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Second Biennial Watershed Management Workshop for the James, Vermillion, and Big Sioux Rivers

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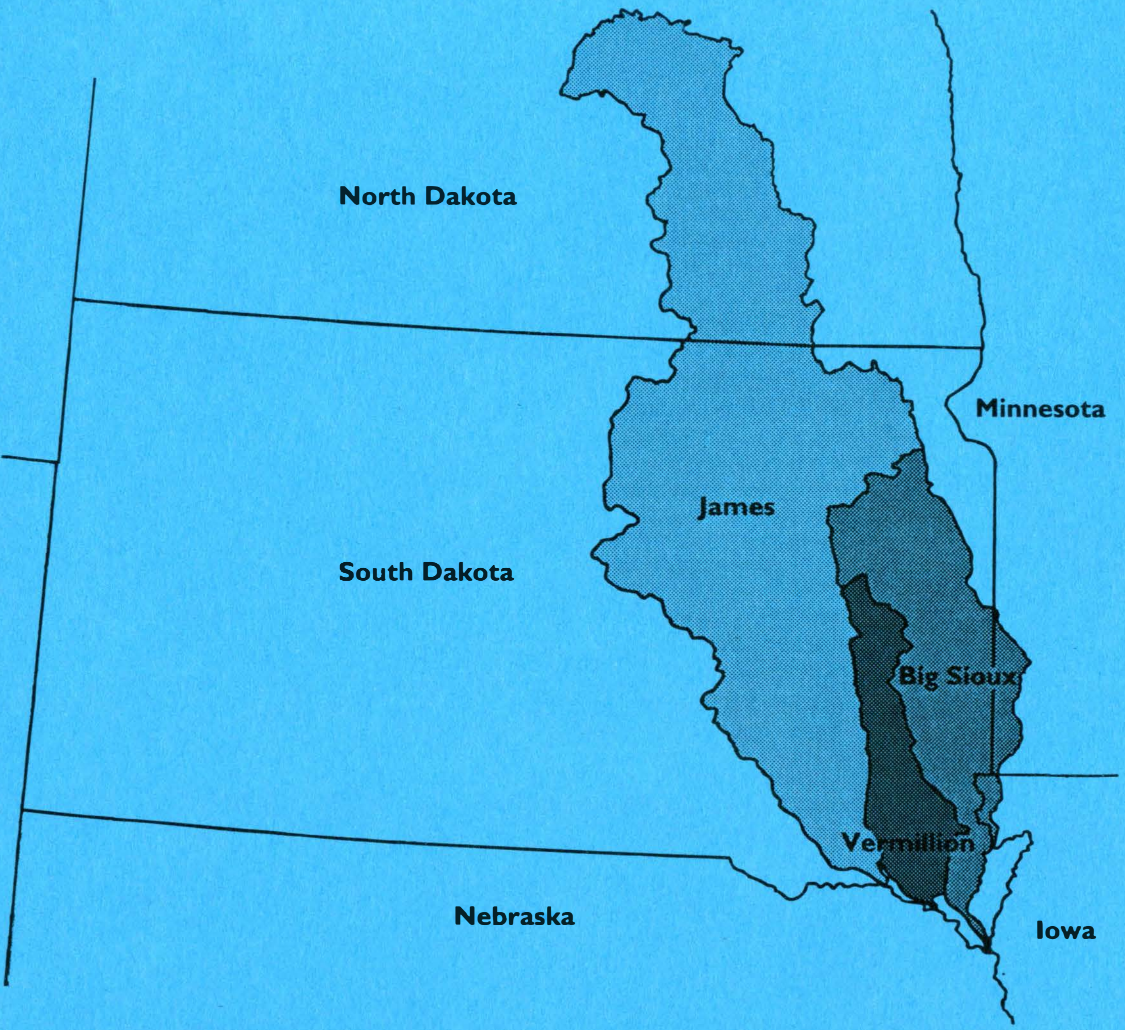
PROCEEDINGS



Second Biennial WATERSHED MANAGEMENT WORKSHOP

For the James, Vermillion, and Big Sioux Rivers

February 11-12, 1997 · Holiday Inn · Brookings, South Dakota

Agricultural Experiment Station · South Dakota Cooperative Fish and Wildlife Unit · South Dakota State University
South Dakota Department of Environment and Natural Resources · South Dakota Department of Game, Fish and Parks
Natural Resources and Conservation Service, USDA · US Geological Survey

Second Biennial

Watershed Management Workshop

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Preface

Watershed management means managing the South Dakota landscape. Many stakeholders are responsible for the landscape; therefore, cooperation, communication, knowledge, and a good sprinkling of wisdom must bring the various issues together for comprehensive watershed management.

This watershed management workshop was a continuation of the first workshop held in Huron, S.D. in February of 1995. As with the first, the goals were to bring people together to discuss principles related to earth processes, natural resources, agronomy, range science, fish and wildlife, and human uses. A third of the workshop was devoted to learning about the diverse programs, projects, people, and funding that are already available. A series of case histories of watershed management from South Dakota and other states was followed by a panel discussion.

We believe that this workshop helped weave the fabric of understanding needed for comprehensive management of South Dakota resources.

Acknowledgments

We sincerely thank all the speakers and poster presenters for creating a successful exchange of information and ideas. Also, we are thankful for the support provided by the South Dakota Department of Environment and Natural Resources, East Dakota Water Development District, and the South Dakota Cooperative Fish and Wildlife Research Unit. The Coop Unit is jointly sponsored by South Dakota State University, the South Dakota Department of Game, Fish and Parks, and the United States Geological Survey.

The Steering Committee:
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Introduction

Since the 1970s, laws like the Clean Water Act and the Safe Drinking Water Act have been successful in controlling water pollution coming from industrial and municipal pipes, which are usually called point sources. Many industrial and municipal leaders have a growing environmental awareness and sense of responsibility for what they send down the pipes to the river. For example, in South Dakota, Watertown Mayor Brenda Barger described upgrading the city's wastewater treatment plant as follows: "...we've said very clearly no more negatives. We're going for the positives and we're going to make the most of a community that's a pretty terrific place to live."(Watertown Public Opinion, August 23, 1995).

However, from time to time we get a reminder that we could do a better job at conserving our land and water resources for ourselves and for generations to come. We hear about wells exceeding federal standards for nitrates, or about crop land with excessive erosion, or about some of our rivers and streams not supporting designated uses, or about most of our smaller lakes having water quality problems. These problems don't come from pipes to the river, but from subtle "nonpoint" sources of pollution caused by the way we use the watershed.

What is a watershed? "Watershed" refers to a geographic area in which water, sediments, and dissolved materials drain to a common outlet. A watershed can be as large as the James River basin that drains 35,000 square miles in two states, or as small as the 106,000 acre basin draining into Lakes Oakwood and Poinsett in Brookings, Hamlin, and Kingsbury counties.

Watersheds **shed** water, sediment, and dissolved materials naturally, but in some watersheds we have changed the natural processes so much that nonpoint source pollution and flooding occur. The Department of Environment and Natural Resources reports that nonpoint source pollution is caused by "diffuse sources that are not regulated as point sources and normally are associated with agriculture, silviculture, urban runoff, precipitation, atmospheric deposition, or percolation." No one needs a definition of flooding, but there are great debates about the best ways to control flooding, and how many taxpayer dollars should be spent to protect people and property in a flood zone.

Governments can't have much effect on the causes of nonpoint source pollution and flooding. Successful pollution control projects are matters for individuals and groups that are concerned enough about water quality problems to take the time and effort to work in partnership with the state and others to improve and maintain the quality of our lakes and streams. Put another way - "when the people lead, the leaders follow." Many landowners are already good stewards. For example, Mark Stime says of his 1,100 acre farm in the Lake Sinai (Brookings County) watershed - - "We've left our wetlands because we enjoy the wildlife they feed, protect, and produce, and because we believe that the health of the wildlife is a good indicator of the health of the land."

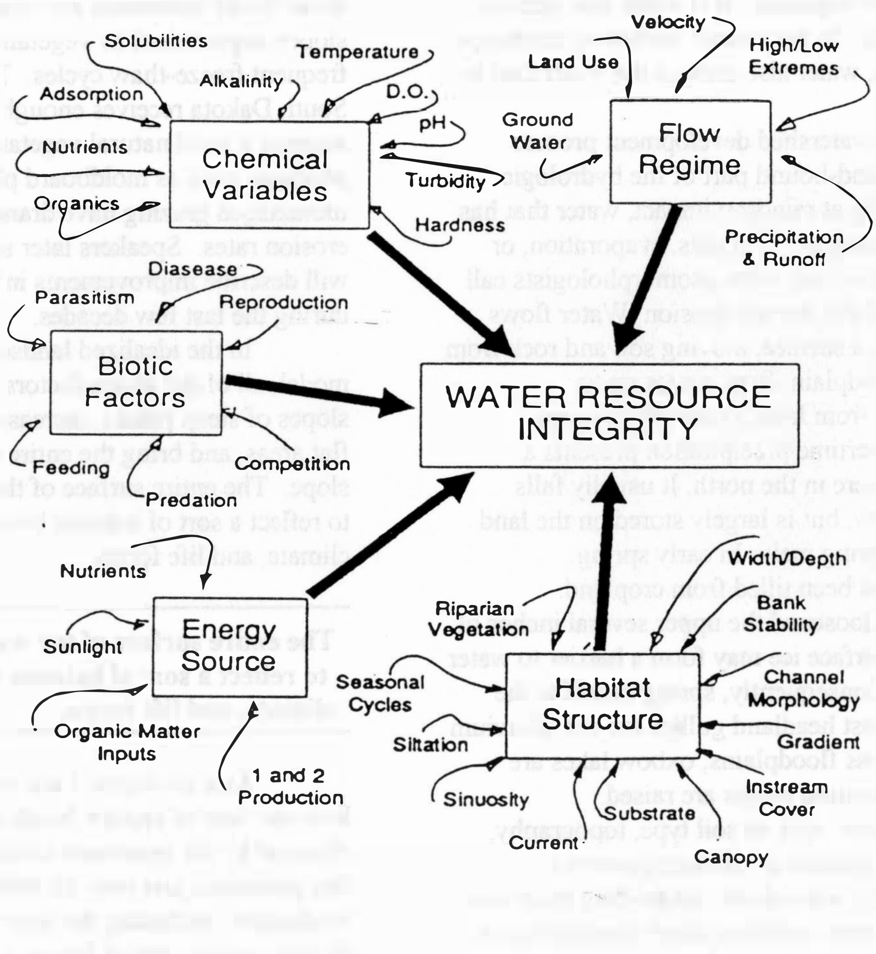
But what can other concerned citizens do? South Dakota author Linda Hasselstrom said it well in her book Reflections of a Women Rancher, "...it is no longer possible to live in splendid isolation and think only of cows, but the next step is sometimes confusing." Our two watershed management workshops were held to take confusion out of and put direction into watershed management. Biologists, agronomists, range scientists, chemists, landscape architects, planners, and other specialists have the knowledge, information and money to help citizen groups get started. There is a lot of support available in South Dakota. Scan this booklet and its companion from the first watershed workshop held in Huron in 1995; you'll be surprised at what is available.

Warning: Watershed projects are difficult! People have different wants, needs, expectations, desires, or visions for their watershed. Our panel of authorities at the second workshop concluded that the greatest needs in watershed management today are ways to help people work together. In a sense, human residents of a watershed are connected to each other. Each watershed "neighbor" needs to think about the effect of his or her land management *downwind, downslope, and downstream*. Finally, healing the earth and its waterways takes time. It is hard to measure our progress toward conserving a watershed as a healthy place to live, work, and play. But we can put it off no longer. There are warnings from some rivers that we need to get more serious about watershed health.

Watershed Processes

This session was designed to increase the awareness and knowledge of the interconnectedness of watershed processes. Watershed managers must appreciate the large-scale patterns, processes, and symptoms in a watershed so that they can accurately identify problems and find solutions that meet long-term goals for conservation.

Large-scale patterns and processes were described from a geologic and climatic perspective and set the stage for discussions on landuse and management considerations. The scope of landuse and management considerations largely addresses soil erosion rates and water quality and quantity. Reducing soil erosion rates is obviously important in agronomics and grazing considerations, wetland and riparian area management, fish and wildlife preservation and restoration, and human resource use. Current and past uses were described, concerns expressed, new approaches shared, and the need for long-term and large-scale approaches defined.



The five principal factors, with some of their important chemical, physical, and biological components, that influence and determine the integrity of surface water resources. *(From Ohio Environmental Protection Agency)*

Watershed Management:
Geology, Geomorphology, and Hydrogeology

Richard Hammond

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Watershed, n. "The entire surface drainage that contributes water to a lake or river" (NRC 1992).

When Craig asked me to talk about the geologic and hydrologic processes at work in a watershed, my first thoughts were of the definition above and the classic principle of landscape development. It is water that defines the watershed. In the classic models of landscape development, water also created the watershed by erosion.

The watershed development process follows the land-bound part of the hydrologic cycle. Starting at raindrop impact, water that has not been intercepted by plants, evaporation, or infiltration goes into what geomorphologists call the "work" of the stream: erosion. Water flows across the land surface, moving soil and rock from upland to floodplain, from upstream to downstream, from land ultimately to ocean.

Wintertime precipitation presents a special case here in the north. It usually falls gently as snow, but is largely stored on the land surface for spring melt. In early spring, vegetation has been tilled from cropland. Freezing has loosened the upper several inches of soil but subsurface ice may form a barrier to water infiltration. Consequently, spring runoff is the time when most headland gullies are cut, alluvium is spread across floodplains, oxbow lakes are created, and natural levees are raised.

Climate, rock or soil type, topography, and geologic structures all exert powerful influence upon watersheds, controlling their size, shape, slope, and countless other characteristics. Climate is probably the dominant factor in the north central United States. About 15 inches of precipitation a year is considered the amount most conducive to erosion. In regions with more rainfall, vegetation will usually grow and help to slow the erosion process. Where less falls, little energy is available to move sediments. Much of western South Dakota receives little more than 15 inches of precipitation per year. Incredibly high erosion rates occur in the Badlands and other areas where sediments are loosely bound, on slopes unprotected by vegetation, and broken by frequent freeze-thaw cycles. Though eastern South Dakota receives enough precipitation to support a good natural vegetation mat, farming practices such as moldboard plowing and unmanaged grazing have dramatically increased erosion rates. Speakers later in today's program will describe improvements in these practices during the last few decades.

In the idealized landscape development model, all of the above factors work to lower the slopes of steep places, increase the slope in very flat areas, and bring the entire landscape into slope. The entire surface of the watershed comes to reflect a sort of balance between geology, climate, and life forms.

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As a geologist, I am impressed at how little the face of eastern South Dakota has been changed by the processes noted above since the last glaciation just over 10,000 years ago. Most landscapes, including the river valleys, still display mainly glacial features with minor to moderate fluvial imprints. The changes that have occurred give us some clues to how our watersheds may evolve in the future. What aspects of the watersheds are resilient? Which ones are more vulnerable?

Maps displaying the state's topography (Fig. 1) show how glaciation has changed the region's surface. Glaciated eastern South Dakota exhibits a smoothed surface in stark contrast to the deeply crenulated surface of western South

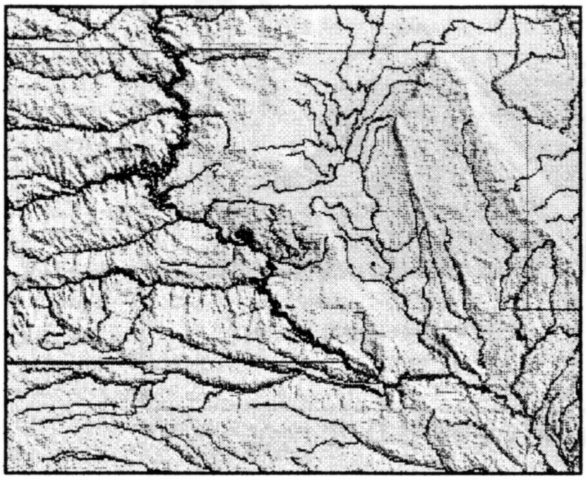

Figure 1. Digital elevation map of eastern South Dakota and surrounding area.

Dakota. Before glaciation, eastern South Dakota was undoubtedly very much like the west. The deeply incised rivers (the Grand, Moreau, Cheyenne, and Bad rivers) all once flowed across the state toward Aberdeen en route to Hudson Bay. Glaciation diverted these streams to the south, remolded the land surface, and formed a new, very *non-fluvial* character to the landscape.

Beginning about two million years ago, Pleistocene glaciation pushed into South Dakota from the northeast several times. The last glacier flowed into the region from the north and split in northeastern Marshall County into two ice lobes around a highland we now call the Prairie Coteau. One lobe, the Des Moines lobe, flowed southeastward over southern Minnesota to mid-Iowa. The other, the James lobe, flowed through east central South Dakota, broadening and deepening a valley now known as the James River lowland. The edge of this glacier pushed to about the path of the present day Missouri, permanently diverting the flow of the western watersheds to the Gulf of Mexico via the Missouri and Mississippi rivers.

An ice-free corridor was left between the ice lobes down the axis of the Prairie Coteau. Meltwater from the adjacent glaciers began to accumulate in this ice-walled valley and flow to the south, mainly along the lower surfaces adjacent to the James lobe ice. This high-energy meltwater carved the valley now occupied by the Big Sioux and most of its larger tributaries. These streams created a very coarse drainage net of broad valleys floored with coarse gravel in most of the basin.

These characteristics are different in many ways from those constructed entirely by fluvial processes. The floodplains are alternately broad gravelly plains and boxy channels, the sediments are much coarser, and the drainage patterns are less dense. These control how water moves in the present environment and also how the watershed may be expected to evolve in the future.

Water transfer is very efficient in these oversized valleys, but recurrent flooding occurs at choke points created during deglaciation or at other geological barriers. One such barrier, the Sioux Ridge, predates glaciation. The ridge forms a high quartzite rock sill across the valley of the Big Sioux under most of Minnehaha County. This acts as a very persistent and effective low-head dam and contributes to flooding in that area.

The hydrogeology of the Big Sioux Basin is also profoundly affected by its glacial history. Ground water quality varies along the watershed depending upon hydrologic connections with more saline buried aquifers. Streamflow along the Big Sioux is moderated by a close hydrologic connection with the Big Sioux Aquifer, an immense reservoir of glacially-derived, saturated sand and gravel. Little of the valley is overlain by finer grained post-glacial fluvial materials. This makes the underlying aquifer very vulnerable to contamination by activities at the land surface.

Even the slope of the stream is a relict of glacial construction: The headwaters region of the Big Sioux was built up more than 600 feet by addition of glacially transported soil and rock (Fig. 2). The powerful effects of glaciation on the glaciation on the Prairie Coteau. The pothole region is essentially a hodgepodge of hundreds of small watersheds. Some are connected with each other or neighboring streams during periods of high runoff. Some of these connections are across

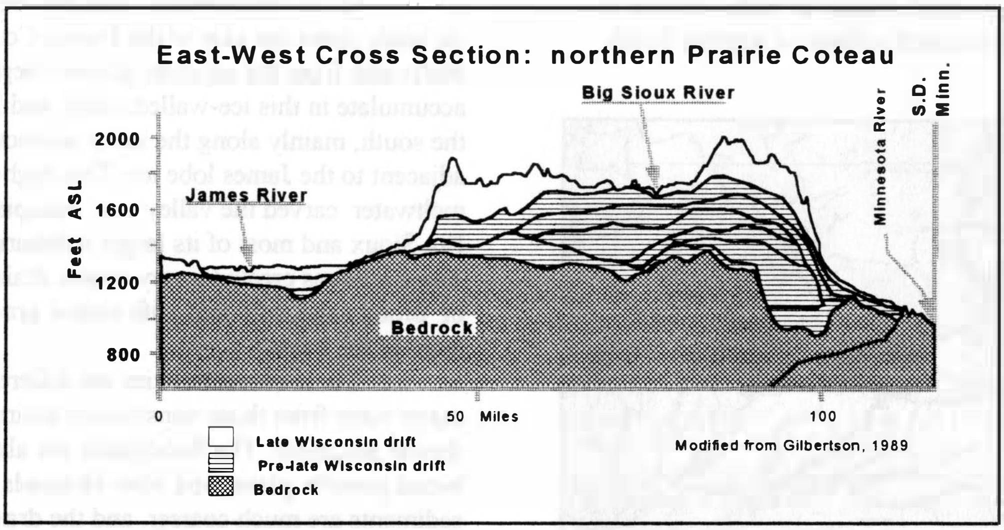

Figure 2. East-West cross section from near Zell, S.D. to near Milbank, S.D.

region's streams and the importance of slope to a watershed are most evident by comparison with the James River. The Big Sioux flows down the axis of a highland elevated by glacial deposition to a slope of more than three feet per mile. Only 70 miles to the west, the James falls less than one-half foot per mile (Fig. 3) in a valley over-deepened by glacial erosion. State Geologist E. P. Rothrock noted in 1941 that flood crests on the James take more than three weeks to traverse the state, and that heavy rains sometimes reverse the flow of the James. Consequently, frequent and widespread floods are a continuing effect of deep glacial erosion along what has been described as "the world's longest non-navigable stream."

The upland areas of the Big Sioux are particularly interesting because of their glacial origins. The smallest tributaries of the basin reach into the glacial lakes (prairie potholes) area fringing the Big Sioux Valley. The lakes and sloughs of this area are the products of irregular melting of stagnant ice abandoned by the last

low saddles in the watershed rim formed during deglaciation. Others formed by natural erosion since glaciation. Many have been created by human activity during the last several decades. The area contributing water to the Big Sioux, therefore, may vary with precipitation over time. This variation is usually very small to nonexistent in non-glacial watersheds.

Hydrologists have mapped these areas as non-contributing areas, "usually non-contributing" or other designations to suggest that they have not normally added to the flow of the area's streams. Normal watershed erosional processes over the last 10 millennia have been slowly linking some of these watersheds to adjacent stream basins, including the Big Sioux. Man-made ditches and waterways have greatly accelerated this process, adding the drainage areas of hundreds of lakes and sloughs in just the last few decades.

Recent problems around Lake Thompson, about 30 miles west of Brookings, show how important these changes in contributing area can be. The USGS Lake Preston West 1:24,000 topographic map show that the lake was clearly the terminus of its own watershed during the 1960s, as it had been for at least several decades. Several streams flowed into the lake; none flowed out.

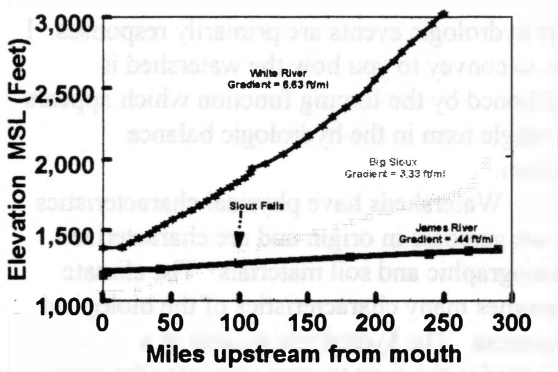

Figure 3. Gradients of the White River, Big Sioux River, and James River.

An increase in effective runoff in recent years has swollen the lake, inundating several hundred acres of adjacent property. The lake is no longer the terminus of the watershed, but now spills across a broad divide to the Vermillion River Basin. Residents of that watershed claim that they now experience more common flooding of higher stage and longer duration due to the spillover from Lake Thompson.

The topographic map also shows evidence that the lake is not really flooded but merely restored to levels that commonly existed during the last 10,000 years. Prehistoric beaches and wave-cut surfaces unmistakably show that Lake Thompson has stood at current levels for long periods in the past. Most other lakes on the same quadrangle and in neighboring areas do not show similar elevated beaches. Some of these smaller lakes form chains of watersheds, each spilling over into a lower neighbor at a certain threshold of effective runoff. Lake Thompson is at the foot of some of these chains. Artificial lowering of connecting spillways and creation of new ones have lowered these thresholds and added thousands of acres to the watershed in just a few decades. Lake Thompson very likely can reach its present spillway volume at much lower precipitation rates than just a few decades ago because of the lowering of these thresholds on many contributing watersheds.

Earlier, I asked what parts of the watershed are resilient. Which parts are more vulnerable? It seems to me that the trunk streams are fairly durable. No great surprises there. The "usually non-contributing" areas and their connections to the basin proper are the most vulnerable to human activities and also hold the most value for most of us, whether as wildlife habitat, water storage and treatment, flood control, great scenery, or a hundred other uses. These areas are also the source of most of the problems that one might find downstream.

Perhaps we ought to make an effort to better understand the interrelationships between these types of watershed systems, including how they affect the Big Sioux and other watersheds. It also makes sense to study rivers and watersheds as a whole, with renewed emphasis on the "non-contributing areas," because at some point they certainly do contribute, and human activities in these areas have far reaching effects.

We also need to recognize that none of the watersheds in eastern South Dakota act exactly like fluvial models predict that they will. There is a good reason: To a large extent, they are still relicts of the glaciers that made them.

South Dakota Climate and Hydrology for the Watershed Workshop

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My background would be described in the current vernacular as "earth system science." Point to a spot in the hydrologic cycle and I've been there at some time during my professional life. The past 5 years I have been the State Climatologist.

Some may be expecting me to show measurement based information that depicts average conditions. That would be reasonable because that is what many think they want to know when they seek to understand the role of climate in the hydrology of an area. It may be so, but it is not a simple question to answer. The question is really about moisture balance which is a function of time and space.

moisture balance = f(time,space)

My intent is to adhere to a systems model to explain the relationship between the watershed hydrology and climate. Obviously that cannot be done in a few minutes, but my intention is to engage you in a simulation of how a watershed hydrologic system responds to the climate. Climate can be considered a series of external forcing events over which the watershed has little influence or control. First, a brief discussion of some basics for the simulations.

Climate can be considered a series of external forcing events over which the watershed has little influence or control.

Basics

Climatology and hydrology are similar words and deal with some of the same physical phenomena, however they are actually quite different. Climatological events are forcing agents while hydrologic events are primarily responses. I want to convey to you how the watershed is conditioned by the forcing function which appears as a single term in the hydrologic balance equation.

Watersheds have physical characteristics that are geologic in origin and are characterized by topographic and soil materials. The climate determines many characteristics of the biological component. The hydrologic system of a watershed is the primary energy source for mass movement of physical materials in a watershed; it is loaded and primed by the climate and triggered by weather events.

The hydrologic system of a watershed is the primary energy source for mass movement of physical materials in a watershed; it is loaded and primed by the climate and triggered by weather events.

Persons interested in these phenomena are typically aware of the causal linkage and will often inquire about the average conditions, be it precipitation, temperature, or any number of measures used to characterize the hydrologic system. Typically the amount of runoff or infiltration is the quantity people are seeking, but they ask for things like average precipitation because that is the data that is available.

I suspect this is the case because runoff and infiltration are definitely some part of the precipitation. While annual precipitation may provide basic information about the climate classification, without the evaporative part of the equation (potential evapotranspiration, PET[2]) not much can be determined about the biological community. The evaporative part is often inferred from things like latitude or other geographic information, which is unusual because much better information can be derived from theoretical relationships that use sparse meteorological measurements alone. In a semi-arid climate evapotranspiration (ET) is the largest consumptive component in the hydrologic balance.

