environmental groups over the issue of water transfers. The results are even stronger for members of the environmental coalition. With the exception of

a trivial percentage of university researchers, *none* of the respondents in the six categories listed members of the water development coalition as allies. In contrast, 55-87% of the actors in each category listed environmental groups as allies! In short, the citation patterns for allies in Table 3 reveals two rather distinct coalitions, each composed of both agencies and interest groups. In addition, the citation patterns by agency officials in the two coalitions were fairly similar to those of their interest groups allies.

[Insert Table 4 about here]

The citation patterns for opponent in Table 4 are similar to those for allies in Table 3. Members of the water development coalition tended not to list each other as opponents (except for the 23% of Southern California officials displeased with agricultural interests), while 59-92% listed environmental groups as opponents and 30-82% listed the U.S. EPA as an opponent. Among members of the environmental coalition, only very small percentages listed each other as opponents, while 30-90% listed members of the water development coalition as opponents. And the percentage of negative citations by agency officials and university researchers tended to be quite similar to those of their interest group allies. The possible exception was BOR/DWR officials, who tended to have a somewhat less negative view of the EPA than did their interest group allies.

One final comment: University faculty tended to view themselves as members of the environmental coalition, i.e. they perceived environmental groups, other researchers and, to a lesser extent, EPA and the fisheries agencies as their allies, while viewing agricultural interests, Southern California cities, and the BOR/DWR as opponents. Table 3 indicates, however, that only about 20% of the other members of the environmental coalition viewed university researchers as one of their three top allies, and Table 4 demonstrates that virtually none of the

members of the water development coalition perceived university researchers as opponents. In short, most members of the Bay/Delta waster subsystem in 1992 seemed to accept the popular portrait of university researchers as neutral, objective, policy indifferent, etc. That may change as findings from this study become known.

IV. Summary and Conclusions

The evidence from this analysis of Bay/Delta water policy elites provides substantial support for the basic contention of the advocacy coalition framework that agency officials and university researchers active in policy disputes are usually members of advocacy coalitions--rather than being "policy-indifferent." Officials in many agencies—including the BOR/DWR, state and federal fisheries agencies, EPA and other state/federal resource agencies, and BCDC/Bay regional agencies—had beliefs very similar to those of interest group leaders in their respective coalitions. These beliefs were as well integrated into coherent belief systems as those of other policy elites in the subsystem. Agency officials were about as likely as their coalition partners to see other agencies and interest groups as allies and opponents.

Most of these conclusions also hold for university researchers involved in Bay/Delta water policy. Their beliefs on a wide variety of policy issues placed them clearly in the environmental coalition. There is some evidence that their policy belief systems were as internally consistent (constrained) as those of other policy elites. And their perceptions of allies and opponents were very similar to those of other members of the environmental coalition. These findings for university researchers are all the more remarkable because we have made no effort to control for academic discipline or institution.

In terms of the hypotheses presented in the first section of this paper, the data in Figures 2-6 and Tables 1-2 clearly support the first part of Hypotheses 1 and 2. Both agency officials

and university researchers tended to have coherent belief systems similar in structure to those of their interest group allies. Whether one regards them as full-fledged "members" of advocacy coalitions depends upon the extent to which one views our data on perceived allies and opponents as reasonably valid indirect indicators of coordinated behavior. If one shares our cautiously favorable interpretation of the indicators, then the second part of Hypotheses 1 and 2 is also confirmed, and the officials of most state and federal agencies and university researchers involved in Bay Delta water policy were members of coalitions. To the extent that one remains skeptical about our indicators, the evidence for the second part is inconclusive. With respect to Hypothesis 3, the evidence in Table 1 provides fairly strong indication that officials in most agencies—with the exception of the two federal fishery agencies—tended to have more moderate views than their interest group allies. University researchers also tended to express more moderate views than their interest group allies (although not necessarily more moderate than their agency allies).

The question now arises, how generalizable are these results? Is there something peculiar about Bay/Delta water policy within the U.S.? If not, is there something about the U.S.—compared to other Western countries—that makes our agency officials and university researchers who are active in policy disputes behave more like members of advocacy coalitions?

Within the U.S., at least four types of evidence are relevant. First, several studies suggest that both federal and state/local bureaucrats are somewhat more liberal on social and economic issues than are the public as a whole, and these disparities increase within several policy domains (Meier and Nigro 1976; Garand et al 1991a,b; but Lewis 1990). Second, at least two other studies have compared bureaucrats' views to those of other elites in their policy subsystem. In an analysis of Forest Service employees in the intermountain states in the early 1970s, Culhane

(1981) found that agency officials' policy views were more or less equidistant between commodity interests, on the one hand, and environmental groups, on the other. While one might interpret this as evidence of policy indifference, Culhane viewed it as consistent with the Forest Service's traditional "multiple use" mandate. In a study of water policy elites at Lake Tahoe in the mid-1980s, Sabatier and McLaughlin (1988) found a situation similar to the Bay/Delta, with environmental groups and federal/state resource agencies clustered at one end of several attitudinal scales, while property rights groups, business associations, and public utility districts were at the other end. Third, numerous studies of the reaction of officials in social and regulatory agencies to the Reagan Administration's attempts to use political appointments and budgetary cutbacks to curtail their programs reveal that many civil servants were not policy indifferent but, instead, fought the cutbacks by leaking damaging information to sympathetic Members of Congress and interest groups (Cook and Wood 1989; Durant 1992; Maranto 1993a,b).

Finally, the principal-agent literature assumes that the ability of principals to control bureaucratic agents is problematic (Moe 1984). Public choice theorists, following Niskanen (1971), assume that the source of control problems resides in bureaucrats' desire to maximize their budgets and/or to minimize their workload.[29] On the other hand, the advocacy coalition framework and the evidence cited above concerning the Reagan Administration suggests that bureaucrats will seek to avoid control by principals when they have value/policy differences, and resistance will be particularly pronounced when principals seek to change the fundamental mission of the agency. Unfortunately, most of the empirical tests of principal-agent relationships have spent much more time analyzing the effectiveness of various type of instruments available

[29] Information asymmetries are less the *source* of the problem than the reason why bureaucrats are able to avoid control with some success.

to principals than in examining alternative explanations of bureaucratic resistance (Wood and Waterman 1991). [30]

Turning now to Western Europe, Aberbach et al's (1981) monumental study of the views of high-level bureaucrats and politicians in ten Western countries revealed that, while 48% of senior civil servants in the ten countries saw "neutral execution" as a desirable trait, an even higher percentage (59%) supported a "policymaking" role (p.104). With respect to Left/Right ideology, Aberbach et al (1981) found that civil servants in most countries had policy views slightly more centrist than most politicians, but their belief systems were as ideologically coherent as elected officials (pp. 122-129). Finally, about a dozen scholars have found the advocacy coalition framework to be useful in explaining policy change in a number of domains in European countries (Sabatier 1998a).

With respect to university faculty, several case studies indicate that many U.S. faculty active in policy disputes behave like coalition members (Primack and von Hippel 1974; Nelkin 1971; Mazur 1981). In Europe, there is certainly a long tradition of faculty political activity, particularly on the Left, and some evidence of faculty involvement in reform movements during the 1960s and 1970s (Wagner 1987).

In sum, we suspect our results from Bay/Delta water policy—indicating that many agency officials and university faculty actively involved in policy disputes are members of advocacy coalitions—are representative of many other policy areas in the U.S. and Western

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[30]We would recommend that principal-agent scholars pay greater attention to resolving different explanations for the sources of resistance. The same instrument can have different effects if applied to budget maximizers than to policy advocates—and, among advocates, the effects will obviously vary depending upon whether they share, or oppose, the views of principals.

Europe. But we'll have to wait for other scholars to do comparable analyses in other policy areas and countries in order to get a better sense of the generalizability of our results.

To the extent these results are generalizable, they will confirm some of the crucial assumptions of the advocacy coalition framework. That, in turn, will strengthen the ACF as a reasonably coherent alternative to the institutional rational choice frameworks currently dominating much of political science (McCubbins and Sullivan 1987; Scharpf 1997; Ostrom 1998).

Appendix A: Scale Construction

The attitudinal scales used here were constructed in two separate operations. First, we used a factor analytic procedure to identify survey items that shared common underlying dimensions. Second, we calculated additive scales using the results of the initial factor analysis and validated them using a reliability analysis.

The first scale was a *Neo-Classical Conservatism Scale* containing the following six items:

- Government laws and regulations should primarily ensure the prosperity of business since the health of the nation is dependent upon the well-being of business (r = .68).
- A first consideration of any good political system is the protection of property rights (r = .66).
- Decisions about development are best left to the economic market (r = .66).
- The best government is the one that governs the least (r = .64).
- Government planning almost inevitably results in the loss of essential liberties and freedoms (r = .61).
- The "welfare state" tends to destroy individual initiative (r = .59).

The second scale was a *Concern for Flows/Fisheries Scale*. It contains a total of three items focusing on the impacts of water quantity and timing (i.e., flows) on Bay-Delta fish populations. The items included in this scale are:

- Upstream dams and diversions have sufficiently reduced inflows to the Delta so as to pose serious problems for Bay/Delta fisheries (r = .67).
- Because political power in the state lies primarily in Southern California nd the San Joaquin Valley, water policy decisions by the Governor and Legislature are more likely to reflect those needs than concern with Bay water quality (r = .66).
- In-stream flow requirements from the Sacramento River to the Bay/Delta should be sufficient to restore fish populations to pre-1976 levels (r = .52).

A reliability analysis on these items produced an alpha of .78.

In calculating individual scores on each scale, we added respondents' scores on specific items and divided by the total number of items on the scale. To deal with missing data, we

retained all respondents who had answered at least one item, but changed the divisor to the number of items answered. If the respondent did not answer any of the items on the scale, their score on that scale was “missing.”.

