Valuing Wetlands for Watershed Planning

Developing leading indicators of relative wetland values would help determine when and where wetlands can be substituted for one another without jeopardizing the sustainability of a watershed

By Dennis M. King

Ready or not, the era of off-site wetland mitigation and mitigation banking is upon us; this means that wetland trading will become more frequent. The cumulative effects of such trading on the level and distribution of wetland benefits within a watershed can be significant. Conventional wetland assessment methods are available for comparing on-site features of wetlands and their capacity to provide certain functions; however, those methods often do not take account of how landscape context influences wetland functions, and they rarely consider how landscape context influences whether wetland functions will provide services that benefit people. Wetland valuation methods are limited in scope at the other extreme. They attempt to assign absolute (dollar) values to specific wetland services, but rarely give consideration to the biophysical or landscape features that generate them. For now, at least, neither wetland assessment methods nor wetland valuation methods provide a solid basis for comparing the value that wetlands add to a watershed.

Having estimates of the absolute (dollar) value of wetlands is useful for some applications and, although the outlook is not very promising, efforts along those lines are proceeding. However, having leading indicators of relative (non-monetary) wetland values would be a more effective way of establishing trading rules to govern wetland mitigation programs. Practical and reliable indicators of the relative value of wetlands can be based on the fact that the functions, services, and values provided by a wetland depend in predictable ways on on-site biophysical characteristics (such as soil, vegetative cover, and hydrology) and landscape context (such as proximity to certain features of natural and human landscapes). On-site characteristics determine the *capacity* of an ecosystem to provide various functions (such as to support waterfowl). Landscape context determines (1) if the ecosystem will have the *opportunity* to provide these functions (attract waterfowl), and strongly influences (2) what *services* will flow from the functions (hunting and birding opportunities), (3) the *values* that will flow from those services (how much people are willing to pay), and (4) the *distribution* of benefits to various segments of society (urban or rural, rich or poor).

Most wetland assessment methods evolved from ecosystem morphology (studies of biological form and structure) and were developed to respond to specific regulatory requirements for comparing functional capacity; few of them are capable of even addressing wetland effects on watersheds or on human populations. However, this is not the only reason why the available guidance for comparing wetlands ignores the importance of wetlands to people. There is also a widely held belief among wetland scientists that expanding "value-free" biophysical wetland assessment methods to consider how wetlands contribute to human values, or "value-laden" watershed goals, requires making ethical and political choices. This is not true. Establishing whether different wetlands or wetlands in different locations will contribute to various watershed goals does not require making decisions about whether any of the goals are worthwhile. Nor does it require that absolute (dollar) values be assigned to wetlands or to wetland functions or to competing watershed goals.

Of course, there are practical limits to how far wetland assessment methods can be expanded to address questions related to values and watershed goals. Despite improvements in watershed modeling, for example, identifying and estimating all the relevant biophysical and socioeconomic relationships for most watersheds is impossible. Selecting a subset of these relationships on which to focus study is a more reasonable undertaking, but provides only partial results and either implicitly or explicitly requires ethical choices and subjective judgments about why wetlands are important (e.g., fish or fowl) and whose interests deserve attention (e.g., fishermen or hunters, urban or rural populations).

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However, watershed managers are not scientists; they must make "value-laden" choices. To do this, they not only need better scientific support to reduce uncertainty about facts, they need tools to face up to socio-economic tradeoffs in the face of uncertainty. In practical terms, this requires that they be provided with indicators that simplify complex phenomena and with rules-of-thumb that are based on well-reasoned assessments of cause-and-effect relationships that take place in watersheds and are important to people.

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Accounting for wetland benefits

The conceptual and practical problems that have prevented researchers from estimating the economic value of wetlands in absolute (dollar) terms have been described in considerable detail elsewhere. These problems are what make it necessary to use indicators rather than more conventional measures of economic value to compare wetlands and evaluate mitigation trades in terms of their effects on people. However, everyone who has attempted wetland valuation is convinced that the capacity and opportunity wetlands have to generate various types of values differ dramatically from site to site and that values developed for any given wetland area would not be very useful outside of its particular landscape context. For purposes of comparing mitigation trades, in other words, having actual (absolute) values for one wetland is not necessary. Differences in site conditions and landscape context, therefore, can be used to assess expected gains and losses from mitigation on the basis of relative indicators of wetland values.