The waste terms in the hydrologic balance are the runoff (RO) and deep seepage (Sp). The hydrologic balance is written in watershed terms below,

$$SM = P - ET - RO - St - Sp$$

where RO, St and Sp are net terms, and ET = k(PET).

They are waste because they result from the supplies exceeding capacity for storage and/or use by the biological community. These terms may have 0 as a lower bound and the distribution of events is log-normally distributed. Is a watershed that produces 0 stream flow a failure or a success? It depends upon your objective. I have implied an objective by the way I have written the equation. Soil moisture determines watershed moisture state.

Before we proceed further, we put average numbers in the balance equation.

$$SM = P - ET - RO - St - Sp$$
$$0 = 20 - 17 - 2 - 0 - 1$$

where k = 0.5

Averages are derived from a series of dynamic interactions. Averages depict equilibrium conditions and the balance equation is not a state equation for a specific point in time. If average lake evaporation is approximately 48 inches, how can k be equal to one half?

Disequilibrium means not normal, i.e., not average. Whatever you have learned about averages, forget it because they do not adequately characterize the dynamic interaction of a watershed hydrologic system in a semi-arid climate setting. A typical approach to accommodate the problem is to use the probability of a weather event, which can give a better explanation of what *can* happen based on what *has* happened, but probabilities are of little value after an event has happened, even for characterizing the hydrologic event. Remember, the watershed hydrology is loaded and primed by the climate and triggered by weather events.

We must consider three things when seeking to describe the impact of climate on the biological system and the response of the hydrologic system.

1. Range of reasonable climate expectations,
2. Catastrophic events, and
3. Time lags in the hydrologic system.

Simulations

This workshop group, a watershed-of-the-mind will simulate what happens when climate happens. Let's consider the bag of tricks the climate system has to offer our watershed. Each of you will be a member of a watershed component. I will be the moderator who perceives the forcing event and orchestrates the watershed response. (See the watershed role sheets on page 11, and simulation scenario for details.)

Conclusions

The point is that there are many possible watershed states that are driven by climatic conditions. You will find runoff data and weather observations that provide necessary information about what may have happened in the past, but the data are not sufficient if the watershed state is not carefully reconstructed. Further, the rainfall data for specific events of significant impact are rarely if ever sufficient to make a proper analysis. Similar results at the stream measuring stations can result from many different climate conditioned watershed states and weather triggers.

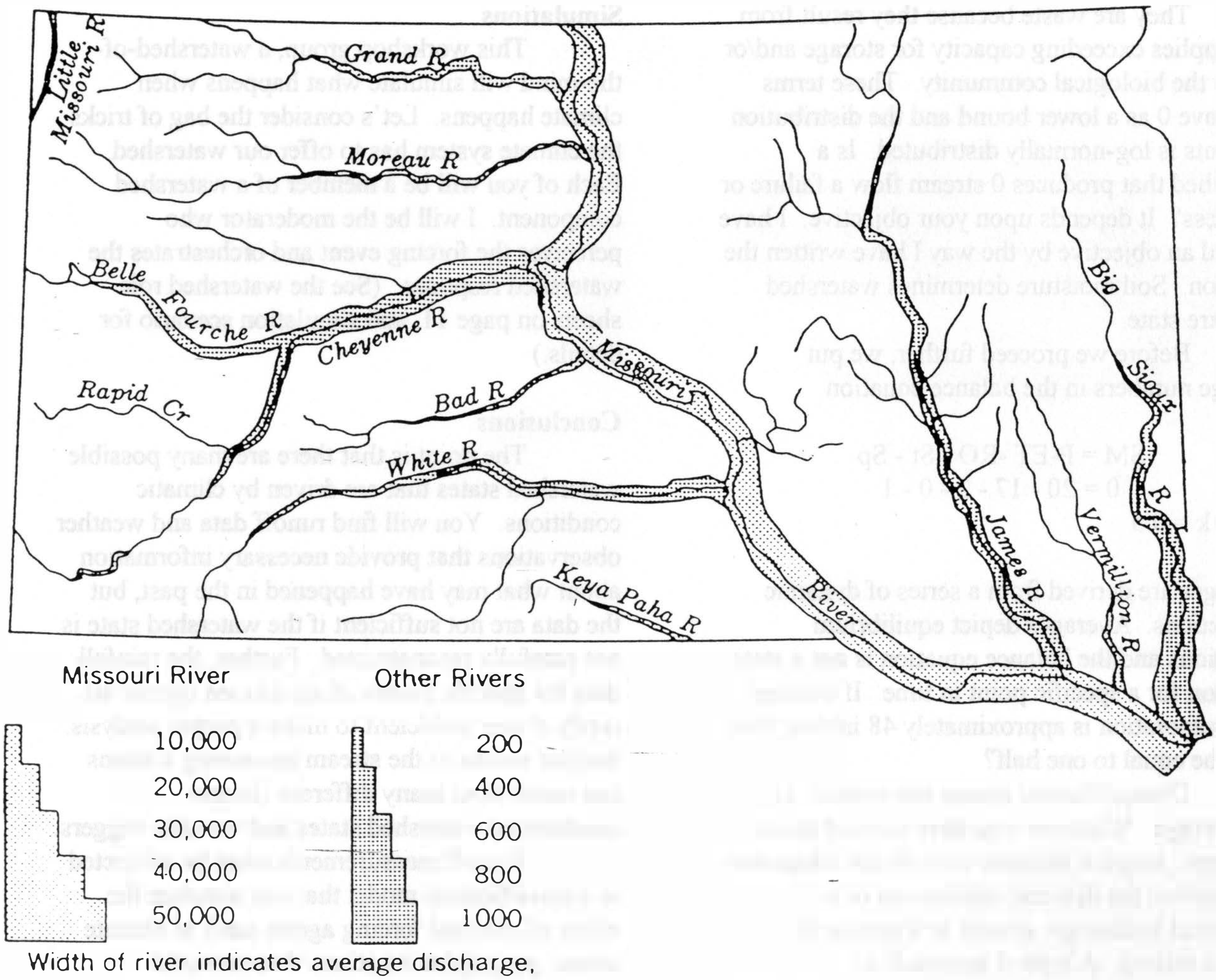
Runoff measurements must be subjected to a classification model that can translate the effect of external forcing agents such as climate across geographic locations if meaningful comparisons are to be made. Data measurements are usually not sufficient to characterize an event without some kind of simulation model to help classify the event. Radar and satellite data are usually necessary to bridge the gap between plot level measurements and watershed level measurements such as stream flow, aquifer levels, and sediment discharge measurements.

Averages are not likely to yield information that is useful for guiding management interventions which are tied to specific events. Even though the success or failure of management is likely to be evaluated by some longer term average measure, averages must not be the basis for management actions.

[1] The probability distribution characterizes the precipitation and/ or runoff and is a critical piece of information before an appraisal of watershed response can be conceptualized. Without a concept of what might happen, almost anything must be considered reasonable, which is an unacceptable position for managers, technologists, or policy makers who intend to make a difference.

[2] The potential evapotranspiration (PET) is a measure of the atmospheric energy available to remove water from a continuous covered vegetative surface that is not moisture limited. It can be calculated from meteorological measures of solar radiation, wind, vapor pressure deficit, and temperature. The actual use of water by a plant is called evapotranspiration (ET) and is related to the PET by some coefficient, k, that is a function of time.

[3] The climate cycle soil moisture condition at a watershed level can be quantified by the Palmer Drought Severity Index (PSI). This is sufficient for interregnal comparisons but it is not sensitive for seasonal variability.



Width of river indicates average discharge, in cubic feet per second

Watershed Role Sheets

You are to play the role of a member of a watershed component:

1990s:	B1 B2 or B3 H1 H2
1890s:	B1 B2 or B3 H1 H2

B. Biological System

1. Pasture, hayland, and permanent grassland
2. Cultivated areas - Bare
3. Cultivated areas - Covered

Other - (not simulated)

H. Hydrologic Features

1. Temporary surface or subsurface storage
2. Lakes and reservoirs

S. Streams

Your role actions will depend upon

1. Soil moisture states are determined by climate cycle

	state
MB. Much below normal	1
BN. Below normal periods	2
AN. Above normal periods	3
MA. Much above normal	4

2. Watershed components are classified by capacity to hold and store water

	Member action
If you are filling or holding water	STAND
If you are draining or losing water	SIT

3. Hydro-graphers time the rain, and record the runoff by standing or sitting

Simulation Scenarios

Each scenario will be the response of our watershed-of-the-mind to climatic events.

1. Introduce the components of the watershed and use the room space to quantify the biological components and the hydrologic components

1990s

2. Number off to designate the Soil Moisture State of each component member

1,2,3,4 in each component
Set the bare or covered lone for cultivated areas - sorry B2s can't play

3. Practice soil moisture states

1990s	MB (much below normal)	1s stand
	BN	1, 2s
	AN	1, 2, 3s

4. Action scenarios based on the occurrence of 4 inches of precipitation during 40 warm season days with different starting conditions and different timing. (This rate of precipitation occurs nearly every year).

5. Arm the hydro-graphers with rainfall depth cards to time the rain (triggers), and record the runoff and sediment (response).

State + precipitation regime	Runoff	Sediment
BN 02101		
BN 11120		
AN 02101		
AN 11101		
MB 00040		
MA 00040		

6. Change the components of the watershed and use the room space to quantify the biological components and the hydrologic components for the 1890s by reversing the room areas for the biological and hydrological components.

Management Practice Considerations for Cropland Resources

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Huron, SD 57350

As an overview I would like to discuss three areas for cropland resource protection. First, I would like to discuss the resource concerns, then review several pertinent management trends in South Dakota, and finally tie all the pieces of the puzzle together by reviewing a crop production example through the systems approach.

The resource concerns for cropland are really no different than planning other land uses. Soil, water, air, plants and animal (SWAPA) resources all play a role in proper cropland resource management. However, in today's discussion I will concentrate on the soil, water, and plant resource concerns.

In the past, the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), has concentrated on soil erosion as a major soil degrading process. However, we recognize that other soil degrading processes do have a major impact on the soil resources of South Dakota. Some of these processes are soil compaction, salinization, loss of biological activity, excessive oxidation of organic matter, deposition of sediments on and offsite, as well as soil erosion. Second, water quality and quantity are obviously a major concern to all the residents of South Dakota. When we talk about the water resources, we commonly break it into two categories, surface and ground water. Nonpoint agricultural contaminants to surface waters normally fall into one of the following groups: sediments, nutrients, or pesticides. Groundwater contaminants are normally either nutrients or pesticides. In addition, as we look at groundwater contamination we must keep in mind the location of groundwater aquifers susceptible to surface contamination in South Dakota. Maps of aquifers vulnerable to surface contamination are available through the U.S. Geological Survey or the South Dakota Department of Environment and Natural Resources.

The third concern I would like to address is the plant community. When we review plant related concerns we evaluate the suitability (varieties, site, hardiness), the condition of the crop (productivity, health), and finally crop management concerns such as establishment, nutrient, and pest management.

Now, I would like to review several pertinent management points and/or trends taking place in South Dakota. Two years ago this watershed conference specifically addressed concerns in the Big Sioux, James, and Vermillion watersheds. This concern is justified by the agricultural intensity in these areas, the vulnerability of the aquifers used as drinking water sources, and the population in the area which includes the cities of Brookings and Sioux Falls. Second, fertilizer use in South Dakota has almost doubled in the last 25 years. Also, when we look at where most of the fertilizer is applied we can refer to the eastern half of South Dakota. The eastern half of South Dakota is very intensively cropped with several row crops such as corn, soybeans, and sunflowers which require higher amounts of fertilizer inputs. Another point worth mentioning is the list of pesticides that are of most interest to the EPA. These pesticides are atrazine, cyanazine, simazine, alachlor, and metolachor. All five of these pesticides are labeled for corn in South Dakota. Tracking pesticide use over the last few years in South Dakota is a little more difficult task than one would expect. Reviewing commercial applicator records for the last 20 years suggests an increase in pesticide applications. However, if we just look at 1993-1995 in South Dakota, 80-90% of the corn planted in South Dakota had a pesticide application.

The last area of change I would like to mention is crop residue management. Approximately 34% of the cropland in South Dakota was involved in residue management in 1985. Of this 3% of the cropland in 1985 was involved in no-till. In 1995, this number had gone up to 70% involved in residue management with 13% of the state's cropland under a no-till system.

Now it's time to tie the pieces of the puzzle together into a conservation crop production system. The critical item to mention in adopting or changing a crop production system is that cropland resource concerns are not only complex but also interactive. An example of this might be a change in a producer's tillage system. If a producer reduced tillage, the result may be an increase in surface residue, tie up of nutrients in the residue, and reduced runoff, which means increased infiltration, resulting in increased available soil moisture, in turn reducing early spring soil warm up, and so on.

I would like to review a list of practices that apply to cropland and break them into two groups, structural and non-structural practices. A list of structural practices would include waterways, terraces, grade stabilization structures, diversions, and sediment retention structures. Non-structural or vegetative practices include crop rotation, residue management, contour farming, contour strip cropping, wind strip cropping, nutrient management, pesticide management, and field windbreaks.

The critical item to mention in adopting or changing a crop production system is that cropland resource concerns are not only complex but also interactive.

In addition to practical applications, the recent advances in biotechnology also provide additional opportunity to manage a crop production system. Several advances such as Roundup Ready-soybeans, Liberty-corn, and Bt-corn provide opportunities to reduce pest concerns without increasing the diversity or adding an additional window of control in a rotation.

I believe the best way to demonstrate the changes that take place in a crop production system is to provide an example. Imagine a field in the Big Sioux aquifer with the following characteristics:

Rotation: Continuous Corn,
Tillage: Conv. <5% residue mgt.,
Soils: Loam surface-moderately drained 2-6% slopes,
Nutrient Mgt.: According to soil test results,
Pest Mgt: AAtrex 2 lbs. (ai/ac),
Erosion: Sheet & Rill 7 T/ac/yr. and a ephemeral gully in the natural drainageway of the field.

Now, let's make the following changes in this field:

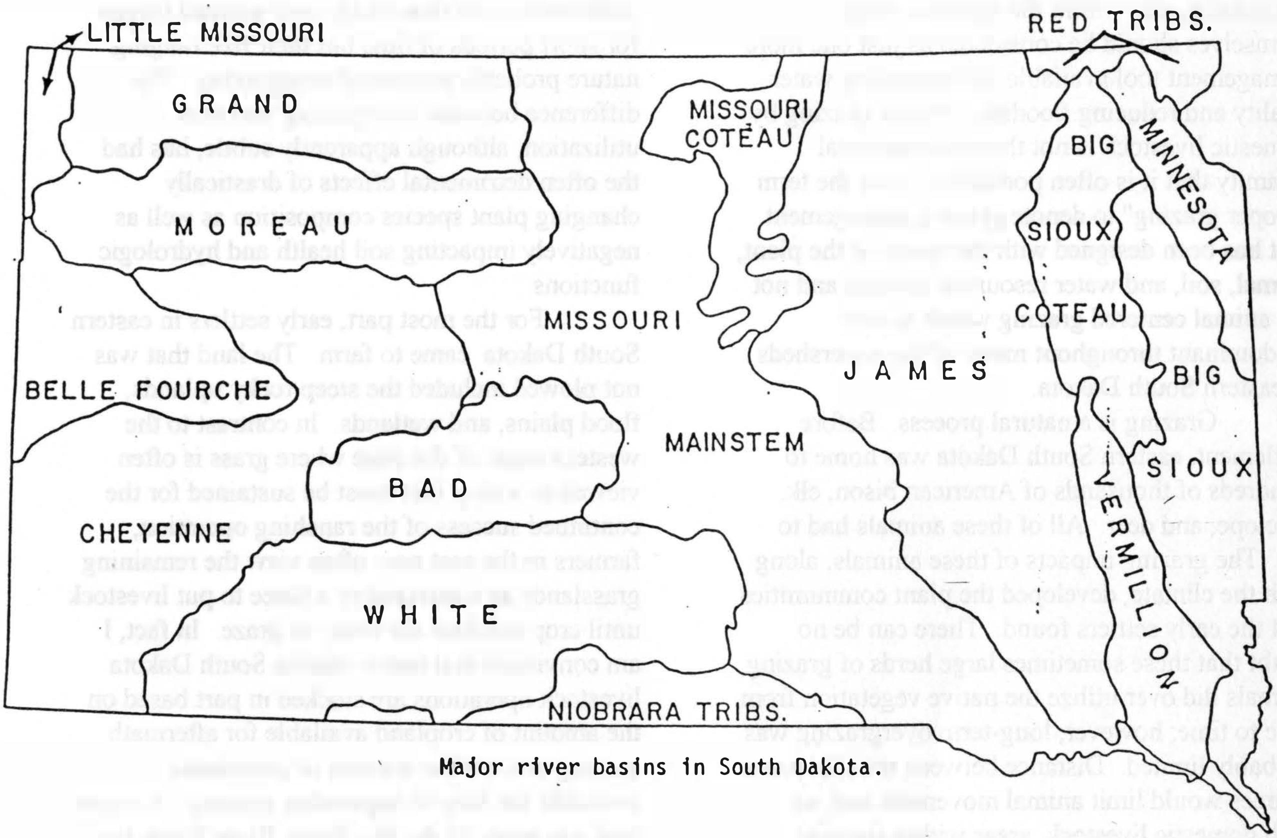
Rotation: Corn/ Soybean,
Tillage: No-till,
Soil & Nutrient Mgt.: no change,
Erosion: installation of a waterway.

With these changes we will also need to change the pest management plan because of the rotation. For this example the pest management plan will change to the following:

Pest Mgt.: AAtrex ¾ lb./ac & 3/4 pt. Fusion.

So, in this example, what were the impacts in the crop production system? When we changed the rotation we increased the diversity, which in turn changed the insect, weed, and disease cycles that affect the system. Because we changed the tillage system we reduced runoff by 35%, increased infiltration, reduced our early spring soil temperatures, and increased available soil moisture for crop production. By the change in rotation we reduced the need for nitrogen fertilizer in the system by 60% and reduced the atrazine application by 60%. Also, the soybeans in the rotation provided an increased opportunity for better grass-weed control. In addition, we reduced sheet and rill erosion by 5 T/ac/yr. and eliminated gully erosion with the application of the waterway. The waterway also reduced offsite sedimentation and deposition as well as offsite nutrient loading of adjacent streams or lakes.

So in summary, I would like to make three points. First, cropland resource concerns are not only complex but also interactive. That is, changes in a cropland management system impact other aspects of the system and very possibly the operation in general. Second, social and/or economic change drives the planning process in fields or watersheds. Examples of this type of change might be the 1985 Farm Bill or the reduction in tillage driven by economics. Third, in watershed planning, cropland resources concerns are an integral part of the inventory and assessment process. After we have determined the problem and our objectives, a proper cropland inventory and assessment is necessary to formulate viable alternatives and make informed decisions.



Major river basins in South Dakota.

GRAZING MANAGEMENT - A WATERSHED APPROACH

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My task this morning is to convince you that proper grazing by domestic livestock both on the uplands and within the riparian zones themselves should be considered as just one more management tool available for improving water quality and reducing flooding. Proper grazing by domestic livestock is not the environmental calamity that it is often portrayed. I use the term "proper grazing" to denote grazing management that has been designed with the needs of the plant, animal, soil, and water resources in mind and not the animal centered grazing which is very predominant throughout many of the watersheds in eastern South Dakota.

Grazing is a natural process. Before settlement, eastern South Dakota was home to hundreds of thousands of American bison, elk, antelope, and deer. All of these animals had to eat. The grazing impacts of these animals, along with the climate, developed the plant communities that the early settlers found. There can be no doubt that these sometimes large herds of grazing animals did over utilize the native vegetation from time to time; however, long-term overgrazing was probably limited. Distance between reliable water sources would limit animal movement and, as with domestic livestock, areas within riparian zones often received the brunt of the grazing pressure.

They (riparian areas) are not a separate ecosystem but are inextricably tied to the surrounding uplands.

Grazing patterns of these large wildlife herds were quite different from the confined herds of domestic livestock. Today the lack of grazing management on many grazing lands has led to continued overgrazing of forage or the continued heavy utilization of forage on a yearly basis. The wild herds more than likely over utilized forage for short periods of time but their free ranging nature probably prevented overgrazing. The difference between overgrazing and over utilization, although apparently subtle, has had the often detrimental effects of drastically changing plant species composition as well as negatively impacting soil health and hydrologic functions.

For the most part, early settlers in eastern South Dakota came to farm. The land that was not plowed included the steep rocky uplands, flood plains, and wetlands. In contrast to the western areas of the state where grass is often viewed as a crop that must be sustained for the continued success of the ranching operation, farmers in the east now often view the remaining grasslands as wasteland or a place to put livestock until crop residues are ready to graze. In fact, I am convinced that many eastern South Dakota livestock operations are stocked in part based on the amount of cropland available for aftermath grazing and not the amount of grasslands available for May to September grazing. A recent land use study of the Big Sioux River Basin has shown that roughly 15% of the land adjacent to small tributaries in the upper reaches of the watershed are used as pastureland. It also showed that 45% of the land adjacent to the larger tributaries and most significantly that 50-60% of the land adjacent to the Big Sioux River itself is utilized as pastureland. With the physical location of many of the remaining grasslands in eastern South Dakota being adjacent to ephemeral and perennial streams and rivers, the impacts on water quality are obvious.

Watershed approaches to land

management issues are perhaps the only long-term effective means of impacting water quality. Today a great deal of emphasis by government agencies is being placed on the degradation of this nation's riparian areas. However, we need to view degraded riparian areas not as a problem but as a symptom of a degraded watershed or poor land management. Riparian areas are just one small part (albeit an important part) of a dynamic ecosystem. They are not a separate ecosystem but are inextricably tied to the surrounding uplands. If we think we can improve our river systems solely by treating the riparian areas while ignoring the surrounding uplands we are doomed to failure.

If you look at the best examples of riparian area management in South Dakota you will also see good upland management or what I call "riparian management by default." In other words, through proper management of all lands including range, pasture, crop, forest, and haylands we have managed to produce healthy riparian areas by default. Practices such as various stream and head cut engineering practices, corridor fencing of streams, or planting trees and shrubs along stream banks have no effect on the uplands of the watershed where the stream problems originate. These techniques often show rapid stream channel improvement but they are also not self sustaining. The only long-term solution to watershed problems on grazing lands is to establish grazing management systems throughout the watershed that are planned with the needs of the plant, animal, soil, and water resources in mind.

These grazing management systems must include rotational grazing strategies. Grazing levels must be such as to insure adequate plant litter to build plant carbohydrate reserves and thus improve plant vigor. Season of use should be controlled to alleviate overgrazing of critically important species such as woody vegetation along stream channels. Adequate rest periods between grazing periods will allow plants to adequately recover. Soil compaction must be avoided. As much as possible livestock must be kept from urinating and defecating directly into streams. Providing alternative water sources and developing hardened watering points will go a long way to reducing these direct deposits by livestock. The trick to grazing management is to accomplish the above items while maintaining livestock production and to do so in an economically justifiable manner.

The benefits derived from grazing management can have major positive impacts on hydrologic functions within a watershed. Rainfall simulations conducted on three soils with differing levels of grazing management within the Bad River Watershed in central South Dakota have shown that infiltration rate can increase from 63 to 94% on high quality well managed rangelands when compared to areas with a history of overgrazing. These same studies showed a 62 to 95% reduction in soil erosion and a 40 to 68% increase in grass production. Grazing level, amount of litter or mulch, and height of vegetation had the greatest effect on the differences measured between the sites. This study has demonstrated the often enormous impacts that grazing management can have on hydrologic functions. On a watershed scale, poor grazing management can mean tens of thousands of acre feet of additional runoff and thousands of tons of increased sediment production, whereas good grazing management provides hundreds of more pounds of grass production for livestock forage. The effects of grazing management on flood control, stream function, water quality, and the economy are tremendous.

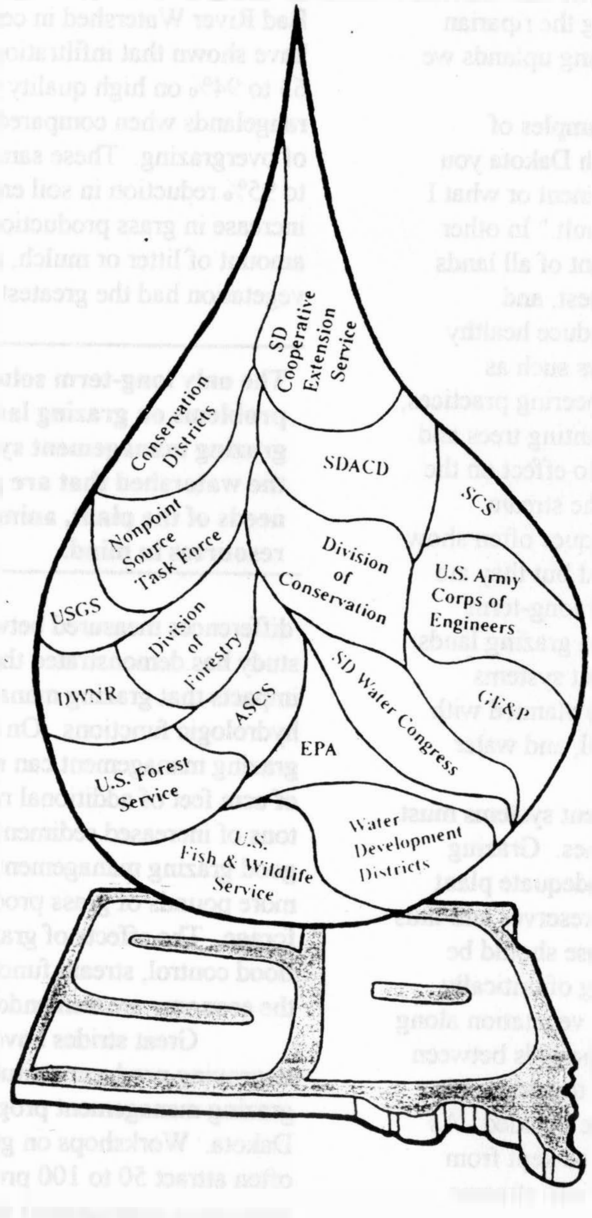
The only long-term solution to watershed problems on grazing lands is to establish grazing management systems throughout the watershed that are planned with the needs of the plant, animal, soil, and water resources in mind.

Great strides have been made in improving producer attitudes toward voluntary grazing management programs in eastern South Dakota. Workshops on grazing management often attract 50 to 100 producers. Many innovative management ideas have surfaced.

However, many complex problems with no easy answers exist. Continued education on methods of improving grazing lands which are economically justifiable as well as manageable will be the key to improving producer awareness in the future. We must also continually make the public aware of the great strides that are being made in improving management of these grazing lands, as public perception will undoubtedly dictate future policy decisions.

team approach to

Water Quality in South Dakota



Wetlands, Water, and Watersheds

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Introduction

In this discussion, some aspects of the general hydrology of prairie wetlands will be presented. Since very little research has been conducted on wetlands in the western unglaciated prairies, the following material is based on the glaciated prairie region more commonly known as the Prairie Pothole Region (PPR).