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AFFILIATION CATEGORIES	BELIEF MEASURES Neo-Classical Conservatism	Flows-Fisheries Concern	Diversions Cause Fish Decline	List Delta Smelt	Build Peripheral Canal
Potential Water Development Coalition					
Interest Groups	***5.15***	***2.04***	***33.59***	***1.58***	***6.58***
Southern California Interests	4.69	2.11	39.09	1.90	6.90
San Joaquin Valley & Statewide Ag	5.56	1.97	28.54	1.30	6.32
Agencies - US BOR & CA DWR	***4.05 ******	***3.07 ******	***62.89 ******	***2.12 #***	***6.33***
Potential Environmental Coalition					
Interest Groups - Environment & Sportsmens	***2.57***	***6.35***	***93.80***	***6.29***	***1.57***
Agencies	***3.02 *****	***5.89 *****	***92.72***	***5.93***	***2.53 ******
USFWS & NMFS	3.01	6.08	97.31	6.73	2.09
CA Fish and Game	3.20	6.00	95.45	5.67	5.00
EPA & Misc. Resource Agencies	2.87	5.66	89.83	6.10	2.50
BCDC & Misc. Regional Agencies	3.11	6.02	92.50	5.45	1.86
Researchers - University & Misc. Bay	***3.04 ****	***5.73 *****	***93.28***	***5.56 ****	***2.16 ****

#, *, **, *** = significant at the .10, .05, .01, and .001 levels, respectively (one-tailed)

Economic and Environmental Tradeoffs at the Watershed Scale: Costs of Stream Temperature Reduction

--Working Paper*--

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Economic and Environmental Tradeoffs at the Watershed scale: Costs of Stream Temperature Reduction

Introduction

Public attention has been focused on resource use for multiple economic and environmental goals. In the U.S., watershed councils are working with local landowners, interest groups and a variety of government agencies to design and implement plans for watershed restoration and protection that balance both environmental and economic goals.

Participation by local landowners in enhancement plans is voluntary. Segerson and Miceli (1998) indicate that compliance with voluntary agreements is increased: i) if there is a perception that non-compliance increases the probability of regulation; and ii) incentives are provided. The success of watershed protection efforts depends on the economic and environmental tradeoffs asked of local landowners. Sectors within the watershed are likely to face different compliance costs and different probabilities of regulation (if any) from non-compliance with protection efforts. Estimates of the distribution of compliance costs between sectors will provide information regarding the likely adoption of enhancement plans. In addition a cost assessment could identify the magnitude of incentives required to achieve environmental goals. Some environmental protection efforts are a joint function of actions taken by several economic sectors in a watershed, highlighting the importance of obtaining compliance by all sectors.

The problem faced by many watershed councils can be considered as the following. The council has *a priori* goals to promote projects for environmental enhancement and protection, but no information regarding: the effectiveness of proposed measures to achieve project goals; the total costs associated with alternative project goals; and the distribution of costs between the

economic interests within the watershed. This paper describes a conceptual framework and associated methodology that can be used to identify economic and environmental tradeoffs at the watershed scale. An empirical model is developed for a case study watershed. The model has two interesting features in that, i) it accounts for the influence of changes in non-market attributes on residential property prices and ii) incorporates an estimate of stream temperature response to selected riparian planting proposals. Specifically this paper addresses tradeoffs associated with planting a riparian buffer to reduce stream temperature.

Study area and Problem Statement

The Mohawk watershed, western Oregon, is used as a case study for this analysis. The watershed spans 113,625 acres. Higher elevations are dominated by industrial timber-land (public and private). These transition through non-industrial timber-land to a mix of agricultural and residential lands on the valley floor (Figure 1).

One concern identified by the local watershed council is elevated summer stream temperatures.[31] These can reduce the survival, growth and reproduction rates of steelhead trout and salmon (Hostetler 1991) and reduce available dissolved oxygen for all aquatic biota (Boyd 1996). However, the council is uncertain how best to achieve this objective, what level of reduction could be achieved or the costs to local resource owners.

[31] The Oregon Department of Environmental Quality has listed the Mohawk River and one of its major tributaries, Mill Creek, as water quality limited on the basis of temperature (ODEQ 1996). High temperatures have also been recorded on other tributaries (BLM 1995).

Actions to Reduce Stream Temperature

The primary source of energy for heating streams during the summer months is incoming solar radiation (Beschta *et al.* 1987). One means of moderating stream temperature is to plant a riparian buffer that increases shade and reduces the direct solar radiation striking the water (Beschta *et al.* 1987; Boyd 1996; Sullivan *et al*. 1990; Brown 1983).[32]

A riparian buffer is a strip of vegetation (often trees) that buffers the stream area from adjacent activities. Riparian buffers run the length of the stream and can extend outward from the stream. Dense vegetation and a wide riparian buffer[33] are associated with more effective stream shading.[34] Riparian buffer width is measured perpendicular to the stream. The spatial location of shading between the headwaters and confluence of the stream is an important consideration (Beschta *et al.* 1987). Once stream temperature is elevated, heat is not dissipated easily, even if the water subsequently flows through a shaded reach (Beschta *et al.* 1987). It is, therefore, important to maintain shade along the headwaters and tributaries of a stream in addition to the mainstem without substantial gaps in the riparian buffer. This requirement stresses the importance of voluntary compliance with riparian plantings by all sectors with stream-side holdings. Non or poor compliance by one sector could negate some of the compliance efforts put forth by other sectors. The magnitude of this problem is dependent on the quantity and spatial location of stream-side land holdings.

Riparian buffer and tax policy scenarios developed for this study are presented in Table 1. **Bold** notation refers to the buffer scenario and *italics* to the tax scenario. Land within the

[32] Stream temperature can also be reduced by increased stream flow, stream bank stabilization (leading to narrower stream channels) and other factors (Moore and Miner 1997; Beschta *et al.* 1987*;* Sinokrot and Stefan 1993).
[33] Beschta *et al.* 1987 show that there are few gains from increasing buffer width beyond 100 ft wide.
[34] Riparian buffers provide additional benefits such as stream bank stabilization, wildlife habitat, reduced sedimentation and others.

watershed is classified into four categories: industrial timber; non-industrial private timber; agricultural; and residential. Buffer scenarios and tax policies vary by land use.

Buffer scenario **B** reflects current production patterns and residential activity. Riparian buffer widths on industrial timber-land are consistent with the Oregon Forest Practices Act i.e. 100 ft wide on large, 70 ft wide on medium and 50 ft wide on small streams with fish and domestic water use (Forest Practice Administrative Rules 1995). Observed buffer widths are used for other areas. In buffer scenario **AB**, riparian buffers consistent with the Oregon Forest Practices Act are assumed on large industrial and non-industrial timberlands. A 50-foot buffer is assumed on all agricultural land and existing buffer widths are assumed on residential lands. Buffer scenario **ARB** is similar to **AB** with the additional assumption of 50-foot buffers on residential lands. Buffer scenario **50B** assumes a 50-foot wide riparian buffer across the entire watershed regardless of stream size or adjacent land use. In buffer scenario **FPAB**, buffers consistent with the Forest Practices Act are assumed across the entire watershed regardless of land use.

Three tax policies are considered with the buffer scenarios. Policy *B*, is the *status quo*, or base tax policy. This policy, combined with the riparian buffer scenarios described above reflects the situation where there are no additional incentives to engage in riparian plantings. Policy *D* provides for a tax deferral[35] on all lands in the watershed that engage in the riparian planting scheme.[36] The tax deferral applies to the entire tax lot not just the area planted in trees and reduces the assessed value of the tax lot upon which riparian plantings are made.

Policy *TIP* is based on the Oregon riparian tax incentive program. All land areas with a *bona-fide* riparian protection plan are totally removed from the owners tax base (that is, their assessed

[35] Modeled on existing farm and forestland tax deferrals within Oregon.

value is zero).[37] The remaining area of the land parcel is assessed at the regular value. Policies *D* and *TIP* are incentives that could be used to encourage landowners to voluntarily adopt riparian plantings. Other incentive mechanisms could be used.

Conceptual framework

A cost-effectiveness analysis is a convenient way of combining economic and physical data in a manner that highlights the tradeoffs associated with a range of alternatives for environmental enhancement. The least cost alternatives are used to construct a cost-effectiveness frontier. The frontier in Figure 2, shows that total costs increase at an increasing rate as the environmental attribute is increased from its base level (consistent with the theoretical expectation of diminishing marginal returns). E_i is the predicted increase in the environmental attribute from its base level (where, $E_1 < E_2 < E_3$) and C_i is the cost of actions considered (where, $C_1 < C_2 < C_3$).

Points A, B, C and D represent different environmental enhancement/cost pairs associated with four alternative plans. Only the least cost points are represented on the frontier. For example A and B achieve the same increase in the environmental attribute to E_2, however, A achieves it at least cost $(C_1 < C_2)$ and is on the frontier. It is important to recognize that empirically generated frontiers may not be as smooth and will not necessarily exhibit this shape. If a larger number of alternatives are considered, the shape and position of the frontier could change.

[36] Industrial timberland is excluded from this tax incentive scheme as similar deferrals are already in place.

[37] The amount of tax paid per acre of land is a combination of the assessed value of that land and the tax rate per $1000 of assessed value. Every landowner is taxed at the same rate. However, landowners can receive a tax break by lowering the assessed value of their land. Policies *D* and *TIP* alter the assessed value of the land, not the tax rate.

Estimates of the economic costs and physical effectiveness[38] of enhancement plans are required to construct this frontier. Measures of cost and effectiveness are described in the following sections.

Economic cost

Connor, Perry and Adams (1995); Turner and Perry (1997) and; Qiu and Prato (1998), among others, have used mathematical programming techniques to estimate change in producer profit in response to new environmental constraints. A change in profit provides a measure of producer welfare change assuming that producers do not shut down.

Many watersheds contain a mix of production activities such as farming and forestry as well as land in residential use. It is likely that plans for environmental enhancement will influence the utility of residential property owners in addition to profits generated by landowners engaged in production activities. The economic costs of environmental enhancement are not complete without accounting for residential property owners as well as producers.

