EVALUATION OF RESTORATION PROJECTS: ARE THERE ELEMENTS OF PROJECTS THAT EXISTING ANALYTIC TOOLS DO NOT DESCRIBE? HOW SHOULD THESE ELEMENTS BE INCLUDED IN PROJECT EVALUATION?

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I. PROLOGUE

What is the problem?

1. The Corps of Engineers (COE) must decide which restoration opportunities to support. They have only enough money to fund the best projects. This leads to questions of what is "best." Project analysts seek a Best Management Practice or checklist solution to a comparison of restoration projects from a holistic standpoint. Others suggest that a cookbook solution is inappropriate.

2. The COE thinks that an ecosystem approach increases the probability of success. The COE believes in the restoration of "ecosystems," not just places. To the COE, ecosystems contain not only biological, physical, and chemical elements, but linking processes as well. Beyond that, some suggested that "the whole was equal to more than the sum of its parts." Given this holistic view, what is the difference between the sum of all the disciplinary analyses and the whole system? In that sense, the COE must decide how to evaluate the differences among various projects.

3. What is an ecosystem? What does it include? How can an ecosystem be managed or restored? This defines circle A found in Figure 1.

4. Economic analysis uses a dollar surrogate measure and public participation tools to count supporters of each project. Both approaches have some utility. The economic approaches merely view the sum of all in different terms. Public polling reflects popularity and population density of the projects under consideration, proper demonstration of the instantaneous political appeal.

5. These social science approaches raise two questions: Are there intrinsic values to ecosystems? Are quantitative measures really valid for social and intrinsic values?

6. Figure 1 uses a simple Venn diagram to help clarify the intent of this essay. The figure shows the area philosophically encompassed by the notion of an ecosystem. Note that the ecosystem boundaries themselves are subjective. Within that ecosystem (circle A), areas show the subsets of values covered by various fields such as economics (B), ecology (C), and social science (D). Other analytic tools are combined together under (n). The diagram shows spaces within the larger circle A that do NOT fall in B, C, D, or n. This space is arbitrarily termed Z. Set A, defined by the encompassing circle, represents the ecosystem involved in a particular project. Its spatial and functional boundaries vary over time, space, and definition. The Z space is composed of various abstract material. These abstract notions frame the difference between the whole of A and the sum of all the parts. Sets B, C, D, and n all contain some risk and uncertainty.

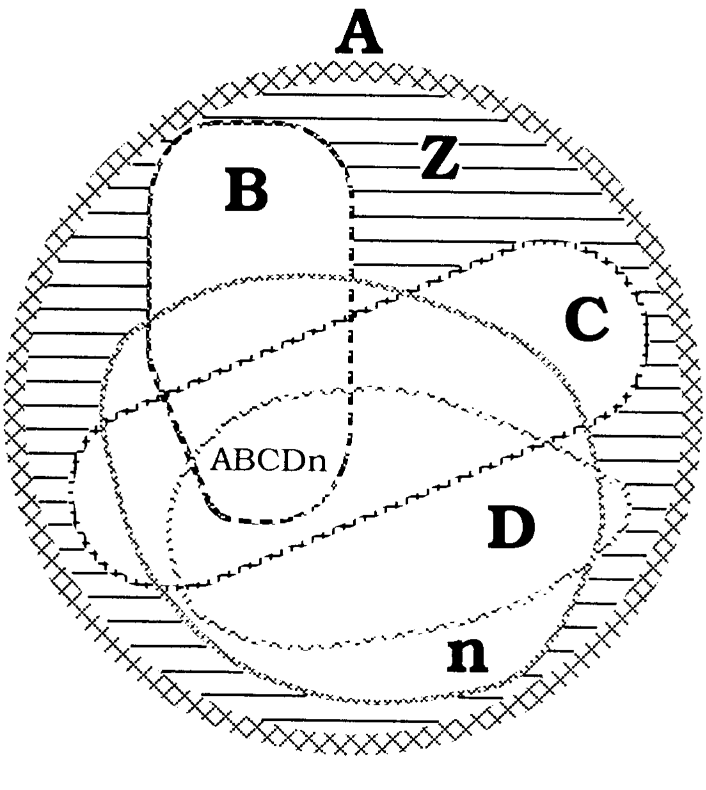

FIGURE 1
ECOSYSTEM

II. ITEMS OF CONCERN

The Tyranny of Numbers

The tyranny of numbers often precludes the evaluation of attitudes, usefulness, aesthetics and intrinsic benefits of ecosystems. Each field of ecology, economics, and social research has developed quantitative techniques to characterize facets of problems. Some examples may clarify the limitations of quantitative manipulation and interpretation of data.

Ecologists have applied the principles of mass balance to material cycling through ecosystems. They use the concentration of nitrogen, phosphorus or potassium to classify bodies of water. Measurements taken from time to time, and place to place will vary. Analysis of these measurements can provide a very precise water quality number. While precise, this number contains uncertainties due to changing conditions and the vagaries of measuring devices. Scientists use a spectrum of statistical tools to differentiate the real effects from the measurement inconsistencies, short term spatial and temporal variations, and the chance vagrant sample. When several sets of data are used to predict trends in a complex system, subtle changes often become buried in the large volume of data.

