The Human Component of Urban Wetland Restoration

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ABSTRACT
Urban ecological restoration can produce important social benefits in addition to those biophysical improvements traditionally included in the evaluation of restoration success. Achieving social benefits requires local people to participate in planning, implementation, and evaluation of restoration. Restoration also provides experimental opportunities to study the interactions between human and non-human components of ecosystems. Existing sociological, psychological, and anthropological literature provide methods for analyzing effects of restoration on adaptive behavior, community structure, values, perceptions, knowledge, and personal efficacy.

Wetland restoration in urban areas is, in effect, restoration of human habitat. The process, goals, and evaluation of restoration success should all include a human component. Urban wetland restoration can restore the ecosystem to a condition that maximizes human benefits while minimizing inputs of energy. This is accomplished most easily and inexpensively, and achieves the longest-term results, by restoring ecological processes suited to the climate, topography, geology, and hydrological context of the restoration site. Such restoration does not require exact duplication of an historic landscape. However, it does imply altering the relationship between human and non-human components of the ecosystem.

The proposed salt marsh restoration in New Haven, Connecticut's West River Memorial Park – the subject of this volume – provides an opportunity to study this approach. During the colonial period, farmers derived economic benefits from the salt marsh system with little input of human energy (Casagrande, pp. 13-40, this volume). This was possible because farmers maintained or enhanced the ecological processes responsible for high biomass productivity. Between 1927 and 1934, a massive investment of energy was directed at eradicating the ecological processes that sustained the salt marsh in West River Memorial Park. This was so costly that the City of New Haven was forced to abandon the project before it was completed. But not before ecosystem processes were redirected to favor a *Phragmites australis* (common reed) dominated system (Orson et al., pp. 136-150, this volume).

Human energy required to maintain the current system is minimal, limited mostly to maintaining the tide gates. However, the system no longer provides benefits. Large stands of *Phragmites* block recreation access and views to the river, and provide for poor bird diversity (Lewis and Casagrande, this volume). Estuary biomass productivity and water quality are reduced, because the current system lacks the ability to sequester pollutants and sediments (Orson et al., pp. 123-135, this volume) and because the tide gates reduce upstream water oxygenation and free movement of fish and invertebrates (Moore et al., Cuomo and Zinn, this volume). Residents of adjacent neighborhoods generally perceive the river as polluted and appear psychologically and behaviorally disconnected from it (Casagrande, pp. 62-75, Page, this volume). They have indicated that they would value the area more if it were restored to a salt marsh (Udziela and Bennett, this volume).

Restoration can redirect ecological processes so that humans once again benefit from the system with minimum sustained input.

The goal of the West River restoration should be to redirect ecological processes so that humans once again benefit from the system with minimum sustained input. This would not require a large investment of energy if the targeted ecological processes are suited to the proposed restoration site. The proposed salt marsh restoration fits this criterion. Indeed, opening one or two tide gates can quickly initiate the desired successional process (Barten and Kenny, Cuomo and Zinn, this volume).

Inability of nearby residents to benefit from the marsh also results from cultural and physical barriers (Casagrande 1996; Page, this volume). Successful restoration will have to include activities other than landscape alterations that re-connect residents – cognitively, physically, and behaviorally – with the non-human ecosystem.

William Jordan (1997) distinguishes the process of ecological restoration from the science of restoration ecology. To him, ecological restoration is a constructive, functional, and self-aware human participation in the ecosystem being restored. Such participation could help link the human and non-human components of the West River ecosystem.

Jordan defined restoration ecology as restoration efforts undertaken specifically to develop and test hypotheses about the ecosystem being restored. Unfortunately, traditional definitions of ecosystems have excluded humans. This will have to change if we, as a society, are to sustain our collective adaptability to environmental change (World Commission on Environment and Development 1987).

Excluding humans from the science of restoration ecology leads to a disproportionate amount of restoration taking place in less densely populated areas. This effect is exemplified by Kentula et al. (1993), who recommend using the differences in quality between urban and non-urban wetlands to "direct wetland protection and restoration to areas with the greatest potential for ecological benefit" (p. 35). Ecological benefits, such as biomass productivity and wildlife habitat, are generally easier to restore in non-urban areas where wetlands are larger and less disturbed by humans. However, potential psychological and social benefits of restoration in densely populated areas are excluded from such an evaluation.