Welfare change experienced by residential property owners due a change in the quantity or quality of an environmental attribute on or adjacent to their property is commonly estimated with non-market techniques such as hedonic pricing. Hedonic pricing is based on the premise that observed differences in property values are a consequence of differences in the attributes possessed by each. Otherwise identical properties can have different sale prices as a result of differing environmental amenities at each location. For example, Kulshreshtha and Gillies (1993); Benson *et al.* (1998); Lansford and Jones (1995) and; Doss and Taff (1996) have used hedonic pricing to consider the impact of proximity to environmental features or access to views on residential property prices.

[38] In terms of changes in the environmental attribute of interest.

Money measures of welfare change for producers and residential property owners (consumers) can be combined to provide an estimate of the total costs of adopting practices for environmental enhancement at the watershed scale. The inclusion of residential property owners in the cost framework is an important extension of existing watershed modeling efforts.

Environmental Effectiveness

An assessment of economic/environmental trade-offs is not complete without an estimate of the effectiveness of plans for environmental enhancement. Biophysical models can be used to estimate the effectiveness of alternative practices for environmental enhancement at the watershed scale. Environmental effectiveness could be measured as increases in the physical units of the resource or the percentage of the resource that meets a particular standard.

Empirical Model

The empirical model is developed with several goals in mind. Firstly, to provide estimates of the total cost, distribution of cost and effectiveness (in terms of moderating stream temperature) of a range of riparian planting and tax scenarios. Secondly, the economic component of the model is designed so that it can be used in similar future analyses of economic/environmental tradeoffs to achieve other goals within the watershed.

Total welfare change across the watershed; the distribution of these changes; and stream temperature response to riparian buffer and tax prescriptions are estimated using an integrated mathematical programming and stream temperature simulation model. Riparian buffer prescriptions constrain economic activities and influence stream temperature, providing a link

between the economic and physical components of the model. Unlike previous integrated bio-physical/economic models, this model estimates welfare changes experienced by residential property owners as well as producers of agricultural and timber commodities. A schematic of the model design is presented in Figure 3 and its major components are described below.

Objective Function

The objective function maximizes producer profits from cropping, timber and livestock activities and sums these with the current 30-year annuity value of expenditure on residential property. The choice variables for the model are cropping, timber and livestock activities. Production decisions are constrained by resources, technology and riparian buffer requirements. Consumer welfare estimation is described in more detail in the following section. The quantity and type of residential properties are not decision variables within the model. The existing property distribution is assumed to represent the observable solution to consumers' utility maximization problems (in terms of housing choice).

Residential/consumer welfare change

Residential properties were divided into three groups based on their market value (low, medium or high). The change in total market value of each group in response to a change in riparian buffer width is estimated as:

(1) $P_{RP}^{c} = Po_{RP}^{c} - \gamma(\Delta RA)$

Where, P_{RP}^{c} is the total market value of residential property in class c (where c = low, medium, high); Po_{RP}^{c} is the original (or base) total market value of all properties in class c; γ is the marginal implicit price of an additional square foot of treed riparian buffer on the mean value property in class c and; ΔRA is the change in riparian buffer area from the base level. In the objective function, the total value for each classification is expressed as an annuity payment

The marginal implicit price of an additional square foot of treed riparian buffer was estimated using a hedonic pricing analysis. Equation (2) represents a hedonic price function, where P_i represents the price of property i, $\mathbf{L}_i$ is a vector of the characteristics of the lot, $\mathbf{R}_i$ is a vector representing the characteristics of the residence and E_i is an environmental attribute.

(2) $P_i = (\mathbf{L}_i, \mathbf{R}_i, \mathbf{N}_i, E_i)$

The partial derivative of (2) with respect to any attribute yields the marginal implicit price of the attribute. A utility maximizing consumer will select additional units of and attribute, for example E_i to the point where their marginal willingness to pay for E_i is equal to the marginal cost of E_i. The marginal cost associated with purchasing another unit of E_i, $\left(\frac{\partial P_i}{\partial E_i}\right)$, is an estimate of the marginal willingness to pay for E_i at current levels of consumption.[39] If the marginal willingness to pay function is assumed constant, an estimate of welfare change can be calculated from the product of the marginal implicit price of E_i at the original utility maximizing level of consumption and the quantity change in the amenity level E_i (Freeman 1993). This results in an overestimate of welfare change if the attribute E_i is desirable and an underestimate if E_i is undesirable. The hedonic pricing analysis indicated that an increase in the size of the

riparian buffer served to reduce residential property prices.[40] The assumption of a constant marginal implicit price (γ) results in an underestimate of welfare change as a wide riparian buffer is an undesirable property attribute.

Stream Temperature Estimates

Riparian buffer prescriptions and their spatial location are used by the stream temperature estimator to relate stream temperature response to a change in riparian buffer width. The estimator uses physically based descriptions of stream energy and hydrologic processes to provide reach based stream temperature profiles in response to changes in vegetation and atmospheric parameters. A reach is a discrete section of the stream. A full description is provided in Boyd (1996). Stream temperature at the headwaters of the system is used as a starting value to calculate temperature change over the first reach. Stream temperature change for the second reach is calculated using the final temperature for the first reach as a starting value. Temperature changes are estimated for 164 consecutive reaches to account for water movement from the headwaters to the confluence.

Oregon Department of Environmental Quality (ODEQ) classify streams as water quality limited on the basis of temperature if the average maximum daily water temperature exceeds 64^{o}F for the stream's warmest consecutive seven-day period during the year. The effectiveness of the riparian buffer scenarios is calculated as the percentage of reaches for which the maximum daily stream temperature at the downstream point is at or below 64^{o}F. A failure in terms of this

[39] The marginal willingness to pay function for E_i can be obtained from a second stage estimation and can be used to calculate the consumer welfare change as a result of changes in the quantity or quality of environmental attributes.
[40] See Mooney (1997) for this analysis.

standard differs from the conditions required to fail the standard set by ODEQ as it is based on a one day exceedence of 64 ^{o}F.

Data Collection

Data requirements for this study were considerable. Key data are described in this section. [41] Current land use was obtained using a geographical information system (GIS) and watershed analyses conducted by Weyerhauser Company (1994) and the BLM (1995).

Agricultural production practices were identified by county agents and a personal interview survey. The most common practices were livestock and hay production with some specialty crops such as filberts. The majority of agricultural enterprises were small scale and much of the agricultural area is underutilized. Agricultural production costs and output prices are obtained from enterprise budgets developed for the area.

Residential property characteristics, sale price and assessed value were obtained from records at the Lane County Department of Assessment and Taxation. Property tax rates were obtained from Lane County Department of Assessment and Taxation (1997).

Atmospheric, hydrologic, vegetation and shading parameters for the stream temperature estimator are collected from: Marron (personal communication); Oregon Atlas and Gazetteer (1991); BLM (1995); A. G. Crook Company ; ODFW (1994a); ODFW (1994b); and Weyerhauser (1994). The existing width of the riparian buffer along streams in the watershed is estimated using aerial photograph interpretation.

[41] For a full description of data see Mooney (1997).

Results

This section summarizes the results from the modeling scenarios. Estimates of economic cost and environmental effectiveness are combined to form an empirical cost-effectiveness frontier depicting economic and environmental tradeoffs resulting from the selected scenarios. The distribution of costs between broad economic sectors of the watershed is presented to illustrate their significance for evaluating alternative environmental enhancement scenarios.

Total Costs and Distribution

Total (watershed wide) welfare changes are calculated by taking the difference between the value of the objective function for scenario **B***B* (the base) and the objective function value under the other scenarios. The effectiveness of each scenario is represented as the percent of stream reaches that achieve a maximum temperature at or below 64 ^{o}F. Table 2 presents the dollar value and percentage change in total welfare under each scenario in addition to their effectiveness in reducing stream temperature. Total welfare change ranges from an increase of 0.25 percent in scenario **AB***D* to a decrease of 1.11 percent in scenario **FPAB***B*.

In addition to total welfare change, it is important to consider the distribution of welfare change between the different sectors in the watershed. The distribution can highlight sectors that might voluntarily comply with enhancement plans and those that would require incentives to adopt management proposals. Table 3 shows welfare change by sector expressed as the percentage change in sectoral welfare in comparison to sectoral welfare under the base scenario. It can be seen from comparing Table 2 and Table 3 that in some scenarios total welfare declines while individual sectors benefit and vice versa.

Welfare changes experienced in the forestry sector[42] are less than 0.2 percent for every scenario. The largest welfare change within the forest sector is experienced under buffer scenario **50B**. Sectoral welfare increases by approximately 0.2 percent and is similar under all tax policies. This benefit is due to an increase in available production area. Under the base buffer scenario (**B**) it was assumed that forest lands followed the Forest Practices Act guidelines resulting in buffers of 50 feet or wider.[43] Forest buffer prescriptions under scenario **50B** are narrower than the base scenario. Tax benefits provided under tax scenarios *D* and *TIP* do not generate large welfare changes as forest-land is already subject to favorable tax assessments under the base tax scenario.

The agricultural sector exhibits changes in sectoral welfare, ranging from a decline of 0.06 percent to an increase of approximately 26 percent. These changes are driven primarily by the tax policy scenarios. The base tax policy always results in a decline in sectoral welfare as land is taken from production with no offsetting incentive scheme. Policy scenarios that include a tax deferral (such as, *D* and *TIP*) result in an increase in welfare on agricultural lands. Tax scenario *D* increases sectoral welfare by almost 26 percent in comparison to the base case. This increase is a result of the significant tax savings on land in low valued crops (such as hay). Under the base scenario many low value crops did not generate enough revenue to cover production costs plus property taxes.[44] The tax savings from land areas taken out of production can help to offset losses created by low valued crops. Even with favorable tax policies many agricultural activities do not contribute a positive sum to the value of production from the watershed.