While a long-term, detailed, and careful study contributes a great quantity of precise numbers, the study may not contain sufficient accuracy to capture general trends. However, this study, accompanied with some knowledge of the activities in the watershed, can predict the future general nutrient loading of the water body. However, without knowing the ecological history of the water body and past land use patterns in the watershed, this nutrient information has little management value. The concentrations themselves must be placed in a spatial and temporal environment to become useful.

The edges of economic analysis also appear vague, imprecise, and often inaccurate. Cost-benefit analysis of water development projects occurs with many projects. Economic analysis generally includes assumptions about the values of the project products and for the activities impaired by it. Because these water projects will last many years, the costs and benefits stretch over those years as well. The costs are preconstruction estimates, and overruns do occur. Analysts assume that the value of these costs and benefits will change over time, so they assume a rate of change of value, called a discount rate. Thus, this process assumes values and then multiplies them by an assumed rate. These assumptions are not entirely arbitrary. Usually, the numbers are taken from the assumptions of other similar studies. These cost/benefit studies often express their conclusions in a single ratio of benefits over costs, such as benefits exceed costs by 2.3 times. The COE has guidelines to suggest at what level projects are feasible. The go/no go ratio is also expressed to the nearest tenth, e.g., 1.8, 2.3.

Few studies exist which examine the validity of the assumptions of the water development cost/benefit studies of the last several decades. Several years ago, three cost/benefit studies of the development of the Tellico Dam project in Tennessee were conducted. One was done by TVA, one by GAO, and one by the opponents of the dam. Each assumed a different value for Snail Darters, for recreation, for Native American artifacts, and for local area jobs. Each assumed a different discount rate. The conclusions by the TVA showed a strong, positive ratio, the GAO showed the benefit/cost ratio about neutral, and the opponents calculated a negative ratio. There is no known subsequent report to determine which study was the most accurate.

A gambling consortium hired a public opinion consultant to find the demand for more gambling facilities. The consultant found that the average adult in the United States spent $200 each year on gambling. However, an informal survey conducted by this author revealed that few admitted to spending more that a few dollars a year. Therefore, it must be concluded that high rollers are skewing the average. When pressed about the details of the study, it was found that the consultants wanted to query respondents who were informed about gambling, so they conducted their study with passengers arriving in Las Vegas.

These examples show that accuracy and precision differ. They also show that the frame of reference and the bias of the person conducting the study affect the outcome. All studies evaluating complex systems always contain bias. These biases come from the training and history of the observer. The education of the observer affects the tools he or she uses. The *a priori* beliefs of the observer determine the conclusions.

ON CLASSIFICATION SYSTEMS, MODELS, AND PERSONAL BIAS

Classification systems and evaluation models all reflect the purpose and training of their creators. Several reasons exist for this often unconscious slant to the system. Usually critics make three points: (1) the system is too complex, (2) it takes too long to become expert, and (3) the classification and evaluation models do not include everything. Most wetland experts are familiar with HEP, WET, the 1989 interagency classification manual and the new Brinson Hydrogeomorphic Classification, so it is not necessary to go into the details of those systems here. These evaluation systems do serve as examples of the general phenomena discussed below.

A Protracted Wetland Example

a. In 1985, more than 50 different wetland definitions used by state federal and local government were collected (Willard, et al. 1990). These definitions served local regulatory purposes adequately. The increased emphasis on wetlands and real enforcement caused considerable conflict. When a definition became part of an active regulatory program, it quickly became the subject of adversarial proceedings. People who did not wish their property controlled by water statutes sought many creative ways to define their particular pieces of property outside the "waters of the United States." During the National Wetland Policy

Forum, private property development groups continually tried to alter the national wetland definition to exclude properties in which they were interested. That caused a shrinkage of the actual property defined. In summary, this objection is that many opponents of wetland regulation do not like any definition that affects them. They simply do not like regulation.

b. Around 1990, many complaints arose claiming that the 1989 classification system, WET, and HEP were simply too difficult and costly to implement. To some extent, this complaint had its root in anti-regulation attitudes. It contained a new element as well. Lawyers and engineers had to depend on biologists for delineation and advice on mitigation. For project developers, this became a new cost. For lawyers and engineers, it became a new series of complexities from outside their fields in project development and construction; in short, a mysterious, nonprofitable, new impediment.

c. Opponents of wetland regulation also argued that a "simple landowner" could not identify the wetlands on his own property and, therefore, could not plan for future development. The "objective" evaluations concocted by the agency scientists require that the wetland professional consultant have basic knowledge of soils, hydrology and ecology.

What Do These Wetland Evaluation Systems Show?

Any of these evaluation systems will provide reproducible results no matter which side (of the issue) does the work. This replication depends on trained operators tempered by the adversarial system. Nonobjective experts can pervert any system. WET evaluators, wetland delineators, and HEP people must do their work openly so all parties can see the work. The evaluations would be more effective if they were done by cooperating multi-sided teams. The merits of the evaluation system are separate issues from whether any party gets what he or she wishes. In a sense, when we condemn these evaluation systems, we are merely killing the honest messenger of bad news.

The study of wetlands contributes an example of these considerations. The essential social and scientific characteristics of wetlands make them difficult to evaluate, classify, regulate, restore, or otherwise manage. Wetlands represent prime examples of controversial ecosystems. They inspire an intricate knot of intertwined social, economic, and scientific attitudes and concepts. Wetland definitions are social constructs conceived as regulatory levers to expand and institute the environmental views of one subset of society. All members of society do not hold these views.

