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ARTICLE: NATURAL CITIES: URBAN ECOLOGY AND THE RESTORATION OF URBAN ECOSYSTEMS

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**SUMMARY:**
... I. Introduction to Urban Ecology ... Urban ecology requires the establishment of a doctrine of ecological knowledge of a city, recognizing the legitimacy of the urban ecosystem. ... Although the legal and policy tools that will be discussed in this section are not specific to urban areas, they must be modified and used in innovative ways to address the unique challenges of urban natural resource protection. ... Such an interim planning district was used in an urban context to control development on a large, abandoned brownfield site in Chelsea, Massachusetts. ... As with the state and local regimes, the role of federal regulatory schemes in protecting and restoring an urban ecosystem is defined by the unique elements of urban ecological advocacy: the commitment to systemic research and management and the city's status as a forgotten environmental zone. ... As an urbanized area launches an urban ecosystem study and begins to identify priority resources, local community organizations will want to share that data with the local Phase II permitting authority in the hopes that Phase II permits can be drafted, or redrafted, to utilize habitat restoration as an important tool for water quality improvements. ...

**TEXT:**
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I. Introduction to Urban Ecology

The relatively young science of ecology attempts to forge a holistic understanding of the natural processes that take place within a defined system. The central idea is that a patch of the planet, a natural community, contains discrete living (biotic) and nonliving (abiotic) elements that interact in synergistic ways. These elements include the living organisms, the landscape patches, the parent geologic materials underlying the soils, and the local hydrologic and weather patterns. These patterns of interactions can be categorized and compared between and among various ecosystems. Energy flow (metabolism), food webs, predator-prey interactions, and co-evolution are typical categories of

investigation common to all ecosystems. n1 The scale of an ecosystem varies with the question being asked. Understanding the ecology of the Charles River in Massachusetts, for instance, requires that the patch include at least twenty-six towns and cities. On the other hand, studies of the ecology of an endangered amphibian, such as the spadefoot toad, may be focused on a single vernal pool and its surrounding upland habitat.

[*319] Ecologists have been comfortable for over a century with the notion of natural ecosystems such as deserts, tundra, grasslands, old growth forests, and estuarine salt marshes. Even animal societies such as honeybee colonies, termite mounds, and wolf packs are routinely considered as ecological units. n2 However, the concept of the natural city, a human city functioning as an ecosystem on the scale of an estuary or a rain forest, is in its academic infancy.

Traditionally, the study of ecology has been applied to natural systems in such a way that the variable of human impact has been excluded from the biological equation. Our understanding of ecology and its younger sibling science, biodiversity, has been developed by sending researchers into pristine ecosystems in order to gather data on the intricate co-evolved relationships among organisms. Ecologists have focused on the interactions within the natural community. The new biodiversity scientists have tried to identify as many species as possible and use those data to forge an understanding of species distribution and abundance. In addition to providing lucent images of nature, these studies have provided the infrastructure for the disciplines of biogeography (the mapping of species), behavioral ecology (the behavior of individuals and groups), and most recently, conservation biology (protecting those species from extinction). With the exception of those researchers interfacing with public health, however, the studies have been conducted in remote areas where the human footprint was as small as possible. Those public health scientists who did work in cities were conducting research on the negative impacts of urban living and essentially trying to stamp out any remaining plant or animal populations that were deemed troublesome. Cities were not viewed as natural entities but as foreign impositions upon the native landscape. n3

The pervading perspective from the academic research centers was that true ecological research was possible only when one reached the wilderness. There, the footprint of human activity was small and had not yet destroyed the elements of a natural balance. The foundation of this approach to ecology traces its roots back to the transcendental writers of the late 19th century, such as Thoreau [*320] and Emerson. These writers desired to escape the artificial environment of the city and therefore wrote from solitary retreats where they encountered nature firsthand. The 20th century gave rise to many influential ecological pioneers who shared this perspective, such as John Muir, Rachel Carson, and Aldo Leopold. In fact, Leopold's account of the natural history of his beloved Wisconsin wilderness in A Sand County Almanac served as a manifesto to a generation of field biologists. n4