Several wetland classification systems provide an initial basis for differentiating wetlands in terms of the functions and values they can provide. The widely used Cowardin system of wetland classification, for example, includes five types of wetland systems, 11 types of wetland subsystems, and 55 classes of wetlands. Some important differences between classes of wetlands in the Cowardin system are determined in a general way by their biophysical characteristics and their landscape context (such as estuarine or intertidal). However, in the Cowardin classification system, as in other similar systems, the landscape context only determines the biophysical features and capacities of the wetland. The fact that the landscape context also affects the functions and values it can and will provide is not considered. These wetland classification systems were not designed to differentiate wetlands within a class (such as two salt marsh or riparian wetlands) or to show how trading a wetland in one location for an identical one in another location will affect their functions or values.

Although the terms functions and values are still used in contradictory ways in some of the wetland literature, it will be assumed here that wetland functions occur independently of any human context (such as fish spawning habitat) and wetland values result when these functions satisfy some human need (such as fishing opportunities). All wetland types do not provide all functions, and wetlands that do provide certain functions may not generate any of the services or values that are generally associated with them. It all depends on the landscape context.

The landscape context affects different functions and values in different ways. For example, fish and wildlife spawning, breeding, and feeding habitats are provided best by wetlands that are surrounded by healthy ecological landscapes and are relatively inaccessible to humans. Other functions, such as sediment and nutrient trapping, generate more benefits if the wetland is closer to disturbed landscapes where sediment, nutrient, and stormwater run-off are a problem. Similarly, certain wetland benefits (such as aesthetics, scientific research, education, and flood protection) require that people reside in nearby proximity to the wetland, while others (such as endangered species habitat) require the opposite condition.

At least two facts are important when comparing wetlands or evaluating mitigation trades from a watershed management perspective. First, relocating and changing the landscape context of wetlands can have significant effects on the mix of functions and values they provide. Second, depending on what other natural assets in the watershed are abundant, scarce, vulnerable, replaceable, and so on, relocating wetlands within the watershed will make it more or less difficult to achieve watershed goals.

Leading indicators

An indicator can be described as "something that provides a clue to a matter of larger significance or makes perceptible a trend or phenomenon that is not immediately detectable" (Hammond et al.). Indicators are classified in many different ways on the basis of what they measure and how they are linked to the genuine focus of interest.

One important distinction is between current indicators and leading indicators. Current indicators refer to measures that reflect phenomena that are happening now, or more typically happened just recently. In economics, the term leading indicators is used to refer to variables that are measured not because they are good proxies for changes that are taking place currently, but because they provide clues as to what important changes are likely to take place in the future. Typical leading indicators of future economic conditions include housing starts, industrial equipment orders, producer price indices, and winter yields of feed corn. The widely used "U.S. composite of leading economic indicators" is a highly reliable indicator of changes in national economic income 6 to 9 months in advance.

Leading indicators are far more useful for purposes of management than current indicators because they provide a basis for evaluating the future payoff from current decisions and from different kinds of assets. For comparing wetland mitigation trades, watershed managers are interested mostly in leading indicators of wetland values. In particular they are interested in variables that provide clues about whether two wetlands are likely to provide the same functions and values.

As mentioned earlier, two sets of observable characteristics determine whether a wetland can and will generate certain streams of values. Site-specific features (such as soil type, vegetative cover, and topographical features) determine its capacity to provide various functions; and landscape context (such as proximity to other features of the natural and human landscape) determines if it will have the opportunity to provide these functions, and strongly influences what services will flow from them, the benefits that will result, and the distribution of benefits.

Research has not been carried out to identify and measure specific leading indicators of wetland values. However, the components of a leading indicator system for wetland values can be classified in terms of four factors: capacity, opportunity, payoff, and equity. With a bit of work to extend conventional wetland assessment, each wetland area can be evaluated with respect to each wetland function in terms of each of these four factors:

1. *Capacity:* Does the ecosystem have the biophysical conditions necessary to provide this function?