Wetlands became part of the waters of the United States partly because of NRDC v. Calloway in 1975. Many wetlands remained on private property. In Wisconsin, Just v. Marionette Co. tried to split the public trust character of water from the private property powers implicit in the 5th Amendment. Some wetland definers have pushed the boundaries to expand the public elements, while others have defined the boundaries to maintain private property rights.

Wetland scientists themselves have individual preconceptions that confound the attempts at objective definitions. Others seek a consensus position, or at least, a majority position. Thus, wetlands become politically defined. Scientists, on the other hand, are confronted by a complex set of dissimilar, natural settings that change both in cyclic and noncyclic ways. Each has a unique set of conditions, yet some resemble each other more than others.

Wetlands and other watershed lands are closely interrelated. Therefore, it is difficult or impossible to evaluate and protect many wetland functions and values without also considering and managing broader watershed activities. The importance of external relationships is why it is so difficult to evaluate, classify, or otherwise manage wetlands in the abstract. In the lower 49 states, most wetlands and watersheds are modified by human activities.

The ongoing wetland debate illustrates this illusion of objectivity quite well. Consider the following syllogism:

a. The category "wetlands" is a construct of several kinds of ecosystems.

b. "Ecosystems" are constructs of natural parts and processes.

c. We know that wetland and ecosystem boundaries are continua that vary over time and space.

d. Thus, wetland delineation must be subjective.

e. Further, everyone tries to design a delineation system consistent with his or her own judgement.

f. Yet further, judgments are culturally and experientially conditioned.

Do Traditional Scientific Studies of Wetlands Help?

Three scientific characteristics of wetlands make them particularly difficult to delineate, evaluate, regulate, and restore.

a. Water levels and patterns of vegetation and habitat use fluctuate within certain ranges. Wetlands are, by their very nature, shallow water and high groundwater systems. They comprise both land and water. This combination makes them different from either water or land and gives them some special qualities.

Wetlands are characterized by fluctuating water levels and many functions are dependent upon those fluctuations. Because of these fluctuations, the appearance of wetlands often changes dramatically from season to season and year to year, including water level and wetland vegetation. Unlike lakes, rivers, and streams, which have readily observable and definable boundaries, wetlands are often difficult to locate because of their fluctuation. Natural fluctuations in water levels due to seasonal or long-term precipitation cycles do not dramatically change the appearance or boundaries of lakes, streams, rivers, and the oceans. However, since they are shallow surface water and high groundwater systems with gentle slopes, wetlands are greatly affected by these fluctuations. Differences in water levels of inches due to normal fluctuations in precipitation or watershed activities may make the difference between "wetland" and "nonwetland," or dramatically change wetland plant species.

Fluctuating water levels have several implications. First, wetlands are not static or relatively static systems that can be delineated or classified based upon a single determination of existing water level or vegetation. Second, a "one-shot" view of wetlands based upon a single field examination of wetland hydrology at the time of a site visit cannot reflect values and functions, nor can it accurately reflect the hydrologic or other wetland characteristics.

Because precipitation varies throughout the U.S. not only seasonally and annually but with long-term cycles, a prairie pothole or other wetland may be wet year-round for two years, seasonally for the next five years, and then almost entirely dry for the following five years. For example, the recent drought in the West has demonstrated that the critical feeding and resting values of wetlands for ducks, geese, and other waterfowl depend not only upon seasonal wetness, but wetness in the "dry years" as well. A long-term as well as a short-term perspective on hydrology is required.

Wetlands do have permanence in the landscape and relatively certain boundaries when viewed from the long-term perspective. The fluctuations occur within relatively fixed limits. The key to understanding frequency of inundation is that it is not an absolute annual, every-other-year, or every-three-years event. It is periodic given the range of hydrologic conditions that occur within a given region or watershed of the country.

b. These fluctuations in water levels result in a combination of natural functions and natural hazards that are not readily observable to the landowner or even a trained scientist from the immediate appearance of a wetland or a causal site visit, particularly during dry periods. The relatively hidden nature of these functions and values and the costs of documenting functions and values are two of the reasons why wetland evaluation, classification, regulation, and restoration are so difficult, time-consuming, and expensive.

Intertwined Functions and Values

Wetland functions and values depend upon not only intrinsic characteristics of the wetland, but what happens throughout watersheds. Wetland functions and values and natural hazards depend upon what happens at other locations in the watershed for two reasons. First, watershed activities affect wetland water quality and quantity, which, in turn, determine all wetland functions and values. Second, many wetland functions and values are dependent upon the relationship of the wetland to other waters and land (i.e., its watershed and landscape context). For example, a wetland is usually important for fish spawning only if there is ingress and egress from the wetland to other water bodies.

Scientists generally distinguish wetland "functions" from wetland "values." Wetland functions consist of the biological, physical, and chemical processes of wetlands. The term "function" is also often used more specifically to refer to particular processes with potential value to man in producing goods or performing services such as flood storage or pollution control. For example, wetlands conveying flood waters from higher to lower points serves a flood storage and flood conveyance function.

a. Wetland functions are also dependent upon the relationship of the wetland to broader ecological systems. For example, the function of a wetland as critical habitat for particular plants and animals depends upon the relative scarcity of the habitat in the area. The function of a wetland for fish spawning depends upon a connection between the wetland and an adjacent water body. The function of a wetland as a wildlife corridor depends upon the connection of the wetland with other wetlands and open space areas.