Hydrology of Individual Wetlands

Prairie wetlands receive their water from either direct precipitation, meltwater from accumulated (drifted) snow, runoff from surrounding uplands, groundwater discharge, streamflow, or a combination of several sources. Water leaves a prairie wetland by one or more of the following ways: direct evapotranspiration (evaporation plus transpiration or "ET") from the pond, marginal ET from the pond edge, groundwater recharge, or by surface water outflow. It is the relationship between the hydrologic inputs and outputs of each pothole that determines the water regimes found within it.

An important point to be remembered is that throughout the Dakotas, average annual precipitation is always less than the average annual evaporation. Thus, ET is a constant driving force during the growing season that pushes a wetland toward dryness. It is the amount of water entering a prairie wetland from runoff, streamflow, meltwater from drifted snow, or groundwater discharge that is in excess of direct precipitation that governs a pond's permanency. In this regard, it is interesting to note that during a 10-year study of pothole wetlands in North Dakota, the 2 years in which the potholes were the "wettest" during the study were also the 2 years with the least total precipitation during the study.

Runoff into wetlands occurs during the spring thaw when melting snow or precipitation flows over frozen soil, or during the frost-free season when precipitation rates exceed the infiltration capacity of the soil. The glacial till derived soils of the PPR are high in smectite clays which expand greatly when wet and are the primary cause of low permeabilities of the soils. The amount of runoff that a wetland will receive can vary greatly among years, and the relative contribution of snow-melt runoff and growing-season runoff can also vary greatly. This is also true among localities in the same year. Variations in annual precipitation and temperature patterns and extremes are normal in the prairie region. In areas of more silty and sandy soil textures, growing season runoff may be minimal, but frozen soil in the late winter/early spring can still yield significant amounts of runoff when late-season snows melt over it.

Other than seepage to groundwater and basin overflow or streamflow out of it, the major route of water leaving a pothole wetland is by ET. ET can not only be separated into its components, evaporation and transpiration, but it can also be separated into that which occurs from the pond itself and that from the marginal (immediately adjacent) plants and soil.

This marginal ET is important in all pothole wetlands in terms of soil formation. However, in terms of water budgets, it is quantitatively most important to the smaller wetlands. In a Canadian study of prairie potholes, water loss from marginal ET was 60-80% from ponds less than 1 acre, but only 30-35% from larger ponds. In that study, the rate of water loss varied directly with the length of shoreline per unit of pond surface area, and although only ponds of about 4.0 ha (10 acres) or less were studied, it would only seem logical that as ponds become very large the effect of marginal ET would become a very small part of total water loss.

In regard to direct ET from the pond, one study reported a 5-year, May-to-October mean of 64.3 cm in 10 North Dakota potholes (all seasonal-wetland-dominated and semipermanent-wetland-dominated basins) of about 3-16 ha or about 7-40 acres. Even though the effect of emergent hydrophytes on ET rates is variable, it has been found that vegetated potholes in North Dakota lost less water via ET during the growing season than did open water potholes. This was caused by the sheltering of the water surface by the senescent plants at both the beginning and end of the growing season.

Surrounding land use can affect water level fluctuations. A recent study in the Dakotas documented that wetlands with cropland watersheds had an average water level fluctuation of 14.14 cm while those in grassland watersheds had an average fluctuation of only 4.27 cm. The mechanism has not been investigated.

A recent study in the Dakotas documented that wetlands with cropland watersheds had an average water level fluctuation of 14.14 cm while those in grassland watersheds had an average fluctuation of only 4.27 cm.

There are three general types of pothole wetlands in regard to groundwater: groundwater recharge wetlands, groundwater discharge wetlands, and flow through wetlands that both recharge and discharge groundwater at various locations within the pothole. However, depending on fluctuations in the water table, a pothole may temporarily change from one type to another. The degree to which groundwater discharge takes place in a pothole wetland is roughly related to its salinity, and therefore, its electrical conductivity. Those with the freshest of waters are generally recharge wetlands, and those with the most saline are discharge wetlands. Flow through wetlands, however, are intermediate in salinities. The high salinities in discharge wetlands are a result of evaporative concentration of salts with no mechanism for their removal (i.e., no downward movement of water into the ground or outward movement through any surface outlet). Major ions responsible for the salinity differences are Mg^{2+}, Na^{+}, and SO_4^{2-}.

Electrical conductivity measurements in pothole wetlands at a point in time are generally not reliable for determination of groundwater regimes for two reasons. First, salinity fluctuates seasonally; tending to be lowest in spring and highest later in the season due to concentration of salts at low water levels. Additionally, large runoff events can dilute the pond water. Second, ground water conductivity is influenced by variations in chemical composition of the soils, till, and other glacial drift, as well as by the type of flow system. These factors can cause enough local differences in groundwater conductivities that general levels in pond waters of a certain area may be higher or lower than those of another area.

Groundwater flow systems in the PPR can consist of either local flow--where groundwater moves between adjacent potholes; intermediate flow--where groundwater may move at deeper depths and discharge into potholes not adjacent to the recharge source but still in the local area; or regional flow--where groundwater moves deep into the till and interacts with wetlands in distant areas. The major systems interacting in regional topographic highs (e.g., the "knob and kettle" or "hummocky moraine" areas of dead ice moraine) are typically local and intermediate, while those in regional topographic lows (e.g., ground moraine) may receive groundwater from regional flow systems that originate in adjacent hummocky moraine. Within any given area, the factors influencing which system a wetland is interacting with depends on the topographic setting, position of the water table, thickness of the drift, anisotropy of the drift, and the configuration of the underlying bedrock.

Within any given area, the factors influencing which system a wetland is interacting with depends on the topographic setting, position of the water table, thickness of the drift, anisotropy of the drift, and the configuration of the underlying bedrock.

The classification of prairie pothole wetlands can roughly be related to groundwater relationships. It may be generally stated that groundwater recharge wetlands are typically temporary-wetland-dominated and seasonal-wetland-dominated basins. Discharge wetlands are usually either semipermanent, intermittently exposed, permanent, saturated, or intermittently flooded. Flow through wetlands are typically semipermanent-wetland-dominated basins but some seasonal-wetland-dominated, intermittently-exposed-wetland-dominated, and permanent-wetland-dominated basins may also be flow through potholes.

Landscape Role of Prairie Potholes in Water Retention

The amount of water that can be collectively stored in potholes over an area is large. A South Dakota study showed that on about 2.5 square miles of high density pothole landscape, the water held after spring snowmelt in 213 small depressional wetlands equaled about 159 acre-feet, or about enough to put 1 foot of water on a quarter section.

Stichling and Blackwell (1957) have described the fluctuating drainage area phenomenon of the PPR in detail and provide an example of a watershed that under dry conditions (depression storage empty) had a net drainage area of 20% of the net drainage area under wet conditions (depression storage full and wetlands overflowing). If a depressional watershed were to be completely "ditched-out," then the net contributing area will be permanently increased to the size of the "net wet drainage area." The relationship between increasing drainage area and increasing watershed discharges has long been recognized by hydrologists. While the magnitude of the largest flood events may not be changed from the natural condition in an artificially drained PPR watershed, it would seem logical to predict that the magnitude of smaller flood events may increase and the frequencies of all flooding events would increase.

Conclusive documentation of the effect of artificial drainage on flooding problems in the PPR has not been published. However, computer simulation studies and empirical studies provide compelling evidence that the artificial drainage of wetlands in the PPR has probably had major contributory effects on flooding problems in the region in recent decades.

Rannie (1980) studied the historic flows in the Red and Assiniboine rivers in and upstream from Winnipeg, Manitoba. He found that the frequency of flood events has doubled on the Red River since 1950, as compared to the previous 58 years. From 1969 to 1979 the mean annual maximum discharges for the Red and Assiniboine rivers were, respectively, more than 80 and 60% higher than the 1913-1968 average. From the beginning of the record to 1978, both rivers demonstrated a rising trend in maximum annual discharge. The author tentatively concluded that a combination of both hydro-meteorological factors and man-made factors, including the reduction of natural water storage due to agricultural drainage schemes, may be the cause.

Brun et al. (1981) studied historic stream flow changes at nine locations on four North Dakota tributaries of the Red River spanning 14 to 46 years. They regressed mean annual flows, maximum daily flows, and mean spring (March, April, May) flows on time. At nearly all locations the regression equations for all three parameters indicated that flows have increased over time with regression equations for locations farthest downstream usually being statistically significant. These researchers also regressed flows on mean annual precipitation and found that flows increased with precipitation; several equations were statistically significant. When precipitation was regressed on time, it was demonstrated that there had been no significant changes in precipitation over the same time periods that stream flows have increased. Thus, the increase in flows of the streams cannot be related to meteorological changes. These results prompted the authors to further investigate the situation on two of the four streams. The catchment basins of the two rivers were determined using U.S. Geological Survey maps and field surveys. They found that because of artificial drainage, the current drainage basins are much larger than the original basins. Assuming that artificial drainage started at the time flow records began at several of the stream locations and has proceeded annually in a fairly uniform manner, the authors found that the increase in predicted flow rates is strongly related to the increase in drainage area (due to artificial drainage) in each basin.

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Riparian Ecology and Management

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Riparian areas are zones next to streams where vegetation interacts strongly with stream dynamics. When resource managers discuss riparian area management, it is quite often in reference to improving water quality, reducing sediment inputs, controlling bank stability, reducing flood damage, and optimizing grazing practices. However, the nature of riparian areas changes in the downstream direction from small, headwater reaches to larger, downstream reaches. Therefore, as the nature of the riparian areas change, perhaps management choices must reflect these changes. What I would like to provide is a framework that outlines the nature of these changes and the implications these have when making comprehensive watershed management choices.

...as the nature of the riparian areas change, perhaps management choices must reflect these changes.

In understanding and assessing riparian conditions, roughly three groups of controlling factors can be considered: ***large-scale watershed patterns and processes, site-specific attributes, and human-induced alterations.***

Large-scale Watershed Patterns and Processes

Let us consider first the large-scale watershed patterns and processes. How do these relate to riparian ecology and management? To begin, the large-scale geologic and climatic setting determines the large-scale template needed to understand three general patterns: vegetation patterns, sediment and water movement, and land-water resource exchanges.

Vegetation patterns.-- A simplistic comparison can be made between forest and prairie environments. In forested environments, streambank vegetation can be dominated by trees along smaller tributaries but become more open in the downstream direction. In prairie environments, streambank vegetation can be dominated by grasses or wetland vegetation along smaller tributaries and progressively become more forested along the downstream reaches. In reality, this generalized continuum of vegetation along rivers and streams is not visually clear but often has abrupt changes in species composition and physical dimension caused by changes in valley morphology and local drainage patterns. For example, a historical description of the Big Sioux River near the mouth of Medary Creek reads, "the river is skirted with cottonwood, elm, and oak, a distance of twelve miles up the stream, the timber ceases and does not again appear in any quantity; below it extends with occasional intervals to the Iowa State line." Most likely, this patchiness along the Big Sioux River is due in part to changes in sediment and water balances associated with floodplain width and valley slope.

Sediment and water movement.--The relative amounts of sediment and water moving past a given point in the watershed change in a manner that can be generalized. Perhaps, a simple definition of a river can help bring the point across. A river can be described as a self-adjusting, self-regulating conveyor of sediment and water. The key is sediment and water movement. How does it change from upstream to downstream reaches? First, two concepts need definition to help understand the movement of sediment and water. Stream power (S_p) can defined as the amount of energy **available** to move sediment, and critical power (C_p) can be defined as the amount of energy **needed** to move sediment. Conceptually, the ratio of S_p to C_p changes in the downstream direction. In small headwater streams, S_p is greater than C_p with downcutting the dominant stream process. In midreaches, S_p can approximate C_p with lateral cutting the dominant process. In lower reaches, S_p is less than C_p with floodplain alluviation being the dominant stream process. The result is net removal of sediment from the higher watershed elevations to net gain of sediment in lower watershed elevations.

Land-water resource exchanges.-- Directly related to movement of sediment and water are shifts in land-water resource (e.g., nutrients, organic matter) exchanges down a watershed. These shifts in exchanges are related to the relative amounts of overland flow and out-of-channel flow of resources. In the small tributaries, overland flow of energy and material resources from the uplands exceeds out-of-channel flow. In the lower reaches, the floodplain alluviation previously described is accompanied by more out-of-channel flow than overland flow of resources into the channel. Taking into consideration large-scale watershed drainage patterns, the small streams (first through third order) comprise roughly 75% of the drainage pathways in a watershed. Therefore, objectives related to management of overland flow of energy and material resources would be best met by collective management of riparian areas along tributaries, while mainstem or downstream reaches would be best managed in entirety with the floodplain.

In summary, riparian management, as one part of comprehensive watershed management planning, must identify where specific sites to be managed are located within the watershed drainage network. With this information, site-specific management choices can be appropriately matched to objectives.

Site-specific Attributes

Within the large-scale watershed framework described above, managers can begin to discern how the strength of site-specific attributes compare with large-scale patterns and processes to control local conditions. Site-specific attributes can be discussed in terms of structure (form) and function (process) at sites along tributaries and lower, mainstem reaches.

Structure and function.-Structure can be defined as the arrangement of physical structure, biological communities, and energy and material resources. These are the attributes that are measurable at one point in time (e.g., channel shape, vegetation composition, forage). Function can be defined as the physical, chemical, and biological processes that control the flow of energy and material resources through a system. These are attributes that require measurements over a defined time period (e.g., deposition, erosion, plant uptake of nutrients, leaf fall, water infiltration). However, the relative intensity of a process can sometimes be inferred by assessing structure. Along the Big Sioux River, the following observations on tributaries and mainstem reaches provide examples of site-specific attributes and their strength relative to large-scale watershed processes.

Tributaries.-- Sites that are heavily grazed lack the channel structure, bank strength, vegetation biomass, bank water retention, and capacity to intercept overland-to-channel flow of sediment, water, and agricultural chemicals and fertilizers. In contrast, sites with no grazing or properly managed grazing systems have a combination of channel structure, bank strength, and vegetation biomass that are resistant to erosive forces, and also have a larger bank capacity for water storage, and a higher capacity to intercept overland-to-channel flow of sediment, water, and agricultural chemicals and fertilizers.

Lower reaches.-- Some downstream sites do not appear to have as strong a distinction in channel structure and bank resistance among riparian conditions because energy associated with high flow events tends to overwhelm the strength offered by bank vegetation. In addition, bank heights and angles may exceed a critical threshold, and bank failure will occur regardless of streambank vegetation. Furthermore, critical bank height threshold depends partially on bank material. For example, sand banks have a lower threshold than clay banks--other variables being constant.

In summary, local riparian vegetation along tributaries can strongly influence the structural and functional condition at a specific site, but the influence of riparian vegetation on the condition of downstream reaches becomes less. The ability to rate the relative influence of site-specific controls and watershed-level controls will help determine if local riparian management can be effective at a site, and determine which management choices will be most viable. However, these phenomena need more detailed study.

Human-Induced Alterations

Riparian ecology and management are affected by a third group of controlling factors--human-induced alterations. These include changes in land cover, channelization, bridges, dams, and impervious urban land surfaces. Assessments of riparian areas must take into consideration two levels of alterations: those that have occurred at the watershed level, and those that are "relatively local" and in close proximity to the site being assessed.

Assessments of riparian areas must take into consideration two levels of alterations: those that have occurred at the watershed level, and those that are "relatively local" and in close proximity to the site being assessed.

At the watershed level, a major alteration in eastern South Dakota has been loss of permanent land cover and acceleration of natural processes, such as overland flow of sediment, water, and nutrients, beyond pre-settlement rates. These rates are beyond the collective riparian assimilative capacity of a watershed. At the local level is channelization of streams, which is often associated with intense agriculture. The effects of stream channelization on riparian ecology and management occur upstream and downstream of the channelized reach. Upstream effects include accelerated downcutting of the stream bed, which increases bank height to a critical level causing bank instability. Furthermore, the drop in the stream bed causes a local drop in the water table and a loss of bank water retention capacity. Immediately downstream of the channelized reach, an increase in stream energy can cause problems with bank erosion as well. Within the channelized reach, reestablishment of riparian vegetation often causes natural stream recovery toward its former structure. Paradoxically, this revegetation is perceived as a problem and, often, is removed with the sediment it has accreted. Perhaps this is a false economy.

Management Implications

So what are the implications of managing riparian areas within a watershed context? I would phrase them in terms of questions that need to be addressed:

> **<u>In small streams:</u>** what kinds of improvements in water quality could be made by managing for healthy riparian vegetation? Perhaps it depends on the amount of overland flow of sediment and water. In other words, even riparian areas have a limited capacity, but what is it?
>
> **<u>In middle reaches:</u>** how much control does streamside vegetation have on the physical structure and stability of banks? In small streams it is great, and in downstream reaches with large floodplains it may be minimal. But in the midreaches, how do resource managers rate the influence of large-scale watershed processes against local riparian vegetation?
>
> **<u>In lower reaches:</u>** what are the lasting benefits to managing riparian vegetation in floodplain areas? Or do resource managers have to look more comprehensively at floodplain dynamics?

In spite of our lack of knowledge on the particulars, the best management choices can be made in the interim based on established principles of watershed processes.

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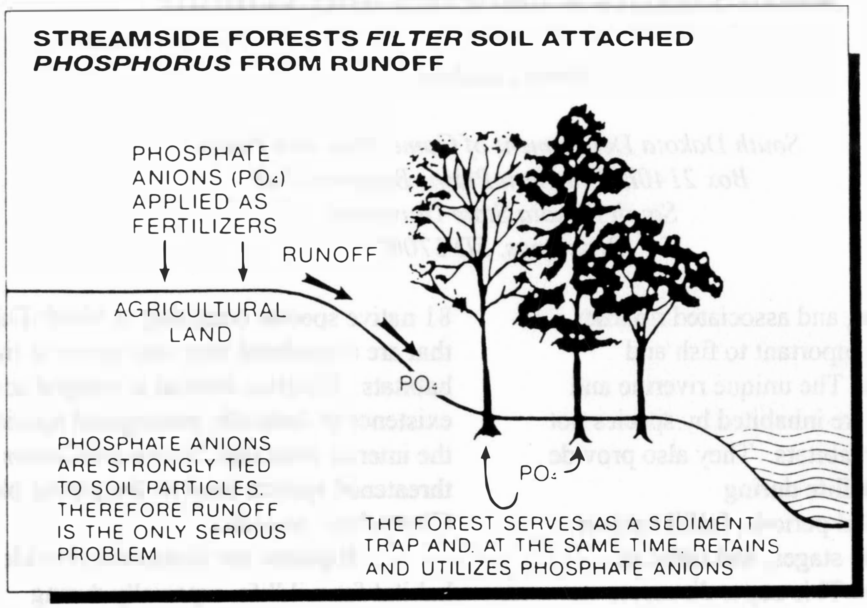

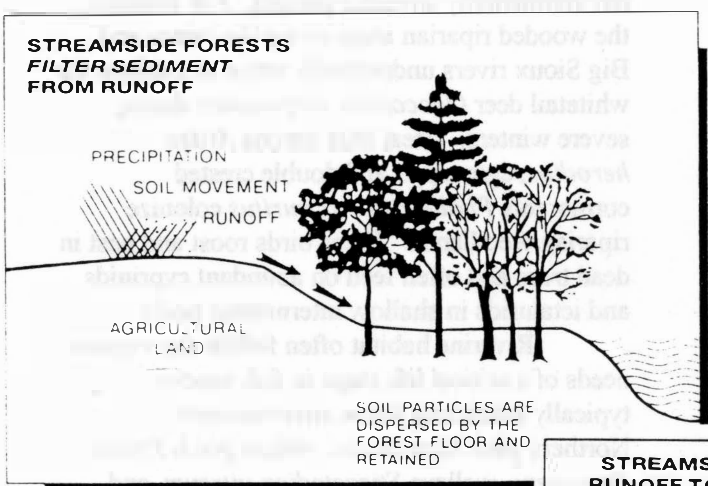

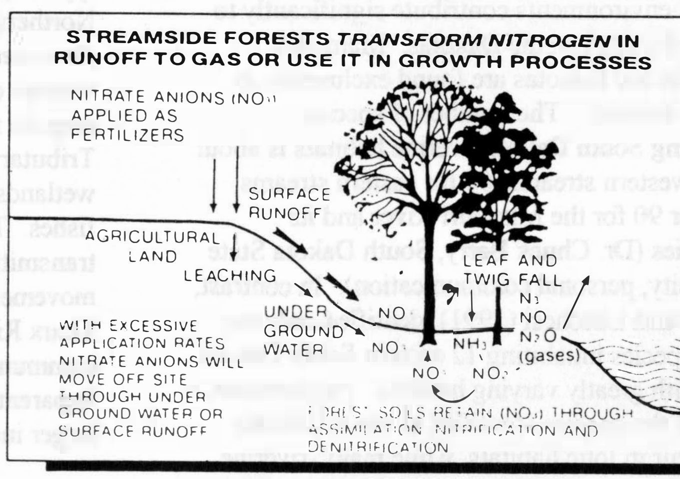

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The Value of Rivers and Streams to South Dakota's Fisheries and Wildlife

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Rivers, streams, and associated riparian habitats are extremely important to fish and wildlife in the Dakotas. The unique riverine and riparian environments are inhabited by species not found in other Dakota habitats. They also provide essential habitat for wildlife during environmentally stressful periods, fulfill various needs during critical life stages, and serve as corridors for migration. This paper discusses these benefits to fish and wildlife, identifies the attributes of riverine and riparian habitats that produce these benefits, and briefly covers management activities being taken to maintain or enhance important riverine and riparian habitats.

Fish and wildlife inhabiting riverine and riparian environments contribute significantly to species diversity in the Dakotas.

Fish and wildlife inhabiting riverine and riparian environments contribute significantly to species diversity in the Dakotas. Many fish species in the Dakotas are found exclusively in riverine habitats. The number of species inhabiting South Dakota riverine habitats is about 20 for western streams, 60 for eastern streams, and over 90 for the Missouri River and its tributaries (Dr. Chuck Berry, South Dakota State University, personal communication). In contrast, Hansen and Lucchesi (1991) identified only two dozen species inhabiting 12 eastern South Dakota lakes with greatly varying habitats. Furthermore, many of the species identified in lentic habitats also occur in lotic habitats, while many riverine species occur exclusively in lotic habitats. Of the 81 native species occurring in North Dakota, nine that are considered rare only occur in riverine habitats. Riparian habitat is integral to the existence of federally endangered species such as the interior least tern *Sterna antillarum* and threatened species such as the piping plover *Charadrius melodus.*

Riparian environments provide essential habitat for wildlife, especially during environmentally stressful periods. For example, the wooded riparian areas along the James and Big Sioux rivers undoubtedly serve as a refuge for whitetail deer *Odocoileus virginianus* during severe winters. Great blue herons *Ardea herodias*, egret spp., and double crested cormorants *Phalacrocorax auritus* colonize riparian woodlands. These birds roost and nest in dead trees and often feed on abundant cyprinids and ictalurids in shallow intermittent pools.

Riverine habitat often fulfills the various needs of a critical life stage in fish species typically inhabiting lentic environments. Northern pike *Esox lucius*, yellow perch *Perca flavescens*, walleye *Stizostedion vitreum*, and various cyprinid species inhabiting lakes often migrate into streams and rivers to spawn. Tributaries, backwater areas, and adjoining wetlands can serve as nursery areas for larval fishes. Tracking walleyes implanted with sonic transmitters in Lake Kampeska showed periodic movements of lake-dwelling fish into the Big Sioux River (Brian Blackwell, SDGFP, personal communication). These "river trips" were apparently feeding forays and often involved larger individuals.

Both riverine and riparian habitats serve as corridors for migration. Migration of fish from rivers and streams into lakes helps to reestablish fish populations after a winterkill. Because there are only a few permanent barriers in South Dakota rivers, fish movements over extraordinary distances have been documented. Examples include a Jamestown Reservoir tagged walleye being caught 200 miles downstream on the James River near Huron (Andy Thompson, NDGF, personal communication), Big Sioux River walleyes tagged near Flandreau being caught from Watertown to Sioux Falls (Fisher 1996), and movement of northern pike from Lake Thompson to Lake Vermillion (Neumann 1994). Smith and Flake (1985) observed that wood ducks *Aix sponsa* use riparian corridors as travel routes.

These benefits to fish and wildlife alone are enough to justify allocation of resources to manage riverine and riparian habitats. Biologists and managers must then determine the most effective means of retaining or enhancing the value of these habitats to fish and wildlife. In order to do this, they must determine what attributes of riverine and riparian habitats are most beneficial to fish and wildlife. Two beneficial attributes of these habitat types that continually are mentioned in the literature are the "uniqueness" of riparian habitats and the "level of complexity" in riverine habitats.

Mesic, wooded riparian areas are unique within the xeric grasslands and agricultural ground of the Dakotas. Forested sections along the Big Sioux River contain trees and shrubs including boxelder *Acer negundo*, green ash *Fraxinus pennsylvanica*, willow *Salix spp*., American elm *Ulmus americana*, hackberry *Celtis occidentalis,* and several other species (Smith and Flake 1983). Unfortunately, the uniqueness of 50% of the remaining habitat, which is 45% of the original wooded corridor, has been jeopardized by overgrazing. One of the most important features of this unique riparian habitat, that is also a large contributor to the complexity of riverine habitats, is dead trees or snags. While standing, snags provide roosting and nesting areas for herons, cormorants, egrets, and raptors, as well as nesting areas for cavity-nesting birds and mammals. After they enter the water, they become perching locations for muskrats *Ondatra zibethicus*, turtles, and amphibians.

Submerged snags greatly enhance the "complexity" of prairie riverine habitat and are heavily utilized by its inhabitants. Fish species use submerged snags as refuge from current, as locations to ambush prey, and as spawning sites. On the James River, Walsh (1992) studied differences in fish abundance among complex habitat types (hardbottom, snags, low-head dams, rock crossings, and tributary confluences) using river stretches lacking instream features as references. He found that the density of fish was twice as high in complex habitats, with densities being highest in snag habitats, especially for game species. Kubeny (1992) observed that radio tagged James River channel catfish *Ictalurus punctatus* spent about 70% of their time around snags and preferred woody cover containing two or more large logs. Schumacher (1995) found 31 species of insects inhabiting James River snags at an average density of over 50,000 insects/m^2, which was five times greater than for rocky habitats. Other "complex" habitats such as hardbottoms are integral to the successful reproduction of both game and non-game species.

In the South Dakota Game, Fish and Parks strategic planning document (SDGF&P 1994), the Rivers and Streams Program planning group identified issues concerning maintenance of riverine and riparian habitats and developed objectives to address these issues. Objectives that will specifically deal with the uniqueness and complexity of these habitats included:

1. Establishing an instream flow reservation on selected stream reaches by 2000;

2. Developing a departmental watershed based aquatic resource management policy for streams;

3. Conducting streams preservation and restoration projects at the rate of at least 1 mile of stream annually; and

4. Maintaining or enhancing all populations of aquatic special status species in South Dakota.

They also identified almost two dozen agencies that could potentially be involved in these stream and watershed management strategies.