While such an approach to ecological studies provides beautiful and robust models of nature, this approach is often inapplicable to some of the most imposing challenges in human ecology, particularly those involving the management of our urban ecosystems. Nearly half of the world's population lives in cities, many in mega-cities that harbor 10 million residents or more (e.g. Mexico City, with more than 17 million people). n5 In the United States, nearly three-quarters of the population lives in urban centers, and that trend is increasing. n6 The declining state, but increasing size and environmental importance of urban ecosystems provide enormous opportunity for the application of ecological thinking and research. The heavy social burden of the injustices born of the urban environment demands that scientific talent be employed in the service of urban management. The ecological models developed in the remote beauty of national parks and wildlife refuges need to be tested and modified in order to provide guidance to those professionals struggling to solve problems and manage dwindling resources within the city landscape. The city as an ecosystem is a radical idea that challenges traditional scientists to think and behave in new ways. n7 There are indications that this urban perspective is grinding up and replacing some of the ecological dogma that currently exists. n8

A revolution in science viewed in real time, however, is like watching the tide come in. Usually, the events are slow to unfold, and we need a marker from which to gauge the change. One notable indication that urban ecology has begun to achieve recognition as a legitimate science is the funding of two major projects by the National Science Foundation (NSF) that seek to reveal the ecological [*321] machinery of cities. Baltimore and Phoenix are urban research sites in the U.S. Long Term Ecological Research Network (LTER), a system of 1100 scientists working at twenty-four distinct

sites across the world. n9 Begun in 1980, the LTER program has attempted to research "ecological processes over long temporal and broad spatial scales" in order to identify and solve ecological problems. n10 The philosophy of the program has tilted towards the applied aspects of ecology, but the study sites have ranged from the polar ice of Antarctica to the rainforests of Puerto Rico. n11 The inclusion of two urban ecosystems in this network represents a sea change in the discipline of ecology and a recognition of the importance of understanding the ecology of our cities.

The development of ecological thinking about cities will have a broad and profound impact on all the issues of social importance to urban stakeholders. Public health, resource allocation, water quality, energy conservation, and historical and natural preservation will benefit from a revisionist approach that includes the biology of the system as the foundation for its understanding and management. The concept of the natural city will have its roots in a series of scientific models that will be testable in a variety of urban environments. n12

A. Why Should Cities Be Studied as Ecological Units?

The interest in urban ecology can be understood from four perspectives. First, human activity is concentrated in urban clusters. Even for those humans living outside of metropolitan centers in what are classified as rural landscapes, the productive activities of these people are often linked to resource requirements in nearby or distant cities. n13 Second, humans as a species dominate each of the earth's ecosystems, whether they are heavily populated or not. n14 Although this idea remains troubling to scientists, anthropogenic impact is an unavoidable variable in the study of ecology. Third, any modern model of ecology must include considerations [*322] of human impact in order to be of use as a predictive tool. Finally, developing an understanding of the ecological processes that occur within urban landscapes can be of great utility to those professionals charged with solving the social problems inherent in city life. We will examine these four elements in more detail.

Human demography has shown a steady increase in the percentage of people living in cities. Beginning with the advent of agriculture 5,000-10,000 years ago, humans have been developing bigger and more densely populated urban centers. The United Nations recognizes over 300 cities with populations over one million people, sixteen of which have been categorized as megacities (10 million or more inhabitants). n15 This pattern of urbanization is evident in both developed and developing nations. In the United States, the trend towards urbanization is accelerating. n16 Despite the migration to suburbia by middle-class Americans after World War II, cities have continued to grow. n17 This growth has occurred both as a function of density within the urban core and as a function of urban sprawl. n18 Over 75 million homes and apartment units have been built in the United States since 1950, most within urban metropolitan areas. n19 The expansion of urban areas since 1950 has gobbled up open space. In the period from 1960 to 1990, the physical footprint of cities doubled to nearly 20% of the nation's land area (675,000 square miles). n20

As human population has increased, so has our species' impact on global ecosystems. n21 The fossil record points to five major periods of rapid extinction on the planet during the past 500 million years, all of which occurred prior to the evolution of our human lineage. n22 These catastrophic events were triggered by rapid, unbuffered environmental change. n23 The most recent major mass extinction cycle, triggered by an asteroid impact on the planet, [*323] occurred approximately 65 million years ago during the Cretaceous period and caused the extinction of approximately 76% of the then existing species on earth, including the last of the dinosaurs. n24 Conservation biologists have now detected the start of a sixth major period of rapid extinction. n25 This latest bout of biodiversity loss is directly linked to environmental degradation caused by human activity and over-exploitation of natural resources. n26 The tremendous impact of humans on the biosphere is concentrated in urban areas where deforestation, soil erosion, pollution, and exhaustion of natural resources are the most intense.