The function of a wetland often depends not only upon "absolute" wetness in the landscape but "relative" wetness. To understand the importance of relative rather than simply absolute wetness to functions and values, compare, for example, two areas: one along a river or stream in Louisiana and one in Arizona. Many of the "driest" adjacent lands in Louisiana with more than sixty inches of rainfall may be wetter than the "wettest" riparian sites in Arizona with less than ten inches. From a national or Louisiana perspective, these Arizona sites would often not be considered "wetland" except that they lack twenty-one consecutive days of saturation. But, from an Arizona perspective, they are relatively wet in comparison to the rest of the landscape. Because of this relative wetness, these lands are characterized by bands of vegetation (cottonwood, willow), which are extremely important habitat but do not meet obligate wetland criteria. Because of this "relative wetness" and location, they perform flood conveyance, flood storage, wildlife habitat, food chain support, stream bank stabilization, and, in some instances, pollution control functions similar to much wetter areas in Louisiana.

b. In contrast, wetland "values" provide economic benefits to man for these goods or services. For example, a wetland conveying flood waters from higher to lower points has a specific economic benefit to a house placed adjacent to the wetland. If the wetland is filled, flood waters will rise, damaging the house.

All of the factors relevant to functions are also relevant to value. In addition, value depends upon the relationship of wetlands to the specific needs of man. These needs differ geographically and over time. For example, consider the wetland that conveys flood waters in its natural state from an upstream to downstream site (flood storage and flood conveyance function).

In a rural setting, the wetland may have little immediate "value" to man if there are no buildings or other activities in the vicinity or downstream that may be damaged by the increased flood heights resulting from destruction of the wetland. However, if houses are built on the margin of the wetland, specific, increased flood damages would occur if the wetland were destroyed. The wetland would have a specific and quantifiable economic value for flood conveyance and flood storage. But this dependency of wetland value upon specific needs means that it is also very difficult to make a once-and-for-all determination of value because watershed contexts change over time.

The existing, specific "value" is often quite different from the future value. As development occurs in a watershed, certain values are typically enhanced—flood conveyance, flood storage, and pollution control. However, certain other values, such as habitat, may be reduced by pollution and cumulative impacts. Reasonably anticipated values are, therefore, best evaluated in terms of wetlands/watershed land use plans that project future uses and activities.

Mitigation

Many projects which require off-site mitigation use small creation efforts which are more likely to fail than large scale projects and are more costly to permittees. Often the Corps does not require full mitigation because they decide that losses from the project will be so small that mitigation is not practical from a cost/benefit perspective. As a result, there is a net loss in wetland habitat. Additionally, required creation projects are often begun concurrently with the project causing the habitat destruction. Creation or restoration of a functioning wetland takes time (five or more years) and has an uncertain outcome. At best, there is an interim loss of habitat. This forces already stressed species to move to other wetlands. If no suitable habitat exists, the interim impacts on the species will not survive.

Not all wetlands are equally valuable to man or equally subject to natural hazards. This has led to proposals to compare the values of wetlands to other wetlands (e.g., classify or rank wetlands for regulatory purposes). But, detailed, advance evaluation of wetland functions and values is difficult, time-consuming, and expensive. And, wetlands with little value may, nonetheless, be subject to severe flooding or other natural hazards.

Furthermore, comparative ranking of wetlands often has limited value in a regulatory context because it provides little information concerning the appropriateness of a prepared activity at a wetland site versus another site. The issue at the site of a proposed activity is usually the appropriateness of a particular use (considering values and natural hazards) at a wetland-versus-upland site and not a wetland-versus-wetland site. For example, a private landowner wishing to construct a house on a lot with a wetland must usually decide whether to put it in the wetland or on the upland rather than in one wetland versus another.

Restoration or Creation

Wetlands are highly diverse and complicated systems. The degree to which various wetland characteristics, including functions and values, can be restored or created varies. A distinction must also be drawn between what is theoretically possible (assuming unlimited funds and expertise) and what is actually occurring and will occur on the ground.

Based upon what we know scientifically, it is not possible to fully "restore" all aspects (e.g., soils) of natural wetlands in a relatively short time period, but it is theoretically possible to restore or create some wetland characteristics and functions. The problem, in part, is actual restoration and creation efforts have almost invariably fallen short of what is theoretically possible due to incorrect design, incorrect construction, or lack of long-term monitoring and maintenance. This is, in part, because traditional science has little ability to deal with holistic systems.

In general, restoration is easier and more successful than wetland creation. And, relatively large scale restoration or creation efforts by expert agencies (e.g., the U.S. Fish and Wildlife Service) with long-term maintenance capability have been much more successful than small scale efforts by private developers who often lack the expertise and long-term maintenance capability.

Some functions can be restored with proper engineering studies and project construction such as flood storage and flood conveyance, wave retardation, and erosion control. Others can also be restored in some circumstances such as fisheries, food chain support, pollution control, recreation, and certain types of habitat. But it is very difficult or may be impossible to restore certain habitat for rare and endangered species. And, the "biodiversity" value of many restored systems is also questionable.