Historical documents describe the rivers in South Dakota as clear, with gravelly bottoms and abundant aquatic vegetation.

Historical documents describe the rivers in South Dakota as clear, with gravelly bottoms and abundant aquatic vegetation (Parker 1967). It is apparent that riverine and riparian habitats have been degraded seriously over the past 100 years to their present condition. Although degraded, these habitats still provide important benefits to fisheries and wildlife in the Dakotas. The success of present management efforts will be evaluated by our effectiveness at maintaining or enhancing the ability of rivers, streams, and riparian areas to continue producing these benefits.

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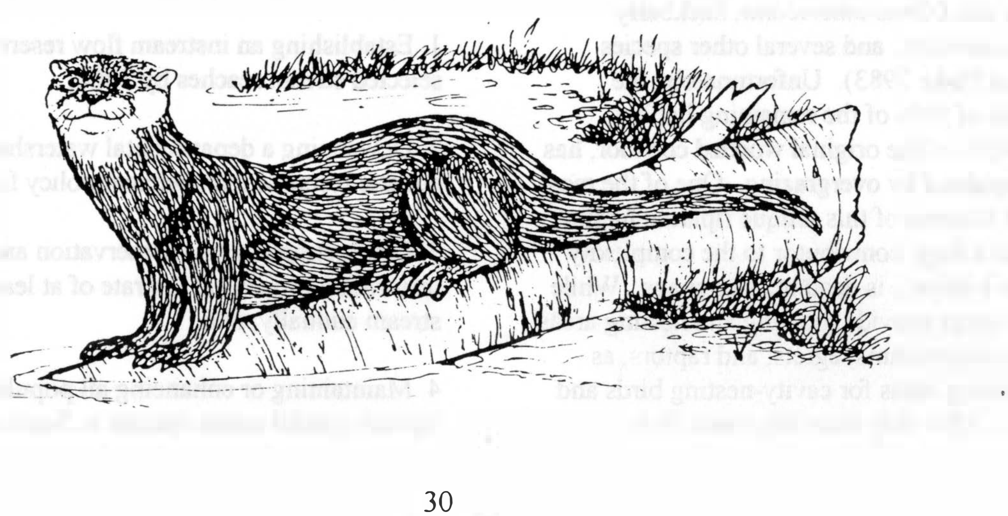

Human Demography and Big Sioux River Recreation

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Watershed managers must consider human demographics when planning basin projects. Human demographics involve the combined effects of population density and land use and the derivation of human services. In South Dakota, population density, land use, and services are controlled by geology and climate. Geology and climate differ in four physiographic regions that we use for contrasting population density, land use, and services. Finally, we summarize our study of the recreational use, which is one of the services provided by the Big Sioux River.

Population Density and Land use

Two regions in the east are the James River Lowlands and Prairie Coteau and the two regions in the west are the Black Hills and Missouri Plateau. Within each physiographic region, population density and land use are limited by the productivity of the landscape and available resources. For example, the landscape of eastern South Dakota supports a dense human population (≈ 135 persons per square mile in Minnehaha County) while western South Dakota's landscape supports a sparse human population (<1 person per square mile in Harding County). In eastern South Dakota, land use is dominated by row cropping, pasture, and livestock. In contrast, the lower rainfall and erosive soils of the Missouri Plateau support a land use dominated by ranching and livestock. In the Black Hills available resources dictate an industry dominated by timber and mining.

Human demographics and natural resources among physiographic regions are different, and so must be watershed management approaches that stimulate awareness of watershed conservation issues.

Human demographics and natural resources among physiographic regions are different, and so must be watershed management approaches that stimulate awareness of watershed conservation issues.

An awareness of conservation issues can begin by understanding that the land provides various services to man.

River Services

The services that rivers provide change by region, although we have little information on many economic and personal values. Information presented at the 1995 Watershed Management Workshop indicated that riverside communities in eastern South Dakota used rivers for disposal of storm water and waste water, intake of industrial process water, intake of municipal drinking water, recreation in riverside parks, and fishing (Loomis and Berry 1995). Paradoxically, municipal leaders felt that rivers contributed little to the local economy. Obviously, more information is needed about the value of river services to local economies.

Each physiographic region determines the presence or absence of certain resources that influence recreational fisheries. For example, the eastern turbid warmwater streams support gamefish such as walleye and catfish. In the Missouri Plateau, prairie rivers are warmwater and support catfish and many minnow species. In the Black Hills, streams are clear and cold and support trout. According to the report titled National Fishing and Wildlife Associated Recreation, about 65,000 anglers fish in rivers and streams in South Dakota (USFWS 1993).

River recreation is important to South Dakota as indicated by a study on the James River where 28 categories of recreation were recorded (Hansen 1981). In 1996, we completed a study of the recreational uses of the Big Sioux River, which shows that the river provides many recreational services.

Big Sioux River Recreation

We recorded the type and number of recreationalists using the Big Sioux River (Doorenbos et al. 1996). We visited 60 river sites from Watertown to Sioux City from March to November in 1995. This section of river was divided into upper (Watertown to Flandreau), middle (Eagan to Brandon), and lower reaches (Brandon to Sioux City, Iowa). We counted 13,930 recreationists taking part in 25 activities (Table 1). The most common activities were fishing (23% of total recreationists), picnicking (23%), exercising and relaxing in riverside parks (23%), camping (9%), and sightseeing (8%). About 3,200 anglers were counted and when extrapolated throughout the survey period, an estimated 20,000 anglers actually fished the river during the survey. Anglers spent an estimated 119,457 ± 550 hours fishing and caught an estimated 171,319 ± 2,958 fishes of 21 species. About 36,956 fishes were harvested, or about 22% of the total catch. Anglers rated 66% of their trips as fair to excellent. Most anglers (88%) traveled less than 26 miles to fish, indicating that the river was a local fishery, and less than 1% fished from boats.

Anglers can maximize their catch from the Big Sioux by changing their target species as the fishing season progresses from spring through fall (Figure 1). Anglers will do best when fishing for walleye and northern pike in May, switching to channel catfish or bullheads in June, July, and August, and trying for northern pike and walleye again in the fall. The highest total catch (about 55,000 fish) was in July; about 25,000 - 30,000 fish were caught in May, June, and August. Most fish were caught in the middle reaches of the river around Sioux Falls, probably because more anglers used that reach.

Table 1. List of recreational activities recorded on the Big Sioux River from March to November 1995.

Activity	Total Counted
Fishing	3214
Picnicking	3159
Exercising	1646
Relaxing	1586
Camping	1228
Sight-seeing	1081
Canoeing	575
Art-fair	500
Environmental Education	228
Rollerblading	137
Other	566

The most sought after fishes were channel catfish, "any species," and walleye in descending order of importance to anglers. During our study, an angler caught a blue catfish weighing 62 pounds, which is currently Iowa's record blue catfish. Proud Angler Awards are given to several anglers each year for catching walleye greater than 8 pounds from the Big Sioux.

Walleye anglers caught about 16,000 walleye and harvested 33% of the walleye caught. Channel catfish anglers caught 32,000 channel catfish and harvested 45% of the channel catfish caught. Black bullheads were the most frequently caught species, composing 46% of all fish caught during our survey. About 80,000 black bullheads were caught of which only 13% were harvested. If success was defined as catching one targeted species during a fishing trip, walleye anglers had a 45% success rate and channel catfish anglers were 49% successful. Anglers targeting "any species" were 84% successful, which makes the river an excellent fishing place for all anglers, especially kids.

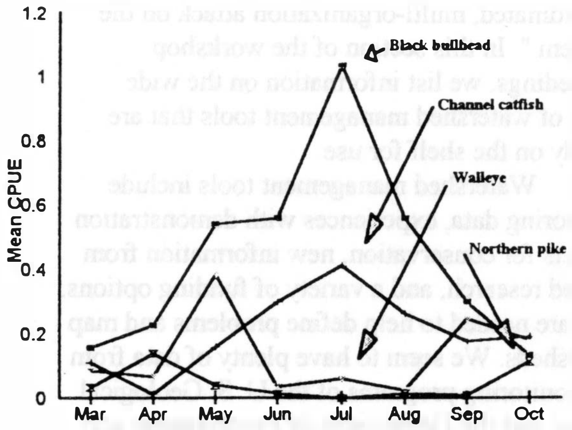

Figure 1. Mean catch per unit effort (CPUE) of gamefish from the Big Sioux River, March to November 1995.

Summary

For proper watershed management, post-settlement changes in the landscape and human demographics must be understood. Geology and climate set the stage in determining human population density, land use, and services. Human demographics involves all people within a basin and is an integral part of managing the resources with the long-term interest in mind. Understanding long-term interests and understanding changing human demographics can improve land-use choices that restore the resources and services provided by rivers in South Dakota.

Fishing is big business in South Dakota, contributing about $70 million to the state's economy. Much of this money is spent in high-profile recreational fisheries like the "Great Lakes of the Missouri River" or the trout streams of the Black Hills. Economists from the American Sportfishing Association used our data to place a $2.4 million price tag on the Big Sioux fishery annually. The estimate comprised only part of the unknown total recreational value of the river because we do not know the value of winter fishing, night-time angling for catfish, camping, hunting, and other recreational activities. Although direct economic impacts of river recreation on communities in the basin are difficult to see, the value is substantial, as are the "quality of life" values evidenced by the heavy use of riverside parks and access areas.

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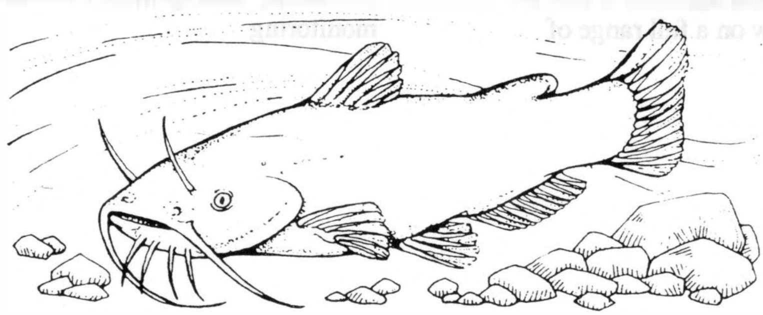

Update on Projects and Programs

One text book on watershed management says "all parties with a stake in the specific local situation should participate in the analysis of problems and the creation of solutions." In this section of the workshop, we have tried to give some meaning to the term "all parties."

The most important parties of course are the private landowners who are sometimes represented by private groups, and sometimes as local government entities. Other "landowners" are the government agencies like the U. S. Fish and Wildlife Service or the South Dakota Department of Game, Fish and Parks that manage public land for all citizens. Our text book lists other potential parties as state and Federal agencies, local boards or commissions, Indian tribes, private organizations, industry sector representatives, local governments, and the academic community.

Representatives from most of these groups have attended our workshops to describe their stake in watershed management. Table 1 lists the stakeholders that were represented at each workshop. If a third biennial workshop is held in West River in 1999, the stakeholder list will grow to include tribes, lumber companies, mining companies, the U. S. Forest Service, the Bureau of Reclamation, and the U. S. Park Service.

"What data, experience, personnel, and funding do you have to help with watershed management?" was the question put to each stakeholder representative by the workshop steering committee. We asked because our watershed management text book said "another key aspect of watershed management is that the actions taken should draw on a full range of methods and tools available, integrating them into a coordinated, multi-organization attack on the problem." In this section of the workshop proceedings, we list information on the wide range of watershed management tools that are already on the shelf for use.

Watershed management tools include monitoring data, experiences with demonstration projects for conservation, new information from applied research, and a variety of funding options. Data are needed to help define problems and map watersheds. We seem to have plenty of data from the monitoring programs of the U. S. Geological Survey and the Department of Environment and Natural Resources. Agencies have a variety of demonstration projects going on to improve instream habitat for fish, reclaim riparian zones, and slow upland erosion. Research projects funded by the South Dakota Department of Game, Fish and Parks are designed to discover new watershed management methods. Personnel, whose job specification includes watershed management, are "on board" in most agencies. The Department of Environment and Natural Resources distributes a packet of watershed management guidelines and states "we suggest that you call the Division of Water Resources Management for additional assistance." Finally, it seems that agencies have a lot of funding; never enough of course, but more and more public funding is available to watershed management groups. Since each agency's grants are for specific types of projects, the key is to find a mix of funding that will cover the wide variety of watershed management needs, including education, management treatments, and monitoring.

Table 1. List of stakeholders in most watersheds in South Dakota, and the workshop in which they discussed tools that their group had for watershed managers.

Stakeholder Group	Workshop 95	Workshop 97
Private organizations and clubs		x
Professional groups		x
Private advocacy groups		x
Local Governments		
Municipals		x
Water Districts	x	x
Conservation Districts	x	x
Watershed Districts		x
Irrigation Districts		x
Water User Districts		x
Sanitary Districts		x
State Agencies		
South Dakota Geological Survey		x
Department of Environment and Natural Resources	x	x
Dept. Game, Fish and Parks	x	
Department of Agriculture	x	x
Federal Agencies		
Environmental Protection Agency		x
Natural Resource Conservation Service	x	x
United States Geological Survey	x	x
United States Fish and Wildlife Service	x	
Corps of Engineers	x	
Federal Emergency Management Agency	x	

Farm Bill Changes

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This presentation is an overview of the Federal Agricultural Improvement and Reform Act of 1996. Information for this presentation was taken largely from a summary of the 1996 Farm Bill Conservation Provisions released by the United State Department of Agriculture in April 1996. The following items are covered.

- Conservation Reserve Program (CRP)
- Wetlands Reserve Program (WRP)
- Environmental Quality Incentives Program (EQIP)
- Wildlife Habitat Incentives Program
- NRCS Technical Guide
- State Technical Committees
- Private Grazing Lands
- Conservation Compliance
- Wetlands

Conservation Reserve Program (CRP)

The CRP has been extended through the year 2002. A cap on the amount of land that can be enrolled is at 36.4 million acres.

Wetlands Reserve Program (WRP)

The WRP has been extended through the year 2002 with enrollment capped at 975,000 acres. As of October 1, 1996, enrollments included one third of permanent easements, 30-year easements, and restoration cost-share. Restoration cost-sharings are as follows: 75-100% for permanent easements, 50-75% for 30-year easements, and 50-75% for restoration cost-share agreements. Also, as of October 1, 1996, no new permanent easements are allowed until at least 75,000 acres of temporary easements have been enrolled.

Environmental Quality Incentives Program (EQIP)

EQIP combines the functions of Agriculture Conservation Program (ACP), Water Quality Incentives Programs (WQIP), Great Plains Conservation Program (GPCP), and the Colorado River Basin Control Program. This program requires a conservation plan, establishes a 5 to 10 year contract for technical assistance, and provides up to 75% cost-share on practices such as manure management systems, pest management, and erosion control.

The program was funded for $130 million for the 1996 fiscal year, and up to $200 million for every year thereafter until the year 2002. Fifty percent of these dollars will be used for livestock operations. Limitations for cost sharing and incentive payments are $10,000 annually or $50,000 for a contract lifetime. Large livestock operations are not eligible for cost-sharing of animal waste management facilities but are eligible for technical assistance.

EQIP establishes conservation priority areas in cooperation with state and federal agencies and state technical committees where significant problems exist concerning soil, water, and related resources. Higher priority is given to areas where water quality objectives can be met with agricultural improvements and where state and local governments offer technical or financial assistance.

Wildlife Habitat Incentives Program

WHIP has provisions to help improve wildlife habitat on private lands. The program provides up to 75% cost-share and has a funding base of $50 million for over 7 years.

NRCS Technical Guide

State level changes that affect Swampbuster and Conservation Compliance now require public notice.

State Technical Committees

The farm bill now requires state technical committees to include producers, non-profit organization, agribusiness, and economic and environmental experts on impacts of conservation techniques. Public notices are required for meetings. Meetings are to be chaired by the State Conservationist.

Private Grazing Lands

The grazing lands provision is a voluntary program for the conservation and enhancement of private grazing lands. It encourages multiple resource benefits. In the fiscal year 1996, $20 million is authorized, but this increases to $60 million by the third year. Two grazing management districts have been established.

Conservation Compliance

Conservation Compliance defines a "conservation plan" and a "conservation system." This provision is extended to production flexibility contracts and EQIP, revises the "good faith" provision that makes penalties commensurate with violations, and expedites temporary variances. Landowners have one year to resolve compliance problems found by USDA employees. Relief for undue economic hardships can be authorized by county committees. Crop insurance benefits are no longer subject to compliance. This provision encourages farmer and third party involvement in residue management records. Multiple sources of technical assistance are allowed and on-farm research is encouraged.

Wetlands

Wetland provisions direct the Secretary to certify wetland determinations. The Secretary has the authority to identify individual producers, the programs affected by violations, and the amount of penalty to be assessed. The Secretary also has the discretion to waive penalties and to grant time for converted wetlands to be restored.

The concept of "abandonment" has been revised so that a Prior Converted cropland designation remains in effect as long as the land is used for agriculture. Also, under an approved plan, Farmed Wetlands and Farmed Wetlands Pasture that were allowed to revert to a wetland status can be converted back to a Farmed Wetland or Farmed Wetland Pasture for agricultural uses without violating Swampbuster provisions.

Wetland mitigation includes restoration, enhancement, and creation as long as functions and values are maintained. "Minimal Effect" determinations are encouraged for effective and timely identification of practices that have minimal effect on the environment. Wetland conversion activities will be accepted if adequately mitigated under a Section 404 permit. A pilot program for mitigation banking has been established to assess the success of mitigation banking for agriculture. "Good faith" provisions have been revised.

The definition of agricultural lands has been broadened by the farm bill. Not only are croplands and pasture land included, but the definition now includes tree farms, rangeland, native pasture land, and other land used for livestock production.

U.S. EPA and Watershed Management

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I. History of the Watershed Protection Approach at EPA

Clean Water Act

The Nation has invested billions of dollars to clean up major industrial and wastewater discharges since the amendments to the Federal Water Pollution Control Act became law in 1972. This effort was largely successful. Sections 209, 303(e) and 319 specifically call for planning and implementation on a watershed basis. As successful as the nation has been in cleaning up its waters, continued discharge and transformation of complex chemicals unknown in 1972 as well as typical chemicals such as chlorine and ammonia still prevent many waters from meeting their designated uses.

Continued Water Quality Problems Not Well Addressed Through Traditional Programs

Other significant water quality problems remain that are often unregulated or are not effectively addressed through a traditional permit and enforcement program. Cumulative impacts from farm runoff, irrigation discharges, residential and municipal runoff, leaking septic systems, construction practices, highway runoff, road maintenance, disruption of hydrologic regimes, grazing, mined lands, and recreation create complex problems that are well beyond the scope of any one program or agency.

II. Watershed Protection Approach

Goal

To maintain and improve the health and integrity of aquatic ecosystems using comprehensive approaches.

What Is a Watershed?

A watershed or basin is an area of land drained by a network of water courses to a particular body of water. It includes both surface and groundwater.

Nesting Concept

The geographic phenomenon in which large watersheds are made up of a series of smaller ones is called nesting. It creates a convenient method for management, allowing one to scale up or down, depending on the objectives of planning.

Water Is an Indicator of Other Environmental Problems

Activities on land manifest themselves most quickly in water. Therefore, although the issue is water quality, the problem usually arises because of some land-based action. Sediment due to erosion is typically associated with activities on land although instream actions such as placer mining and channelization cause sedimentation.

Taking a Broader Perspective

Addressing complex water problems that originate throughout the watershed requires a broader perspective than one offered point-source-by-point-source.

III. Watershed Protection Framework

The framework has three parts: sound science, collaborative problem solving, and integrated action.

Sound Science for Problem Identification

Scientific data, techniques, and tools are essential for sound, iterative decision making. They include:

- assessment and characterization of the natural resources and the communities that depend on them;

- goal setting and identification of environmental objectives based on the condition or vulnerability of resources and the needs of the aquatic ecosystem and the people within the community;
- identification of priority problems;
- development of specific management options and action plans;
- implementation; and
- evaluation of effectiveness and revision of plans, as needed.

The iterative nature of the watershed approach encourages partners to set goals and targets and to make maximum progress based on available information while continuing analysis and verification in areas where information is incomplete. EPA has a number of scientific tools to assist with assessment and improvement such as ecological risk assessment framework, Total Maximum Daily Load (TMDL) modeling, rapid bioassessment protocols, and stream restoration techniques.

Collaborative Problem Solving

All interested and affected people are encouraged and allowed to participate in goal setting, planning, and implementation. Through a collaborative process, partnerships are formed that lead to solutions and results that otherwise could not or might not be accomplished. Public participation and collaborative processes require skills that are often not readily available such as facilitation, meeting management, conflict management, and large-scale coordination. These skills must be combined with an ability to understand and incorporate technical situations.

Integrated Action

Integrated actions may be as simple as understanding that solving water chemistry problems alone may not be enough to reach a brown trout fishery goal if the physical environment or habitat is inadequate. Integrated action even for some of the simpler problems usually means finding a way to work across a multitude of agency jurisdictions and county, municipal, and landowner boundaries. Obtaining agreement or even just permission for integrated action is typically time consuming and frustrating, requiring facilitation, conflict mediation, and other process skills and patience. Such a collaborative approach does not mean that it is a way out of compliance with existing requirements. Compliance becomes a part of planning and implementation. Sometimes greater regulatory flexibility and reduction of burden on individual facilities can be obtained from collaborative planning.

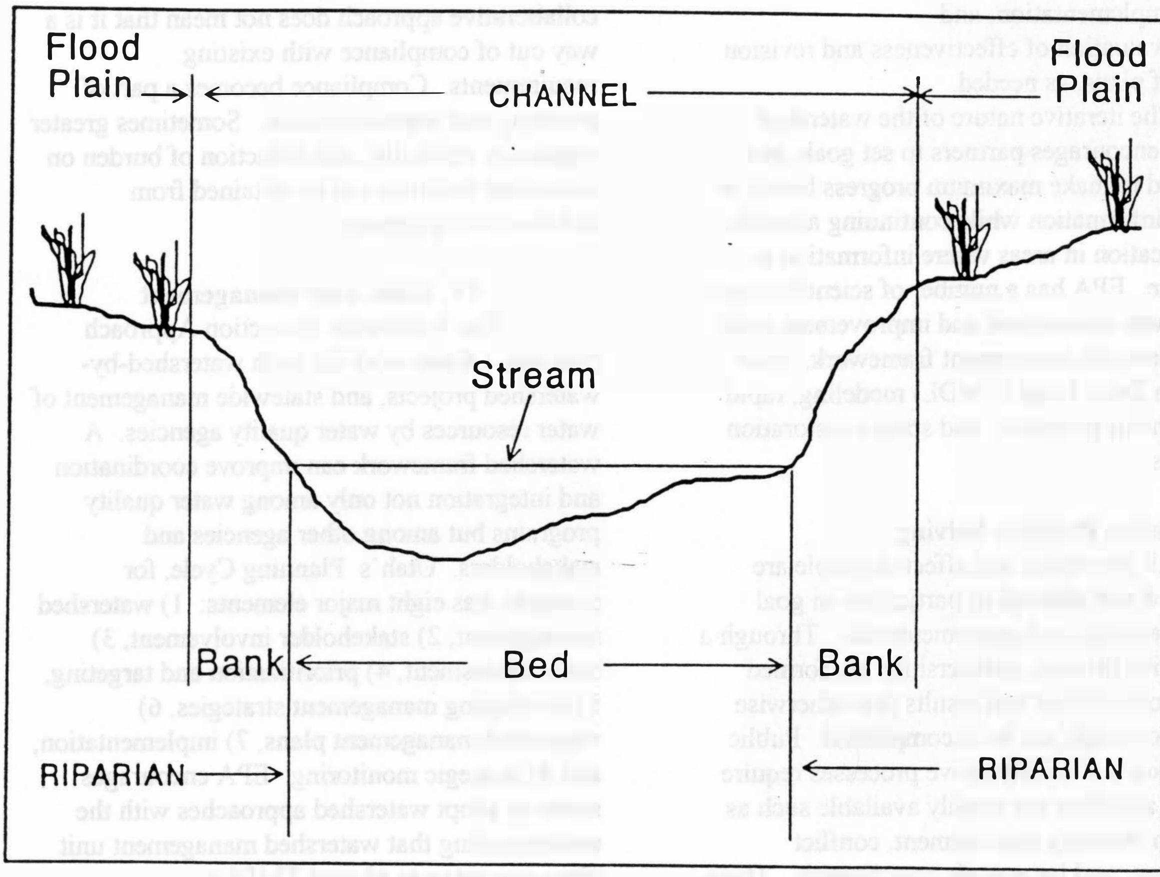
IV. State-wide management

The Watershed Protection Approach provides a framework for both watershed-by-watershed projects, and statewide management of water resources by water quality agencies. A watershed framework can improve coordination and integration not only among water quality programs but among other agencies and stakeholders. Utah's Planning Cycle, for example, has eight major elements: 1) watershed management, 2) stakeholder involvement, 3) basin assessment, 4) prioritization and targeting, 5) developing management strategies, 6) watershed management plans, 7) implementation, and 8) strategic monitoring. EPA encourages states to adopt watershed approaches with the understanding that watershed management unit plans can serve as phased TMDLs.

Adopting a watershed approach statewide is an initiative taken by a state water quality agency in consultation with other stakeholders, usually in response to a self-assessment of that state's programs. It is not a simple process, but one that requires time, energy, and perseverance.

Some of the benefits of the investment in developing this approach are:

- Water quality programs can focus more directly on the resource;
- The basis for management decisions is improved;
- Program efficiency is enhanced;
- Coordination among agencies in the state can be improved;
- Resources are better directed to priority issues;
- Consistency and continuity are encouraged;
- Opportunities for data sharing are enhanced;
- Public involvement is enhanced;
- Innovative solutions are encouraged.



Typical stream cross section, showing the components of the channel and riparian zone.
(U.S. Forest Service)

Nonpoint Source and Statewide Water Quality Monitoring Programs

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Nonpoint source water pollution results from diffuse sources such as agricultural runoff, road construction, logging, and urban lot development rather than discrete sources like wastewater discharge pipes.

Nonpoint sources cause 85% + of the water pollution in South Dakota. The primary parameters of concern are silt, nitrogen, phosphorus, and bacteria. Nonpoint source problems and impacts are widespread in South Dakota. Economic impacts of nonpoint source pollution in South Dakota are generally undocumented but huge. Power generation reductions at Oahe Dam caused by silt from the Bad River annually average $12,000,000. The cost to restore Swan Lake, a 180 acre lake in Turner County, including silt removal, will exceed $ 1,100,000. Costs to relocate public wells in the Sioux Rural Water system near Watertown due to nitrate contamination will exceed $ 1,200,000. They previously moved the wellhead in 1984 at a cost of $750,000.

The nonpoint source control program reduces and prevents water pollutant loadings to rivers, lakes, wetlands, and groundwaters so that water quality standards are met and the assigned beneficial uses are supported.

The South Dakota program is built on VOLUNTARY participation. All projects are sponsored by local entities such as conservation districts and water development districts. The NPS program provides leadership, technical planning, and financial support along with information and education. Projects are managed by local sponsors which are typically conservation districts, cities, and water development districts.