Ecological research has pondered the interactions of species in their natural setting for nearly 200 years. However, the shift from viewing humans as a "confounding variable" to regarding them as a central element of scientific investigation is in an uncomfortable transition. The tension between natural and social scientists is caused, in part, by this very issue. Although both camps embrace the scientific method, natural scientists and social scientists are separated by a methodological rift that runs along the axis of humans as a research variable. Natural scientists, such as physicists,

chemists, geologists, and biologists, study natural phenomena in which human impact is minimized, or at least controlled. Social scientists, such as psychologists, sociologists, and economists, embrace the human variable and make it the focus of original research. The city as a subject forces all practitioners of science to cross the rift and work with a shared acceptance of the human factor as a legitimate subject of controlled study. n27

Finally, an ecological perspective provides a new set of tools for addressing the problems of our cities. n28 Social injustice, poverty, public health, and pollution are all societal problems with deep ecological and environmental roots. One of the tremendous advantages of science as a lens for viewing the world is that it brings with it a sense of dispassionate neutrality that can provide a fresh perspective on these problems. The teaming of science with [*324] social concern has spawned the relatively new field of environmental justice, which has proven to be a robust approach to problems like toxic waste management and brownfields reclamation.

B. What Should the Scientific Protocols for Urban Ecology Look Like?

Once the decision is made to tackle ecological questions within the urban landscape, we are confronted with the challenge of designing relevant protocols that address human social needs. The historic absence of a human dimension in traditional ecological study has forced urban ecologists to redefine the way in which they frame their questions. The old idea that cities are an imposition on the landscape leads an investigator to pose only certain types of ecological questions. Traditionally, these questions tend to be organized around ecological measurements in the city that can be compared to conditions outside of the urban setting, in "undisturbed" areas. While these kinds of questions are potent sources of good science, they provide only a limited understanding of the city as an ecological entity in itself. Urban ecology requires the establishment of a doctrine of ecological knowledge of a city, recognizing the legitimacy of the urban ecosystem. n29

Emerging in the literature is a dichotomy between studies that have addressed the ecology in a city n30 and those that describe the ecology of a city. With the exception of seminal research on the ecology of Hong Kong, n31 researchers doing work in the urban context have posed "ecology in" questions. These questions ask about conditions within cities compared to those conditions outside of the urban landscape. The city infrastructure, viewed as an imposition, modulates the natural processes in many complex ways. Popular topics include plant and animal distribution patterns, edge effects such as roads and fences, before and after construction effects, and pollution impacts. A more holistic approach to understanding cities requires the formulation and investigation of questions regarding the ecology of the urban landscape.

[*325] "Ecology of" research topics that recognize the city as a legitimate ecosystem include the ecological effects of land-use change, the spatial distribution of resources (abiotic) or populations (biotic), and whole system metabolism (energy flow). The watershed approach provides the perspective and scale necessary for "ecology of" questions. n32 In a watershed model, all of the metabolic inputs and outputs (energy and nutrients) to the system are defined by the boundaries of the land that is drained by a single river or stream. As the science matures, the appropriate application of ecological science to city systems will require both a shift in perspective and the addition of new tools of investigation.

One particularly important addition to the urban ecologist's toolbox will be a set of research protocols that calculate the human social component. Standard ecological models suggest three biophysical forces or "drivers" that stimulate and modulate the nature of any ecosystem: the flow of energy, the cycling of matter, and the flow of information. n33 These forces exert influence on five major ecosystem patterns and processes: primary production (energy captured by plants through photosynthesis), populations (growth and decline), organic matter (the raw "stuff" of food), nutrients (available food), and disturbance (climatic, geological, etc.). n34 In standard ecological models, the human dimension is generally categorized as "disturbance." n35 The new paradigm for studying "ecology of" questions requires that the researchers' toolkit be equipped with a way of calculating socioeconomic "drivers" to the urban ecosystem. These "drivers" must be considered just like the three biophysical "drivers" mentioned above.

Like the biophysical "drivers," the socioeconomic "drivers" include information flow, but also include cultural

values and institutions that create a suite of additional patterns and processes that contribute to ecosystem dynamics. n36 Grove and Burch suggest that additional patterns include the economic system, power hierarchies, land use and management, demographic patterns, and the designed or built environment. n37 The integration of these socioeconomic [*326] "drivers" into the ecological equation requires cooperation among natural and social scientists, as well as urban planning professionals.