Hence, restoration that provides social benefits involves two approaches. Ecological restoration is the process of reconnecting the human and non-human components of ecosystems. Restoration ecology that includes humans is required for evaluating the success of restoration.

The effort to re-connect people – cognitively and behaviorally – with their urban ecosystem is a daunting yet essential task. American industrial culture is being transformed by science and technology into an ecological culture (Siry 1984, Merchant 1989). The focus on material satisfaction and the dominant perception of "man over nature" are gradually giving way to an appreciation of the inter-connectedness of life (Kempton et al. 1995, Metzner 1995). But this change lags behind in urban areas where knowledge of ecological concepts and participation in environmental activities are much lower than in suburban or rural areas (Kellert 1984, Taylor 1989). Impediments to inner-city participation in environmental activities include low personal efficacy,[1] lack of financial and political resources, lack of outdoor recreation, and cultural norms.[2]

Analyses of ecosystems will have to include humans if we are to sustain our collective adaptability to environmental change.

Despite impediments to environmental activities, urban residents strongly desire to interact with non-human nature and are concerned about environmental issues (Kaplan 1983, Kempton et al. 1995, Casagrande, pp. 62-75, this volume). Indeed, Knopf (1983) found that levels of desire to reduce stress through outdoor recreation were correlated with degree of urbanization. The gaps between the desire and ability to experience nature and between environmental concern and action result in a debilitating psychological tension (Metzner 1995). For the city-dweller, this stress is exacerbated by the cultural perception that nature is inherently non-urban, and the realization that we rely on ecosystem health, but are powerless to change our environmentally destructive lifestyles (Hartig et al. 1994). Psychologists are beginning to treat this stress using ecological restoration as therapy (Cahalan 1995, Shapiro 1995). This approach is not surprising if restoration is considered analogous to gardening, which has long been known to reduce stress and foster a sense of connection with the living world (Kaplan 1983).

[1] Mohai's (1985) definition of efficacy is used here: "The individual's perceptions of his or her abilities to affect his or her social and/or political environment."

[2] See for example Washburne (1978), Mitchell (1980), Van Liere and Dunlap (1980), Mohai (1985), and Mohai (1990). Disparate theories have been synthesized by Taylor (1989) and Casagrande (1996).

Ecological restoration can provide a bridge between the industrial and ecological cultures – easing the social unrest and personal anxiety of transition. But cities will continue to decay if urban residents do not benefit from this bridge. It is difficult, though not impossible, to psychologically re-connect inner-city populations with their ecosystems. Successful cases indicate that the following six approaches are helpful, and in most cases essential, for ecological restoration to produce maximum social benefits in urban areas.

LOCAL PARTICIPATION

The success of re-connecting local people with their ecosystems lies within the people themselves and their empowerment. They must feel a sense of ownership of the restoration site. The traditional approach, with neighborhood residents periodically commenting on a plan developed outside of their community, is insufficient. Neighborhoods, government agencies, private consultants, and/or industry must all participate in planning, implementation, and evaluation of the restoration as equals. Otherwise, the local community is not likely to develop a sense of ownership.

Lack of personal efficacy is a major impediment to involvement in community affairs and environmental activism (Mohai 1985, Taylor 1989). A key benefit of participation is improving personal efficacy (Kaplan 1983). Ecological restoration enables people to directly experience connections with the plants, air, water, wildlife, ecological processes, and other people of their environment. This promotes a sense of place within the ecosystem – a groundedness that is essential for mental health (Cahalan 1995). Environmental restoration also engenders a sense of dignity (Shapiro 1995) and may reduce stress by creating a sense of control (Hartig et al. 1994). Groundedness, dignity, and control all clarify the means by which disenfranchised urban residents can change their environment, which will enhance their personal efficacy. Hence, the individual is empowered through participation in restoration. Personal empowerment can carry over to other neighborhood revitalization efforts including economic development (Burch and Grove 1993).

Participation in planning activities is also an effective tool for communicating among stakeholders such as neighborhood groups and government agencies who may have fundamentally different perspectives of the local ecosystem. Examples of participatory planning activities include field trips to the restoration site and participatory mapping.[3] Local residents are more likely to be outspoken and think more seriously about environmental resources as a result of participatory activities. Observation of behavior during meetings, field trips, or other activities can also help environmental managers learn more about the needs and desires of local people.