Success rates and ability to restore also varies greatly depending upon type of area and the source of water. In general, salt marshes and others dependent upon water supply from adjacent lakes and streams have been restored with relatively high rates of success. It has been more difficult to restore shrub and forested wetlands due to their greater sensitivity to water depths. It has been even more difficult to restore freshwater, isolated wetlands dependent upon surface runoff due to uncertainties in calculating and projecting this runoff. Finally, it has been very, very difficult (with low success rates) to restore wetlands dependent upon groundwater.

ON UNIQUENESS AND GENERALIZATION

The confounding problem with comparing ecosystems arises from the contrast between these two statements.

1. Each place is unique.

2. Much of our traditional scientific knowledge about ecosystems depends on theory and generalization.

   Therefore: While the patterns and processes existent at one place resemble those at another, the actual consequences of the local interaction may vary considerably from place to place. Natural history studies act to validate and calibrate the local applicability of the deductions from traditional science.

Uniqueness is in the mind of the observer. Experienced observers see greater detail and difference than remote observers. This sharp cognitive discrimination comes from years of concentration on a specific place or thing. For example, entomologists such as Paul Ehrlich and E.O. Wilson see thousands of different kinds of insects. The rest of us see only a few.

Natural historians, whether they are birders, fishermen, or wildflower aficionados have an intimate knowledge of place that general theory can never describe. They see uniqueness where others see similarity. In the afterword to *Cold Running River* (Willard 1994) I described the intimate knowledge of a long time river guide.

> This very concentration creates a philosophical paradox. The more we study a site to find similarities with other like sites, the more we notice the uniqueness of each site. As we attempt to find discrete sample sites, we find few sharp boundaries. The more we try to get a fair sample, the more nonrandom our sample.
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> In scientific works, the method section often goes into considerable detail about how the investigator carefully set up his or her transect using this random number generator or this double blind technique. Many of these straight forward statements come from months of frustrating trial and error in which the investigator tries to get a method which gives logical results and fits the situation. He or she may have tried tens of different sampling systems and analytic tests before simply writing, " We analyzed our data with the Smith-Jones test. The results are provided on table whatever."
>
> Our laboratory for these studies is the Pere Marquette watershed. No hill looks like any other hill. Each bend has unique features. I have spent some time floating and fishing on the river between highway 37 and Gleason's Landing. I still get lost. But many people ... know the entire stretch so well that placed down blind-folded on any piece of the river, and the blind-fold removed, they would know their location within inches. Each place varies enough that an experienced person can recognize it.
>
> On the other hand, this same person, let's say a guide, if placed down in some place hither-to-unknown, on the Pere Marquette or any nearby similar river, would look around, muse, read the water and figure out where the fish ought to be and how to proceed. I suggested to Bob Nicholson [a guide] once that this first cast was simply an empirical natural experiment using a hypothetical-deductive model based on years of observation, induction and development of grounded theory. He snorted and commented on the absurdity of professors. But he did recognize that this place shared enough characteristics with other sorts of places that he understood its workings.
>
> Our problem then is to capture the elements of a place on the river with enough precision to understand its workings; then to understand the workings of similar places sufficiently to apply them across the landscape.

RISK AND UNCERTAINTY

Uncertainty and risk appear in the forms of ignorance, error, and stochastic events. Knight (1921) noted that "risk" can be quantified, "uncertainty" can not. Experts can calculate the reoccurrence frequency of floods, droughts and hurricanes. Complex soils and substrates cause uncertainty to groundwater hydrologists. Fast climate change makes the calculation of risks uncertain.

Decision trees using ecological risk assessment help understand the limits of applicability in these water accounts. For example, many biological systems are especially adapted to temporal and spatial variability in water regime patterns providing some potential to self-regulate within ecosystems. Many common sorts of wetlands are evolved especially in response to variable water systems. The ability of a watershed to regulate homeostatically depends in large part on the presence of wetlands in the watershed. Antithetically, watershed-wide disruption of the historic patterns of variability will perturb the wetlands throughout the watershed.

A lack of understanding about the self-regulatory properties of complex natural ecosystems frustrates ecologists' attempts to manage watersheds. The mechanical and stochastic properties of physical systems become confused with the adaptive, often counter-intuitive homeostatic processes of biotic systems. Many watershed/wetland systems require spatial and temporal variability of external stimuli to support the diversity of organisms which allow the system to adapt. They thrive on risk and uncertainty.

We have attempted to manage this disconcerting inconsistency out of the system. In the process of making watersheds predictable and consistent, we have lost the biotic parts. Nonliving systems just do not adapt well.

III. A SUGGESTION

Narrative, ecological history studies provide comparisons of intrinsic features of ecosystems. Ecological histories combine the elements of classic natural history, journalism, scientific history and oral history to describe a place. These naturalistic methods best show the intrinsic ecosystem relationships such as biodiversity, patch dynamics, and landscape relationships. These studies incorporate the activities and consequences of human management of the place as well.

THE LIMITATIONS OF NATURAL HISTORY

Natural history studies describe the place and report on the occurrences there. Generally, pattern and process emerge because the observer has concentrated on a particular place or thing over a long period of time. Many of such studies exist: John Wesley Powell's *Exploration of the Colorado*, Murre's *Naturalist in Alaska*, Austin's *Land of Little Rain*, and many others. Because these studies reflect the natural passage of time and season and report only what the observer has the attention to see, they require years and often decades.