The biggest challenge to creating robust scientific models of the natural city is finding ways to blend the ongoing requirements of the city with the needs of the scientists to collect information. Typically, when scientists are conducting ecological research, the site at which they are working is essentially isolated from human disturbance. For example, if a team of scientists were conducting biodiversity studies of a local bird population in a rain forest, they would include as part of their methodology assurances that no other humans had entered the study area during the time they were collecting their data. In this way, scientists would be confident that the data they collected would represent the most accurate picture of the avian community structure. However, when scientists are working in the city and the subjects include humans, this type of approach is essentially impossible. Avian biodiversity studies conducted in the urban context need to accept human presence as part of the model and actually find a way to quantify and understand the character and quality of human presence. In an urban setting, humans should be viewed as a "keystone species" whose own ecology has a dramatic and integral impact on all other species within the system being studied. Sociologists have known this for decades. As a result, they have found ways to gather scientifically robust information and have developed methodologies that are noninvasive to the peoples they study. Urban ecologists will need to adopt similar strategies.

A second important hurdle to clear is the obstacle of arbitrary political boundaries. Cities are often characterized by delineation along county, town, ward, and precinct lines. While these boundaries may make sense in the context of the management of human behavior, they are typically meaningless to the plants and animals that constitute the natural community. Ecological studies must be rooted in solid methodologies, one of which is the recognition of the functional boundaries that have an impact on the migration or dispersal of the organisms being studied. In the emergent science of urban ecology, the watershed boundary has become the coin of the realm. n38

Watersheds represent the total land area drained by a river or estuary and present a reasonable unit of study. From a water pollution [*327] perspective, a watershed will contain both the source of a polluting chemical, such as a factory or sewer pipe, as well as the bodies of water most directly affected by the discharge. Thus, from a public water safety perspective, the watershed represents the local "vessel" from which water is both withdrawn and recharged. There is an inherent sense, therefore, to studying ecological process at the watershed level, despite the fact that a given city's limits might include more than one watershed, or a given watershed might include more than one city.

Protocols for studying urban ecology and focusing on "ecology of" questions are being adopted at a variety of sites around the United States. As mentioned earlier, two of the most notable current urban ecology projects are located in Phoenix and Baltimore. Heavily funded by the National Science Foundation (NSF), these two projects are part of the NSF's efforts to support long-term ecological research. n39 These research programs are conducted by an organized network of ecologists whose studies are designed to last at least thirty years. n40 The goal of these integrated programs is to provide a research framework that is applicable to any urban ecosystem. n41

Although long-term studies are preferable, they are not always possible in the urban context. Sites of interest within the natural city may be under pressure for development, with associated changes in their land use. In addition, long-term ecological research is expensive, and local municipalities often cannot afford to support projects for extended periods of time. These kinds of pressures call for a more rapid assessment of the ecological value of the site, which poses an additional challenge to scientists, as the luxury of time has been removed from the research methodology.

In response to the need for more tools to analyze urban ecosystems, the Urban Ecology Institute in Boston is coordinating a collaborative project that places the task of ecological research of urban resources into the hands of local stakeholders. n42 This scholarly, though grassroots, approach is needed because most cities, including Boston, do not

have the resources associated with a long- [*328] term ecological research designation by the NSF. Instead, local governments have to be frugal and investigate their city's resources using local talent and resources. The goal of the collaboration in Boston is to establish, with modest funding, a rapid assessment methodology that both describes and evaluates the ecological or biodiversity value of a given patch within the city. The program provides a mechanism to directly link the fieldwork of scientists to the active steps of open space protection and restoration. n43

The initial work products of this pilot program include: 1) the development of novel field protocols that will be used by scientists to characterize appropriate patches, 2) the application of these protocols to a sample of open space patches within the Boston metropolitan area, and 3) an ecological review of the assessed lots that have been ranked for further economic and political analysis.

The critical idea being explored here is that the data collected have a novel purpose. They will not be used to compare urban sites to some rural standard that suggests that these urban sites are degraded beyond repair. Inevitably, if the standard were a pristine ecosystem, an analysis of urban sites could yield no other result. Instead, these data are useful in the context of measuring the diversity of many urban sites and developing a relative sense of their biological value. The sites will be analyzed for additional characteristics such as connectivity to other open spaces, proximity to water, potential benefits for watershed health and function, ease of restoration, patchiness of the natural community, and overall size. These inquiries will result in a value system that is nested within the context of an urban system and recognized for both its biogeophysical and socioeconomic "drivers." The true efficacy of this approach will be realized when these value systems are linked to urban restoration projects that maximize the existing resources of the city and link them to the surrounding ecosystem.