- Example: Can it support migratory waterfowl or filter nutrients?
- Information needs: site-specific biophysical characteristics

2. *Opportunity:* Is it located in the ecological landscape where it will serve this function?

- Example: Is it situated along a flyway or adjacent to a farming area?
- Information needs: location and landscape context

3. *Payoff:* How will providing this function at this location rather than at another affect benefits to people?

- Example: How will attracting waterfowl to this site or improving the quality of adjacent water here rather than elsewhere affect people?
- Information needs: location and landscape context

4. *Equity:* Who gains and who loses as a result of the ecosystem providing the function at this location and not elsewhere?

- Example: Will attracting waterfowl to this site make them more valuable to some and less valuable to others (intragenerational equity) or more vulnerable to hunting and other pressures (intergenerational equity)?
- Information needs: location and landscape context

Society may be more concerned with identical wetlands that generate identical values at two different locations if there are significant differences in who gains from them (rich or poor, urban or rural)

Working through an illustration using just one of the many functions provided by wetlands — nutrient trapping — will show how the four factors reflect specific conditions that contribute to wetland values. First, consider the capacity of a wetland at a given location to filter nutrients and prevent their adverse impacts on adjacent water bodies. A wetland's capacity to provide this function depends primarily on its slope and vegetative cover and other site-specific biophysical features; these can be considered independently of its watershed context and are the focus of most ecosystem assessment methods.

The opportunity for the wetland to trap nutrients depends on the expected flow of nutrients from adjacent land, which is determined almost exclusively by its location within the watershed, in particular its proximity to certain upland land uses (such as farms and construction sites vs. forests and grasslands). Opportunity determines the "rate of capacity utilization," which is a critical factor in establishing the level of function provided and the resulting service flows and values.

Similarly, the payoff from the nutrient trapping function depends on the wetland's location, in particular the characteristics of the adjacent (receiving) water body and the resources that exist in it or depend on it. A wetland at one location, for example, may result in important water quality payoffs and improvements in nearby shellfish beds and finfish spawning areas because it reduces overnutrification. At another location, a wetland with identical capacity to filter nutrients and the same opportunity to filter nutrients might be adjacent to a fast-moving, highly polluted river emptying directly into the open sea, resulting in no watershed-level payoff at all from reduced nutrient loadings. The residence time of water is a measure that is used for many other watershed modelling purposes and is certainly "value-free." Nonetheless, it might be an important component of an index of the relative social payoff from having a wetland prevent nutrients from entering the water body at one location rather than another.

Watershed managers must make "value-laden" choices. They need tools to face up to socio-economic tradeoffs in the face of uncertainty

And finally, there are equity considerations. Society may not be indifferent between identical wetlands that generate identical values at two different locations if there are significant differences in who gains from them (rich or poor, urban or rural). Equity considerations involve policy choices, not scientific or economic criteria, but the nature of the policy choices depend in critical ways on location: Who has access to the wetlands or to the different fisheries or waterfowl populations that depend on them? Whose property is protected from flooding? Whose scientific or educational opportunities or aesthetic values are enhanced and diminished? Indicators of who gains and who loses from wetland mitigation trades can be developed quite reliably without making any ethical decisions or value judgments about whether the group that gains is more or less "deserving" than the one that loses. The indicators can inform the policy decisions without recommending what they should be.

A graphic illustration

The situation depicted in Figure 1 illustrates how the capacity, opportunity, payoff, and equity criteria affect the services and values of two wetlands. In the situation depicted, two wetland areas are located on either side of a highway. They are being compared on the basis of the values they generate by providing three specific functions: nutrient trapping, wildlife habitat, and fishery support. The two wetland areas are the same size, the same shape, and have identical biophysical characteristics. However, because of slight differences in their landscape contexts, Site A is shown to generate significantly more benefits in each of the three categories than Site B.

There are no differences in the capacity of the two sites to trap nutrients, support wildlife, or protect and nourish coastal fish habitats; however, Site A has more *opportunity* to provide all three of these functions because of its proximity to upland land uses that generate nutrients, its closeness to the coast and adjacent fish habitat, and its accessibility to wildlife from the upland wildlife refuge area.