The soul of natural history is observation and induction. Observation and its documentation involve symbolic communication and are thus not precise. But they can be made accurate and extensively reproducible. The hard sciences also contain considerable subjectivity. The selection measuring tools and hypotheses to study limit the scope, outcome, and applicability in these fields. Much science gets done to prove a point, and is not published unless it does. Interpretation of scientific studies involves even greater subjectivity. A critical observer need only follow the national debate on smoking or climate change to find examples of different interpretations of a set of observations.

Such studies are too time consuming for the purposes of evaluating potential restoration projects. On occasion, historic studies do exist; for example, if the COE were about to undertake a restoration of Walden Pond or the Colorado River. Often partial studies exist, such as the many stories of the Mississippi or the Everglades. The literature concerning a place may have influenced the choice of projects. *The River of Grass* played an important role in bringing the Everglades to public attention. Considerable literature describes the Chesapeake.

Similarly, nature writing has two contradictory intents: description and advocacy. On one hand, writers wish to describe some bit of natural history so that others may see it. They wish to add an objective description of some phenomena to our knowledge about the natural world. Writers attempt to get the facts. On the other hand, they want readers to support, enhance, enlarge, protect, or otherwise do something the authors believe is good. Writers are not objective. We always tell the truth, of course, but the truth is a construct flavored by the words we choose to use.

The students of nature, as John McPhee says, want to understand, organize and control nature. People construct an ordered nature for their own pleasure and convenience. Mankind will never be able to reconstruct natural systems in a predictable way. Restoration will always remain an art. Each place will behave in a slightly different fashion. Each place needs its reporters and documenters to tell what happened there. These collected chronicles will tell a variety of stories. The stories help readers develop a grounded reality, or at least a reality that looks generally the same to enough people that there is a confidence in the range of outcomes from a particular action.

The semantic problem is real. Two filters blur communication. The writer picks the best fitting word, which he or she knows for the meaning intended. The word or phrase will not be exactly right. There are no synonyms in English. No words are neutral. The word may carry extra implications. Then the readers filter the words through their own cognitive filters. They hear a slightly different meaning than the writer intended. Each person shades inferences of another's words. Each has these cognitive filters. They design themselves from experience and cultural background. Thus, the subjectivity versus objectivity dichotomy dissolves. Because of the symbolic nature of language, objectivity is diaphanous. All writing about nature, all descriptions, all propaganda is subjective.

During EPA's Natural History and Nature Writing Workshop, two views about nature writing emerged. Some thought that the perceptions and emotional responses of the writer were the focus of nature writing. The contrasting position believed that the primary role of nature writing was to describe nature as clearly as possible. The writer entered the story only after nature's story had been told.

Norman Maclean in *Young Men and Fire* describes the story of the Mann Gulch fire in Montana two ways. In 1949, eleven fire-fighters perished in the worst fire loss until the recent 1994 Colorado fire. First, he wrote the story as he read and heard it. Then, years later, Maclean undertook an intensive investigation of the Mann Gulch fire. He interviewed experts and the surviving participants and, though old and debilitated, revisited the site. Maclean attempted to reenact the tragedy. He measured the site extensively. He used the expert information to reconstruct several possible courses of the fire. He analyzed the scene as a detective. The first section was nature writing while the second section contained natural history. Each contains elements of the other. Both depend on what is there and what the writer perceives. Clearly, the writer's perceptions are colored by his emotional response to the natural event. While Maclean does not discuss his reason for such an intense interest decades after the event, evidence of his fixation permeates the second section.

From this discussion, it can be concluded that nature writing and natural history overlap necessarily and considerably. Nature writing may include work primarily derived from the author's own thoughts but stimulated by some natural event or phenomena. The "naturalness" of the event or phenomena is a construct of the author's mind and may include a range of subjects from human centered to much less so. The work may be fiction to nonfiction. Though in the context of constructed reality it is all fiction.

Natural history is a special case of nature writing which attempts to describe and analyze environmental phenomena using a variety of epistemological tools. Natural science uses qualitative and quantitative methods to construct general principles to describe the truths and facts of the natural world. These general principles emerge from theories which are tested and retested to establish their consistency and applicability. Natural science attempts to organize a view of the world of such agreement among experts that it provides the illusion of objectivity.

JOURNALISM AND THE MEDIA

Other projects are born out of catastrophic events. Restoration in the Mississippi floodplain became a national issue as a result of the recent floods. Hurricanes demonstrate the importance of the South Florida drainage systems. Often the media coverage of these catastrophic events contains grains of information about the ecological capacity of the system. These grains may contain the only data about the ecosystem under stress. These stories combine vignettes of people interacting with nature, under stress. Thus, journalism and the media at the time provide an array of nonquantifiable data about a potential project.

ECOLOGICAL HISTORY METHODS

1. **The Use of Written History**. A variety of documents are relevant: scientific reports, newspaper articles, historical accounts, personal memoirs, pictures, and maps.

2. **The Use of Oral Histories**. Follow archival research by interviewing members of the community with considerable first-hand experience on the site.

3. **The Use of Existing Scientific Information**. Existing scientific information is an essential form of the scientific record. Weather records, stream records, flood and drought events, fish censuses, water quality surveys, trapping records, logging, vegetation surveys, and any other records help interpret history.

4. **Current Studies Integrate and Calibrate Historical Observations**. Small local studies may be necessary to understand and use historic scientific and lay observations.