[42] Defined as industrial (public and private) and non-industrial private timberland use.
[43] Under buffer scenarios **AB**, **ARB** and **FPAB** buffer widths on industrial forest lands remain the same as the base buffer scenario (**B**). Small width changes are experienced on non-industrial forest lands.
[44] The majority of these land areas were in low yielding low quality hay. Local extension agents suggested that this land may be held for speculative purposes and the observed cropping activities are a response to factors such as fire risk or improvements in the aesthetic appearance of the area.

The residential sector experiences welfare changes ranging between a gain of 0.44 percent to a loss of 6.21 percent. Small gains in welfare under buffer scenario **AB** are a result of tax policies, the riparian buffer width on residential property is not altered from base under this scenario. Buffer scenarios **ARB** and **50B** combined with tax incentives achieve identical welfare declines for the sector as the buffer prescriptions for the residential sector under each policy are the same (i.e. residential properties are assigned a 50 foot buffer). The average buffer width on residential properties under the base scenario is 37-feet. As the buffer is widened to 50-feet under scenarios **ARB** and **50B** and then to 100-feet in scenario **FPAB**, welfare losses experienced by the sector increase. Even the most generous tax incentive, *D*, is not sufficient to offset the reduction in property value as a result of planting wider riparian buffers.

These results clearly indicate that the welfare implications of the proposed scenarios differ in magnitude between sectors. The forest sector experiences little welfare change primarily because they already comply with Forest Practices Act provisions that are similar to buffer scenarios used in this analysis. Residential landowners are shown to experience the greatest losses as a result of riparian plantings even when plantings are coupled with the tax incentives used in this study. It has been demonstrated that the agricultural sector in the Mohawk watershed could receive considerable benefits as a result of riparian plantings associated with incentives such as a tax deferral program. However, it is important to recognize that there could be agricultural landowners in the watershed that individually experience large welfare gains or losses as a result of riparian plantings. Landowners that might experience greater losses are those with efficient management practices producing high valued commodities on riparian lands. These losses will be exacerbated if the landowner has a large riparian frontage. Landowners that might benefit considerably are those with

inefficient management practices producing low valued commodities on riparian lands. These benefits will be increased by a long riparian frontage.

Effectiveness

The percent of stream reaches at or below 64 ^{o}F range from 10 percent under scenario **50B** to a high of 44 percent under buffer scenario **FPAB**. Table 2 indicates that 21 percent of stream reaches meet the standard under the base scenario, increasing to 36 percent under scenarios **AB** and **ARB**, dropping to a low of 10 percent under scenario **50B** and achieving a high of 44 percent under scenario **FPAB**. In many respects, scenario **50B** is identical to scenario **ARB** except for the narrower riparian buffer width on forested lands; most of which surround the headwaters and tributaries to the mainstem (Figure 1). This reduction in the effectiveness of riparian buffers underscores the importance of maintaining well-shaded headwaters and tributaries to reduce the rate of stream heating.

Empirical Cost Effectiveness Frontier

Figure 4 displays the welfare change and corresponding effectiveness of all buffer and tax policy alternatives reported in Table 1. The cost of each scenario is measured on the x-axis as the total watershed wide welfare change from the base scenario **B***B*. The effectiveness of each scenario is plotted on the y-axis. The physical effectiveness of each scenario in reducing stream temperature is the only benefit considered in this study. However, it is important to note that planting a riparian buffer to reduce stream temperature will provide secondary environmental benefits, such as stream bank stabilization, not accounted for in the decision criteria used in this study. The cost effectiveness frontier depicts the least cost alternatives (among those considered)

that can be used to decrease overall stream temperature (i.e. increase the percentage of model runs with a daily maximum temperature equal to or below 64 ^{o}F).

Scenarios **AB***D* and **FPAB***D* are on the cost-effectiveness frontier. Under scenario **AB***D* the welfare of watershed residents increases by $127,000 in comparison to the base scenario and the percentage of stream reaches with a maximum temperature at or below 64 ^{o}F increases from 21 percent to 36 percent. These results indicate that an additional 15 percent of stream reaches can achieve the temperature standard while increasing total welfare if the riparian planting scenario is accompanied by an incentive that grants a tax deferral for all lots on which a riparian buffer is planted. All sectors experience an increase in welfare under this scenario.

However, this welfare gain is generated at the expense of a decline in property tax revenues, which could reduce the services provided in the area or alternatively increase the tax burden faced by residents in other areas to make up the shortfall. The tax deferral will reduce tax dollars generated in the watershed by approximately $138,000 in comparison to the case where no tax incentive is offered for the same buffer requirement (scenario **AB***B*).

Scenario **FPAB***D* provides for a riparian buffer strip consistent with the Forest Practices Act in addition to a tax deferral. An additional 23 percent of stream reaches meet or exceed the temperature standard under **FPAB***D* in comparison to the base scenario (an increase from 21 percent to 44 percent) at a cost of $414,371 across the watershed. The reduction in tax revenues in comparison to the case where no tax incentive is offered for the same buffer requirement (scenario **FPAB***B*) is also approximately $138,000.[45] Although the scenario results in an overall welfare loss this tax deferral scheme increases the welfare of agricultural and non-industrial timber producers in relation to the base case scenario. The majority of costs associated with this

scenario are experienced by the residential sector in the form of a lower willingness to pay for properties with wider treed riparian buffers.

The policy choice from those on the frontier in Figure 4 is a choice to be made by the residents of the Mohawk watershed.[46] Both **FPAB***D* and **AB***D* increase the percentage of reaches that meet the 64 ^{o}F temperature standard. However, they differ in their effectiveness, total costs and distribution of costs. From the perspective of a policy maker, both policies cost the same in terms of a reduction in tax revenues ($138,000), but scenario **FPAB***D* is more effective in reducing stream temperatures. Although the policy may appear to place a disproportionately heavy burden upon residential land owners in comparison the agricultural and forestry sectors, this cost is skewed as it does not take into account the welfare losses already accepted by the forestry sector as a result of the Forest Practices Act (this was taken to be the *status quo*).

Conclusions

A cost effectiveness analysis was shown to be a suitable means of examining tradeoffs between economic and environmental goals at the watershed scale. The analysis provides information for decision-makers and planners about the costs their distribution and effectiveness of actions to reduce stream temperature. The economic model identified that, in the absence of mitigating tax programs, measures to reduce stream temperature did decrease welfare in the watershed. The largest reduction of net annual welfare was $552,133 (scenario **FPAB***B*, Table 2). Most of this decrease was experienced by the residential sector. The scenarios examined in

[45] The difference will be the same no matter how much of the tax lot is planted in a riparian buffer as the entire tax-lot is eligible for a deferral and so the tax cost is the same under this policy whether the area is planted in buffers 10 feet wide or 100 feet wide.
[46] It is assumed that the tax incentives discussed are acceptable in practice.

this study are not exhaustive. Results produced from this analysis can be used to refine or suggest additional planting and incentive scenarios that require consideration.

The model developed demonstrates the importance of examining the distribution effects of methods to achieve environmental enhancement and of including residential property owners within the analysis in addition to industry. Protection afforded by riparian plantings is a joint function of efforts by forestry, agriculture and residential sectors. The importance of voluntary compliance by any sector is a function of their spatial location and quantity of riparian frontage. The sectoral distribution of costs identify those sectors that would require incentives to comply with environmental goals.

Riparian buffers were demonstrated to be an effective means of reducing stream temperature over part of the Mohawk watershed. However, the buffer scenarios considered could not reduce temperature in all reaches sufficiently to meet the temperature standard. It might be possible to reduce stream temperatures further by combining the riparian buffer prescriptions with additional practices such as flow augmentation.[47]

The tax programs considered, i.e., a tax deferral and riparian tax incentive, indicate that it is possible to alter the distribution of welfare changes between resource users and in some cases reverse the direction of welfare change in comparison to scenarios that do not consider incentive programs. This effect is particularly apparent on agricultural lands in the scenarios that consider a tax deferral. This indicates that an improvement in environmental quality need not come at any welfare loss to residents if the right incentive programs can be identified for different sectors. In fact it is probably possible to increase agricultural welfare without offering a tax incentive. For example, riparian plantings could be combined with education to increase production efficiency, which could both increase the non-market amenities and agricultural welfare. The tax programs

also influence welfare changes in the residential sector. However, in general the analysis showed that a reduction in tax revenues is not sufficient to offset the perceived amenity loss resulting from wider treed riparian buffers on residential properties. The distribution of welfare changes between sectors will influence policy chosen from the frontier by local interest groups if riparian plantings are voluntary.

From a policy makers perspective each policy on the cost-effectiveness frontier results in the same decline in tax revenues. If the plantings were mandatory the choice of which policy to select will depend on whether a particular standard needed to be met or political factors such as the will of policy makers to request property owners to bear the welfare loss.

The location of riparian planting is an important consideration when designing riparian buffer prescriptions on the watershed scale. A comparison of the buffer prescriptions **50B** and **ARB** demonstrate the importance of keeping a stream shaded from the headwaters on down, to maximize the effectiveness of buffer prescriptions. This suggests that policies based on land use might not be as effective as policies that target lands on the basis of spatial location.

[47] Stream heating is inversely proportional to flow (Boyd 1996, Beschta *et al.* 1987).