The *payoff* from providing functions at Site A is also greater than at Site B because of its accessibility to people and the fact that the fish habitat it protects is larger and less contaminated than the one adjacent to Site B. For the sake of argument, Site A and the fish and wildlife resources it supports are also assumed to be located where they provide scarce aesthetic and educational opportunities to a large urban disadvantaged population. Site B, on the other hand, is surrounded by large tracts of private land and forest areas that benefit only a few relatively wealthy families.

One problem with using the criteria described above is that they are based on a static landscape context. The criteria may be useful, therefore, only for forecasting in the relatively short-term, as long as the biophysical conditions and landscape context are expected to persist. For some purposes, it may be important to take a broader and longer perspective that accounts for the likelihood that conditions may change and may not affect wetlands at different locations in the same way. Different wetlands may be more or less resistant (able to withstand change) and resilient (able to recover from change) or vulnerable (likely to encounter change), and the people who benefit from various wetlands may have different capacities to adapt.

In the following list of criteria, the site-specific factors mentioned above are included under the heading of "Quality"; they reflect one important consideration: a wetland's ability to generate various values under current landscape conditions. However, to introduce a broader and more long-term perspective, they are placed within the context of other criteria that reflect concerns about change and our capacity to respond to change.

1. Quality

- Capacity (Can this wetland trap nutrients?)
- Opportunity (Is it in a location where it will trap nutrients?)
- Payoff (What resources are protected by trapping nutrients at this site?)
- Equity (Who gains by having nutrients trapped here rather than elsewhere?)

2. Scarcity

- Is this type of habitat relatively scarce or abundant?
- How would marginal changes in acres affect overall functions and values?

3. Vulnerability

- Is the site likely to be lost anyway, making it less valuable?
- Are other similar sites being lost, making this one more valuable?

4. Sensitivity

- Is the level of overall stress higher at this site than elsewhere?

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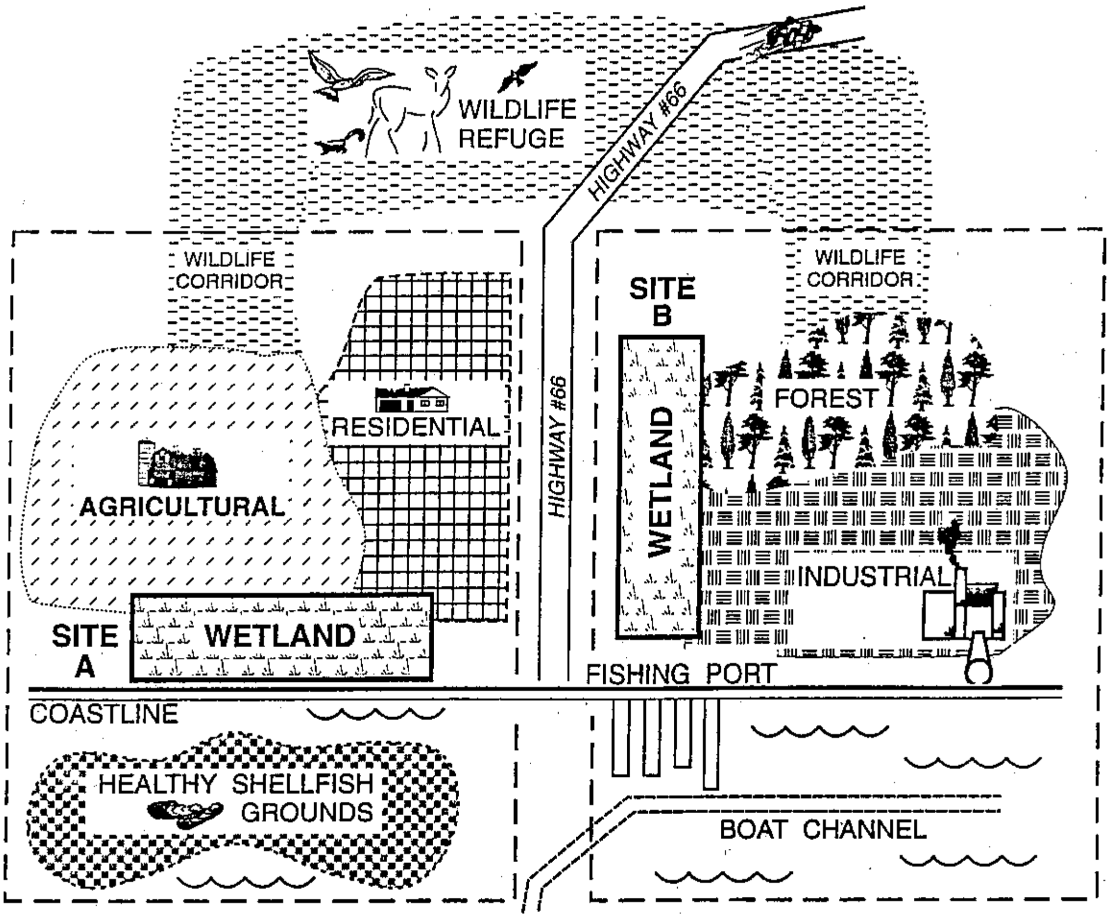
Figure 1