"Barring love and war, few enterprises are undertaken with such abandon, or by such diverse individuals, or with so paradoxical a mixture of appetite and altruism, as that group of avocations known as outdoor recreation. It is, by common consent, a good thing for people to get back to nature."

– from A Sand County Almanac, *Aldo Leopold*

[3] Participatory mapping is a social forestry technique in which local people and environmental agencies collaborate to draw maps of the environmental resource in question. It is very effective at communicating the landscape attributes that are most important to various stakeholders. This, and other social forestry techniques that can be applied to urban areas, are described by Fox (1990), Mascarenhas (1991), Gibson (1994), and Jackson et al. (1994).

Local people can also participate in collection of water-quality, wildlife, and vegetation data (Holloran 1996). Data collecting can enhance local interest and sense of ownership of restoration projects. It serves to de-mystify science and technology, and builds community self-confidence. This is particularly effective when data collection is incorporated into local school curricula (Tanner et al. 1992).

Although inner-city, minority communities suffer a disproportionate amount of environmental degradation, they show the lowest rates of environmental activism (Mohai 1990). Research has indicated that outdoor activity, especially in a social setting, is a prerequisite to environmental activism (Taylor 1989). Inner-city residents generally do not pursue outdoor recreation because of limited access to high quality recreation settings and cultural norms. Because ecological restoration is a nature-based social activity, it can help break down these barriers to environmental activism.

Cooperation among stakeholders will also require environmental management agencies to help urban communities develop resource management capabilities (Poffenberger 1990). An excellent example is the community-based stewardship approach that the National Park Service is taking in San Francisco (Holloran 1996). This program uses volunteer participation to empower communities and help them develop a sense of resource ownership.

Incorporating ecological restoration into community-based initiatives aimed at economic development, neighborhood beautification, job training, and school improvements can help circumvent impediments to urban environmental action.

FOCUS ON COMMUNITY

A general disillusionment with the ability of government bureaucracies to address inner-city problems has encouraged the growing movement to take a community-based approach to problem solving (Gurwitt 1992, Gibson 1994). Across America, communities with few resources have made remarkable progress against poverty and urban blight. The community-based approach has become *de facto* anti-poverty strategy in many cities (Gurwitt 1992).

The basic concepts of community-based development also apply to ecological restoration. Government, philanthropic, and corporate resources can be channeled through small-scale community groups that set the agenda for their neighborhoods, and are free to discover benefits of ecological restoration themselves. Only through self-discovery and community empowerment can the full range of possible ecosystem benefits be retained.

Many inner-city neighborhoods have become repositories of environmental degradation because they have failed to act on environmental issues (Mohai 1990). Incorporating ecological restoration into community-based initiatives aimed at economic development, neighborhood beautification, job training, and school improvements can help circumvent impediments to urban environmental action.

The neighborhood is a logical scale of organization for consensus building, because it is small enough to be responsive to individuals yet provides the refuge and power of a group. Individuals are more likely to accept risks in groups than alone. Psychologists recognize the neighborhood (or rural village) as an ideal unit of participation (Cahalan 1995). A major problem in blighted, urban areas, however, is that social structure has deteriorated (Gibson 1994). Many neighborhoods lack basic communication, family function, and political leadership, which enhances criminal opportunities. Therefore, neighborhood revitalization is often a struggle to restore basic community structure.

External parties (including environmental agencies and activists) can help restore community structure by interacting with community leaders. This can enhance the legitimacy of leaders and increase the community's power base. Restoration activities also have the potential to encourage communication between generations, strengthen social bonds, improve perceptions of the neighborhood, and stabilize home values and ownership (Burch and Grove 1993). Hence, urban ecological restoration can help restore social structure as well as non-human ecosystem structure.

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In recognition of these potential benefits, the West River Neighborhood Association (WRNA) has included the West River salt marsh restoration in their neighborhood revitalization plan. This grassroots organization of residents from a neighborhood adjacent to the restoration site has successfully implemented revitalization efforts funded with government grants totaling over one million dollars. Marketing the neighborhood as a "Gateway to New Haven" has been central to their economic development plan. Community leaders recognized that *Phragmites* eradication would support this effort by opening views and access to the river. Another community goal is to rebuild an aging school by converting it to an inter-district environmental education school that uses the West River and the restoration as learning tools. Efforts are also underway to link the restoration with job creation and youth entrepreneur training. Ideas include aquaculture and urban eco-tourism. This high level of community participation will help restoration benefits flow to the community.