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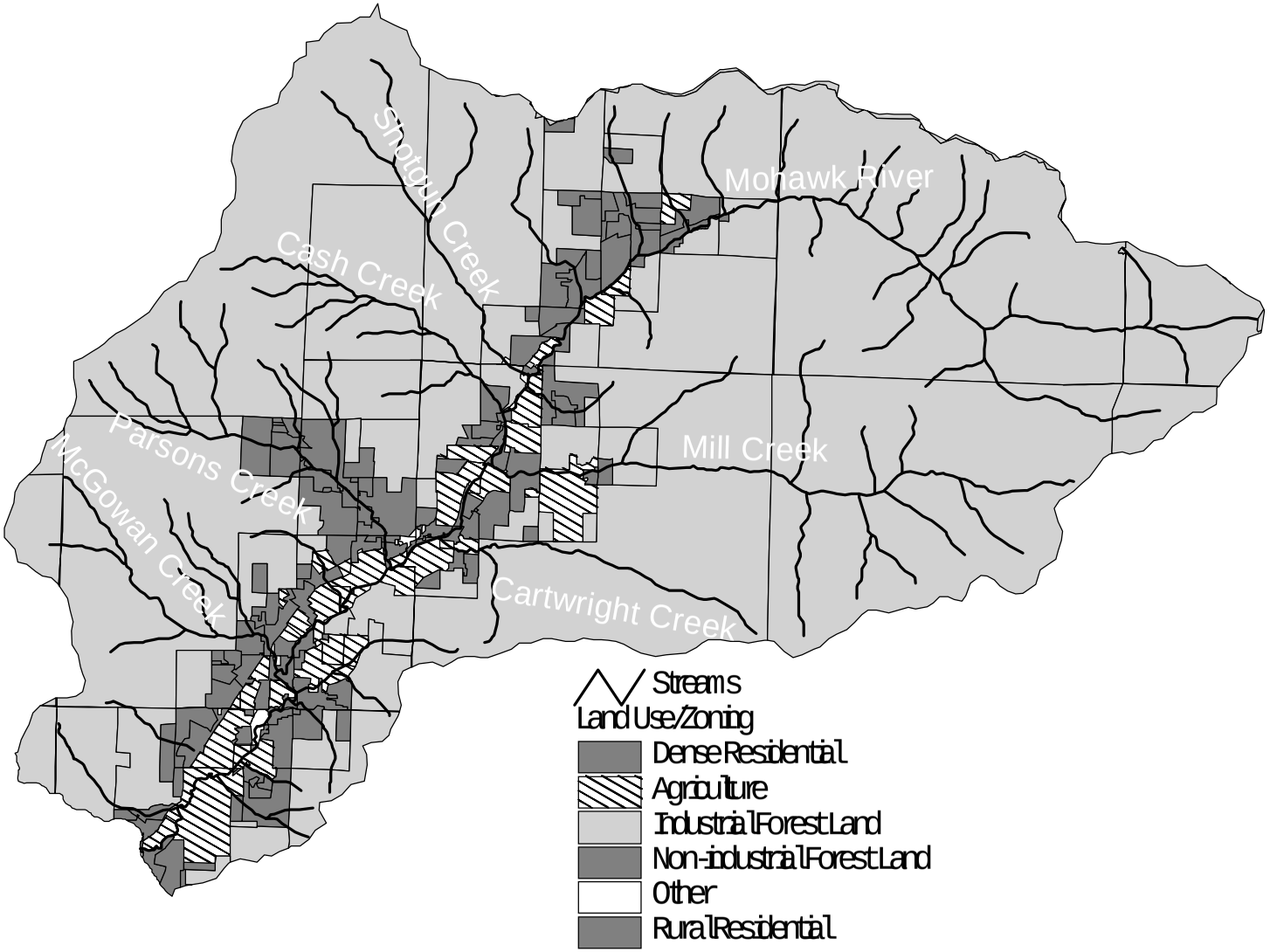