Effects of wetland location on function, service, and value



SITE CHARACTERISTICS

Wetland Site A and Wetland Site B are identical in size, shape, and bio-physical characteristics and are located in the same sub-watershed on either side of Highway 66.

LANDSCAPE CONTEXT

Site A:

- near the coast, downstream is a beach area
- adjacent to large healthy shellfish grounds that are accessible to the community
- upslope is agricultural land (nutrient runoff)
- wildlife corridor open from the North
- near residential areas (aesthetics, scenic)
- good access, adjacent public lands
- access to many urban poor people

Site B:

- slightly off coast, downstream is industrial site
- adjacent to fishing port and small shellfish beds that are contaminated and remote
- upslope is forest (no nutrient runoff)
- wildlife corridor is blocked by Highway 66
- nearby industrial sites (no proximity to people)
- poor access, surrounded by private lands
- access to few suburban rich people

• Is this site more or less resistant or resilient than others?

5. Reversibility

• Is it easy or difficult to restore if we reconsider priorities later?

• Would restoration depend on natural processes or engineered solutions?

• What would restoration cost and how long would it take?

6. Substitutability

• Are there perfect or near-perfect substitutes for functions and values?

• If so, are there differences in quality, costs, and who has access to them?

7. Replaceability

• Can similar habitat types be created or constructed elsewhere?

• If so, at what cost and with what risks?

The site-based criteria and risk-based or landscape-based criteria listed above provide a basis for developing a system of leading indicators of wetland values. In the absence of credible dollar estimates of wetland values, such indicators could be used to evaluate how wetland mitigation trades are likely to affect people and the achievement of watershed goals.

Such indicators have not been fully developed and tested, but preliminary research suggests that they can be developed objectively, are not very "data hungry," and can be applied in a wide range of situations. Sources of useful information to develop leading indicators of wetland values range from topographical and resource maps and land use and demographic information to more advanced GIS (Geographical Information System) applications.

In the final analysis, the range of wetland assessment methods that are useful for purposes of watershed planning is limited by two facts. At one extreme, bio-physical (value-free) assessment methods, by themselves, cannot provide an acceptable basis for prioritizing wetlands, because they do not answer the all-important question: So what? At the other extreme are methods of estimating the absolute (dollar) value of wetlands, which address the right question but are too expensive, too controversial, and too site-specific to be useful now, or perhaps forever. The indicators outlined in this article fall somewhere between these two extremes. They provide a value-based approach to answering questions about the relative wetland values that don't rely on experimental "nonmarket dollar valuation methods."

Developing such indicators would not be difficult or expensive. However, interest in doing this is very limited among academic researchers because it is too value-laden to appeal to wetland scientists, and too far removed from true "valuation" to appeal to economists. A nudge from prospective users — planners, regulators, public interest groups, environmental groups, and so on — would be needed to focus serious research on these kinds of indicators. I hope the proliferation of wetland mitigation banks and other wetland trading systems may have put wetland and watershed managers in a position where they are ready to take this step. ■

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