C. Conclusion

While the development of a new perspective on the ecology of urban systems requires considerable effort on the part of the scientific community, the potential payoff on the investment is enormous. If one accepts the premise that science should serve humanity, then the needs of urban dwellers worldwide provide a compelling challenge to natural and social scientists. Many conservation biologists agree that densely populated urban centers [*329] represent the most likely scenario for a sustainable planet. Understanding the ecology of cities is the first step towards improving the quality of life for all of its living inhabitants. Livable natural cities increase the probability that sprawl can be minimized and that the remaining open spaces outside the city limits can be preserved. The promise of science done well is that its findings will provide the basis for rational solutions to human problems. The application of ecological thinking to the vexing problems of the world's cities provides tantalizing opportunities for science to do more good work.

II. Legal and Regulatory Tools: Introduction

Just as the science of urban ecology is in development, regulatory efforts to protect and restore urban ecosystems are in their infancy. Urban ecology as a field of research and advocacy is unique in several ways, each of which has implications for regulatory efforts.

Advocacy to protect urban ecosystems proposes that environmental resources are to be studied and understood in a systemic context. That is, natural resources are to be understood and managed within the context of a regional ecosystem, not as individual media (land, water, or air). In other words, the resources are managed on the basis of a specific place, as defined by scientific boundaries (an ecosystem) rather than by political boundaries (a town) or regulatory boundaries. Insofar as the environmental regulatory scheme is based on statutes that focus on specific media, these statutes must be utilized in creative ways to manage resources on a systemic basis.

In this regard, urban ecological research and advocacy can draw on the recent commitment at the state and federal levels to place-based environmental protection. The foremost examples of this approach to environmental protection and management are the watershed management programs implemented over the past five to ten years in many states and at the federal level. These programs are based on the realization that environmental impacts cannot be limited to a

particular geo-political area, and they evaluate an entire watershed when devising regulations to deal with issues such as land use and effluent limits (limits on discharge of pollutants).

Secondly, of course, urban ecology is a departure from traditional environmental advocacy in that the focus is on places that [*330] have long been considered the antithesis of the environment or of nature: urban areas. As noted in the introduction, urban areas are important focal points for environmental protection because of their enormous impact on natural communities and resources. Urban areas, although not typically thought of as important to environmental protection, may be the most important environmental challenge of the next century. The wisdom of focusing attention on healthy urban environments is clear. Demographic trends are putting an ever-increasing percentage of our population in urban centers, and metropolitan areas are growing at an alarming rate. In Massachusetts, for example, there was a 21.7% increase in developed land from 1982 to 1992. n44 In the greater Boston area, the population increased 24.3% between 1950 and 1990, while the urbanized area grew 158.3%. n45 Massachusetts is the thirteenth most populous state, with 96.1% of its population in metropolitan areas. n46 These data reflect trends that are occurring across the country. n47 Urban population is indeed growing. However, the amount of land being consumed by development far exceeds this population growth. These statistics are leading many in the environmental movement to think about environmental protection in cities, including topics such as sustainable development, smart growth, and sprawl. With more people living in cities and urban areas expanding beyond their current boundaries, ensuring that these areas are ecologically healthy presents a great challenge to the environmental movement. Indeed, many environmentalists are coming to the conclusion that developing more sustainable, healthy cities may be the key to saving the overall environment. n48

Although the legal and policy tools that will be discussed in this section are not specific to urban areas, they must be modified and used in innovative ways to address the unique challenges of urban natural resource protection. The goal of these strategies is to improve the ecosystemic functions of an urban area. The city is an ecosystem in its own right, with energy and resources flowing into and out of the system, and with human beings as the keystone species. [*331] The goal of the application of these legal tools in an urban area is to improve the ecological health of urban environments and surrounding ecosystems, and to improve the quality of life for urban residents by linking urban ecosystem restoration to public health, economic development, educational opportunity, and community development.

## III. Local and State Regulatory Programs for Urban Ecosystem Protection and Restoration

### A. Zoning/Local Regulation

If you want to make your community better, begin at once by throwing out your zoning laws. Get rid of them. Throw them away. Don't revise them. Set them on fire if possible and make a public ceremony of it - public ceremony is a great way to announce the birth of a new consensus. n49