Figure 1. Land Use in the Mohawk Watershed

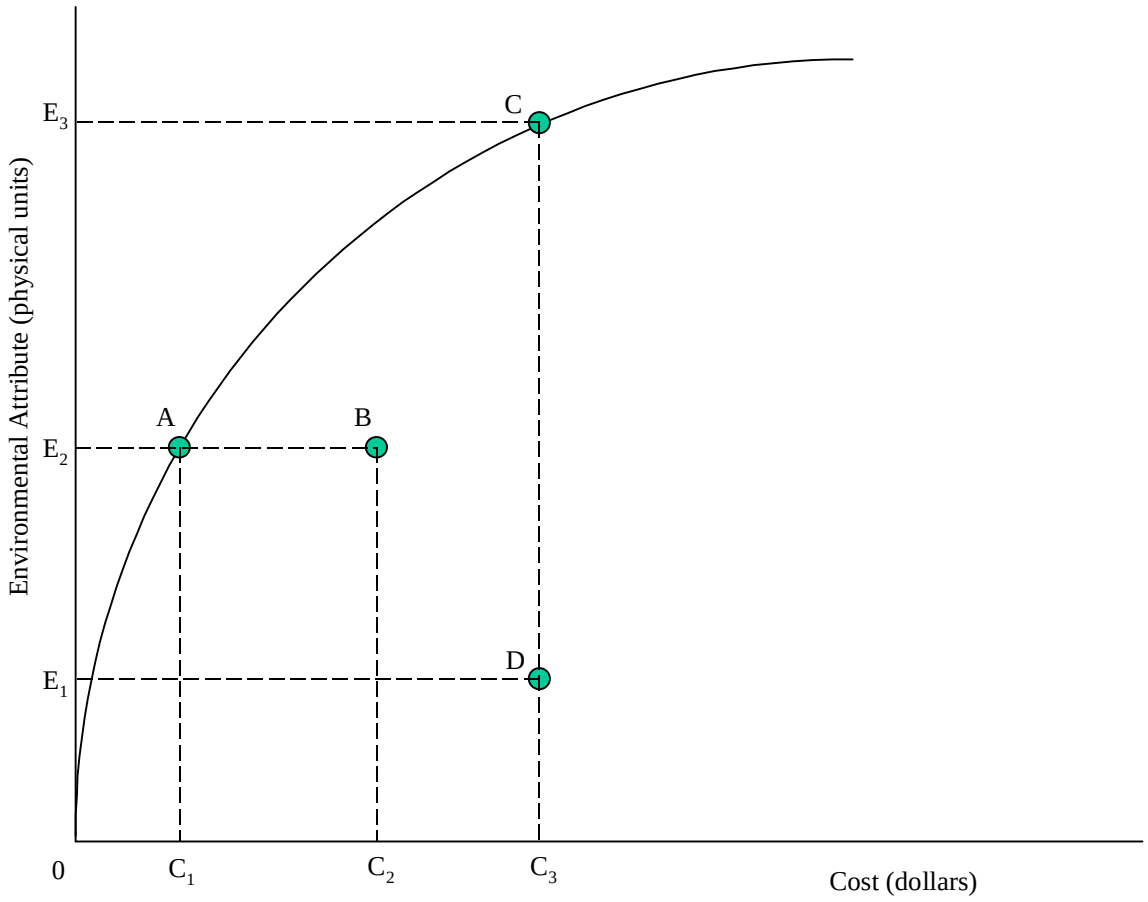


Figure 2. Cost-Effectiveness Frontier

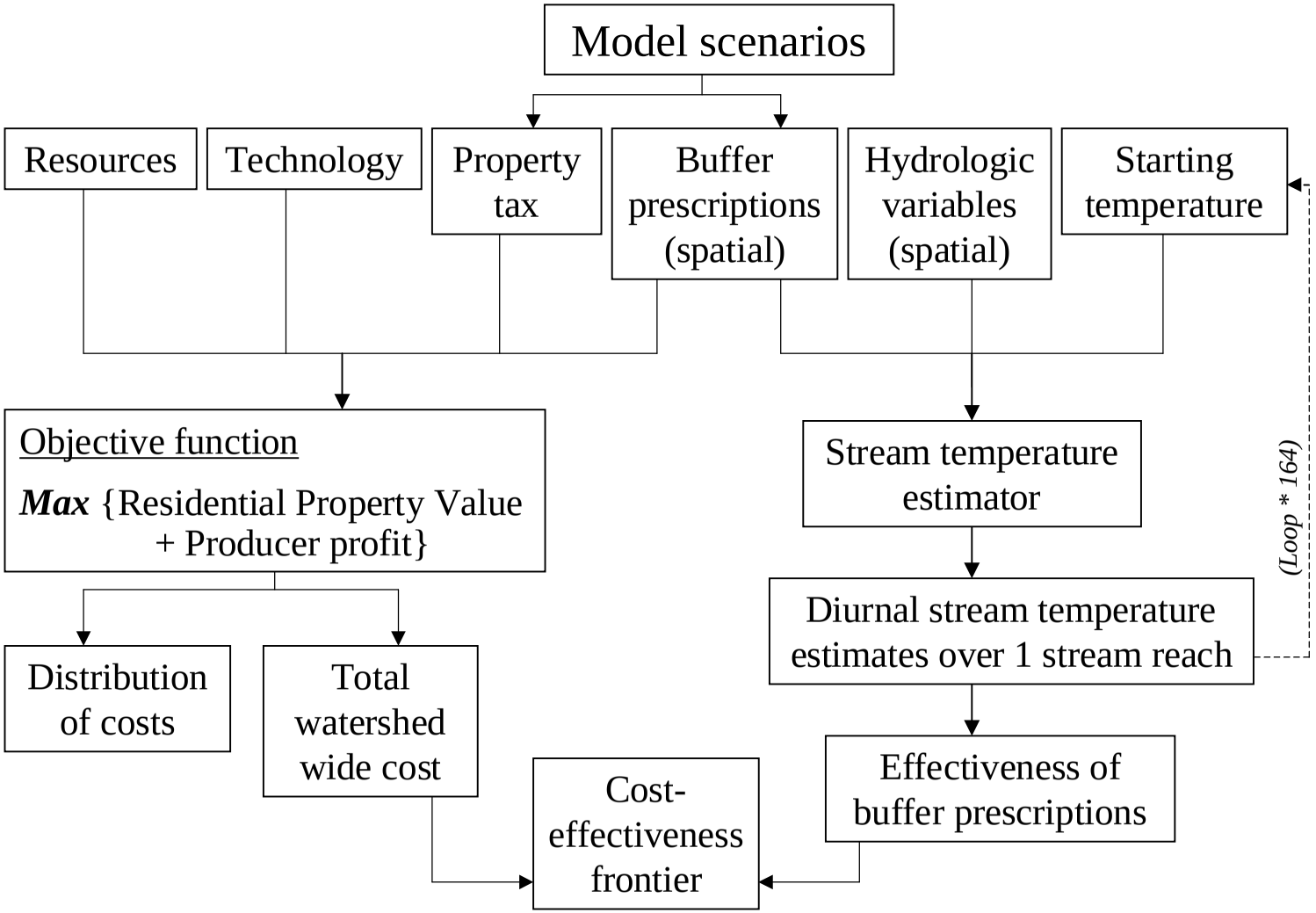


Figure 3. Schematic of Model

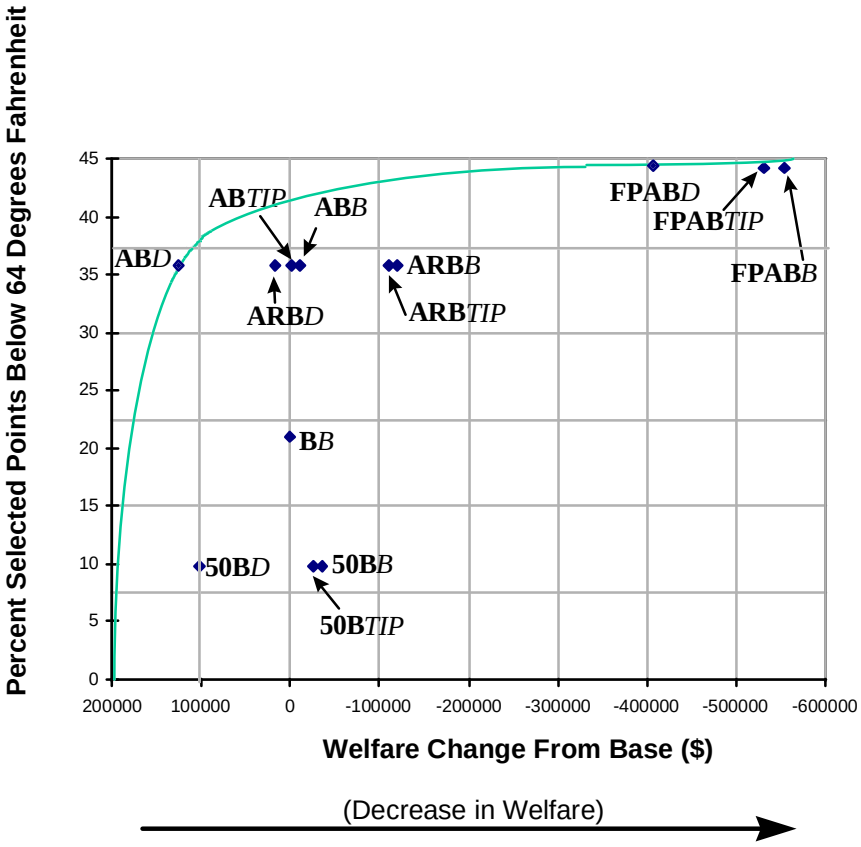


Figure 4. Cost and Effectiveness of Actions and Policies to Reduce Stream Temperature

Table 1. Summary of Riparian Buffer and Tax Policy Scenarios[a]

Tax Policies / ***Buffer scenarios***	Policy 1 *Status quo*	Policy 2 *Farm or Forest Deferral*	Policy 3 *Riparian Tax Incentive Program*
Scenario 1 *Current Conditions*	**B***B*		
Scenario 2 *Agricultural Buffer*	**AB***B*	**AB***D*	**AB***TIP*
Scenario 3 *Agricultural and Residential Buffer*	**ARB***B*	**ARB***D*	**ARB***TIP*
Scenario 4 *Complete 50 foot buffer*	**50B***B*	**50B***D*	**50B***TIP*
Scenario 5 *Forest Practices Act*	**FPAB***B*	**FPAB***D*	**FPAB***TIP*

[a]*The first part of the abbreviation refers to the buffer prescription and is noted in bold type. The second part of the abbreviation represents the tax policy and is noted in italics.*

Table 2. Total Welfare Change in Comparison to the Base Scenario **B**B and Effectiveness of Each Scenario

Scenario	Welfare change from scenario BB ($)	Percent Welfare Change from Base	Effectiveness, % reaches $\leq 64\ ^{o}F$
B*B*	0,000	0.00	21
AB*B*	-10,553	-0.02	36
AB*D*	127,209	0.25	36
AB*TIP*	-926	-0.00	36
ARB*B*	-120,628	-0.24	36
ARB*D*	17,134	0.03	36
ARB*TIP*	-110,890	-0.22	36
50B*B*	-34,946	-0.07	10
50B*D*	-102,816	-0.20	10
50B*TIP*	-25,404	-0.05	10
FPAB*B*	-552,133	-1.11	44
FPAB*D*	-414,371	-0.08	44
FPAB*TIP*	-533,121	-1.07	44

Table 3. Percentage Welfare Change by Sector

	Forestry	**Agriculture**	**Residential**
AB*B*	-0.03	-0.01	0.00
AB*D*	-0.02	25.72	0.44
AB*TIP*	-0.02	2.36	0.00
ARB*B*	-0.03	-0.01	-1.28
ARB*D*	-0.02	25.72	-0.85
ARB*TIP*	-0.02	2.36	-1.28
50B*B*	0.18	-0.01	-1.28
50B*D*	0.19	25.72	-0.85
50B*TIP*	0.18	2.36	-1.28
FPAB*B*	-0.03	-0.06	-6.32
FPAB*D*	-0.02	25.67	-5.88
FPAB*TIP*	-0.02	4.67	-6.31

Discussion of Focht, DeShong, Wood, and Whitaker paper and of Sabatier and Zafonte paper

by Dr. John Tanaka, Oregon State University

I am pleased to be able to provide comments on the papers by Focht et al. and Sabatier and Zafonte. The papers I reviewed were in draft form and/or focused on material that was only partially presented here at the workshop. In the case of Sabatier and Zafonte's paper, the data were only from the 1992 survey and did not include any analysis from the 1997 survey reported in Seattle. My remarks are intended to look at the papers from a positive aspect and also to raise issues that could affect their implementation or utility.

As the reader will note, I have some significant concerns with the Focht et al. paper as presented. Most of my concerns center on the fairly loose way that surveys and statistics were used and data manipulated. While I agree that the protocols used are generally accepted, I believe the authors are overstepping the bounds of what their data can show. The purposive sample they chose to interview is only appropriate in certain cases, "especially for exploratory research intended to generate new ideas that will be systematically tested later … to organize communities, identify leaders or build networks" (Salant and Dillman[48], p. 64). They go on to emphasize that it is imperative not to use these types of surveys if the goal is to learn about a larger population. On the other hand, the Sabatier and Zafonte paper use a similar sampling selection process, but use the data in a manner consistent with survey theory.

Specifically in both papers, the authors have used a nonrandom sampling procedure to obtain information about a target population. In neither paper did the authors discuss the limitations of their methods related to coverage, sampling, measurement, or nonresponse errors. It is not apparent that either set of authors spent much time considering the effect of these on their results. Sabatier and Zafonte did attempt to get an indication of coverage through their questioning process, but otherwise did not address the error sources. The issues are raised because each of these types of error leads to problems of accuracy of the results, and as Salant and Dillman point out in their book on *How to Conduct Your Own Survey*, "although none of the four can be completely avoided, each has the power to render survey results useless" (p. 15). In both cases, the use of nonprobability sampling renders knowing accuracy a moot point and the information gained can only be applied to the sample itself.

The Focht et al. paper

The Focht et al. paper obviously represents a small portion of an on-going large project. Not having ever spent much time in Oklahoma, I read it mostly from the perspective of trying to understand their protocol and how the results could be used. The authors outlined 8 different methodologies used in the sociopolitical assessment protocol. The baseline information will be used in developing a decision support tool that will enable interactive, multimedia, impact visualization. I will focus my comments on the participant population, sample selection, and interview setting, the 8 methodologies, and the preliminary results.

[48] Salant, P., and D.A. Dillman. 1994. *How to Conduct Your Own Survey*. John Wiley & Sons, Inc. New York.

The participant population is supposed to be the basin population. It should be noted that it is only the Oklahoma segment of the Illinois River basin population that is considered. This population was segmented by geographic and demographic criteria. Geographically, there are 7 regions within the basin plus two called "outside users" and "policy elites." The population was also divided into 15 stakeholder classes (16 presented in Seattle) based primarily on occupation. There was no attempt to utilize random sampling or ensure the participants resemble the general population. The purpose was to "obtain the maximum range of opinions that exist on impact concerns and management preferences." Selection was made by reputation or reference by previous interviewees. They attempted to have a representative from every stakeholder class in every region (9 x 15 = 135 or 9 x 16 = 144).

The first round of open-ended interviewing had 150 participants. The conclusion from this is that they generally had 1 person from each stakeholder class in each demographic region. The second round of interviews only included 60 interviewees so that they only got input from less than half of the stakeholder X region combinations. Finally, in the 3rd round of interviews, there were 120 participants and again did not fully sample.

The sampling protocol raises some large concerns on the applicability of the results, the usefulness of the results, and whether the researchers can achieve their purpose above. If the purpose was to obtain the maximum range of opinions, then clearly the only way to do that is to select the most radical elements of each stakeholder class. Sampling (if you call it that) less than the full range of geographic and demographic combinations in the second and third rounds of interviews with different interviewees makes cross comparisons across protocols extremely tenuous at best and probably misleading at worst.

Methodology 1 – While the results are not presented here, I have concerns about them regardless. I think the only thing they can do with their survey results is report simple means as descriptives. Given the paucity of data and nonrandom sampling, the use of any type of comparative statistic will be biased. In other words, about all it can do is confirm that a biased sample was selected. All of the statistics books I can find say the same thing, while nonrandom sampling can be done for reasons of cost savings and efficiency, the results will likely be (statistically) biased and all measures of statistical inference will be suspect.

Methodology 2 – The authors report using quantitative content analysis as a way to measure the frequency and extent of messages present. Going back to the selection of the sample, I question the accuracy of such data as meaningful to the basin.

Methodology 3 – Likert scales and card ranking exercises were subjected to various statistical procedures designed for random sampling experimental designs. The authors also report that Likert scale responses were used to predict which of the 8 decision-making procedures were preferred, but no details are provided.