The NPS program has annually secured federal 319 funds of approximately $1.8 million through a competitive process at the EPA regional level. Beginning with FY97, the process is noncompetitive and relies on a national formula for distribution of 319 funds. If Congress appropriates the expected $100,000,000, South Dakota's target is $1,253,790 of project funds. These funds are matched by local entities and supplemented by other project funds. The NPS program is involved in about 60 projects worth about $15 million at any one time. We also receive $100,000 annually under section 604(b) to support local planning efforts. A good summary of projects is available in the Nonpoint Source Control Program Annual Report.

South Dakota's nonpoint source program has some relatively unique aspects which contribute to its success. The first is the composition of the Nonpoint Source Task Force. Unlike most governmental groups which are appointed, this task force has open membership which allows the members to participate with equal status. This has lead to a free exchange of ideas and resources.

Another is the technical assistance provided. When a watershed problem is brought to us by a group or resident, we assign a staff member to assist throughout the assessment, planning, and implementation phases. The staff member does not lead the effort but rather assists the sponsors with their efforts.

Another factor leading to success is the use of program neutral planning. Rather than chasing funding programs, we focus on defining the problem and the solution. Once it has been determined what needs to be done, we assist in finding the necessary resources.

Another large factor in the program's success is the requirement that each project be managed by a local sponsor. This leads to project ownership and a resolve to solve any problems as they occur. Our experience has shown a much higher satisfaction rate with local sponsorship and management.

Parts of a restoration project

Successful watershed projects follow a logical progression through five phases. These phases are:

- **problem identification and prioritization**
- **assessment**
- **planning**
- **implementation**
- **operation and maintenance**

The watershed planning and implementation process is explained in detail in the DENR publication " Citizens' Guide to Lake and Watershed Restoration Projects."

The first question that needs to be answered in developing a watershed project is, "**What is the problem**?" The answer may not be as obvious as first thought. Often symptoms are confused with sources of problems. Also, while a group of citizens agree that the problem is with water levels, further examination may determine that some people think that high water levels cause their problems, while others may be negatively affected by lowered water levels. It is also quite common to find that the local citizens have a number of different problems they wish to address, but resources don't allow tackling them all at once. Then a decision must be made as to which problems to address first. It is extremely important that all the participants understand which problems are being addressed at any one time. Only in this manner can the correct information be gathered and resources be properly directed. A written statement of the problem with as much detail as possible will be helpful.

An **assessment,** or evaluation of the problem, is an essential part of any lake or watershed restoration project. A thorough assessment documents problems and identifies the feasibility of possible solutions.

A typical watershed assessment consists of a 2-year effort that includes gathering and analysis of all pertinent existing information, water quality sampling, runoff measurement, biological information, land use, social and economic concerns, watershed modeling, and development of restoration alternatives. Project sponsors may have adequate information already to prepare an assessment report or may prefer to complete an assessment on their own. However, if grant funding is to be pursued, all assessment information is subject to review and approval by the Watershed Protection Program. This will ensure that there is sufficient detail to prepare project implementation plans and funding applications.

A completed study report is a requirement for most types of funding for implementation. There is usually some type of financial assistance available for assessment activities. Matching fund requirements to complete an assessment are typically 60/40. This means that the local sponsor will need to come up with 40% of the cost of the assessment. This non-federal match may be any combination of cash and donated services.

Other types of assessments may also be conducted depending on the nature of the problem, type of watershed, and availability of funding. The Watershed Protection Program staff will meet with you to determine the type of assessment that is appropriate to your situation and assist you in assessment design.

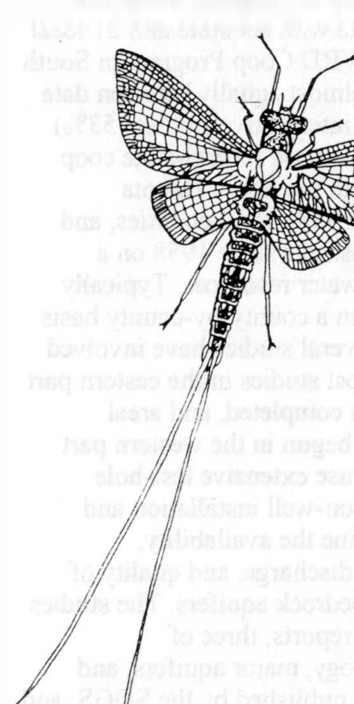
The **planning** stage of a restoration project comes after the assessment is completed. Information from the assessment study report is used to design an implementation project. A funding package including several different sources of funds is typically needed for implementation. During planning, applications are prepared for funding, budgets are developed for restoration activities, and work plans and milestone schedules are prepared. Also, application is made to the Board of Water and Natural Resources for inclusion in the State Water Plan. This work is to be completed by the local sponsor with technical assistance from DENR. Depending on need, funding assistance may be available for planning activities. Inquiries for funding assistance in planning should be made to the Watershed Protection Program.

The **implementation** stage begins when construction or resource management activities are initiated to correct or prevent sources of pollution. Implementation encompasses activities ranging from lake dredging projects to land-use management changes in a watershed. Generally, this is the most costly portion of a restoration project.

Operation and maintenance of the project will assure that these efforts will continue to deliver benefits into the future. After the implementation stage is completed, a system will be needed to assure that the practices and structures developed during the implementation project continue to be maintained and operated.

The Watershed Protection Program has several publications to assist with watershed planning and implementation. These are packaged in the blue Lake and Watershed Management Guide folder. The Citizens' Guide to Lake and Watershed Projects walks the user through the above five project phases one step at a time. The South Dakota Handbook of Special Purpose Districts will help you determine if formation of a special purpose governmental district could help you with your project goals. The South Dakota Nonpoint Source Program Manual outlines many available programs which can provide technical and financial assistance for your project. With all the recent changes in government funding, this manual is somewhat out of date but still useful. It will be updated later this year. A brochure on SMART Planning will help you determine the correct level of detail for your planning efforts. Also included in the package are three Terrene Institute publications; Organizing Lake Users: a Practical Guide, Handle With Care: Your Guide to Preventing Water Pollution, and Clean water in Your Watersheds: a Citizens' Guide to Watershed Protection.

DENR can also assist with water quality data and interpretation to determine if you have a water quality problem. The Department maintains an ambient surface water quality monitoring system of 136 sites statewide, some of which have records back to 1967. The data is maintained on the STORET computer system maintained by EPA. The data is also interpreted and reported biennially in the 305(b) Water Quality Assessment. This is one of your best initial sources to determine how the water quality in your water body compares to the water quality standards designed to protect its beneficial uses.



USGS Programs and Projects

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The U.S. Geological Survey is made up of four divisions---National Mapping Division (NMD), Geologic Division (GD), Biological Resources Division (BRD), and Water Resources Division (WRD). Five USGS offices in South Dakota represent three of the divisions---NMD at EROS Data Center near Sioux Falls, BRD at the Coop Fish and Wildlife Research Unit at Brookings, and WRD at offices in Rapid City, Huron, and Pierre. Ken Lindskov, District Chief of the WRD Office in Rapid City, is the USGS Director's state representative for South Dakota programs. The remainder of this presentation will discuss WRD programs and projects in South Dakota.

The 1996 District WRD program in South Dakota was slightly more than $4 million dollars. About one fourth of this amount was Federal-State Cooperative Program funds that were used to cooperate with six state and 21 local agencies. The 1996 WRD Coop Program in South Dakota was divided almost equally between data collection (47%) and interpretive studies (53%).

The USGS has used federal-state coop funds to cooperate with the South Dakota Geological Survey (SDGS), local counties, and water development districts since 1958 on a program to appraise water resources. Typically the studies are done on a county-by-county basis and last 3-5 years; several studies have involved multiple counties. Most studies in the eastern part of the state have been completed, and areal studies have recently begun in the western part. The studies typically use extensive test-hole drilling and observation-well installation and monitoring to determine the availability, movement, recharge, discharge, and quality of water in glacial and bedrock aquifers. The studies usually result in four reports, three of which---detailed geology, major aquifers, and sand and gravel---are published by the SDGS, and one---detailed water resources---is published by the USGS. All counties in the Big Sioux Basin have been completed, except for Roberts County which is in progress, and McCook County (which is not scheduled).

The Big Sioux Hydrology Study began in 1982, with a major objective of providing a scientific basis for evaluation and efficient use of water resources within the Big Sioux River Basin. The county water-resources appraisals (described above) that had yet to be completed within the Big Sioux Basin were incorporated into the study. In addition, five digital models of the Big Sioux aquifer were developed to analyze the hydrologic system and to provide an improved, quantitative understanding of the Big Sioux aquifer. Although not specifically part of the Big Sioux Hydrology Study, a water-quality investigation was begun in 1986 in cooperation with the SDGS to define the quality of water in surficial-outwash aquifers in the Big Sioux River Basin.

The USGS cooperated with the East Dakota Water Development District, the South Dakota Department of Water and Natural Resources, and the U.S. Bureau of Reclamation to complete drainage-area studies within the Big Sioux River Basin in 1985. Drainage areas were delineated on 1:24,000 scale quadrangle maps and determined for all named stream basins and for all unnamed basins larger than 10 square miles. Similar studies have been completed for the James and Vermillion river basins. A similar study is in progress in cooperation with the Sisseton-Wahpeton Sioux Tribe and the East Dakota and James River Water Development Districts for the Little Minnesota and Red River of the North basins in extreme northeastern South Dakota.

The USGS, in cooperation with the Department of Environment and Natural Resources (DENR) and local lake associations, has conducted sediment surveys of several lakes in eastern South Dakota. The studies are done using a high-frequency, continuous seismic-reflection system to estimate sediment thickness in conjunction with GPS to determine horizontal positioning. Within the Big Sioux River Basin, a detailed study has been completed for Pelican Lake near Watertown and reconaissance studies have been done on Lake Kampeska and on Lake Madison. Other studies have been done on lakes Byron, Redfield, and Faulkton in the James River Basin. The U.S. Army Corps of Engineers has had the USGS do sediment surveys on the Missouri River near the confluence of the White River, near the confluence of the Bad River, and below Gavins Point Dam.

The USGS, in cooperation with the South Dakota Department of Transportation (DOT), has recently updated frequency curves for all gaged streams in South Dakota. The USGS currently is cooperating with DOT on a statewide frequency study to update equations from 15 to 20 years ago that relate peak-flow magnitudes to basin characteristics. Many of the sites used in these studies are within the Big Sioux River Basin.

The USGS, again in cooperation with the DOT, has recently completed a 5-year investigation of channel scour at 31 bridges located on primary roads in South Dakota. Nine of these bridges were located within the Big Sioux River Basin.

The USGS cooperated with DENR; DOT; the Department of Game, Fish and Parks; and East Dakota Water Development District in 1995 to document high-water levels that have occurred in eastern South Dakota lakes during the recent wet cycle. High-water marks were documented at the same time that DENR was making its regular water-level field trip. Sub-centimeter accuracy GPS equipment and software were used to determine the mean sea level elevation of reference marks at certain lakes where levels had not previously been run. Again, many of these lakes are within the Big Sioux River Basin.

The USGS has completed or is working on several smaller, site-specific investigations within the Big Sioux River Basin. The USGS has cooperated with the City of Sioux Falls to investigate the potential for artificial recharge of the Big Sioux aquifer; to determine the potential sustained yield of the Split Rock aquifer; and to determine the quality of urban runoff from industrial, commercial, and residential areas in Sioux Falls in order to obtain an NPDES permit. The USGS currently is cooperating with the City of Sioux Falls to determine the artificial recharge potential of a constructed wetland near Lyons. The USGS cooperated with North Sioux City and Union County to do the hydrology portion of a FEMA Flood Insurance Study for North Sioux City.

The USGS Midcontinent Pesticide Initiative was a regional-scale study of the occurrence, fate, and transport of agricultural chemicals in streams, reservoirs, shallow aquifers, and precipitation in the central U.S. Eight stream sites, three wells, one reservoir site, and one precipitation site in eastern South Dakota were sampled during 1989-95 for commonly-used pesticides and selected nutrients related to agricultural activities.

For more information on USGS assistance through the Federal-Cooperative Program, please contact Ken Lindskov at (605) 394-1780 (ext 220) or Rick Benson at (605) 353-7176 (ext 204). The Email address is dc_sd@usgs.gov. Additional information can be found by accessing the USGS Home Page on the World Wide Web at http://www.usgs.gov/

South Dakota Geological Survey Program and Projects

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The South Dakota Geological Survey (SDGS), which is a program in the South Dakota Department of Environment and Natural Resources (DENR), was established by the legislature on March 6, 1893. The mission of the SDGS is to conduct geologic studies and research; and to collect, preserve, interpret, and disseminate information, leading to a better understanding of the geology and hydrology of South Dakota. Special emphasis is placed on ground water quality and quantity and other natural resources of economic value. The SDGS has no regulatory authority; instead, it provides information and interpretations on natural resources and related issues and assists agencies and individuals in making well-informed decisions. To carry out its mission, SDGS conducts a variety of activities.

Statewide Ground Water Quality Monitoring Network

The purpose of this network is to examine the water quality in sensitive surficial aquifers across South Dakota. Currently, 68 monitoring sites have been established in 17 aquifers. An additional nine aquifers will be included in the network over the next 2 years. Information generated through this network will be used to aid proper development of the state's water resources, to facilitate early recognition of water quality problems, and to assess regulatory and land use practices.

County Resource Assessments

The South Dakota Geological Survey, in cooperation with the U.S. Geological Survey, has been conducting county-wide studies since 1958. These studies are designed to evaluate the geology, hydrology, and mineral resources of the state on a county-by-county basis. These studies have been undertaken at the request of individual counties and are funded by the counties, water development districts, applicable tribes, and the state and federal governments. Field investigations for all but six counties in eastern South Dakota have been completed and most of the final reports (more than 100) have been published. A study for Roberts County, in cooperation with Sisseton-Wapeton Tribe, is currently in progress. Also, field investigations for the first two counties in western South Dakota (Todd and Mellette) are near completion. This project is being conducted with the cooperation of the Rosebud Sioux Tribe.

Black Hills Hydrology Study and Black Hills Water Management Study

The Black Hills Hydrology Study began in 1990 and is a cooperative study involving the U.S. Geological Survey, DENR, and local government organizations. The study is planned to span a 10-year period and to culminate in a better understanding of the complex hydrologic conditions of the Black Hills region. Phase I of this study, which is coming to a close, emphasized a comprehensive data gathering network including installation of observation wells and stream-gaging stations, and determination of baseline water quality. Development of the Phase II study plan is currently in progress. A Black Hills Water Management Study has also been undertaken by the U.S. Bureau of Reclamation to complement the Black Hills Hydrology Study and to formulate water management alternatives.

Studies of Low Permeability Sediments

During the last several years, SDGS has been involved with the study of water movement in clayey till at several locations in South Dakota. The need to better understand the suitability of till for irrigation and waste disposal and the need to better understand recharge rates to buried aquifers through these sediments and the fate and transport of chemicals in these sediments have been the reasons for the study. SDGS in cooperation with the South Dakota State

University and the University of South Dakota has recently completed a study at the Sioux Falls Regional Sanitary Landfill. The results of this study are consistent with other studies conducted in the state and were the basis for determination by the South Dakota Board of Minerals and Environment that an engineered bottom liner was not necessary in this location, saving approximately $2 million for the users of the landfill. Additional research is being planned to quantify lateral movement of water in weathered till and to better quantify evapotranspiration rates.

Special Resource Assessment

These studies are designed to respond to specific problems or needs. Currently, SDGS is studying the potential of the Wall Lake aquifer as a supplemental water source for the City of Sioux Falls. Also, a study was recently conducted near Lake Cochrane to determine the impact of pumping by a rural water system in Minnesota, on the surface water resources of South Dakota.

Public Water Supply Investigations

During the last four decades, SDGS has been assisting cities, rural water systems, or water development districts to improve the quantity or quality of public water supplies. More than 150 such studies have been conducted. However, budget reductions and desire to privatize some tasks have reduced these activities.

Core Samples

Many core samples have been collected during investigations by private companies and governmental agencies. Some of these samples are stored at the SDGS core repository and are available for inspection by government and private entities.

Data Storage

Basic data from the above-mentioned studies are entered into a Visual FoxPro database management system on a local area network that SDGS maintains. At present, approximately 32,000 test hole and well logs, 4,400 water quality logs, and 245,000 water level measurements, collected by DENR, are in computer storage. A computer-aided drafting system is used at SDGS to digitize project information and produce graphical output. A Geographic Information System (GIS) is currently being designed using ArcINFO on a Windows NT workstation to integrate image and attribute data.

Currently, SDGS is integrating data sets based on U.S. Geological Survey DLG files into ArcINFO and ArcView. Also, SDGS is beginning to create updated aquifer boundaries by utilizing various data sets. Emphasis is being placed on understanding of possible hydraulic connections of these aquifers to each other and to the surface water resources. A better understanding of recharge sources and rates to these aquifers and discharge sources and rates from these aquifers are of utmost importance for protection and prudent development of these resources.

Local Government Options for Watershed Management

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When considering watershed protection or restoration efforts, most project supporters immediately look to state or federal programs for assistance, both technical and financial. These are often the highest profile programs, and from a funding standpoint, they have the deepest pockets. However, in the current political climate, these same agencies are now being asked to do more with less; which means they typically end up being able to provide less help. In this environment, the support and assistance that can be provided from other types of agencies and organizations is increasingly important.

Many such entities can be found in South Dakota, ranging from regional groups with broad interests to small, narrowly-focused organizations. This talk is intended to cover a number of these "alternative" groups that may be in position to assist watershed activities.

The South Dakota State Legislature has authorized a number of different special purpose districts. These districts are, for the most part, established for the purpose of managing or supporting water or natural resource related projects within their jurisdictions. Some have fairly broad mandates and have the ability to deal with several issues. Others are limited in scope and responsibility. The creation of one or more of these districts in a particular area has depended on local interest and desires; only the conservation districts have complete statewide coverage. A listing of these entities and the legislative reference is given below:

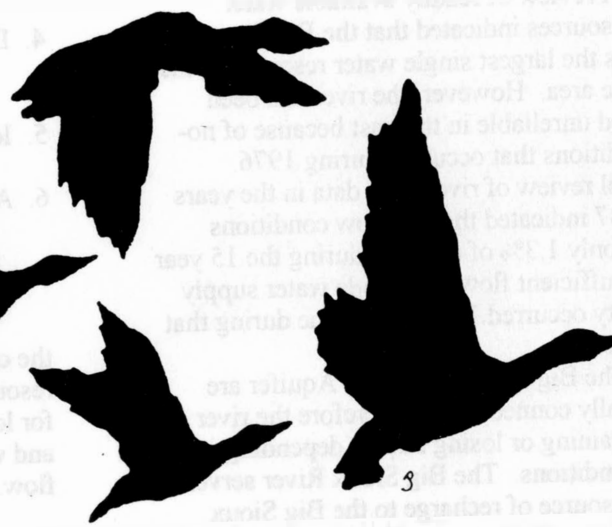
1. Water Development Districts
2. Water Project Districts
3. Conservation Districts
4. Watershed Districts
5. Water User Districts
6. Sanitary Districts
7. Irrigation Districts

More conventional "local" governmental groups that may be of assistance are municipal and county governments and their regulatory and advisory boards and commissions. These entities are often the most familiar to the general public. Because of the more general mission of these bodies, their level of participation may not be as great, but they are often quite willing to lend moral, if not financial, support.

An exception may be with water utilities, either as municipalities or rural water systems. By definition, they have a very keen interest in water quality and quantity issues. Consequently, if a direct benefit of a particular action or project can be demonstrated, their involvement may be quite substantial. Remediation or replacement of a public water supply can easily run into the millions of dollars, making support of preventative efforts quite acceptable.

In addition, don't forget the role of non-governmental interest groups and organizations. These can be found almost everywhere and can be invaluable in almost any activity. In many ways these are the most effective, because their existence is centered on a particular issue, and the membership, although often small, tends to be extremely committed. If an appropriate group does not exist, one should probably be organized. Most governmental entities, at whatever level, find it easier to work with groups, rather than numerous individuals, even if the goals are the same. Membership in such a group is also a good indication of the level of local commitment.

Finally, the importance of personal commitment and involvement must be stressed. All of the groups listed above are likely to have more requests for help than their resources can handle and it is unreasonable to expect them to deal with every problem that is presented to them. Individuals must be willing to expend some of their own time and money in pursuit of the objective, in addition to requesting help from others. While there is invariably a general public benefit to any watershed project, individual property owners within the watershed are the principle benefactors. If the primary beneficiaries of a project show little real interest in supporting it, why should anyone else?



If you don't think you can
help solve environmental problems
then you are one of them.

Environmental Education
Division of Elementary and
Secondary Education
State Capitol Building
Pierre, S.D. 57501

The Big Sioux River as a Resource

Lyle D. Johnson

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Sioux Falls, SD 57104

Introduction

Sioux Falls is located in an area of southeastern South Dakota that does not have an overabundance of water supply resources. Water resources near Sioux Falls consist primarily of surficial aquifers and the Big Sioux River. In the past, the City has relied on the Big Sioux Aquifer as its sole water supply. Extended dry conditions in the late 1980s led to declining water levels in the Big Sioux Aquifer due to over pumping of the City's well field. This demonstrated that the Big Sioux Aquifer alone could not meet the water supply needs of a growing Sioux Falls.

Water Supply Options

A review of readily available water supply resources indicated that the Big Sioux River was the largest single water resource in the immediate area. However, the river has been considered unreliable in the past because of no-flow conditions that occurred during 1976. Additional review of river flow data in the years 1973-1987 indicated that no-flow conditions occurred only 1.3% of the time during the 15 year period. Sufficient flow to provide water supply for the City occurred 70% of the time during that same period.

The Big Sioux River and Aquifer are hydraulically connected and therefore the river can be a gaining or losing stream depending on aquifer conditions. The Big Sioux River serves as the major source of recharge to the Big Sioux Aquifer. Drought cycles and high groundwater use can produce low river flows. To incorporate the direct use of the river into the City's water supply resources, consideration of the groundwater usage from the Big Sioux Aquifer was also needed. To address the interaction of the two resources and the reliability problems with the Big Sioux River, the City developed a Water Management Plan. The Water Management Plan was developed to ensure all resources were used wisely and to provide adequate water supplies during drought conditions.

Elements of the Water Management Plan

The Sioux Falls Water Management Plan provided for:

1. Use of the river as the primary water supply resource when flows are adequate and quality is acceptable;
2. Utilization of the water storage capacity of the Big Sioux Aquifer to allow groundwater use during periods of low river flows;
3. Maximizing recharge of the aquifer by artificial recharge and removal of sediment from the river channel;
4. Development of other groundwater water resources to supplement existing supplies;
5. Identification of water demands and provisions for demand side management; and
6. Analysis of future demands and establishment of schedules for expanding resources and future long-term water supplies.

The Water Management Plan allows for the comprehensive management of water supply resources. The plan acknowledges the potential for low river flows. In fact, groundwater usage and water usage restrictions are keyed to river flow.

Utilization of the Big Sioux River

Significant direct utilization of the Big Sioux River began in September 1990 with the completion of a 45 MGD pumping station. The City has withdrawal rights of 10,000 acre-feet annually from the Big Sioux River but the City is not allowed to withdraw water when river flows drop to 20 cubic feet per second. River flows are monitored at the Dell Rapids gaging station and utilization of river water is curtailed when flows drop below 50 cfs. Since September 1990, adequate flows have existed each day to allow use of surface water from the Big Sioux River.

Overall surface water quality is good except for sediment and natural organic matter. Synthetic organic chemicals such as pesticides and herbicides are normally not present and those that are detected are found at levels below drinking water standards. Historic levels of nitrate in the Big Sioux River at Sioux Falls have never been a problem. Since 1994, the City has monitored for *Cryptosporidiam* and *Giardi* and to this date none of these organisms have been confirmed as present in the Big Sioux River.

Treatability of surface water is a challenge particularly because of rapidly changing water quality. The treatment of surface water in Sioux Falls is somewhat more difficult in that the City's water treatment plant was designed specifically for groundwater. Operational modifications were necessary to treat surface water. The City has increased the pH of the lime softening process, relying on the production of magnesium hydroxide for turbidity removal. Lime usage has increased 30% as has carbon dioxide which is used to lower the pH of the water from the softening basin. Chlorine usage, on the other hand, has dropped 20%.

To control taste and odors, a granular activated carbon cap was added to the gravity filters. While this has helped control taste and odors, usage of surface water during spring runoff can still create water quality problems. Higher water temperatures and natural organic matter in the surface water have contributed to increased levels of disinfection byproducts in the finished water. The City is currently working with powdered activated carbon and ferric chloride to remove disinfection byproduct precursors. If these efforts are not successful in lowering the concentration of disinfection byproducts, use of ammonia to form chloramines may be necessary.

Conclusion

The use of surface water from the Big Sioux River by Sioux Falls has reduced withdrawals from the Big Sioux Aquifer as shown in Table 1. Groundwater utilization from the Big Sioux Aquifer is currently within safe withdrawal rates for the City's well field. Surface water utilization has also extended the life of the City's water supply resources, providing time for the City to explore long-term water supply option.

Table 1. Historical Water Supply Volumes for Sioux Falls (in million of gallons).

	Year						
	1996	1995	1994	1993	1992	1991	1990
Total Pumpage	6968.34	6657.32	6751.69	5466.50	6133.46	6345.89	6660.14
Supply from Big Sioux Aquifer	3449.60	2804.42	3444.03	3253.54	4017.48	3340.94	5794.25
Supply from Big Sioux River	3239.00	3133.00	2898.03	2023.00	1895.63	2705.52	771.54

Selected Watershed Management Organizations

David Fryda

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American Fisheries Society (AFS). The AFS, founded in 1870, is the oldest and largest professional society representing fisheries scientists. AFS promotes scientific research and enlightened management of aquatic resources for optimum use and enjoyment by the public. The Society publishes journals and one magazine which often contain watershed-related papers. In addition AFS publishes and distributes numerous books on watershed management. Contact: American Fisheries Society, 5410 Grosvenor Lane, Suite 110, Bethesda, MD 20814.

American Rivers, Inc. American Rivers is a national organization that protects and restores America's river systems. The organization focuses its conservation program in six areas: nationally significant rivers, hydropower reform, urban rivers, clean water, endangered aquatic species, and Western water issues. *American Rivers* is published quarterly to inform and educate about river conservation issues. Annually, the organization publishes its *10 Most Endangered Rivers* list. Contact: American Rivers, 801 Pennsylvania Ave. SE, Suite 400, Washington, D.C. 20003

American River Management Society (ARMS). ARMS is a national nonprofit professional society, dedicated to the protection and management of river resources. Their objective is to advance the professional field of river management by providing managers, researchers, and interested individuals with a forum for sharing information about the appropriate use and management of river resources. Publications include *ARMS NEWS, River Skills Bank,* and *River Information Digest.* Contact: ARMS, P.O. Box 621911, Littleton, CO 80162-1911.

Association of State Floodplain Managers (ASFPM). The ASFPM is an organization founded in 1977 by professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program, and flood preparedness, warning, and recovery. They manage the Floodplain Management Resource Center, which is a computerized database, library, and referral service for floodplain management publications. The organization has numerous special publications dealing with watershed management. Contact: ASFPM, P.O. Box 2051, Madison, WI 53701-2051.