Urban form affects habitat, ecosystems, endangered species, and water quality through land consumption, habitat fragmentation, and replacement of natural cover with impervious surfaces. At the local level, urban form is dictated primarily by a municipality's zoning code. Zoning has been defined as "the division of a municipality or other local community into districts, and the regulation of buildings and structures according to their construction and the nature and extent of their use, or of the regulation of land according to its nature and uses." n50 There is, however, a growing feeling that zoning codes in the United States have created an urban environment that lacks a sense of place or community. Pedestrian-friendly, mixed-use neighborhoods have been sacrificed to the separation of cities into use districts. This separation increases American dependence on the automobile, which in turn increases air pollution and the amount of impervious surfaces. Urban landscapes have changed little since Ian McHarg described them as "the expression of the inalienable right to create ugliness and disorder for private greed." n51 Environmentalists are now

looking toward revising and rewriting zoning codes to create more sustainable, healthy environments. Further, there is a movement towards providing a sound ecological basis for zoning decisions. Although environmental concerns are not the primary focus of zoning today, [*332] this movement can be seen as the natural extension of the environmental concerns upon which the first zoning decisions were based.

Land use regulations based on nuisance have existed in the United States since the 17th century. n52 When urbanization began to occur, the need for a comprehensive system of land use control to avoid overcrowding and separate uses became evident. Residential uses needed to be separated from the odor and noise of slaughterhouses and other noxious uses. In 1924, the U.S. Department of Commerce promulgated the Standard State Zoning Enabling Act (SZEA), which "provided a model for state legislatures to follow in delegating police power to municipalities to prepare, adopt, and administer zoning codes." n53 In the following years, many cities and towns adopted comprehensive zoning ordinances. n54 Although SZEA required that zoning regulations be made "in accordance with a comprehensive plan," it failed to detail exactly what was to be included in a comprehensive plan. n55 Devising environmentally sensitive land use schemes may depend on basing decisions on an underlying map of a municipality's sensitive areas in order to reach its full potential to protect natural resources. The comprehensive plan could provide the basis for reorienting zoning codes on the basis of ecological systems and goals.

The constitutionality of a comprehensive municipal zoning ordinance was first tested before the United States Supreme Court in 1926, in the case of Euclid v. Ambler Realty Company. n56 In Euclid, the Supreme Court upheld a municipality's right to divide itself into residential, industrial, and commercial districts. n57 In this case, the Court had to determine whether the ordinance at issue was a valid exercise of the police power or an unreasonable and arbitrary exercise of the powers of self-government and an impairment of the rights guaranteed by the U.S. Constitution. n58 In upholding the ordinance, the Court reasoned that the exclusion of industrial and commercial uses from the residential district bore a rational relationship to the health and safety of the community and was, therefore, [*333] a permissible exercise of the police power. n59 For the past seventy-five years, the police power has served as the basis for the adoption of local zoning ordinances.

Traditional zoning of the kind that was upheld in the Euclid case divides a municipality into districts based on economic and social values. Uses are separated and land use designations are made in order to further economic interests of landowners and social goals. This type of zoning rarely reflects an understanding of, or an interest in protecting, the underlying natural resources, and instead increases landowners' economic expectations based on density allocations. Once a density allocation is established, it is difficult to persuade a developer not to build out to capacity, regardless of the harm to the community or the underlying natural resources. There are, however, mechanisms whereby ecological values can be incorporated into the zoning process. Traditional zoning, overlay zoning, and ecologically based municipal land use planning are all local tools available to protect a municipality's natural resources. n60

B. Euclidean (traditional) Zoning

The 1975 Act n61 which forms the basis for the current Massachusetts Zoning Act n62 suggests the following as some of the possible objectives which a municipality might seek to achieve through zoning laws:

To lessen congestion in the streets;

To conserve health;

To secure safety from fire, flood, panic, and other dangers;

To prevent overcrowding of land;

To avoid undue concentration of population;

To encourage housing for persons of all income levels;

To facilitate the adequate provision of transportation, water supply, drainage, sewage, schools, parks, open space, and other public requirements;

To conserve the value of land and buildings, including the conservation of natural resources and the prevention of blight and pollution of the environment; and

To encourage the most appropriate use of land throughout the cities or towns, including consideration of the recommendations of the master plan, if any, adopted by the planning [*334] board and the comprehensive plan, if any, of the regional planning agency. n63

Obviously, it was anticipated that zoning could contribute to the protection of environmental values. To a large degree, however, zoning has failed to protect natural resources, focusing instead on economic and social values. It will take a paradigm shift to get municipalities to plan based on an understanding of their underlying natural resources. Community groups must be at the forefront of advocacy for such a change.