Methodology 4 – The use of cognitive mapping were used to get "participants to conceptualize river basin impacts about which they are concerned." Given the methodology used (reflective mapping, 3 card sizes for importance, color dots for level of knowledge, and arrangement, self), are the results replicable? That is if another researcher conducted the session on a different day/time/place, would the results be the same? In other words, what is the degree of measurement error?

Analysis methods – *Frequency analysis* of individual impacts included two data reduction steps, one subjective by 2 researchers reaching consensus (87 groups – 69 reported in Seattle) and the other through cluster analysis. Impact concern categories (145 usable maps) were constructed basin-wide and for region and stakeholder classes. *Analysis of relative*

importance based on median card size within each category – there were 3 card sizes. Combined with mental modeling results to "increase the validity of those results." *Analysis of perceived knowledge* – descriptive statistics based on median dot color (3 colors). *Relationship between importance and knowledge* – Test for statistical significance between relative impact importance and perceived knowledge. *Cluster analysis of impact concern groups* – Recoded map groupings based on the 87 groups established by researchers were analyzed using cluster analysis which resulted in 45 clusters with 10 eliminated. *Cluster analysis of categorical group clusters* – Cognitive maps (138) recoded using the 35 concern clusters just defined. These were then clustered and 8 aggregate maps were identified.

Methodology 5 – Use of a mental modeling exercise whereby the developed model can be used to qualitatively estimate effects of various policy interventions throughout all subsystems. The authors try to tidy this up by stating that IF influences can be quantitatively determined, then magnitude of impacts can be determined. Claims model allows identification of areas amenable to education to correct knowledge deficiencies and misconceptions. Also claims model can identify potential conflicts that arise due to differences in knowledge.

In the analysis of responses, descriptive statistics were used and then average scores between the mental mapping exercise and the self-perceived knowledge were computed. The authors note that of 30 **selected** knowledge areas there was a distribution of 6, 15, and 9 for perceived greater than, equal, and less than assessed knowledge, respectively. The scoring system and arbitrary assignment to high, moderate, and low knowledge levels creates difficulty in knowing if this is due to random chance or actually measured responses.

Methodology 6 -- This methodology is entirely confusing in how the card ranking results were manipulated to obtain scores. It appears that the 87 (69 in Seattle) created impact categories from Methodology 4 were somehow reclassified into 16 pollution sources, then the respondents card size was used to calculate an average importance score, and then the 16 pollution groups (?) were ranked by the average relative importance scores.

Methodology 7 -- While Q methodology may be used in this field of inquiry, the explanation was pretty confusing with phrases such as "ability to generate grounded understanding (Verstehen) by abductively revealing subjectivities that are both self-referent and operant." Regardless, the authors identified 3,000 statements from their interviews relevant to impact concerns and management preferences. Out of these they selected 500 statements for their analysis. These selected statements were apparently carefully chosen to ensure that they get results. These were then further scrutinized to select 47 statements for the concern Q sample and 58 for the preference Q sample. They then checked these for "a balance of items across categories of potential meaning" using a factorial design but then state that strict adherence to the 20 categories was not followed to ensure maximum representativeness. This is a very curious statement. How can you not cover all the categories and then claim maximum representation?

The methodology then goes into a structured sort. The authors assume that the sort will be quasi-normally distributed and set up the sort to meet that assumption. The Q sorts were administered to 120 stakeholders, of which 40 were also the same respondents from interview 1.

The sorted responses were analyzed using factor analysis to determine common perspectives. The forced nature of the quasi-normal distribution will obviously miss the subjective strengths of agreement and disagreement that the method is designed to test. That is, it forced respondents to only have 2 most strongly held beliefs and similarly forced them to have 2 most strongly objected to beliefs.

Methodology 8 -- This methodology attempts to determine how stakeholder and policy maker concerns and management preferences have changed over time. I'm really not sure of the value or expense of conducting this exercise. The newspaper articles reflect what was "hot" at the time and obviously influenced by the writer's perspective and note-taking abilities. I doubt that any effort will be made to validate accuracy of the reports. The OSRC transcripts will also provide a slice of interest in what the hearings covered and who took the time to testify. Does putting a number or relative value on an issue tell us anything of change over time? Don't people that have been involved in the issues over the years know?

Selected Preliminary Results of the Baseline SPA

I cannot comment on the specific findings, but will rather try to address generalities of whether the results are meaningful from the perspective of making decisions. I come at this as a representative on a Federal Advisory Committee chartered under FACA that is responsible for providing advice to the BLM and FS on approximately 6 million acres. The test is whether the results would tell me anything.

From this perspective, I have serious doubts that the results will be useful to many policy makers. Noting that groups don't trust each other, items in the media are the most known, property rights are important to private landowners, there is a lack of scientific understanding of impacts (at least clear and convincing) as viewed by those impacted, and education in non-controversial issues are not ground-breaking revelations. The authors also make a case that "dissensus" exists. My dictionary does not define such a word. If they mean that there is not consensus, this again is not surprising.

The clustering of the 16 pollution source cards is singularly non-instructive. What a surprise that nutrient impacts, toxic impacts, and physical impact cards clustered similarly. The other clustering of participants at least makes some intuitive sense. The blame someone else mentality should be familiar to anyone involved in large-scale problems. In the PNW where we deal with spotted owls and anadromous fish, the blame game is a long-standing tradition. Finally, the authors seem willing to state that they have proved that the two different techniques of card ranking of 16 pollution sources and cognitive mapping produced similar results. What they didn't prove is whether the similar results are valid and accurate.

The knowledge assessment section of the results is somewhat disturbing. In this section we see that the authors are now willing to extend their small nonrandom sample results and infer results for the population of the basin. For example, they state that "80% of those working in agriculture, including ranchers, are unaware" of the influence of livestock trampling and streambank erosion compared to a "perfect 100%" correct for environmentalists. They go on to conclude that this may be a source of stakeholder class conflict.

In comparing perceived versus assessed knowledge, the focus seems to be on identifying educational opportunities. The authors conclude that in the case where perceived knowledge is high but assessed knowledge low, the role of educators is to reduce overconfidence and eliminate entrenched misconceptions before beginning an education program. I suggest that this is a very treacherous path being advocated. You have now chosen sides rather than going out with an educational program based on scientific results of impacts. Note that this is different than a program based on professional/scientific judgment. The real trick is to design and deliver an educational program to the proper audience.

The explanations for no significance between perceived knowledge and relative importance seem to indicate the need to reassess all of the results. If reason 1 is true that low importance and/or low knowledge impacts are missing from the rankings and the results are therefore skewed, then all of the results obtained using this data set are also skewed (regardless of any other concern on data gathering and measurement error). It also appears that the authors suggest that respondents change their relative rankings of importance depending on the context of the question. This would seem to be an important introduction of bias in the results.

The authors state in the section on the identification of shared schema on impact concern that the cognitive mapping results are instrumental in revealing how stakeholders conceptualize their concerns, which are important to formulating impact management policy that will be politically acceptable. While I agree with the former, I am not clear on how it relates to the latter part of the statement. The authors make 3 conclusions regarding a consensus that may be developing that seemed to have come out of thin air: quiet majority believes blame is shared and impacts accumulating over a long time, going to take all stakeholder groups to cooperate, and very few under the delusion have a short-term solution. While I agree that these are true, I don't know where they came from nor do I believe we need a study to tell us that.

The discussion of Q methodology is fairly well presented. The authors rightly depict the results as a qualitative difference in perspectives that does not indicate proportions of perspectives within the entire basin population. For the first time they also do not put the number of respondents in each cluster. This is the proper reporting for all of their data. In most of the earlier clusters they emphasize which is largest which implies relative proportions in the population. The authors conclude with a statement that to avoid conflict what is needed is a combination of education and a consensus building approach designed to gain a voluntary commitment to protection and risk mitigation. Again, I completely agree but don't see where that came out of the protocols.

The final conclusion is that there is varying trust among impact management preference clusters relative to the appropriate role of government in managing impacts. They suggest a resolution is to use "neutrals to facilitate a policy dialogue among stakeholders, coupled with efforts to maximize the quality of stakeholder participation."

To summarize, while I think the authors have collected a lot of information from a select group of stakeholders, there is a need for a more intensive study if the results are to be extended to the population. If the goal is to produce a multimedia tool, using the extremes will not be very instructive. If, as the author stated in his reply to these critiques, the nonrandom nature is adequate since the goal is to not infer to the population but rather get at qualitative differences, I can accept that IF AND ONLY IF they follow that rule. In most of their methodologies, they go through extensive attempts to quantify their qualitative data and then report frequencies, numbers, or other values. The inference from this is that these are relative proportions that can be extended to the population. If it is truly qualitative data, then why all the effort to quantify and make it look more scientific than it is supposed to be?

Sabatier and Zafonte

This paper is well written and I look forward to hearing the results of the comparison between years. The basic conclusion of the paper is that there is no such thing as a neutral or unbiased person, especially if they have chosen to get involved in a controversial issue. The authors go on to conclude that, at least for this case study, that the bureaucrats and scientists align themselves with specific interest based coalitions.

There are a few issues I would like to raise regarding the study design and applicability of the results to other areas. The second point first. As in the Focht et al. paper, the authors have chosen to select their sample rather than randomly sample the identified population. In this case, however, their approach is probably more justified given the small identified population of interest. The study (at least the first round of sampling) could have been improved if the researchers had validated the results more carefully. What I mean by this is that they received just over half of the surveys back. From what is reported, they did not follow-up to find out if there was any nonresponse bias in their results. That is, are the respondents similar in their characteristics to the nonrespondents. If they had done this, I would be much more comfortable in some of their conclusions. For example, the fact that they identified the scientists more closely with the environmentalists may have been due to the fact that only that portion of the scientific community returned the survey or it may actually be so. There is no way to know without the follow up.