Center for Watershed Protection. The Center for Watershed Protection is a nonprofit corporation, dedicated to finding new, cooperative ways of protecting and restoring watersheds. Principal functions are independent research and technical support to professionals. Publications include *Techniques*-a quarterly bulletin on urban watershed restoration and protection tools, *Pond Design, Site Planning*, and a *National Directory*. Contact: Center for Watershed Protection, 8737 Coleville Rd., Suite 300, Silver Spring, MD 20910.

Izaak Walton League of America (IWLA). The IWLA is a national nonprofit conservation organization founded in 1922 by 54 anglers who joined together to save the Mississippi River. The League is dedicated to conservation of America's soil, air, woods, waters, and wildlife. The League also sponsors two watershed education programs-Save Our Streams and Stream Doctor. Numerous publications and educational packages are available from the organization. Contact: Izaak Walton League of America, 707 Conservation Lane, Gaithersburg, MD 20878-2983.

National Watershed Network-Know Your Watershed. The National Watershed Network is the largest network of watershed partnerships in America. The Know Your Watershed campaign promotes an understanding of watersheds, and encourages local voluntary watershed partnerships to address natural resource concerns. The national campaign is coordinated by the Conservation Technology Information Center (CTIC), a nonprofit technology transfer center. Contact: CTIC/Know Your Watershed, 1220 Potter Drive, Room 170, West Lafayette, IN 47906-1383.

National Watershed Coalition (NWC). The NWC is an alliance of national, regional, and state organizations and associations that is promoting use of the watershed concept when dealing with our natural resources. The Coalition also provides active leadership in support of using the Small Watershed Flood Prevention Program and Watershed Protection Program (PL 83-566) when dealing with water resource problems. Activities include *Watershed News*- a quarterly newsletter, and a biennial national watershed conference. Contact: National Watershed Coalition, 9150 West Jewell Ave., Suite 102, Lakewood, Colorado 80232-6469.

The Soil and Water Conservation Society (SWCS). The SWCS is a nonprofit, multidisciplinary organization for natural resource management professionals. Its mission is to advocate the protection, enhancement, and wise use of soil, water, and related natural resources. Publications include *Journal of Soil and Water Conservation* and the *Conservogram*. The Society is the distributor for the Revised Universal Soil Loss Equation software developed by the USDA. Contact: The Soil and Water Conservation Society 7515 N.E. Ankeny Road, Ankeny, IA 50021-9764.

South Dakota Lakes & Streams Association (SDLSA). The SDLSA, organized in 1992, is a nonprofit corporation comprised of individuals and associations who desire to improve and protect South Dakota's lakes and streams. The Association encourages and supports all lakeshore property owners, lake and stream associations, agencies, and water users to protect "swimmable" and "fishable" waters and to prevent contamination of groundwater. Contact: South Dakota Lakes and Streams Association, PO Box 7041, Pierre, South Dakota 57501.

Terrene Institute. The Terrene Institute, a nonprofit, nonadvocacy organization, links business with government, academia, and citizens to improve the human environment. Education and public outreach comprise the cornerstones of the Institute. Newsletters include *Runoff Report, Wetland Celebration*, and *Nonpoint Source News-Notes*. A wide variety of products including books, posters, pamphlets, resource kits, and databases are produced by the Institute. Contact: Terrene Institute, 1717 K Street, N.W. , Suite 801, Washington, D.C. 20006.

Trout Unlimited (TU). TU is America's leading trout and salmon conservation organization. Since its inception in 1959 in Grayling, Mich., TU has been dedicated to conserving, protecting, and restoring coldwater fisheries and their watersheds. Publications include *Saving A Stream- A Practical Guide For Coldwater Habitat Projects* and *Trout-The Journal of Coldwater Fisheries Conservation*. Contact: Trout Unlimited, 1500 Wilson Boulevard, Suite 310, Arlington, VA 22209-2310.

Case Histories In Watershed Management

People presenting Case Histories of watershed management. (L to R) Curt Hansen, Chuck Lebeda, Mike Williams, Linda Kingery, Bruce Schmidt, Chris Freiburger.

The workshop steering committee invited six speakers to tell about their experiences in watershed management. We heard that watershed management in Oregon is led by the Governor's mandate that agencies work together. We heard about the Big Sandy Lakes, Minnesota, watershed program, and the Tongue River, North Dakota, watershed program to improve Renwick Reservoir. From South Dakotans involved in watershed management, we heard about projects in the Big Stone Lake, Lake Kampeska, and Vermillion River watersheds.

A summary of each talk is included in the following section of the workshop proceedings.

Panel Summary

A variety of questions were asked of the panel by the audience and by the moderator. One issue was by far the most important. It was the issue of educating people and achieving compromise. The panelists agreed that we know how to manage the land, the water, the fish, and the wildlife. The residents of the watershed that are the hardest to deal with are the people. One panelist said that the most critical needs were for 1) ways to educate citizens about complex problems like watershed management, and 2) ways to facilitate the social interaction that is needed for grass roots projects. Another panelist cited distrust, self-interest, and short-term economic thinking of landowners as impediments to progress in watershed management.

"How do I prepare to be a watershed manager," was a question from a student in the audience. Each panelist talked again about the importance of "people" skills for one-on-one relations with landowners, backed up with skills for writing clearly and simply, for effective public speaking, and for understanding economics. One panelist stated that the student doesn't need to be an expert on specific issues because of all the help that is available, but does need to expertly find the help.

Some of the panel discussion was about how to recognize that a project was making any difference, and how to keep people involved when environmental changes were slow and hard to see. Two panelists presented data from lakes that suggested improvements within a few years. The panel talked about the mix of chemical and biological monitoring that was being done to determine the success or failure of their projects, and to determine whether funds were being well spent. Several panelists stated that landowners were recognized in various ways for the participation and cooperation and emphasized that feedback and frequent communication were necessary.

Chris Freiberger reminded workshop attendees that nonpoint source pollution is too complex and too widely dispersed to be controlled by government regulations alone. He stated that watershed management was one remedy, but the real solution was proposed 50 years ago by Aldo Leopold who said "An ethical obligation on the part of the private owner is the only visible remedy for these situations."

See anything wrong with the caption below this picture?

"Good morning, folks. My name is Mr. Jones. I represent your local, state and federal government. You needn't be concerned about degradation of your water and shoreland resources because we are going to take care of them for you."

Applying Ecosystem Management Beyond Limited Fisheries Agency Authority

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Introduction

Fisheries managers are keenly interested in watershed management for a number of obvious reasons. Fish require water as the primary component of their habitat. As the product of their environment, fish populations are controlled by the character of the habitat, including water quality, quantity and distribution of flow, and physical habitat characters such as channel complexity, presence of wood or rock cover, siltation, pool:riffle ratios, spawning gravels, water velocities, and migration blockages. Activities in watersheds that affect any of these factors ultimately affect the species and abundance of fish in that watershed. As a result, fisheries biologists and managers are becoming more and more interested in watershed management. In fact, the greatest challenge facing the fisheries profession today is how to implement fish habitat protection and restoration on a watershed or ecosystem management basis.

In many regards, fisheries managers have sport fish management pretty well worked out, and we have a wealth of examples which might suggest that we are in firm control of the future. Consider some of the outstanding examples of successful sport fish management: We have excellent reservoir fisheries all over the country, like Flaming Gorge Reservoir producing 33 pound brown trout and lake trout over 50 pounds; superb largemouth and smallmouth bass fishing to add to the spectacular scenery at Lake Powell; reservoirs in Texas and California that regularly pump out largemouths in excess of 10 pounds, with talk of breaking the long standing 22 pound record; and how about the spectacular walleye and chinook fishing in Lake Oahe, just a few hours west of here? "Blue-ribbon" quality trout streams are found across the northern part of the country, from legendary streams like the Beaverkill and AuSable in the East to the Madison and upper Deschutes in the West. And, how about the spectacular tailwater fisheries like the Green River in Utah, the San Juan River in New Mexico, or the Red and White rivers in Arkansas? Who can count all of the productive farm ponds in North America? These and many other fishery successes are the result of modern fishery management techniques, including introductions and stocking, use of productive artificially created environments, and careful regulatory control over use and harvest.

We can't let the successes blind us to the problems and failures in our record, however. Populations of west coast salmon and anadromous trout are listed or proposed for listing under the Endangered Species Act. Naturally spawned paddlefish and sturgeon are in critical condition in many portions of the Mississippi River watershed. A variety of unique desert fishes are facing extinction. There have been serious declines in range and abundance of interior cutthroat trout. Efforts to restore lake trout and whitefish populations in the Great Lakes have shown only minor success. Exotic species now dominate the fish populations in south Florida. Formerly productive reservoirs have silted in and are dominated by a handful of opportunistic species.

...agencies have full control over the management actions that influenced success, but have little control or authority over the factors influencing the failures...

The common thread among these problems and failures is physical and biological alteration of native habitats, including dams, migration barriers, watershed and water quality degradation, and introductions of exotics, either accidentally or intentionally.

When we compare the factors responsible for success or failure in the above cases, we find that agencies have full control over the management actions that influenced success, but have little control or authority over the factors influencing the failures (with the exception of some intentional introductions). This may point to a fundamental flaw in our approach. Our management agencies do not have adequate authority over habitat and land uses to allow us to approach watershed or ecosystem based management in the same way we have imposed the more traditional fish management activities like regulations and stocking.

The basic reason for this limitation becomes evident when we examine the missions and legal authorities for our wildlife agencies. When we cut through the legalese, most wildlife management agencies have authority for only two basic kinds of activity: regulating use and harvest and controlling distribution. Not surprisingly, most of our successes have resulted from these activities. Our agencies were established around controlling and promoting use, and they have gotten quite good at it. Where watershed restoration is needed, however, our traditional approaches and authorities are inadequate. Worse yet, we haven't always recognized this fundamental difference between population management and habitat management, or that we can not successfully accomplish watershed and ecosystem based management with the same kind of single agency, regulatory based approach.

Realistically, then, how can we improve management of watersheds? Economic forces will continue to stress the landscape, and multiple agencies and organizations represent a myriad of authorities and competing interests. Despite our well intentioned words about watershed restoration and ecosystem based management, can we actually implement these concepts to keep up with the impacts, let alone make headway in repairing the damage? And, if our traditional authorities and approaches are not sufficient, what **can** we do to successfully restore declining fisheries and aquatic systems?

Finding Successful Approaches

While this challenge may seem daunting, there **are** examples of successful watershed restoration and ecosystem management projects and programs. These success stories may provide us with concepts and approaches that will help management agencies define new ways of conducting management to compensate for our lack of authority and improve our habitat and watershed management efforts.

Last year, the Fisheries Administrators Section of the American Fisheries Society sponsored a symposium at the annual meeting designed to highlight projects which successfully accomplished watershed or ecosystem improvement projects beyond the scope of traditional fisheries agency authority. As hoped, we found a number of consistent themes among the highlighted projects that offer insight into approaches that may help agencies transcend their traditional limitations. A dozen speakers were invited to the symposium from coast to coast. The projects differed in scope, from single stream reaches to statewide legislative perspectives, yet all shared common themes of public and land owner involvement, cooperation, combined authorities, and voluntary action. The projects highlighted in the symposium can be grouped into several approaches.

...we can not successfully accomplish watershed and ecosystem based management with the same kind of single agency, regulatory based approach.

Several presentations illustrated how much can be done to restore watersheds and fish habitat by volunteer groups working with local land owners, state agencies, and many other entities, including irrigation districts, NRCS and SWCDs, industry groups, and federal land managers. These projects, conducted on the Blackfoot River, Mont., the Henry's Fork River, Idaho, the Mattole River, Calif., the Little Tennessee River, N.C., and the Coos and Coquille rivers, Ore., had strong involvement and guidance from an assortment of organizations, from local chapters of groups like Trout Unlimited to more formal associations or foundations created specifically to conduct watershed-scale restoration. One such group, the Henry's Fork Foundation, was formed when two former adversaries, an environmental group and an irrigation district, decided that they could accomplish more working together than fighting each other. In all of these cases, the cooperating organizations, not the fish and wildlife management agency, were able to take the lead role in involving land owners and the public. In Oregon, watershed councils made up of local citizens, land owners, constituent group members, agencies, and local officials functioned to accomplish far more than the fisheries agency could by itself. The Coquille Watershed Council acquired and effectively spent over $4 million on habitat restoration in only a few years. The lesson for the agency was to guide the council gently in the right direction as a technical advisor, not try to be the boss.

Several projects illustrated how separate agencies can pool resources and authorities to accomplish improved fisheries or watershed management far beyond what the fisheries agency could do alone. On Meadow Fork, a small Appalachian stream in North Carolina, the Wildlife Resources Department convinced the Department of Transportation to contract with them to relocate a stream. Using an approach that replicated nature rather than building a rip rapped ditch resulted in a naturally functioning stream that cost less than the heavily engineered approach. NCDOT has now adopted the natural approach as its standard method for unavoidable stream relocations.

In Arizona, the Game and Fish Department, the Bureau of Reclamation, and the irrigation district worked together to manage flows in a major desert basin, the Bill Williams River, on a whole-basin approach, providing needed flows for fisheries while meeting system demands for water. In Oregon, the Department of Forestry developed forest practices rules which restrict logging in riparian zones and provide major protection for fish habitat.

Several large-scale watershed rehabilitation efforts further illustrated the power of cooperative efforts with non-traditional partners. The Iowa Department of Conservation utilized Clean Lakes funds from EPA to work with municipalities, farm groups, local agencies, and other partners to improve watershed conditions and increase water quality in many Iowa lakes, to the betterment of fisheries. In Wisconsin, the Delavan Sanitation District teamed with the Department of Natural Resources and local partners to control nutrient inputs to Delavan Lake from the watershed, seal in nutrients already in the lake, and to remove carp which were recycling nutrients. The result was a complete transformation of the lake from a major muddy carp hole into a clear lake with dramatic increases in walleye reproduction.

Two states demonstrated that the general public, acting through the legislature, can make good decisions for watersheds. Illinois passed a major initiative, Conservation 2000, that establishes biodiversity preserves on all state lands and emphasizes ecosystem management as the approach for managing watersheds. Nebraska passed an aquatic habitat stamp targeted expressly at improving declining habitat conditions in Nebraska's aging reservoirs.

A lot can be learned from these successful projects. One key similarity among the examples is that they all represented cooperative, not coercive, efforts. Even the new aquatic habitat conservation stamp administered by the Nebraska Wildlife and Parks Department, essentially a one-agency program, required cooperation and support from anglers and a coordinated campaign to develop the legislative support necessary for passage. Cooperation seems essential, given the mixed land ownership in most watersheds and the many competing interests. Having a coalition of various people, groups, and agencies with varied perspectives, but sharing a common vision and purpose, provides the strongest potential to build support among all interested or affected interests in a watershed.

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It should also be obvious that a fisheries agency would never be able to conduct watershed restoration or ecosystem based management alone. Despite a general feeling that we are the experts on what fish need, including management of their habitats, many other agencies have specific responsibilities for land management and other activities that can affect fish. Water quality, water allocation, pollution discharge, land use planning, agricultural or forest practices, mining, and other activities are regulated, managed, or supported by a variety of agencies and programs. Watershed restoration can succeed only with all of these interests represented in the program. This does cause a challenge for fisheries agencies, however. Fisheries managers are usually focused closely on fish habitat quality and can sometimes be suspicious of other agencies or programs that have responsibility for activities that take place in watersheds but do not necessarily support fisheries. Balancing the missions of competing agencies may be one of the largest challenges in managing watersheds.

Another important factor was that the state fisheries agency, a partner in all of the examples cited, was not necessarily the lead agency in the project. In some cases their role was only advisory and the real impetus for the project came from the cooperators. Having others take a lead role allows more total effort, given the limited staff in most agencies. It also gives cooperating groups and agencies more ownership in the program and a larger sense of accomplishment, which is particularly valuable in maintaining the enthusiasm and support of volunteer groups.

If there is a problem with this, it is that agencies sometimes are reluctant to give up control. Accepting a somewhat limited role as technical advisor to cooperators rather than being in charge requires substantial trust, which often develops slowly and only after several successful experiences with the other entity. Working with an agency or a group that has a mission or objective that may not necessarily parallel or even be compatible with the wildlife agency mission presents even more challenges to developing effective joint programs. It is also not uncommon for professional biologists to question the long-term commitment of volunteer groups or competing agencies. The reverse can be true, as well, with citizen groups often expressing suspicion of agencies. One value of forming formal groups or associations to conduct watershed programs is that their more permanent nature may allow for the time necessary to develop trust and confidence over a number of projects. Despite these challenges, collaborative approaches can work, as demonstrated by our examples, but it requires a willingness to accept and work with others as equals.

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Another element in our successful projects entailed non-fisheries agencies bringing their expertise and authority to support watershed protection or restoration. More progress can be made by other agencies recognizing responsiblilty for fisheries or watershed objectives than from a fisheries agency just trying to tell the other agency what to do. It obviously takes some time to encourage other agencies to adopt a sense of responsibility for fisheries or watershed values, and patience is required. Sometimes external motivations, like impending ESA listings, are required, as in the case of Oregon's timber operators. Other approaches would include starting small with local demonstration projects, as with the Meadow Fork relocation project. Either way, it takes a careful search for common values between agencies to establish appreciation for fish habitat as a value for the other agency.

A common thread in our examples was that they required considerable public involvement and communication. Permission to conduct habitat restoration on private lands required direct communication with land owners. Cooperative projects required motivation of people to volunteer their efforts. Residents in the watersheds needed constant information regarding what the projects entailed and how they were benefited in order to develop widespread public support. The large statewide initiatives would never have achieved legislative approval without developing public support first.

Conclusion

The AFS symposium ended with an open discussion session with the presenters and the audience. A free ranging discussion revolved around the necessity of habitat and watershed restoration to change the trends of our declining native fisheries. Despite the enormity of that task, the discussion was quite positive. The successful examples discussed in the symposium offered concrete evidence that we can accomplish much of what is needed. Concepts that build success are 1) involving the efforts and authorities of other agencies to address habitat and watershed restoration; 2) cooperating with a wide variety of citizen based organizations, coalitions, and associations; 3) involving local communities and officials in those cooperative efforts; and 4) emphasizing communication.

As a postscript, there is one additional example of these concepts in action, which was not developed well enough at the time to include in the AFS symposium. Oregon's Coastal Salmon Restoration Initiative represents a major attempt to apply all of the approaches discussed above to restore watersheds and their native salmon runs before more populations need to be listed under the Endangered Species Act. Initially conceived by Oregon's new governor, the initiative commits 11 state agencies to a common goal of restoring salmon runs in the watersheds draining directly to the Pacific Ocean. The centerpiece is coordinated action by the agencies working in concert with local watershed councils, and relying on them to involve local land owners, communities, timber and agricultural groups, and officials, and to conduct many of the restoration projects in their respective watersheds.

In the year since the initiative was first announced, a detailed plan was developed and submitted to the National Marine Fisheries Service. The intent is to have sufficient habitat restoration activities in place so that coho salmon do not need to be listed under ESA. If listing is still warranted, we expect that the initiative plan will form the basis of the recovery plan. We hope, of course, that listing won't be necessary, since we are concerned that a listing would result in a reversal of land owner, industry, and community support for the restoration effort. Unfortunately, public sentiment these days is decidedly suspicious of federal regulatory programs, and it is likely that support for voluntary restoration efforts would immediately switch to resistance with a listing.

On the positive side, it is amazing how much has already been accomplished. The Department of Transportation is replacing road culverts that do not allow fish passage. The new Forest Practices Act protects timber in riparian zones and fallen timber in the streams, with strict cutting standards along fish bearing streams. The Department of Agriculture is applying new rules restricting discharge from animal feeding operations. The Economic Development Department is screening all development proposals for impacts to fish or their habitats. The Department of Water Resources is evaluating water rights applications on a new cooperative, multi-agency basis. And the Fish and Wildlife Service is altering stocking programs, has established a new approach for determining the numbers of spawners needed to sustain populations, and has developed a new approach toward setting allowable fishing quotas to ensure adequate spawning escapement. These and many more specific actions are all pointing toward a reversal in the trends of watershed health and salmon population status.

While the ultimate outcome is not yet known, there is ample reason for hope. This massive cooperative approach to restoring our watersheds and their valuable fish runs is unprecedented. Given the myriad of causes for the declining salmon runs, only a broadly based effort that involves all coastal residents and leads to changed attitudes toward how we treat our watersheds has any real hope of making a difference. If this approach can not succeed, then there is serious question whether anything can.

BIG STONE LAKE RESTORATION PROJECT

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Big Stone Lake is located on the eastern border of South Dakota. It extends southward from Browns Valley, Minn., to Ortonville, Minn. The Lake occupies the valley of a glacial river that drained Lake Agassiz. Big Stone Lake is a 12,610 acre interstate body of water. The lake is 25.8 miles long. It has an average depth of 8 feet and 59.9 miles of shoreline. Big Stone Lake has a 740,157 acre watershed. Principal tributaries to Big Stone Lake include the Whetstone River which enters the lake from the southwest near the lake's outlet and the Little Minnesota River which lies northwest of the lake and empties into its upper end.

Water chemistry data for Big Stone Lake date back to 1883. In 1967 a Big Stone Lake study was initiated jointly by the governors of South Dakota and Minnesota. This data is supported by a 1971-1975 US Army Corps of Engineers study and a D/F Study completed during 1983. Monitoring of the lake and its watershed continued during the Phase II Step I restoration effort. The studies determined that total phosphorus levels almost always exceed the 0.50 mg/l levels recommended for lakes by the National Technical Advisory Committee. The lake is classified as hypereutrophic. Analysis of water quality data indicates that the Little Minnesota River annually contributes 48.9% of the phosphorus or 392,000 pounds and 143,200 tons of sediment reaching Big Stone Lake. Presently, agricultural sources contribute 88% of the phosphorus entering the lake.

The overall goal of the restoration effort is to increase the recreation potential and lifespan of Big Stone Lake by decreasing sediment and phosphorus loadings by 56%.

Since implementation of Phase II in 1989, 4 point sources of pollution, 34 animal waste management systems, 39 multiple-use wetlands, 10,000 acres of no-till, grass waterways, riparian projects, and other supplemental projects have been completed. This has resulted in the following improvements at the outlet of Big Stone Lake:

1. Decrease of 40% in phosphorus levels;
2. Increase of 38% in secchi readings; and
3. Increase of 30% in state park visitations.

In 1990, Roberts County became the sponsor of the project. The commissioners assigned responsibility for the project to Roberts Conservation District. In 1991, the Big Stone Lake Project office was relocated in the NRCS office. This allowed for a close working partnership.

The funding for the past projects has been made possible through the partnerships of many organizations. Initially, EPA 319 and South Dakota Consolidated Water Facilities Construction Program funds were responsible for project funding. As the project has expanded, Roberts County, Citizens for Big Stone Lake, ACP, and local funds were included. Presently, these past funds along with FEMA, US Fish and Wildlife, Ducks Unlimited and PL-566 project funds are the funding sources.

The Lower Little Minnesota River/Big Stone Lake PL-566 Project is a plan of accelerated land treatment to follow the EPA 319 funding that has been issued over the last 13 years. The sponsors of the watershed plan are the Roberts County Commissioners, Roberts Conservation District, and Marshall County Conservation District.

The recommended plan consists of the following water quality and soil conservation practices: 30 animal waste management systems, 120 acres of critical area treatment, 194 acres of grassed waterways, 47,300 acres of conservation tillage (13,500 Ac. no- till/ 33,800 Ac. minimum till), 33,600 acres of grazing management with water development, and a riparian demonstration project.

Conservation plans will be developed on an annual basis. Assistance for planning, design, and construction layout will be provided by

NRCS. The measures will be installed by the landowner/operator with his or her own forces or contracts, and in accordance with NRCS's standards and specifications.

The total cost of the project is $3,376,200. Public Law 83-566 will provide $1,993,500 of the total. Financial assistance will be made available through cost-sharing using 65% PL-566 funds and 35% local funds. Landowners/operators will apply for assistance through the Roberts and Marshall conservation districts.

The project's annual economic benefits are estimated to be $1,775,900. The annual average costs are estimated to be $400,000. This results in a benefit cost ratio of 4.4 to 1.

Vermillion River Basin Project

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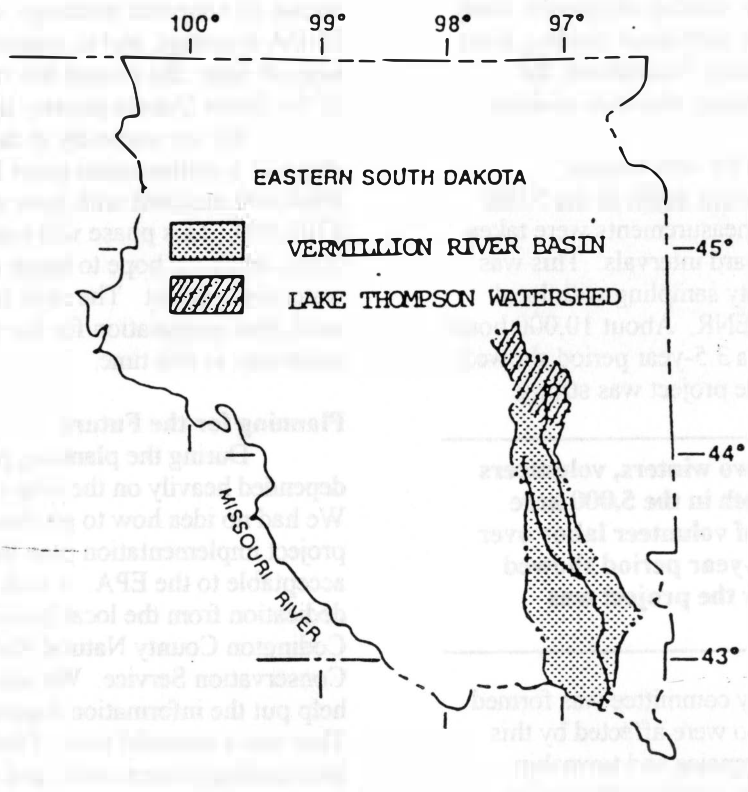
The Vermillion River Project had its origins back in the late 1950s. Land users in the watershed had organized an Upper East Vermillion River Watershed and applied for PL-566 funding. The watershed district was dissolved in 1981 because a satisfactory cost-benefit ratio was not achieved. However, the flooding problems within the watershed did not go away. High water conditions of the mid-1980s brought an attempt to form a Vermillion Basin Water Development District by SECOG and First District. A Vermillion Basin WDD was formed for the counties in the lower reaches of the watershed. The National Park Service sponsored a week-long analysis of flooding problems in 1994. Seven counties within the watershed formed a Vermillion Basin Water Management Advisory Board through the Joint Powers Authority. The seven counties, the State, East Dakota and Vermillion Basin water development districts have sponsored a upper basin study to complement the U. S. Army Corps of Engineers study for the lower basin completed in 1992. This study will be completed by March 1, 1997.