Methods by which zoning may incorporate environmental values will be discussed later in this section. Short of such a shift in focus, however, traditional zoning ordinances can be formulated in such a way as to have positive impacts on air pollution, as well as land use, in an urban environment. For example, often included in zoning ordinances are provisions for parking spaces associated with particular types of development. n64 By limiting the number of parking spaces required, a zoning ordinance can provide a disincentive for people to drive to the site, thereby improving air quality in the area. Further, by requiring fewer on-site parking spaces, there will be a decrease in the amount of impervious surfaces and a corresponding improvement in water quality and amount of runoff.

In Massachusetts, zoning has come to have a broader meaning than just dividing a municipality into use districts. In the Zoning Act, zoning is defined as "ordinances and bylaws, adopted by cities and towns to regulate the use of land, buildings and structures to the full extent of the independent constitutional powers of cities and towns to protect the health, safety, and general welfare of their present and future inhabitants." n65 This definition does not differentiate between a zoning ordinance and any other land use regulation adopted by cities and towns. Any land use regulation can, therefore, be considered a zoning regulation as long as it is within the constitutional powers of the municipality and is adopted pursuant to the Zoning Act. Thus, "sign and earth removal regulations [as well as floodplain and wetlands construction] are often carried out through zoning regulations that are applied in a uniform manner [*335] throughout a town or city, without differentiation from district to district." n66 Consequently, zoning ordinances can also be used to protect wetlands, n67 which are one of the most valuable urban resources.

Regulating what can be done in a wetland area by way of a zoning ordinance is an effective local management tool, as the only route for appeal of a permitting decision is to Superior Court, where the level of deference to a municipal zoning decision is high. On the other hand, permitting decisions made under a zoning bylaw are not made by a conservation commission, which is the only local body devoted exclusively to protecting the environment. n68

As noted, zoning maps currently bestow economic value on private property through density allocations. These allocations are not based upon any analysis of the carrying capacity, health, structure, or function of the community's natural resources. Furthermore, it can be expected that the owner/developer will build the property out to maximum density, thereby optimizing profit for the parcel. Zoning bylaws dictate the uses to which a certain piece of property may be put. Indeed, property law often collides with zoning and other local land use regulations when a property owner challenges the effect that a particular regulation has on the economic benefit of his property through a takings claim. n69

In addition to traditional zoning tools, other local regulations can be used to effect positive environmental change in

an urban setting. For example, regulations designed to reduce the amount of impervious surfaces and the number of cars on the roads can have a positive impact on the urban environment. Toward that end, the Boston Air Pollution Control Commission adopted regulations limiting the number of off-street parking spaces for cars in downtown Boston and providing for the granting of permits for such spaces. n70 The Massachusetts Supreme Court upheld this regulation, noting [*336] that "municipal regulation by a combination of zoning controls and other statutorily authorized means is proper." n71

Local permits can be conditioned on the dedication of a certain amount of property to improving the environmental condition of a city, as long as the regulation does not go "too far" and effect a taking. n72 One case of particular relevance in an urban setting was the U.S. Supreme Court decision in Dolan v. City of Tigard. n73 In Dolan, the city gave petitioners a discretionary permit to expand their store and parking lot, but required that they dedicate roughly ten percent of their land to establish a "greenway" and improved storm drainage system in the 100-year floodplain of an adjacent creek, along with a fifteen-foot strip of their land for a bike path. n74 The city justified the imposition of these conditions on the basis of promoting flood control and minimizing traffic congestion. n75 The Supreme Court held that the city did not make sufficient findings to justify these conditions. The city must "make some sort of individualized determination that the required dedication is related both in nature and extent to the impact of the proposed development." n76

The Dolan case provides guidance to municipalities and community groups working to condition local permits in order to improve urban environmental health. Grassroots environmentalism is needed to keep track of development projects that will impact neighborhood quality of life. In order to ensure that projects are appropriately structured, it is necessary for community groups to keep apprised of, and get involved in, local permitting processes.

This vigilance is particularly important in urban areas where "white flight" and disinvestment have left a large low-income, minority population in the inner city. These often disenfranchised communities have suffered disproportionately from noxious uses being located in their neighborhoods, raising environmental justice concerns. Zoning codes, while appearing neutral on their face, may be perpetuating the cycle of siting environmentally harmful uses in these neighborhoods. For instance, in Boston, the Boston Zoning Enabling Act asks whether "a conditional use such as an [*337] asphalt plant is 'appropriate'" for the surrounding neighborhood. n77 A heavily polluting industrial use will be considered appropriate in an area where property values are low and similar uses have previously been located. n78 Furthermore, there is currently no mechanism whereby cumulative impacts of polluting industries are taken into account when permitting decisions are made. Therefore, a large number of relatively small polluting industries may be located in one particular neighborhood. Although each use is not in and of itself a major health problem, in the aggregate there is a great impact on the residents of the neighborhood. Thus, without a holistic look at zoning codes and local permitting decisions, unhealthy environmental conditions are likely to continue in the urban core.