REFERENCES

Andrewartha, H. G. and L. C. Birch. 1984. The Ecological Web: More on the Distribution and Abundance of Animals. University of Chicago Press. p. 506.

Brown, J. H., and B. A. Maurer. 1989. "Macroecology: The Division of Food and Space Among Species on Continents." Science. 243:1145-50.

Cairns, J., Jr. 1979. "Academic Blocks to Assessing Environmental Impact of Water Supply Alternatives." Ed. A. M. Blackburn. The Thames Potomac Seminars. Pages 77-79. Interstate Commission on the Potomac River Basin, Bethesda, MD.

Cairns, J., Jr. 1990. "Gauging the Cumulative Effects of Developmental Activities on Complex Ecosystems." Eds. J. G. Gosselink, L. C. Lee, and T. A. Muir. Ecological Processes and Cumulative Impacts: Illustrated by Bottomland Hardwood Wetland Ecosystems. Pages 239-256. Lewis Publishers, Inc., Chelsea, MI.

Cairns, J., Jr. 1991. "The Need for Integrated Environmental Systems Management." Eds. J. Cairns, Jr. and T.V. Crawford. Integrated Environmental Management, Pages 5-20. Lewis Publishers, Chelsea, MI.

Cairns, J., Jr. and T. V. Crawford, eds. 1991. Integrated Environmental Management. Lewis Publishers, Chelsea, MI.

Cairns, J., Jr. and J. R. Pratt. In press. "Restoring Ecosystem Health and Integrity During a Human Population Increase to Ten Billion." Ed. M. Munawar. International Symposium on Ecosystem Health, Waterloo, Ontario.

Dale, V. H., R. H. Gardner, and M. G. Turner (guest eds.). 1989. "Predicting Across Scales: Theory Development and Testing." Landscape Ecology. 3:147-252.

deBoer, P. S. 1968. "Spreading of Risk and Stabilization of Annual Numbers." Acta. Biotheor. 18:164-194.

Edwards, C. J. and H. A. Regier, eds. 1990. An ecosystem Approach to the Integrity of the Great Lakes in Turbulent Times. Great Lakes Fishery Commission, Special Publication. pages 90-4, Ann Arbor, MI.

Ehrlich, P. R., and J. Roughgarden. 1987. The Science of Ecology. McMillan, NY.

EPA. 1989. Wetland Creation and Restoration: The Status of the Science. USEPA 600/3 - 89/038a. EPA Environmental Lab, Corvallis. EPA. 1988. Lake and Reservoir Restoration Guidance Manual.

Forman, R. T. T. and M. Godron. 1986. Landscape Ecology. J. Wiley & Sons, NY.

Goldfarb, T. D. 1983. Taking Sides: Clashing Views on Controversial Environmental Issues. Dushkin Publishing Group, Guilford, CT.

Guba, E. G. and Y. S. Lincoln. 1981. Effective Evaluation: Improving the Usefulness of Evaluation Results Through Responsive and Naturalistic Approaches. Jossey-Bass Inc. San Francisco, CA.

Hardin, G. 1968. "The Tragedy of the Commons." Science. 162:1243-8.

Hill, R. D. and E. C. Grim. 1977. "Environmental Factors in Surface Mine Recovery." Eds. J. Cairns, Jr., K. L. Dickson, and E. E. Herricks. Recovery and Restoration of Damaged Ecosystems. Pages 290-302. University Press of Virginia, Charlottesville.

Holling, C. S. 1978. Adaptive Environmental Assessment and Management. J. Wiley & Sons, NY.

Karr, J. R. In press. "Landscapes and Ecosystem Management." Eds. K. C. Kim and G. L. Storm. Biodiversity and Landscapes: Human Challenges for Conservation in the Changing World. Center for Biodiversity Research, Pennsylvania State University, University Park, PA.

Knight, F. 1921. Risk, Uncertainty, and Profit. Houghton-Mifflin, London.

Kramer, R. A. 1991. "Decision Analysis as a Tool in Integrated Environmental Management." J. Cairns, Jr. and T.V. Crawford, eds. Integrated Environmental Management. Pages 53-62. Lewis Publishers, Chelsea, MI.

Leopold, L. B. 1990. Abel Wolman Distinguished Lecture to the National Research Council. Washington, DC.

Levine, D. A. and D. E. Willard. 1990. "Regional Analysis of Fringe Wetlands in the Midwest: Creation and Restoration." J. A. Kusler and M. E. Kentula, eds. Wetland Creation and Restoration, The Status of the Science. Pages 299-326. Island Press, Washington, DC.

Levins, R. 1969. "Some Demographic and Genetic Consequences of Environmental Heterogeneity for Biological Control." Bull. Entomological Soc. Amer. 15:237-40.

Levins, R. 1970. "Extinction." Lectures in Mathematical and Life Sciences. 2:75-107.

Likens, G. E., ed. 1985. An Ecosystem Approach to Aquatic Ecology. Springer-Verlag, NY.

MacArthur, R. A. and E. O. Wilson. 1967. The Theory of Island Biogeography. Princeton University Press. Princeton, NJ.

Magnuson, J. J., B. J. Benson, and T. K. Kartz. 1990. "Temporal Coherence in the Limnology of a Suite of Lakes in Wisconsin, U.S.A." Freshwater Biology. 23:145-59.