UPPER BIG SIOUX RIVER WATERSHED PROJECT
WORKING TOGETHER FOR THE WATERSHED

Mike Williams

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Partners for Success

This project grew out of a desire by the Kampeska Izaak Walton League to improve water quality on Lake Kampeska. Study after study had been done on this subject, dating back as early as 1933. The most recent was a 208 study done with volunteers in the early 1980s, but the funding was cut just after the study was completed, and the volunteers quit in disgust.

In 1989 the Ikes brought together the Natural Resources Conservation Service, the Game, Fish and Parks, and the Department of Environment and Natural Resources, at their annual meeting to ask for advice on how to proceed. The result was another diagnostic study by the Kampeska IWLA with local funding from the Watertown Community Foundation, the IWLA National Foundation, and local in-kind donated labor.

Every weekend for two winters, volunteers measured the silt depth in the 5,000 acre lake. Over 2,800 measurements were taken through the ice at 100 yard intervals. This was followed by water quality sampling with local volunteers led by the DENR. About 10,000 hours of volunteer labor over a 3.5-year period showed that local support for the project was strong.

Every weekend for two winters, volunteers measured the silt depth in the 5,000 acre lake....10,000 hours of volunteer labor over a three-and-one-half-year period showed that local support for the project was strong.

A local advisory committee was formed with all the partners who were affected by this project. Twenty-two agencies and township representatives from four counties formed the Upper Big Sioux River Watershed Advisory Board to provide leadership and planning. A meeting of watershed landowners and farm producers laid out concerns and possible solutions of the farm community in the watershed. The Board incorporated these needs into a work plan and applied for an EPA 319 grant with the City of Watertown as sponsor. During the lengthy application process, the Board began working on conservation practices with local funding.

In 1994 the EPA approved our application for $250,000 and the Ikes contributed $550,000 for a state and local match. The City of Watertown signed a contract with the EPA and appointed the Advisory Board as the working entity. Through diligent efforts by the Board to attend all nonpoint meetings, education seminars, USDA meetings, and to maintain a strong local support base, the project has remained at the top of the South Dakota priority lists.

We are currently in the implementation phase of a continuation grant from the EPA of $660,000 matched with state and local funds of $700,000. This phase will continue until the year 2000, when we hope to begin a USDA PL-566 watershed project. The river basin study and work plan preparation for the 566 project is underway at this time.

Planning for the Future

During the planning process, we depended heavily on the help of the SD DENR. We had no idea how to go about developing a project implementation plan that would be acceptable to the EPA. It took a great deal of dedication from the local board and help from the Codington County Natural Resources Conservation Service. We hired a technician to help put the information together in proper form. This was a stressful time. Meeting deadlines, anticipating project costs, and allocating monies for the different practices, writing revisions, and putting all of this in an approved format, caused some unanticipated expenses, both in the writing phase and in the implementation phase.

I suggest that new projects obtain work plans from other projects that most duplicate their watershed goals.

For example, travel expenses to this meeting were not specifically included in the work plan. We will need to cover these expenses with unused funds from other practices in the work plan. Be certain that registration fees, mileage fees, advertising expenses, small office equipment, etc. are included in administration expenses. These minor costs can cause accounting problems. However, we saved one full year of the application phase with our work.

Writing the work plan for the continuation phase was much easier, because we had a precedent to follow. Our current work plan is being used as a bench mark for other watershed projects. I suggest that new projects obtain work plans from other projects that most duplicate their watershed goals.

Watershed Management

This project has determined that soil loss and nutrient loadings of water supplies is in part a result of intensive farm practices. Soil types indicate that this is a prime farmland area within the state. However, topography of the river basin flood plain causes runoff events annually. These events cause flooding and increased soil and nutrient loss to water bodies. The best long- term plan would be to return most of the watershed to grass. This action is not currently realistic or affordable. Our short-term goals are to use Best Management Practices in agreements with land owners and producers to reduce loadings.

It is too early in the project to effectively note any water quality improvement. Unusually high water tables, cool weather, and excessive rainfall have prevented construction of animal waste systems, grassed waterways, filterstrips, and stream bank restoration. Most of the watershed has experienced historical highs in water quantity since the project started. Water monitoring will begin again in late summer in 1997.

At a time when farms are growing larger with fewer operators, and farm practices are changing, technology makes farming success more complex. Economics is driving the system to more intensively use all the land that is available, regardless of its environmental sensitivity. This is a short-term economic band aid that will require a greater cost at a later date for all of us. Education and awareness programs are gradually making headway with resource management, and that may well be the key to long-term effectiveness.

Economics is driving the system to more intensively use all the land that is available, regardless of its environmental sensitivity.

To remain a successful project you must find ways to keep it in the mind of the citizens for whom you are working. Newsletters and mailings, seem to only stimulate minor interest. One-on-one meetings in the watershed, attending farm forum meetings, fairs, livestock sales, or township meetings work better at stimulating farmer interest. Producers are interested in what a neighbor is doing more than in newsletters. Having a few key people join as cooperators in conservation is the best way to gain cooperation from others.

One interesting problem developed in 1995 and 1996 with construction work that was on drier ground. Getting someone to bid on our projects was difficult because there was so much road and bridge work in the area because of the flooding. Even when we found a contractor, coordinating engineers, contractors, and landowners to a start date took some doing. We learned that when a contractor said he would be on site first thing Monday morning, you had to ask him what month. In one instance a contractor called and said he would start on an animal waste containment structure on Monday. We called the owner, and told him to move his livestock and take down his fences in preparation. Instead of the short holiday he planned, he spent the weekend removing fence. Engineers showed up to finish staking, but the contractor did not show up for 2 more weeks. That is not the way to build a good relationship with the producer and his neighbors.

Partnerships

Partnering during the planning stage is critical to the eventual success of a project like this. If you leave anyone out of that process, you are certain to hear from them at a later date. It is a must that the sponsoring agency include all stakeholders from the very beginning. If conflict exists, mitigate it immediately. Find a common ground that is agreeable to all citizens in the watershed. From out of this group you must find one or more persons with the strongest interest to keep the wheel turning. Do not let it turn into just another government project.

Volunteers are easy to find; leaders are not. Most people will volunteer occasionally, but do not want responsibility. If you find a leader, give him your support for his term, and when he must step aside, make certain that he trains an apprentice before turning over leadership. Leaders can become focused on their own agenda if they stay in that position too long. Use citizen interest whenever possible. If they don't want to be a leader, get them involved as much as possible. They like to talk to friends about these activities. It's a great way to spread the word.

It is a must that the sponsoring agency include all stakeholders from the very beginning. If conflict exists, mitigate it immediately.

Having the best relationship with the news media that is possible is a key to keeping the project in front of the public. Your project is news, but it must be kept fresh so that the media will publish it. If at all possible, make them a partner in the project. They will tell you what is needed to make the news. Always remember to say thank you for their help.

Cost-sharing partnering includes all agencies that work for conservation. Each agency seems to have its own regulations, and those regulations are always changing. Regular meetings with agency department heads to discuss the best way to maximize all the funds available for the common goal is recommended. Our watershed project is having great success partnering with the new US Fish and Wildlife Service programs. About 60 acres of wetlands have been created with shared funds from the Service and the Project. We have also been sharing funds for rotation grazing management. Other agencies included are SD Game, Fish and Parks, Farm Service Agency, Codington Conservation District, NRCS, Ducks Unlimited, Pheasants Forever, US Forest Service, Codington County Extension Service, and the IWLA. We also have local help from the County, City, and both lake associations.

The farm producer must have a stake in this process. The more involved he is, the more successful the program. Walk them through every step in the construction process. Discuss the problems that could develop, and be there during the construction. One unhappy producer can have an effect on all his neighbors. Make him your most important partner.

Long Term Effectiveness

I have some personal concerns on the long-term benefits of the project. Since the program is a voluntary one, it could be dependent on farm economy. Taking land out of production, even if it is environmentally sensitive, has an effect on personal farm income. In recent years coming up with landowner cost-share dollars has been difficult for many. If we wind up in another recession, we could be right back where we started. It is apparent that this project may be unending.

The project does have some long-term plans that could include restoring an outlet, dredging, and diversion, but for now we must depend on the stewardship of the landowners. Only through education can the importance of the water resource problem that we face be solved voluntarily. I suggest we put more effort and money into our education problems on a local, state, and federal level.

Most of the BMP applications will have a financial impact in the long term. However, many producers look only to the short-term effects during hard times. We will need to be patient for the next few years.

A Case Study:
The Big Sandy Area Lakes Watershed Management Project

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Part I: The Components

My presentation will be a little different than you've heard from some of the other speakers today. I'm not going to tell you a lot about the scientific nature of our watershed project, because it probably wouldn't be of value for most of you to hear about Best Management Practices associated with forestry management in Northeast Minnesota out here on the prairie. I would assume that most of you here are doing good science, however science is only part of watershed management. The other part is what I'll be talking about today.

Before I begin, I would like to give a little background about myself. I was trained as a fisheries biologist at South Dakota State University and was hired by the Minnesota Department of Natural Resources to do fish management work. I enjoyed this work for several years and still do today but I became frustrated, because it seemed to me that we had a difficult time trying to get the data in the hands of the public where we could make some real changes. Often, in survey write-ups we documented resource decline but due to limited time, knowledge, or because it was perceived to be some other agency's job we weren't able to make changes in the management of the resources. In essence we did the easy work (diagnostic) but we really never talked to individuals to change attitudes.

What I would like to do is cover four points which were partially formulated on my experience as the Big Sandy Area Lakes Watershed Project Watershed Coordinator and by studying other successful projects. These are some general propositions that have worked for us and them.

1.) Comprehensive

2.) Citizen Participation

3.) Effective Partnerships

4.) Long Term

The first item I will expand on is Comprehensiveness. Our project has defined comprehensiveness in two ways: The first is to plan on a large geographical scale such as a watershed or large landscape scale (ecological unit). The second is that it must include diverse interest. This is a necessity if you are going to have broad based support to implement actions. I'm not going to spend any more time on comprehensiveness; just by your being here today you are at the very least questioning the need to look at this type of management.

The next item that I want to spend time on is citizen participation. This is where many agencies and projects fail to get good propositions off the ground. We can do all the good science we want but are not able to actively apply it because we fail to get the public sector involved.

Public involvement is sometimes viewed as an inefficient, time-wasting exercise that leads to needless hassles. However, this view does not apply in today's socio-economic environment. There are many examples of the need to get public support for implementation of management objectives. Initiatives that are well planned and scientifically based and that represent sound management practices will not necessarily succeed without broad public understanding and support.

Quite frankly, we can not do it alone. Agency folks can't do it alone and the citizens can't do it alone. The citizens rely on the agency folks for technical advice and resources and the agency folks rely on citizens because they have the political will to get items enacted. They also will take it a step further than you or I would dare to go as professional resource managers.

The citizens rely on the agency folks for technical advice and resources and the agency folks rely on citizens because they have the political will to get items enacted.

Interestingly, a couple of weeks ago I was reading Aldo Leopold's The Sand County Almanac and he wrote in there that "There is a clear tendency in American conservation to relegate to government all necessary jobs that private landowners fail to perform....It tends to relegate to government many functions eventually too large, too complex, or too widely dispersed to be performed by government....An ethical obligation on the part of the private owner is the only visible remedy for these situations." Aldo Leopold was talking about this 50 years ago and we're just beginning to talk about it again.

Let's assume for the remainder of this presentation that you agree that citizen participation is absolutely essential and that we all understand why it is essential. How do we continue to encourage and maintain citizen volunteer input and support for watershed management? Again this is another area why projects never get off the ground or fail. This is an area like the rest of what I'm talking about that doesn't just happen. It takes a considerable amount of time and effort. It's work!

You must have:

1) Sustained day-to-day citizen contacts from highly qualified and trusted agency staff;

2) Citizen involvement in decision making as full partners;

3) An ethic of "servant leadership;" and

4) Financial support for citizens by providing help with expenses associated with communication (long distance, fax, e-mail) and mileage.

Lastly, participate in community meetings at every opportunity. What you don't know **will** hurt you. A bonus to being at all meetings is that people are less likely to say negative things about you if you are present and knowledgeable. Be ready--when you begin to actively attend and participate in meetings this will mean going to meetings on week-ends and evenings. This again is a necessity if you're going to meet a broad diverse public and not just agency folks. You must attend meetings at these times because that is when these people are not working.

The third item that I will talk about that is part of citizen participation is effective partnerships. Without effective partnerships, at best you have duplicated and disjointed efforts, and at worst you have agencies working at cross purposes. Again the resource is the only loser.

Without effective partnerships at best you have duplicated and disjointed efforts and at worst you have agencies working at cross purposes.

Expect internal resistance when you begin to do this type of management and don't be surprised if you find it more difficult to work with your colleagues than with your neighbors. You know you're being effective when your colleagues begin to question whose side you are on. In order to counter this you'll need strong effective partnerships.

You'll also need effective partnerships because most of what you'll be dealing with is trying to make changes in land use. Land use decisions are made by the individuals that live there and manage the land. Local decision makers regulate land use so you had better have citizen participation and effective partnerships with local units of government if you intend on making any comprehensive changes.

Lastly, we must manage for the long term. We need to educate all partners that are managing our resources. If we want to sustain them, we must be looking 10, 20, 50, 500 years down the road. We must also educate our partners that many of the Best Management

Practices that we institute today may not show results in the resource for many years or we may never see them. This allows people to understand how complex these systems are and not to expect too much too soon. This needs to be done to have long-term continued support.

Part II: The Case Study

The Big Sandy Area Lakes Watershed Management Project (BSALWMP) has been recognized locally and nationally as a low cost, citizen initiated and citizen directed partnership. It has been identified as a prototype effort that may provide information on effective and efficient ways to successfully seek balanced management of natural resources for sustainable development and that serves as an example of Ecosystem Based Management.

We have often been asked to answer questions from individuals who see the need for watershed management but are not sure if they should attempt to initiate a similar project. For those who already have a watershed project, we're asked whether they should adopt some of the approaches used in the BSALWMP. In this report, we will attempt to answer those questions and several other related questions about watershed management. Each watershed is unique. Each has its own geographic and political boundaries, citizens, geological characteristics, land use practices, fisheries, wildlife, political structure, economic base, and civic leadership. Therefore, we recognize that management details will vary from one watershed to another. However, some basic watershed management principles apply everywhere.

Question: What is the Big Sandy Area Lakes Watershed Management Project?

Answer: It is a grassroots effort of citizens in the watershed to promote protection of natural resources. It is a voluntary cooperative project of watershed residents, local decision-makers, governmental units, and agencies. The purpose of the project is to provide a local mechanism to encourage a partnership that promotes greater protection of the aesthetic, economic, and recreational values of lakes, streams, and shoreland in the Big Sandy Area Lakes Watershed. It spans over 400 square miles and includes portions of Aitkin, Carlton, and St. Louis counties. Forested lands, wetlands, and lakes comprise nearly 80% of the 260,000 acres. A steering committee of citizen volunteers provides overall direction for the project. Policies are based upon consensus of citizens and upon technical advice from: Minn. Extension Service, Minn. Pollution Control Agency, Minn. Department of Natural Resources, U.S. Army Corps of Engineers, county boards, county Soil and Water Conservation Districts, Planning and Zoning Offices, county land departments and Minn. Board of Water and Soil Resources.

Question: Can state agencies achieve the required outcomes in resource management when the public is involved in decision-making?

Answer: Public involvement is sometimes viewed as an inefficient, time-wasting exercise that leads to needless hassles. However, this view may not apply in today's socio-economic environment. There are many examples of the need to get public support for implementation of management objectives. Initiatives that are well-planned and scientifically based and that represent sound management practices will not necessarily succeed without broad public understanding and support. Enforcement is a needed tool in making certain that those who are uninformed or are slow learners may be properly informed of their responsibilities in resource protection. Educational efforts are much more effective and much less expensive. When watershed citizens are fully aware of their potential role in resource protection, they are much more likely to see the value in following protective ordinances and in using Best Management Practices on a voluntary basis.

Question: Would you explain what you mean by the word "partnership" when used in the context of watershed management?

Answer: The term is vague but simply means "working together." While it may be easy to support the idea of working together, it's often not easy to put the idea into practice. Partnerships form: a) around opportunities, such as reduced cost, improved efficiency, and quality of service, greater innovation, broader expertise, and improved image and b) in response to dilemmas, such as resource scarcity, fragmentation, problem solving, and crises.

Finding reasons why we should work together is easy. But maintaining successful partnerships is difficult because partners must sacrifice autonomy and use scarce resources that entail loss of: a) flexibility, b) ability to act, and c) glory. Benefits of partnering will outweigh costs only if a partnership is well implemented and managed. Partnerships are complicated and dynamic. Partnerships are not always the answer to resource management problems. They must be appropriate for the task at hand, for the people involved, and for the ability of partners to share power or to commit time and resources necessary to achieve goals.

Partners may work together in three different organizational strategies: 1) Cooperation--A partner uses its resources to assist other partners. Partners choose to work together but make decisions independently. 2) Coordination--Partners organize or combine their resources to more effectively reach a goal. Partners make their own decisions but do so after discussion with others. 3) Collaboration--Partners collectively apply resources toward problems which lack clear ownership. Decision-making is collective. May form a new entity to manage resources (E.Hubbard, 1995).

Question: How was the BSALWMP initiated and how is it being implemented?

Answer: Top-down and bottom-up strategies are balanced. Consensus approaches, not grenade or bomb throwing, are encouraged. New ways to approach resource conservation are explored. All stakeholders are involved. Expanded volunteer involvement is encouraged. Scientifically-based decisions are supported through extensive diagnostic work. Educational efforts are continuously supported. Continued funding is carefully and vigorously sought. Citizens provide checks and balances that may reduce the inertia that often plagues local governments and agencies when changes are needed or when practices are at odds with good resource protection and management. For many of us, including agency staff, it is difficult to release or to share control, to share credit for successes, to be willing to try new methods, and to be willing either to admit to or to correct mistakes. Further, larger organizations, such as the MDNR and MPCA, may sometimes be defensive and permit incompetence. Challenging staff who are senior to the critic or who are in another unit that might take offense if someone in the organization questions their actions may lead to retribution, to chronic bad relations, and to poor performance. As a result, little or nothing critical may be forthcoming. Therefore, while honest comment may be needed, nothing may be said for fear that bad consequences will happen when the smoke clears. Volunteers, on the other hand, may not generally have an adequate scientific background to comment on details of many management issues but they should have less reason to be inhibited in their suggestions and criticisms and, hopefully, will usually offer something that is both constructive and heartfelt.

Question: How can agency staff and others improve their role in protection of natural resources?

Answer: Emphasize inclusiveness. Early and throughout the process involve people with varied backgrounds and interests. Identify roles and functions of partners. Share information. Set goals. Some partners should represent interests of future generations. Representation should be sufficient to make outcomes stick. Ways must be found to balance power at the table using money, technical help, and knowledge, voting and veto structures. Develop an ethic of "servant leadership" by government partners. Improve and expand the agency's capability to professionally advertise and market management ideas and strategies. Most agencies do not retain experts in message delivery. Agencies need to groom scientists with communication and social science skills in addition to their scientific expertise.

Question: Do you have examples of how the BSALWMP partners have successfully worked together to protect and enhance resources?

Answer: Yes, the list below includes some notable examples.

1. Completion of a 2-year diagnostic study of nutrient loading from the major tributaries of Big Sandy Lake, which requires establishing water level gauges, mapping land use in shoreland and other areas, surveying on-site septic systems, designing lake assessment programs, educational programs and workshops

for a citizen task force, monitoring permit compliance, and writing a plan and application and receiving approval for a Phase II Grant, Implementation Phase (1996-1998) of a Clean Water Partnership are noteworthy.

2. As a result of: a) educational efforts, b) citizen involvement in advisory committees at the township and county level, c) newsletters, and d) workshops, shoreland ordinances are being followed more carefully, county boards are more supportive of efforts to protect resources and encourage use of Best Management Practices, and lake associations have increased efforts among shoreland property owners to protect water and shoreland resources.

3. An educational 18 minute video tape, "On Common Ground," was prepared. Over 300 copies have been distributed. The video tape has been used at many meetings to assist in informing watershed residents about the importance of everyone working together to protect valuable water resources and how citizens can help to protect water resources through use of Best Management Practices.

4. In cooperation with staff from the University of Minnesota Extension Service and Department of Horticultural Science and the Minnesota Board of Water and Soil Resources, shoreland property owners on Big Sandy Lake are participating in a 5-year pilot revegetation research project in 12 selected sites to establish improved natural upland and aquatic vegetation.

5. An extensive erosion problem at the Prairie River inlet to Big Sandy Lake that had existed for over 30 years was repaired with funds provided by the Minnesota Board of Water and Soil Resources and technical advice provided by the Aitkin County SWCD.

6. Several new volunteers of the MPCA's Citizen Lake Monitoring Program began taking and recording transparency readings for watershed lakes.

7. McGregor and Cromwell Schools were provided with guidelines for the 1996 National Environmental Poetry and Poster Contest for students in K-12 and encouraged to submit entries with the contest theme "watersheds." Copies of the video tape "On Common Ground" were donated to the schools by the Big Sandy Lake Association. Thirteen entries were submitted for judging in both local contest as well as in the national contest.

8. The Aitkin County Board of Commissioners, a group that has been very supportive of the watershed project, has recently taken three important steps in environmental protection: a) adopted an ordinance that regulates extractive land uses (gravel pits), including appropriate reclamation of areas when mining is completed, b) drafted and adopted an ordinance to regulate land application of residential septic tank waste, and c) established a position of Assistant County Attorney to be filled by an individual who would be responsible for issues of ordinance violations and for attending meetings of the Board of Adjustment and Planning Commission to provide legal counsel on the many occasions when it is needed.

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Renwick Dam Watershed and Icelandic Aquifer Case Study of Watershed Implementation Project

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Description of Project Area

The Tongue River Watershed is located in Pembina County in the far northeast corner of North Dakota. It joins the Pembina River prior to merging with the Red River of the North at the City of Pembina. During the 1950s and 1960s, ten flood control structures were built throughout the Tongue River Watershed. Controlling water quantity was the top priority during that period. By 1988, improving water quality became the unifying goal.

The Renwick Dam Watershed/Icelandic Aquifer water quality project began in 1991 with a proposal for section 319 funding. This area includes the 99,161 acres in Pembina and Cavalier counties of North Dakota along the Tongue River. The Icelandic Aquifer is included in the project because of its proximity and hydraulic connection to the Renwick Reservoir. In addition, the well field for North Valley Rural Water system which supplies water for 13,000 people in the county is located in the aquifer and uses Renwick Dam as a contingency water supply. Since Renwick Dam was constructed by the Soil Conservation Service in 1971, the Icelandic State Park has been developed and is an important tourist attraction in the county with over 125,000 visitors annually.

Water Quality Concerns/Comprehensiveness

Renwick Dam is hypereutrophic, with profuse algal blooms occurring in the summer and low dissolved oxygen common in winter. The primary water quality concerns for the reservoir are sedimentation and nutrient loading.

Since the unconfined Icelandic Aquifer is overlain by 2 to 24 feet of highly permeable material, the leaching of nutrients and herbicides used in agriculture are the main concern. The project targets dryland agricultural practices to alleviate nonpoint source pollution from dryland agricultural practices. Both technical assistance and cost share payments for Best Management Practices are provided. During the past 2 years, two irrigation permits were approved in the project area. Sponsors have expressed interest in continuing the project, especially over the aquifer, to ensure that management practices implemented on the irrigated acres are effective in preserving water quality.

Streams and rivers in the watershed are entrenched and paralleled by strongly sloping to very steep slopes. This cross-section suggests land use changes that have increased delivery of water to the drainage network. Both the removal of native timber and the reduction in moisture holding capacity of the soil explain this adjustment. The riparian vegetation has been progressively degraded by grazing practices and removed for agricultural production. In hindsight, it is evident that the comprehensiveness of this project would have been improved by including incentives for the maintenance, enhancement, and management of native timber resources and the development of additional riparian buffers throughout the watershed. These resources will be an important component of watershed activities in the future.

Citizen Participation

Several events have been planned during the project period (1992-1997) to increase the public awareness of the project. Each year, the watershed conservationist prepared a display for the County Fair. The conservationist made annual presentations at all elevator meetings hosted by the county agent. The conservation tours for 7th graders in the county focused on the Renwick Dam. Third graders in the county were treated to a visit from "Sam Ting", an interesting Norwegian settler who mixes conservation lessons with humor.

The most interested citizen group in the county throughout the project is the Board of Directors of North Valley Rural Water system. The Board's interest was increased when irrigation over the aquifer began in 1995.

Partnerships

Several local sponsors provide matching funds of $13,000 annually for the project:

Pembina County Commission
Pembina County Water Resources Board
Pembina County Soil Conservation District
North Valley Rural Water
North Dakota State Park and Recreation
North Dakota State Game and Fish

The Section 319 Program provides 60% of the cost of personnel in addition to cost share payments. Producers throughout the project area entered into contracts for implementing Best Management Practices.

Both Water Quality Incentive Program (WQIP) and Section 319 funds were available for cost-share. Crop residue use was the most commonly implemented Best Management Practice (BMP). Several producers also began Integrated Crop Management and conservation tillage and received cost-share payments. The soil savings results of these practices are quantified below.

42 plans for WQIP funds -- 78,211 tons of soil saved annually

11 contracts for 319 funds -- 40,726 tons soil saved annually

Figures 1 and 2 illustrate the land use changes and treatments in the watershed.

Monitoring Results

The surface water monitoring program data are shown in Table 1. Samples were collected on a tributary to the Tongue River, and on the main stem of the Tongue just upstream from Renwick. Figure 3 illustrates a slight improvement in water quality in the tributary sub watershed. Figure 4 indicates that the trend for the entire watershed has not been reversed as a result of the efforts in this watershed.

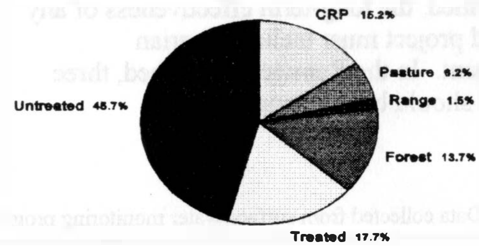

Figure 1. Renwick watershed land use including treated areas.

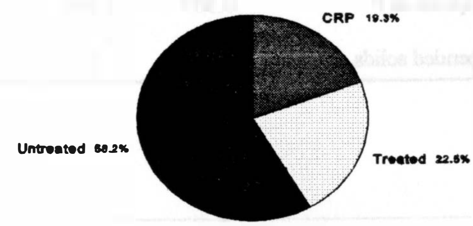

Figure 2. Treatments in the Renwick watershed.

Long-Term Effectiveness

As this project comes to a close, it will be important to maintain and further develop the concept of watershed identity. In the Red River Basin, flooding is an obvious illustration of the watershed concept, but is unfortunately often divisive. Water quality goals can be a connecting issue, one that brings together a number of interests to reach a common goal.

The producers who have participated in the project will be surveyed next month regarding the changes they have made in their operations. The most common BMPs in the area are residue use and integrated crop management. Many producers have upgraded equipment to be better able to deal with more residue, and will likely continue that practice.