Establishing consensus between neighbors of the potential restoration area and the implementing agency can also help avoid opposition to restoration after the project has begun. The genesis of salt marsh restoration in Fairfield, Connecticut (Steinke 1986) came from homeowners adjacent to large stands of *Phragmites* who were suffering damage from periodic brush fires. The goal of *Phragmites* eradication was set by the community. Therefore, residents were prepared to accept temporary inconveniences of salt marsh restoration and were willing to negotiate compensation for permanent property losses caused by increased soil salinity.

THE ROLE OF FACILITATOR

Urban restoration can involve local community groups, researchers, industry, private consultants, and government agencies. These stakeholders may have fundamentally different perspectives, which are difficult to communicate and reconcile. Also, urban community groups or local politicians without environmental agendas may be unaware of ecological restoration benefits and may not be interested in participating in restoration.

Individuals who understand the perspectives of the various stakeholders can facilitate communication and promote agreement. A facilitator can balance technical possibilities with ecosystem constraints and community needs within the context of social goals, human and economic resources, and community desires (Burch and Grove 1993).

To be successful, a facilitator needs to be sympathetic to all perspectives and hold the trust and respect of the various stakeholders. Gaining the respect of environmental agencies often requires demonstration of experience in restoration or an appropriate technical education. Also, a facilitator must understand financial, policy, and procedural issues of the participating government agencies. Gaining the trust of community groups requires spending time in the community and participating in activities such as clean-ups and community meetings.

Even though inner-city people often care about environmental issues (Taylor 1989), their ability to take action can be constrained by a lack of resources including money and political knowledge (Mohai 1985). The facilitator can bring resources to the community by assisting with grant applications or providing knowledge about government agencies and programs or private foundations.

Private consultants, state government agencies, town officials, environmentalists, educators, and students can potentially act as facilitators. In the case of New Haven's West River salt marsh restoration, staff and students affiliated with the Center for Coastal and Watershed Systems (CCWS) are acting as facilitators between the Connecticut Department of Environmental Protection (CT DEP), city staff, and The West River Neighborhood Association (WRNA). CCWS is a research and public outreach center within the Yale School of Forestry and Environmental Studies. It is respected by the CT DEP because of its university affiliation and past research partnerships with government agencies. CCWS holds the trust of the neighborhood because its office is in New Haven, and its staff have lived in the West River neighborhood or have been involved in New Haven politics. More importantly, CCWS staff and students have attended community meetings regularly and contributed to other aspects of neighborhood revitalization efforts. This has included assisting with grant applications, collaborating with development of the environmental magnet school, and providing information about the science and politics of the proposed restoration.

EDUCATION

Environmental education through community-sponsored programs and school curricula is fundamental to enhancing the relationship between human and non-human components of urban ecosystems. Increased ecological knowledge can reduce barriers to environmental activism (Taylor 1989) and outdoor recreation so that benefits can flow to the community.

Incorporating ecological restoration into school curricula can stimulate interest in science and math (Tanner et al. 1992). This, in turn, contributes to personal efficacy and community empowerment. Children also provide an excellent way to involve adults in restoration (Tanner et al. 1992, Chow-Fraser and Lukasik 1995). Adults become interested by seeing children working at restoration and by talking about projects at home. Student presentations are valuable because parents are much more likely to come to a presentation about restoration and make the effort to understand restoration principles if their own children are presenting information. College and high school internships linked to environmental curricula have also been found to be valuable for restoration efforts (Holloran 1996).

Combining ecological restoration with education can reduce barriers to environmental activism and outdoor recreation, stimulate interest in science and math, enhance personal efficacy, and empower communities.

DEMONSTRATION PROJECTS

A fundamental concept of community-based development is that progress happens project by project (Gurwitt 1992). Neighborhood-based restoration projects that are highly visible can help build community development momentum because they display success (Burch and Grove 1993). It is also helpful to make field trips to restored urban ecosystems, so that community members can envision a finished product in their neighborhood.

EVALUATION

Urban, community-based, ecological restoration is becoming more common (Holloran 1996), and it would be prudent to evaluate the success of the various approaches. It has been argued that ecological restoration has the potential to promote democracy (Light 1994, Holloran 1996), reduce psychological stress (Shapiro 1995), and fulfill a basic human need for ritual that is currently expressed by our culture in destructive ways (Jordan 1997). These potential benefits imply that social goals can be set and that progress toward those goals can be evaluated using the social variables discussed below.