Maguire, L. 1988. "Decision Analysis: An Integrated Approach to Ecosystem Exploitation and Rehabilitation Decisions." Cairns, Jr., ed. Rehabilitating Damaged Ecosystems, Vol. II. Pages 105-22J. CRC Press, Boca Raton, FL.

Matson, P. A. and S. R. Carpenter, eds. 1990. "Special Feature on Analysis of Ecological Response to Large-Scale Perturbations." Ecology. In press.

Naiman, R. J., C. A. Johnston, and J. C. Kelley. 1988. "Alteration of North American Streams by Beaver." BioScience. 38:753-63.

National Academy of Science/National research Council. 1986. Ecological Knowledge and Environmental Problem Solving. National Academy Press, Washington, DC.

National Academy of Science/National Research Council. 1987. River and Dam Management: A Review of the Bureau of Reclamation's Glen Canyon Environmental Studies. NAS Press, Washington, DC.

National Academy of Science/National Research Council. 1989. Irrigation-Induced Water Quality Problems: What Can Be Learned from the San Joaquin Valley Experiences. Washington, DC.

National Academy of Science/National Research Council. 1991. Restoration of Aquatic Systems. NAS Press. Washington, DC.

Naveh, Z. and A. S. Lieberman. 1984. "Landscape Ecology: Theory and Ecological Processes in the Time and Space of Farmland Mosaics." Eds. I. S. Jonneveld and R. T. T. Forman. Changing Landscapes: An Ecological Perspective. Pages 121-33. Springer-Verlag, NY.

O'Neill, R. V. 1991. "The Systems Approach to Environmental Assessment." Eds. J. Cairns, Jr. and T.V. Crawford. Integrated Environmental Management. Pages 39-51. Lewis Publishers, Chelsea, MI.

Pulliam, H. R. 1988. "Sources, Sinks and Population Regulation." Amer. Nat. 132:652-661.

Shapiro, J. 1979. "The Importance of Trophic Level Interactions to the Abundance and Species Composition of Algae in Lakes. Soc. Int. Limnol." Workshop on Hypertrophic Ecosystems. Dev. Hydrobiol, 2:105-16.

Tanji, K., Lauchli, A., and J. Meyer. "Selenium in the San Joaquin Valley." Environment. 28:6-39.

Tonn, W. M. and J. J. Magnuson. 1982. "Patterns on the Species Composition and Richness of Fish Assemblages in Northern Wisconsin Lakes." Ecology. 63:1149-66.

Turner, M. G., ed. 1987. Landscape Heterogeneity and Disturbance. Springer-Verlag, NY.

Urban, D. L., R. V. O'Neill, and H. H. Shugart, Jr. 1987. Landscape Ecology. Bioscience.

U.S. Fish and Wildlife Service. Division of Refuge Management. 1986. Preliminary Survey of Contaminant Issues of Concern on National Wildlife Refuges. (Draft). U.S. Government Printing Office, Washington, DC. p. 175.

Walters, C. 1986. Adaptive Management of Renewable Resources. Macmillan Press. NY.

Walters, C., J. S. Collie, and T. Webb. 1988. "Experimental Designs for Estimating Transient Responses to Management Disturbances." Can. J. Fish. Aquat. Sci. 45:530-8.

Wiens, J. A. 1985. "Vertebrate Responses to Environmental Patchiness in Arid and Semiarid Ecosystems." Ecology of Natural Distance and Patch Dynamics. Ed. Pickett S.T.A. and P.S. White. p. 169-96.

Wilson, E. O. 1978. On Human Nature. Harvard University Press, Cambridge, MA.

Willard, D. E. 1988. "Restoration of Wetlands from Abandoned Surface Mines." J. Cairns, Jr., ed. Rehabilitating Damaged Ecosystems, Vol. II. CRC Press, Boca Raton, FL.

Willard, D. E., K. E. Van Vlack, and R. B. Reed. 1990. "Wetland Definitions in Leslie M." Clark and Bingham, eds. Issues in Wetlands Protection: Background Papers prepared for the National Wetland Policy Forum. Conservation Foundation, Washington, DC.

Willard, D. E., V. M. Finn, D. A. Levine, and J. E. Klarquist. 1990. "Creation and Restoration of Riparian Wetlands in the Agricultural Midwest." J.A. Kusler and M.E. Kentula, eds. *Wetland Creation and Restoration, The Status of the Science*. Pages 327-50. Island Press, Washington, DC.

Willard, D. E. and A. K. Hiller. 1990. "Wetland Dynamics: Considerations for Restored and Created Wetlands." J.A. Kusler and M.E. Kentula, eds. Wetland Creation and Restoration, The Status of the Science. Pages 459-66. Island Press, Washington, DC.

Willard, D. E. 1994. "Speaking for the River." An afterword. In D. Cassuto Cold Running River. University of Michigan Press.

Willard, D. E. 1994. "The Ecological Approach to Watershed Management." J. Cairns, Jr., ed. Rehabilitating Damaged Ecosystems, 2nd Ed. CRC Press, Boca Raton, FL. (Reproduced with some additions as a manual for Association of State Wetland Managers, Watershed Conferences and Workshops at Palm Beach, Buffalo, Atlanta, Reno and Washington, DC. in 1993.)

Willard, D. E., C. P. Wolfe, and A. G. B. Primack. 1993. The Peculiar but Widespread Problem of Altered, Degraded or Disturbed Wetlands. Proceedings Association of State Wetland Managers.