Since riparian buffers play such an important role in nutrient and sediment cycling in the watershed, the long-term effectiveness of any watershed project must include riparian management. In the Renwick watershed, three strategies should be implemented:

1. Preserve native woodlands;
2. Establish buffers of sufficient width throughout the watershed; and
3. Improve/Maintain vigorous growth in the riparian community.

Table 1. Data collected from surface water monitoring program.

	Monitoring Site 380111				Monitoring Site 380112			
	1993		1994		1993		1994	
Water Quality Parameter	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Total ammonia as N	0.248	0.061	0.49	0	0.106	0.092	0.014	0
Total nitrogen as N	1.672	1.009	1.951	1.327	1.644	1.106	0.891	0.84
Total phosphate as P	0.307	0.207	0.278	0.252	0.278	0.198	0.204	0.172
Total suspended solids	101.2	31	186.8	66	127.9	31	39.4	23

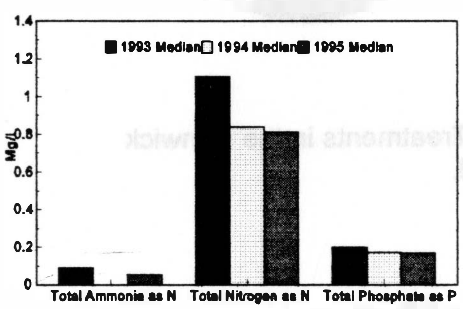

Figure 3. Water quality trends for a tributary subwatershed (Site 380112).

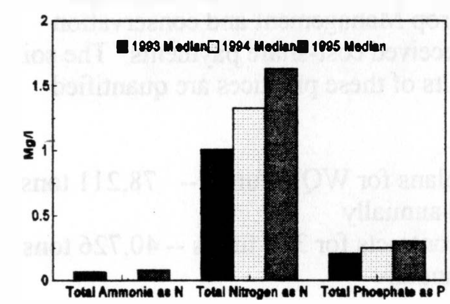

Figure 4. Water quality trends for the Tongue River (Site 380111).

Other Information

* A Characterization of Workshop Attendees

* Videos on Watershed Management

* Appendix A. Responses to Workshop Terminology Questions

* Appendix B. List of Workshop Attendees

A Characterization of Workshop Attendees

Craig L. Milewski and Charles R. Berry

Department of Wildlife and Fisheries Sciences
South Dakota State University
Brookings, SD 57007

Managing the resources at the watershed level requires cooperation among diverse professional fields of interest, some baseline technical understanding of natural processes, a basic concensus of environmental health and concerns, and perhaps intimate experiences with the resources outside the formal work place. A short survey was distributed to workshop attendees during the first morning of the workshop. The survey was designed to characterize 1) professional duties, 2) familiarity with natural processes by defining commonly used terminology, 3) opinions on river health and watershed concerns, and 4) recreational uses of the rivers by workshop attendees. Of the 109 workshop attendees, only 41 attendees responded to the survey.

Professional Duties

A diversity of job related duties was listed (Table 1). Most had duties associated with conservation. However, this is a broad field with many other duties (e.g., agronomy and range) inherently part of this category. Nevertheless, the types of duties do show the diversity of disciplines of watershed managers.

The workshop drew participants with responsibilities covering all of eastern South Dakota; however, many participants had responsibilities in a specific watershed in eastern South Dakota (Figure 1; black bar = 1995 workshop data; grey bar = 1997 workshop data). The survey results also show that job responsibilities related to a particular river were less than 50% (Figure 2).

Familiarity with Terminology

Participants were asked to define the following: watershed, riparian area, ecosystem, and watershed management. The majority of definitions provided by attendees for these terms suggested an understanding needed for interdisciplinary discourse on watershed management approaches.

Table 1. List of disciplines and the number and percentage of job duties in each.

Discipline	Number	Percentage
Administration	16	39.0
Agronomy	9	22.0
Biology	15	36.5
Chemistry	4	9.8
Conservation	27	65.9
Hydrology	13	31.7
Range	10	24.4
Research	12	29.7
Other	6	14.6

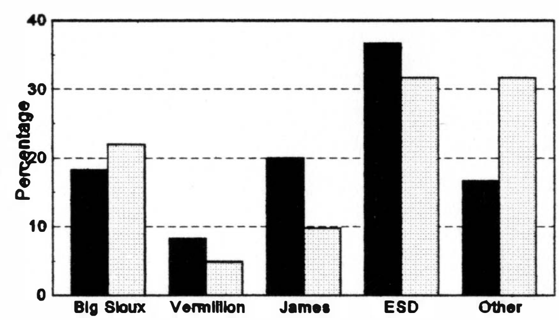

Figure 1. The number of participants with responsibilities within a specific watershed. Note that many had responsibilities that encompassed all of eastern South Dakota (ESD).

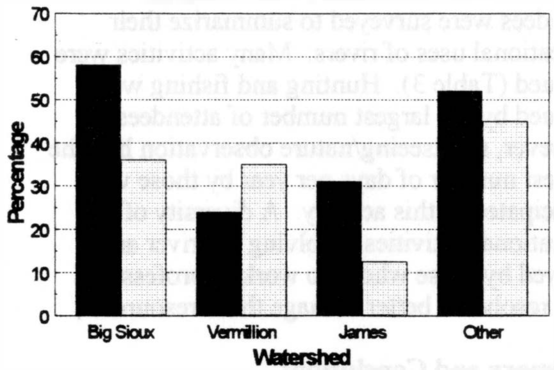

Figure 2. Mean percentage of job responsibilities related to an eastern South Dakota river.

Watershed.--Of 35 responses, 34 related to the concept of an area where water drains to a certain point or water body. Eight responses also referred to sub-surface movement of water. A few responses referred to movement of materials other than water.

Riparian Area.--Of 34 responses, 32 conveyed the idea of an area along a river or other aquatic system. Terms used were transition zone, boundary, border, or buffer. Seventeen responses explicitly included vegetation in the definition, which suggests an understanding of the important role of vegetation. Eight of the responses showed a recognition that interactions with upland and stream processes are part of a riparian area.

Ecosystem.--Of 29 responses, 26 recognized a definable area, boundaries, or system. Twenty responses referred to both biotic and abiotic components (a few explicitly included humans), and 14 responses included the idea that these components interact.

Watershed Management.--Of 32 responses, 17 indicated a conceptual understanding that watershed management encompassed all the components of a watershed. Terms used were "holistic," "comprehensive," and "ecosystem." Most other parts of the responses were equally general and, for some attendees, may fall under the umbrella of "comprehensive". For example, definitions included general ideas related to management or planning with all stakeholders and interested parties (5 responses), to protecting and restoring the resources (8 responses), and improving landuse practices or human activities (6 responses). Specific problems of erosion, sedimentation, and water quality were included in at least 6 responses. Only 2 responses specifically included maximized production. There were no responses that specifically included long-term planning and effectiveness or vision statements.

Definitions for "watershed management" seemed more varied compared to the other terms. Most surveys were completed before the case history session. Perhaps, responses would have been less varied if surveys were completed after the session of case histories.

Opinions of River Health and Watershed Concerns

Opinions on river health and on the relative importance of tributaries vs. mainstems were remarkably similar to the watershed management workshop held in 1995 (Figures 3 and 4). Perhaps the similarities in opinions reflect a consistent assessment and understanding of the conditions of the rivers and watersheds. When

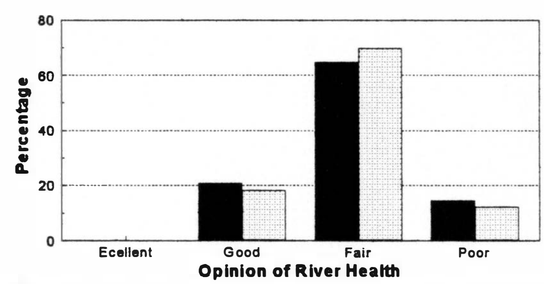

Figure 3. The percentage of responses by workshop participants for opinions of river health.

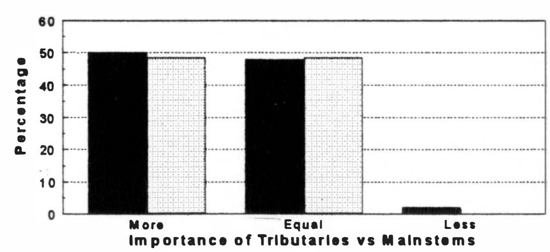

Figure 4. The percentage of participant ratings of the importance of tributaries vs mainstem reaches.

asked why a river was anything less than excellent, the majority of replies were related to nonpoint source pollution (or water quality) and to siltation. In agriculture-dominated landscapes these are the common problems.

Although NPS and siltation are common problems, and were listed as current and future concerns in watershed management (Table 2), the vast majority of concerns were related to general, large-scale approaches to management and to approaches that require cumulative efforts at local or site-specific areas to be successful. The general, large-scale approaches were described as planning and management concerns such as aquifer protection, conservation reserve program, long-term solutions, landuse planning, multiple-use management, riparian zone management, statewide watershed prioritization, and sustainable natural resource management. Local, site-specific management approaches that were described are concerns that are addressed with a landowner-by-landowner approach such as agricultural waste management, best management practices, conservation tillage and residue management, and integration of new technologies.

Recreational Uses of Rivers

Aside from duties and concerns, attendees were surveyed to summarize their recreational uses of rivers. Many activities were pursued (Table 3). Hunting and fishing were pursued by the largest number of attendees. However, sightseeing/nature observation had the highest number of days per year by those who participated in this activity. A diversity of recreational activities involving the river are enjoyed by those who also work in professions with resolve to better manage these resources.

Summary and Conclusions

Workshop attendees are familiar with the major problems affecting land resources in eastern South Dakota. And clearly, their concerns lay primarily with large-scale long-term planning, which is appropriate for watershed management; and with management practices that require landowner support locally at specific sites, which is appropriate for the size and number of farms in eastern South Dakota.

Furthermore, workshop attendees have more than a professional interest in managing the resources. The fact that they use rivers for enjoyment, like many other people in South Dakota, may actually compel them to be more concerned for a healthy environment.

Table 2. Potential current and future concerns in the management of watersheds listed by workshop attendees.

Concern	Current	Future	Concern	Current	Future
Ag waste management	x	x	Herbicides/pesticides/ fertilizers	x	x
Aquifer protection, ground water quality	x	x	Instream flow	x	x
Best management practices	x		Lack of regulatory function	x	
Channelization, snag removal		x	Landuse planning		x
Conflict resolution	x		Long-term solutions		x
Conservation reserve program		x	Maintaining interest	x	x
Conservation tillage, residue management	x	x	Monitoring		x
Contamination	x	x	Multiple-use management	x	
Corporate farms	x		Nonpoint source pollution	x	x
Development, increased		x	Nutrient loading	x	
Erosion	x	x	Ordinances		x
Exotic invasions		x	Population pressure	x	x
Flooding, flood control	x	x	Recreation		x
Farming intensity, intensive cropping patterns	x	x	Riparian zone management	x	x
Fish, wildlife, migratory birds	x	x	Sedimentation/siltation	x	x
Funding projects, stable funding	x	x	Statewide watershed prioritization		x
Grazing, rangeland condition/health	x	x	Sustainable natural resource management	x	
Integration of new technologies		x	Urban stormwater	x	
Economic benefits, showing		x	Water quality, improvements	x	x
Source identification	x		Wetland losses/drainage	x	x
			Wellhead protection areas	x	

Table 3. Summary of recreational uses of South Dakota by workshop participants. Mean and median values apply only to attendees who listed the use.

Use	Number of Participants	Number of Days /Year	
		Mean	Median
Camping	3	4.7	2.0
Canoeing/boating	9	4.6	2.0
Fishing	19	11.8	8.0
Hunting	13	8.1	7.0
Sightseeing/nature observation	6	29.7	22.5
Swimming	3	10.0	10.0
Trail use	5	6.8	5.0

Videos About Watershed Management

WE ALL LIVE DOWNSTREAM

We All Live Downstream is an educational video that examines Oregon's Tualatin River, a waterway that struggles to survive under pressure from nonpoint source pollution. Like many fresh water supplies across our nation, the Tualatin absorbs pollution from a variety of sources. This video examines how local residents and government officials are trying to reduce nonpoint source pollution. It also offers tips to help each of us play an active role in cleaning up our nation's drinking water supplies.
28 minutes

Source
Publications Orders
Agricultural Communications
Oregon State University
Administrative Services Building A422
Corvallis, OR 97331-2119
Phone:(503) 737-2513; Fax: (503) 737-0817
$30

THE WEALTH IN WETLANDS

This video features five farmers telling why they keep their wetlands. Each explains personal convictions on the values of wetlands, in terms of both the farming operation and personal satisfaction.
Also included are:

- brief overview of wetlands losses;
- restoration methods; and
- sources of help in wetlands conservation and restoration in the United States.

23 Minutes

Source
National Association of Conservation Districts
P.O. Box 855
League City, TX 77574-0855
1-800-825-5547
$10

SOUTH DAKOTA UNDERWATER HABITAT A FISH-EYE'S VIEW

This video features underwater film footage from lake and river habitats in South Dakota. The video explains the different habitat requirements of fish in these two habitat types.

Source
SD Dept. Of Game, Fish, and Parks
Division of Wildlife-Education Services
Foss Building
523 E. Capitol
Pierre, SD 57501
Phone:(605) 773-5511; FAX: (605) 773-6245

RUNNING WILD REBUILDING STREAMS FOR SALMON

This video reviews numerous stream restoration techniques and efforts being conducted in the Columbia River Basin. The video specifically addresses mitigation activities by Bonneville Power Administration in restoring salmon runs which were severely reduced after the construction of numerous hydroelectric dams on the Columbia River. Also included is a brief overview on the life history of salmon.
15 minutes.

This video was produced by the Bonneville Power Administration and the Department of Energy.

Source
Charles Berry
South Dakota Cooperative Fish & Wildlife Research Unit
Box 2140 B
SDSU
Brookings, SD 57007
Phone:(605) 688-6121

CLEAR CREEK HABITAT ENHANCEMENT

This video describes restoration efforts which were conducted on the Umatilla National Forest in Northeast Oregon. Dredge mining activities during the early part of this century resulted in a severely altered stream channel devoid of quality salmon habitat. Restoration efforts included the construction of rock and log weirs, rip-rap shorelines, log deflectors, channel relocation, and planting riparian vegetation. The video was produced by the U.S. Forest Service.
13 minutes

Source
Charles Berry
South Dakota Cooperative Fish & Wildlife Research Unit
Box 2140 B
SDSU
Brookings, SD 57007
Phone:(605) 688-6121

LAKE RESTORATION AN INVESTMENT THAT PAYS OFF

This video, produced by the Iowa Department of Natural Resources, addresses the causes, effects, and treatment of nonpoint source pollution in lakes. The video gives an example of lake restoration on Swan Lake and the positive effects it had on recreational usage of the lake. After restoration, fishing activity increased 800 percent and camping activity more than doubled. An economic evaluation of the project is included in the video.
21 minutes.

Source
Charles Berry
South Dakota Cooperative Fish & Wildlife Research Unit
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Phone:(605) 688-6121

WILLOW POST STABILIZATION TECHNIQUES

This video describes a method of streambank stabilization utilizing transplanted willow shoots. The effectiveness of this technique is demonstrated during flood and post-flood conditions.

Source
Illinois State Water Survey
1320 S.W. Monarch, P.O. Box 697
Peoria, Illinois 61652-0697
Phone: (309) 671-3196 FAX: (309) 671-3106

NONPOINT POLLUTION CONTROL

This video describes methods of reducing urban streambank erosion with the use of "Lunkers." An example of park restoration in Waukegan is highlighted and the recreational benefits are discussed.

Source
Illinois State Water Survey
1320 S.W. Monarch, P.O. Box 697
Peoria, Illinois 61652-0697
Phone: (309) 671-3196 FAX: (309) 671-3106

LUNKER APPLICATIONS IN ILLINOIS STREAMS

This video describes methods of reducing streambank erosion with the use of "Lunkers." These structures consist of wooden pallets placed along eroding shorelines, which are then covered with soil and rock. The result is a stabilized, undercut bank which provides quality fish habitat.

Source
Illinois State Water Survey
1320 S.W. Monarch, P.O. Box 697
Peoria, Illinois 61652-0697
Phone: (309) 671-3196 FAX: (309) 671-3106
8:33 minutes

PARTNERSHIPS FOR WATERSHEDS

This video focuses on the formation of local partnerships in watershed improvement projects. Sources of point and nonpoint source pollution are identified along with solutions for correcting various problems. Several examples of local partnerships restoring watersheds are detailed.
13 minutes

Sources
Video, Teleconference, and Radio Division
Office of Conservation
U.S. Dept. Of Agriculture
Washington, D.C.

WHAT MAKES A QUALITY LAKE

This video is an introduction to an environmental issue that concerns many people - lake eutrophication or the nutrient enrichment of lakes. Also discussed are the distinct expectations that various user groups have when it comes to creating a "quality" lake.
24 minutes

Sources
University of Florida
Institute of Food and Agricultural Sciences
Center for Aquatic Plants
Information Office
7922 N.W. 71st Street
Gainesville, Florida 32606
Phone: (904) 392-1799

Appendix A. Responses to workshop terminology questions.

What is a watershed?

Area which drains into a tributary or a river.

A catchment or basin that provides runoff to given stream.

1) A watershed is defined initially by a downstream point on a main drainage 2) the surface area, defined by topography, is the area contributing to flow 3) the groundwater subsurface interaction , 4) and the ecosystem therein.

A naturally bounded area which provides for mixing interactions of atmospheric, land surface, and subsurface contributions, while the boundary on the surface may be fairly clearly defined by topography, the subsurface boundaries are less well established.

Drainage area for surface water movement.

A surface area which contributes to a water area - surface or ground.

The drainage of pot holes/wetlands. The area that needs to have a drainage system put into use.

Land area contributing to a waterbody.

An area that determines the flow (divide) of rain-event run-off.

Is a drainage basin.

The area which contributes runoff water to a particular point.

Area that "contributes" water to a larger body of water.

Aquatic systems and land base that have an influence on a specific water body.

All area contributing to a source/pt.

The area of land contributing discharge to some point of interest downstream.

The area where surface runoff contributes to a point defined stream or lake at a defined point.

The geographic area above a certain point that contributes both surface and ground water to that point. The size of a specific watershed is dictated by the geography of the land.

All the area which contributes runoff to a major/minor tributary/lake.

Entire surface area of drainage that contributes to a waterbody (ie stream or lake).

An area that drains based on runoff to a concentrated flow.

Land surface area that contributes surface water runoff to a concentrated flow, such as a river.

Area of land which carries, collects, holds, or stores water in association with a particular drainage system in question including tributary streams, reservoirs, wetlands, aquifers, and the area of land around these which directs water into them.

Entire surface drainage area.

The entire surface area of the landscape that drains into a waterbody - either lakes or streams.

An area representation of water that limits its travel after falling as precipitation. This limit also affects all natural resources, etc. in and near the area.

Areas that contribute surface flows to a waterbody.

The total area that drains to one certain area.

Land area drainage to a water body such as a stream, river, or lake.

Total land area that drains to a common point.

An area that contributes surface water and ground water to a given river or lake.

The geographical area which contributes surface water to a lake, stream or river.

A defined boundary of the landscape that water drains from.

Area of land drained by a network of water courses to a particular body of water. Includes surface and ground water.

A land surface area that drains to a common point or outlet.

Geographic area which all precipitation and ground water drain toward a common point.

What is a riparian area?

Area bordering the river often composed of forested areas.

Buffer area along a waterway that is protected from degradation.

The area along a water boundary that reflects the transition from what might be upland down to the water surface.

A boundary region along the sides of a river or stream which provide physical, chemical, and biological stabilization to the watershed outlet processes.

Stream, river, and wetland areas near the banks.

Transitional area between the water in the stream and the upland area. The area adjacent to a stream which holds mostly wetland plants. Very productive part of the stream in terms of gross production.

The area that makes up the vegetation on the river or stream edges/banks.

Area adjacent to a waterbody.

An area near and bordering a stream/river/lake.

A zone along waterways.

Area immediately adjacent to rivers or streams which is affected by that stream.

Zone along a stream where there is interaction between the stream flow and bank vegetation.

A riparian area is the unique corridor of habitat that is influenced by the adjacent river, stream, lake or other wetland.

Where fluctuating water affects soil/plants/animals.

The boundary area along riverine systems between the terrestrial and aquatic habitat.

The area influenced by the water associated with a stream, river, or wetland.

The corridor area along a stream or river that is affected by the hydrology of the stream or river. The area is characterized by a unique vegetation community and soil composition different from the surrounding upland area.

An area adjacent to a stream.

Areas adjacent to water characterized by a unique plant community.

It is the area adjacent to a stream, riverine corridor not to include total floodplain.

Linear area such as river, creek, channel of concentrated flow of surface water.

The terrestrial component of a watershed.

The area around a water body that is comprised of hydrophytic plants.

A corridor along streams related to type of vegetation and aquatic organisms that is needed by wildlife. A special small ecosystem.

Area adjacent to waterways which contains vegetative species not found in abundance in the upland areas.

An area around a moving water source floodplain stream banks, etc.

Land area adjacent to a stream, river, or lake which directly impacts on the flow and/or water quality of the water body.

Area of land adjacent to a lotic stem including channel and floodplain.

The plant community that exists between upland habitats and aquatic habitats.

The area of vegetation which borders a water body.

A vegetation area immediately juxtaposed to a stream or river.

"The green ribbon." Streambanks and area adjacent to a waterbody. Supports additional vegetation: trees, willows, etc.

The zone between uplands and rivers where the streamside vegetation interacts regularly with flow dynamics.

Land immediately adjacent to water, including land that influences water.

What is an ecosystem?

The whole system look - every critter, plant, etc.

A group of organisms and habitat interacting as a unit. The physical, biological and chemical characteristics and their interactions and continuum.

Ecosystem is a conceptual construct or classification that considers all the physical, biological, chemical interactions and impacts that occur within a defined area.

Interdependent flora and fauna communities.

The place where something lives including all things that do and don't affect it.

Made up of all living and non-living things in an area.

The wildlife and microorganisms in a particular area.

Is an inorganic and organic community.

An area which has unique characteristics (flora or fauna), which are specific to that area.

Interaction of environmental/biological factors in an area (could be any size).

An ecosystem is a group of biotic and abiotic entities and their interactions.

Any area with an environmental boundary.

A system consisting of all the physical, biological, and chemical resources and all of the interactions between these.

The interrelationship of living things in a defined area (microcosm or the world) and the effect of biological, physical, and chemical processes on those living things.

A defined geographic area that is characterized by ecologically similar vegetation communities, and is influenced by similar climatological events.

Includes all needed elements - animals, plants, nutrients, air, sun, etc. to sustain itself.

The interaction of soil, water, air, plants, and animals.

It is the interaction(s) of all factors within a specified community.

Some type of community, plant, animals, etc. and how it relates to environment and the rest of its surroundings.

A watershed could be considered an ecosystem if all living organisms (terrestrial and aquatic) within it were considered, as well as geological features.

An ecosystem is the area which is being studied.

An area within the landscape representing similar climate, soils, and habitat that should determine landuse.

Dynamic relationship between man, animals, bio-species and vegetation.

The typical animals, plants and human interaction in a certain geographic area.

The inter-relationship of natural resources and living organisms within a defined geographical area having common ecological factors.

Interaction of soil, water, air, plants, and animals in a common area.

The relationship between soils, water, animals and plants of given area.

It is a region defined by the user defining an area with its abiotic and biotic features.

Any defined landscape unit used to understand biotic and abiotic structure and function.

All organisms and the environment in which they occur.

What is watershed management?
Process of researching and managing ecosystems and riparian areas within watersheds.

Understanding the process and interaction of the watershed ecosystem with development due to anthropogenic activities. Controlling these activities to maintain ecosystem balance through prevention and restoration.

Watershed management is ecosystem management.

I don't know. Perhaps to reduce the effects of resource use closer to its pre-human occupation.

Managing the resources in a watershed to reduce erosion and nutrient inputs to water sources. These management practices many times benefit the producer as well.

The developing of a plan or system to get drained without endangering land, downstream banks, and/or vegetation along banks of stream.

Protecting natural resources within a defined area.

Trying to alter and improve existing practices to benefit the watershed's quality.

Where you manage the ecosystem of a drainage basin.

Management of all factors which might influence the flow of water from that area and quality of water.

Improving quality of water in a watershed through various practices to reduce erosion, sedimentation, and nutrient loading.

A holistic approach to solving water quality, fisheries/wildlife and use issues within a watershed.

Natural resource planning on the entire watershed.

All activities in a watershed may have some impact within the watershed or outside the watershed downstream.

Administrating and implementing practices designed to address a certain problem or problems identified in a certain watershed. The practices may be watershed and/or soil conservation practices, practices to address nonpoint source pollution, and even managing the watershed stakeholders.

Management of all ecosystems in a watershed.

Management of the resources based on looking at the big picture.

It is the management of individual aspects (sometimes manipulation) of a watershed dependent upon individual and community objectives!

Wise use of SWAPA in watershed area, protecting, managing, improving resources.

It's what I'm here to learn, but I would guess the management of everything in the watershed including plants, animals, water levels, wetlands and wetland drainage, farming practices, grazing, logging, and any other activities.

The encouragement of physical or management practices that reduce soil erosion, improve range conditions, and improve water quality and riparian areas.

Stewards of the land whether landowners or local, state, and federal agency staff doing good planning and then implementing programs for wise use of the land and the natural resources.

Proper management of the landuses and operations to ensure that the natural resources are improved and/or protected.

To manipulate a watershed to maximize production while protecting environmental concerns.

Ethical stewardship of the natural resources within a watershed by all the stakeholders: landowners, government, recreation sector, etc.

Manipulation of a watershed to gain maximum production while improving environmental quality.

Making and implementing management decisions about resource conservation on a watershed basis.

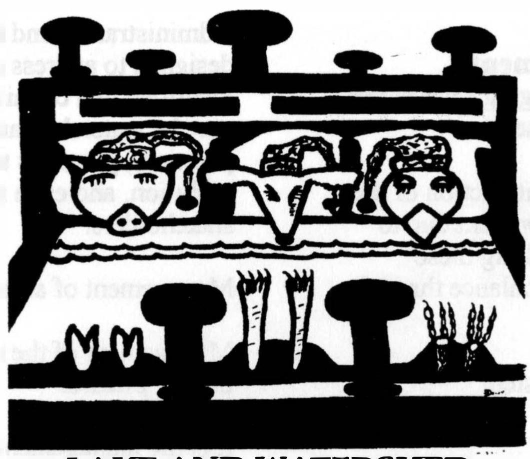
Managing the air, water and land located within the watershed, and communicating with all people affected by that watershed.

It is management of a defined area - management of the aquatic and terrestrial components of a defined area to maintain the biotic integrity and habitat within the basin.

Should be a method of balancing competing needs and priorities in a watershed. Goal of watershed management is to maintain and improve the health and integrity of aquatic ecosystems using comprehensive approaches.

Comprehensive management of large-scale watershed processes, site-specific attributes, and human choices on a continual, flexible basis.

A holistic approach to considerations involving a geographic area that shares common drainage.



LAKE AND WATERSHED MANAGEMENT MAKES STRANGE BEDFELLOWS.

Appendix B. List of workshop attendees

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