The hypotheses laid out by the authors are good. I believe they need to tighten up the language some so that phrases such as "…will engage in some non-trivial degree of coordinated behavior" are restated so that they can actually be tested.

I was curious about a statement that indicated clustering 465 respondents is simply unmanageable. Instead the authors aggregated respondents on the assumption that individuals within an organization will have relatively homogeneous beliefs. They then further reduced this aggregation to an arbitrary 20 groups based on criteria of similar functions and/or location and if respondents expressed similar views on attitudinal scales. I question both the assumptions of forming their groups and why a cluster analysis was not conducted. Cramer et al.[49] showed in an attitudinal survey of Forest Service employees that beliefs varied by position in the agency as well as length of employment. So the question is whether the arbitrary grouping algorithm used by the authors leads to more defensible results than a formal cluster analysis or to pre-ordained results. My conclusion is that given the scope and objectives of the paper and the authors knowledge of the players, the cluster analysis may have uncovered different groupings but would not likely have added a whole lot more to the analysis.

The authors point out that researchers, as a group, fall into the environmentalist camp based on their attitudes and whom they consider as allies. It should be noted that the respondents to the survey were a very select group of researchers that came largely from a list of technical advisors to the Estuary Project. The obvious question is who hired these researchers and is that more of an explanation of why their beliefs, as a group, fall where they did?

The last comments have to do with perceptions of allies and opponents. The main concern I have that I cannot tell from the paper deals with question bias. In the selection of allies and opponents was none an option or were the respondents expected (or did it appear that they were expected) to answer something? This also relates to measurement error that is being addressed apparently better in the 1997 survey results.

For example, only 3-29% of the other groups listed university faculty as an ally. Based on one of 3 definitions of an ally being a top source of information this is disturbing. Based on the other 3 definitions (voluntarily modifying behavior to assist with expectations of future reciprocity, voluntarily modifying behavior because of shared goals, and developing joint policy positions or strategies) it is encouraging that the numbers are so low. This appears to be the case

[49] Cramer, L.A., J.J. Kennedy, R.S. Krannich, and T.M. Quigley. 1993. Changing Forest Service values and their implications for land management decisions affecting resource-dependent communities. Rural sociology 58(3):475-496.

since very few respondents listed researchers as opponents, regardless that those in the survey were more affiliated with the environmental coalition.

Discussion of Mooney and Eisgruber paper

by Charles Griffiths, US EPA Office of Economy and Environment

I. Overall Comments

-It is nice to see a cost-effectiveness study
-Benefits maybe important
-Not enough on the voluntary aspect
-Need more information on the mathematical programming
-Be careful about implied incentives

II. Residential Gains

Why would there be a 0.44% welfare gain to the residential sector if the tax deferral is only for farms and forest land? Back of the envelope calculation suggest that this gain is substantial (=$38,775).

III. Perverse Incentive

-"Many low valued crops did not generate enough revenue to cover production costs plus property taxes. The tax savings from land areas taken out of production can help offset losses created by low valued crops". Some of the welfare gain comes from removing low valued crops.
-Why not just take all of the low valued crops out of production?
-In the mathematical programming model, why would anyone plant low valued crops if cropping decisions are a choice variable?
-Would those who plan low-valued crops want to be regulated?

IV. Policy-maker's frontier

-Cost-effectiveness frontier for the policy maker is the dashed line
-"This welfare gain is generated at the expense of a decline in property tax revenues".
-A policy maker would consider tax policy B, the status quo.

V. Mixed Strategy

Scenario	Welfare Change	%Welfare Change	Effectiveness	Forestry	Ag	Residential
ABB	-10,553	-0.02	36	-0.03	-0.01	0.00
ABTIP	-926	-0.00	36	-0.02	-2.36	0.00
ARBB	-120,628	-0.24	36	-0.03	-0.01	-1.28
FPABB	-552,133	-1.11	44	-0.03	-0.06	-6.32

-There is no effectiveness gain between ABB and ARBB, suggesting little effectiveness gain to adding residential sector.
-Policy maker would consider ABB
-What about status quo for residential sector and FPABB for forestry and Ag sector?

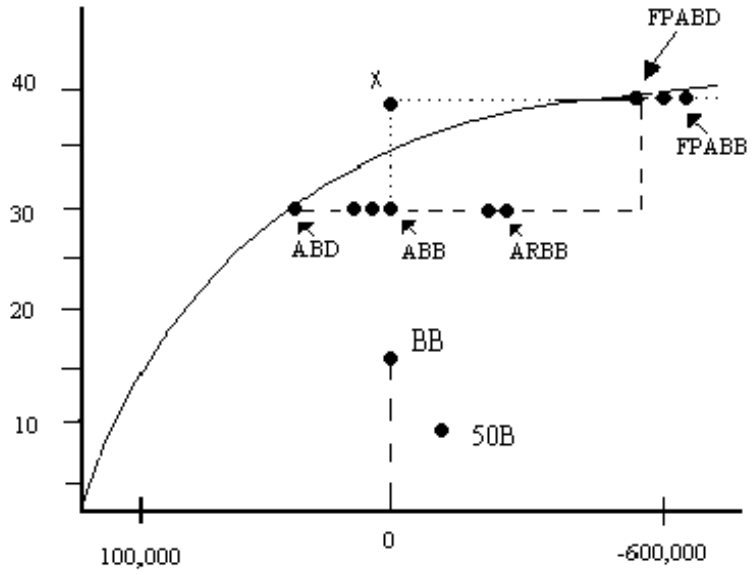
-Welfare loss calculations

-0.03f-0.01a=-10,553 ⇨ f=350,652

-0.02f-2.36a=-926 a=3,364

➪ -0.03f-0.06a=$-10,271 or -0.02% Δ from base

-If effectiveness contribution of residential sector is small, when the cost-effectiveness would lie some where around point x



Question and Answer Period for Session 4

The speakers for Session IV offered responses to some of the comments made by the discussants for the session. Will Focht, Oklahoma State University, responded to the concerns raised by John Tanaka, Oregon State University, about their research methodology. Mr. Focht pointed out that the "Q research" methodology employed by their group is intended to obtain people's *subjective* views, and to study people across traits. Q research does not claim that it applies to a larger population. This research pertains to conflict assessment, and is intended to identify the largest variety of views, not which views are most prevalent. Further, Q research is an attempt to prevent the researcher from imposing her own prior beliefs upon research subjects. Mr. Focht also clarified the definition of the term "self-referrent," which refers to the respondents' views of their own beliefs.

Paul Sabatier, University of California at Davis, responded to a question raised by Mr. Tanaka regarding the reason that university researchers were aligned in their views with environmental organizations. Mr. Sabatier stated that the interesting aspect of the result was that university researchers placed themselves in the environmentalist coalition, but nobody else perceived them that way.

Sian Mooney, Montana State University, responded to a question Charles Griffiths, US EPA Office of Economy and Environment, had regarding the presence of low-valued crops and how they affect farmers' decisions to plant riparian buffers. Ms. Mooney stated that the most common low-value crop was hay, and this was harvested not so much for profit, but to improve aesthetics and reduce fire risks. Ms. Mooney commented that it was possible that the cost-effectiveness frontier could be different if one took into account the lost hay production, but it would depend upon the policy options.

Maureen Sevigny, Oregon Institute of Technology, raised the point that riparian buffers do not lower stream temperatures, they prevent them from rising. An alternative to planting trees in riparian areas is to plant low vegetation, which also solves the problem of visibility. Ms. Sevigny noted, however, that trees also provide woody debris, which has other ecological benefits. Ms. Mooney acknowledged Ms. Sevigny's point, and added that the most critical problem is that gaps in stream coverage cause the temperature to rise, and allowing the temperature to cool is difficult.

Mitchell Mathis, Center for Global Studies, noted that his responsibilities include monitoring stream temperatures in the Rio Grande River, and has found that streamflow is also very important. Ms. Mooney agreed, noting that increased streamflow necessarily results in a lower temperature since there is a greater volume of water being subjected to the same amount of UV radiation. Mr. Mathis also asked if there were any programs that looked at the water allocation issues from the standpoint of increasing streamflow. Ms. Mooney suggested that Mr. Mathis contact the Oregon Water Trust, a non-profit organization that purchases water rights for water quality improvement.

Tony Prato, University of Missouri, pointed out that riparian buffers also provide other benefits, such as habitat for wildlife and prevention of nonpoint source pollution by trapping nutrients and pollutants from agricultural runoff.

Brian Garber-Yonts, Oregon State University, noted that there were two significant belief changes within federal agencies occurring at the time that Mr. Sabatier's study was conducted. Mr. Garber-Yonts asked Mr. Sabatier what he could conclude from institutional theory about his surprising results about the general lack of changes in beliefs. Mr. Sabatier replied that the interesting question was whether the interest group coalitions were moving together. Surprisingly, neither the California Department of Water Resoures and the Southern California interest groups seemed particularly interested in economic analysis. Mr. Sabatier interpreted this as a belief on their part of getting economic factors into the Endangered Species Act listing process is too difficult.

Thomas Leschine, University of Washington, proposed that perhaps the university faculty in Mr. Sabatier's study are an internalized group, in that they have uniform beliefs that stem from their training in the biological sciences, and are the academic opposites of those in the property rights movement, which have emerged form law schools and economics departments, and have followed their respective funding possibilities. Mr. Sabatier agreed that this was a possibility, and that this would reinforce his belief that people reflect the beliefs of their organizational values. For example, in the contentious San Francisco Bay-Delta hearings which have been held to help formulate water policy for the San Francisco Bay and the Sacramento-San Joaquin Delta, most of the participants who were biologists or hydrologists exhibited the strongest environmental beliefs. In 1997, more economists were included in the process, introducing a more conservative element. Another factor at work in the process was a form of selection bias whereby many participants were so dismayed by the acrimonious nature of the policy conflict that they left the process, leaving only those that were highly motivated to stay and continue to engage in conflict. John Tanaka, Oregon State University, pointed out that he also had a view of faculty members in the technical advisory committee, and cautioned against extrapolating these findings to university faculty.