RESTORATION ECOLOGY: THE HUMAN COMPONENT

It is essential to include biophysical processes in the study of ecosystem restoration, and methods have been discussed throughout this volume and elsewhere.[4] However, ecologists' attempts to include humans in ecosystem analysis have mostly focused on one-way effects of humans on ecosystems (see for example McDonnell and Pickett 1993). Other disciplines such as environmental psychology, environmental history, and ecological anthropology are valuable for generating hypotheses of human-environmental interaction.[5] But these approaches do not allow experimental tests for cause and effect – a fundamental goal of ecology. Using the social variables described below, restoration ecology can provide experimental opportunities for studying human interactions with ecosystems.[6]

ADAPTIVE BEHAVIOR

It is through adaptive behavior that humans respond to continously changing ecosystems (Ulrich 1983, Smith 1992). Therefore, monitoring behavior is essential for analyzing the effects of restoration on humans. Human behavior can be monitored directly or indirectly. A rapid and inexpensive direct method is to travel line transects or visit points and record data about activities, group composition, gender, age, time of day, and duration of activities (Altmann 1974, Ås 1975). Indirect sampling involves observations of physical evidence of past behavior. For example, a survey of litter can be used to determine if an area is being used for picnicking, fishing, or taking illegal drugs.

Preliminary behavioral sampling by Page (this volume) indicated that recreation near the West River was mostly limited to organized sports in playing fields. Few people were observed walking, enjoying views, fishing, or observing wildlife, even though residents desired these activities (Casagrande, pp.62-75, this volume). Enhancement of recreation opportunities through improved aesthetics and fish and wildlife habitat is an important benefit of urban restoration (Kaplan and Talbot 1983, Knopf 1983). Passive and nature-based recreation could be monitored to evaluate behavioral response to restoration.

Observations of group size and composition can indicate social structure and cultural norms when combined with block level census data. Behavioral sampling can also be used to verify interview surveys of environmental resource use. However, other social variables must be monitored to evaluate restoration benefits, such as increased personal efficacy and non-use economic value (Udziela and Bennett, this volume).

[4] See for example Westman (1991), Kentula et al. (1993), and Shreffler and Thom (1994).

[5] Ulrich (1983) and Roszak et al. (1995) provide introductions to environmental psychology including effects of ecological restoration. Cronon (1983) and Merchant (1989) used environmental history to generate hypotheses of feedback mechanisms. Steward (1955), Rappaport (1968), Smith (1992), Bennett (1993) and Richerson (1993), provide examples of anthropological approaches to human-ecosystem relationships.

[6] For examples of ecosystem models that include humans, see Kowalewski et al. (1983), Burch and DeLuca (1984), Lee et al. (1992), and Boyden (1993).

KNOWLEDGE OF THE ECOSYSTEM

A prerequisite for adaptive behavior is sufficient knowledge of the ecosystem (Hunn 1982, Berlin and Berlin 1983, Heerwagen and Orians 1993). Ecological restoration provides a direct learning experience, although knowledge acquired through restoration is not confined to the participants. Humans are a social species and circulate knowledge throughout their community in order to enhance collective adaptability. Ideally, a restoration project would maximize the transfer of ecological knowledge by linking the project with education and other community-based initiatives.

A restoration project's effectiveness for enhancing knowledge can be evaluated using surveys before and after restoration. A preliminary survey of neighborhoods near the proposed West River restoration site suggested a low level of ecological knowledge (Casagrande, pp.62-75, this volume), which is typical for urban areas (Kellert 1984). It is possible that the residents possess a different kind of ecological knowledge than was tested for in the survey, which was not designed as a comprehensive test for ecological knowledge. For example, residents indicated poor knowledge of pollution processes, but some fishermen were very knowledgeable about the area's wildlife and history of environmental disturbance (Casagrande, unpublished data). A more comprehensive survey could be designed to specifically test for changes in ecological knowledge as a result of restoration.

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VALUES AND PERCEPTIONS

Although ecological knowledge is necessary for sustaining a beneficial human/environmental relationship, knowledge does not translate directly into adaptive behavior. Values, social norms, individual perceptions, and social institutions influence behavioral decisions and interpretation of knowledge (Casagrande 1996). Values and perceptions can be rapidly quantified using surveys.

Surveys in the West River area indicated that residents valued the potential restoration area for its naturalness and for wildlife habitat (Casagrande, pp. 62-75, Udziela and Bennett, this volume). But they perceived the river as polluted and aesthetically displeasing. As a result, they placed a high priority on restoring an environment suitable for relaxation and encountering wildlife. These data indicate that – in this case – values and perceptions would support changes in behavior (i.e., increased outdoor recreation) as a result of restoration. Continuous periodic surveys would be necessary for evaluating restoration effects on perceptions and values.

PERSONAL EFFICACY

Ecological knowledge and cultural values can encourage behavioral responses to environmental change. However, individuals may not act if they lack self confidence and/or a clear cognitive model[7] of how their action will result in benefits. Cognitive models can be based on personal experiences or, as in the case of religion, cultural influences (Holland and Valsiner 1988). Self confidence and cognitive models combine to shape personal efficacy. Increased personal efficacy could be a major benefit of urban ecological restoration.

Semi-structured interviews and photo-questionnaires used by anthropologists and environmental psychologists can be used for studying personal efficacy (Kaplan 1983, Kempton et al. 1995). These methods are time consuming and require special skills. But they are necessary for evaluating restoration projects that emphasize human behavioral change.

[7] Cognitive models are mental maps of our relationship with our social and physical environment. These models enable us to predict the results of our actions.

TIME AND MONEY

Exchanges between humans and ecosystems can also be measured using time and money. Municipal expenses required to maintain the West River tide gates, for example, represent current human inputs to the system. Volunteer time and municipal expenditures being considered for park clean-up and *Phragmites* mowing represent potential inputs aimed at increasing aesthetic benefits. Increases in expenditures of time or money to visit the restored area would indicate increased human benefits.

Restoration benefits, such as satisfaction from knowing wildlife exists or that future generations will have a cleaner environment, are difficult to value economically and are not reflected in behavior. However, they can be measured using economic techniques such as contingent valuation (Udziela and Bennett, this volume).

COMMUNITY STRUCTURE

Characteristics of the community can greatly influence the ability of restoration to increase ecosystem benefits. Demographic characteristics such as age distribution, population density, and race are easily obtained from census data (Page, this volume). Information regarding community leadership, cultural norms, and institutions (e.g., civic groups, churches) can be obtained from interviews and systematic observation.

Additional information about cultural norms and communication between residents can be acquired from behavioral sampling. For example, observations of West River anglers indicated that Hispanics were most likely to fish in family groups – a cultural norm (Casagrande, pp. 62-75, this volume). Perceptions of the river are probably communicated between generations of Hispanics more quickly than generations of other cultures.

WEST RIVER RESTORATION: A HYPOTHETICAL EXAMPLE

The following simplified, hypothetical example using the West River restoration illustrates how the human component can fit into ecosystem research. Collaboration between the CT DEP, neighborhood groups, and Yale University researchers could result in a mutual goal of reducing non-point source (NPS) pollution.[8] Water chemistry studies conducted by Yale researchers and funded by the CT DEP have identified NPS pollution as a problem in the watershed, and neighborhood residents indicated pollution as a major concern (Casagrande, pp. 62-75, this volume). Landscape and hydrological alterations to the marsh within West River Memorial park can be designed to restore ecological processes that remove NPS pollution (Barten and Kenny; Orson et al., pp. 123-135; this volume). But long-term pollution reductions require changes in the values and behavior of watershed residents, because much NPS pollution can be attributed to automobile use and maintenance, lawn care, and illegal dumping. Comprehensive ecological restoration with an educational component and widespread participation of residents could achieve additional water quality improvements through behavioral change (Table 1).

Baseline survey data indicate that residents have no knowledge of NPS pollution (Casagrande, pp. 62-75, this volume). If neighbors participated in salt marsh restoration with an educational component, they would learn about watershed hydrology, non-point source pollution, and their ability to affect the environment. As a result, they might limit their use of chemical lawn treatments, refrain from changing automobile oil in the street, or maintain automobiles to reduce leaking fluids. If community social structure were amenable, this behavior could spread from the participants to other residents. Increased water quality could enhance perceptions of the river and recreational opportunities – further strengthening the human bond with the river. Every step of this hypothetical, positive feedback loop could be measured using biophysical and social variables.

[8] Non-point source pollutants originate from activities conducted over broad areas, or through the cumulative effect of many, small activities (Benoit 1995). They are more difficult to regulate than point-sources, such as factories or sewage treatment plants. Lead and nitrates from surface run-off and combin-ed sewer outflows and copper from algae control are the major pollutants in the West River watershed (Gaboury Benoit, Tim Rozan, and Jeffrey Albert, Yale F&ES, personal communication). Orson et al. (this volume) discuss the potential for restored salt marshes to sequester pollutants.

Table 1. Differences in urban salt marsh restoration approaches using the hypothetical goal of nonpoint source pollution reduction.

BIOPHYSICAL APPROACH ONLY	APPROACH WITH HUMAN COMPONENT
Implementing agency designs marsh restoration.	Plans are developed through collaboration of local people and the agency.
Implementing agency restores hydrological function and plants vegetation.	Community participates in restoration work, and the project includes links to education and community revitalization.
Implementing agency monitors water quality, soils, and sedimentation rates.	Community participates in monitoring. Local behavior, perceptions, and values are also monitored.
Desired Result: improved water quality in estuary.	Desired result: additional water quality improvements through behavioral change within the watershed.
No knowledge gained regarding the human component.	Water quality improvements can be enhanced by calibrating education, recreation, and participatory activities, or additional social barriers to behavioral change can be identified.

The amount of time needed to detect social change is uncertain. Kentula et al. (1993) have proposed a method for evaluating biophysical changes using a performance curve. This concept can be expanded to include social variables, such as perceptions of marshes (Fig. 1). A salt marsh restoration in Fairfield, Connecticut provides an example of changes in perceptions after restoration. Steinke (1986) indicated that before restoration neighbors had a negative perception of the *Phragmites* dominated marsh, because brush fires were damaging their property. Immediately following restoration complaints increased because of negative effects such as snakes and rats migrating off the marsh and into yards. But several years later, perceptions were mostly positive, including an increased appreciation of wildlife.

Perceptions could be monitored by annual surveys and plotted on a performance curve (Fig. 1). The maximum increase in benefit would occur as the curve levels off and the system stabilizes. Ideally, stable post-restoration perceptions would be more favorable than the pre-restoration condition.

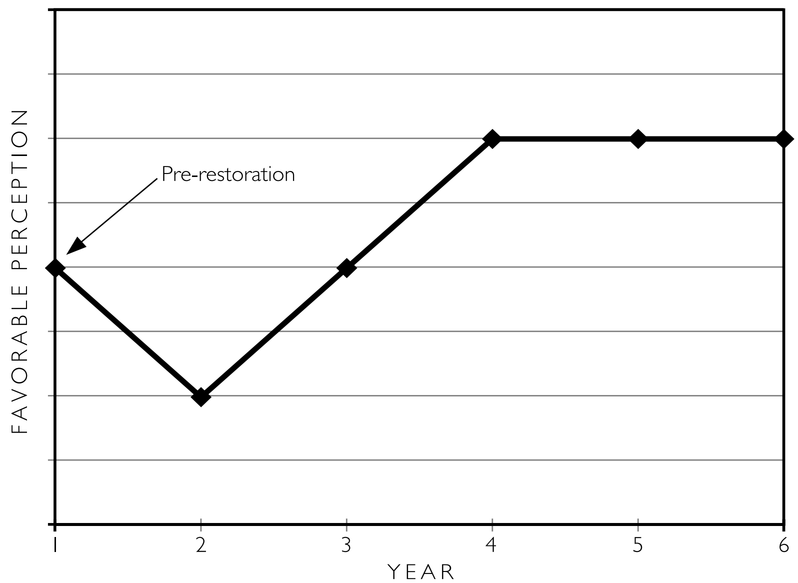

Figure 1. Hypothetical change in human perceptions of a marsh as a result of restoration.

CONCLUSION

Urban ecological restoration provides an opportunity to study the interactions between human and non-human components of ecosystems by taking an experimental approach. The sociological, psychological, and anthropological literature provide methods of analysis for determining the effects of restoration on adaptive behavior, community structure, values, perceptions, knowledge, and personal efficacy. Success of ecological restoration could be measured by the amount to which social benefits – as well as bio-physical benefits – exceed human inputs of time and energy necessary to maintain ecological processes.

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