Environmental justice advocates in Massachusetts have begun to address this issue with a bill currently pending in the state legislature. The Environmental Justice Act would create a new program to identify Areas of Critical Environmental Justice Concern - a new "ACEJC program" to protect people where they live, work, and play. n79 The bill directs the state Office of Environmental Affairs to develop statewide regulations for the protection and use of areas of critical environmental justice concern. n80 Once the bill is passed, the regulations specifying the details of the program will be developed through public participation. n81 Citizens of polluted areas could direct their own future by applying for ACEJC status. The bill would increase the level of protection afforded to environmental justice communities, in the same way that projects in Areas of Critical Environmental Concern are currently scrutinized more carefully. n82 In this way, cumulative impacts could be considered when analyzing proposed projects in already overburdened neighborhoods.

C. Ecologically-Based Land Use Planning

In order to force local zoning to take natural resources into account, community groups must advocate for a local process that starts with a natural resource inventory. In this way, zoning decisions [*338] can be made with the

complete knowledge of the community's resources, and planning can occur prior to making these decisions. Initially, "zoning was expected to be subordinate to a comprehensive master plan." n83 Beginning with a natural resources inventory, however, gives the community an opportunity to determine its long-term interests by consensus. Only with a full understanding of the underlying natural resources can a community make informed decisions that protect the environment.

This type of planning based on natural resources has been called ecologically-based municipal land use planning, environmental zoning, and watershed-based zoning. Whatever the name, the concept remains the same: growth and development should be directed to those areas that can best manage the impact, namely those areas that contain comparatively less sensitive ecological resources. In an urban area, there may not be a great deal of choice as to where to locate development, but the principles of this type of planning can be used to improve site design by integrating open space and placement of buffers, as well as by minimizing the amount of impervious surfaces. In addition, local design codes could even be drafted to encourage biodiversity of different sorts. For example, all new development in a given area might be required to include vegetation of a particular density and type that would provide habitat for birds and butterflies. This might turn all new development into habitat islands in a sea of concrete. With an understanding of how an urban area functions ecologically, it may be possible to write zoning codes with an eye towards increasing tree cover in a particular section of town. This type of ecologically sensitive design has been found to increase property values. A study conducted in Atlanta found that the presence of trees and natural areas measurably increased the residential tax base. n84 Such a change in zoning requirements would, therefore, be both sound ecological and sound economic policy.

The Charles River Watershed Association (CRWA), a nonprofit organization located in Newton, Massachusetts, has piloted the innovative use of zoning to protect environmental values. CRWA has undertaken an environmental zoning project in conjunction [*339] with the Town of Holliston, Massachusetts. n85 This project seeks to turn the planning paradigm on its head, starting with an analysis of the town's water resources - local water supplies, stream flow, and capacity for wastewater treatment and stormwater management - and designing zoning ordinances and directing growth to minimize impacts on those resources. n86 CRWA undertook an analysis of Holliston's groundwater recharge areas, and also determined which lands were unprotected and undeveloped, in order to create a hierarchy of lands that needed to be protected as open space to protect recharge areas. n87 CRWA then drafted model zoning ordinances to direct the town's future growth in ways that protect these high priority lands from harmful development. n88 This demonstrates how a municipality's zoning code can be used to protect beneficial environmental resources.

D. Overlay Zoning/Interim Planning Overlay Districts

As previously discussed, traditional Euclidean zoning, the division of a municipality into use districts, focuses on economic and social values rather than environmental values. In addition to its failure to focus on environmental values, Euclidean zoning is often too inflexible to accommodate the irregular boundaries of environmentally sensitive areas and resources. Therefore, another method is needed to provide additional protections for these areas. Overlay zones use performance standards to protect environmental resources, whether they be reservoirs, aquifers, forests, or beach areas. n89 Performance standards are criteria designed to limit the offensive by-products of land uses. Examples of these by-products include noise, odor, pollutants, and runoff. n90 These overlay zone requirements do not take the place of traditional zoning controls, but impose additional requirements on properties within sensitive environmental areas. n91 Overlay districts are subject to the same type of judicial scrutiny requiring a connection between the standard [*340] and the governmental objective that was discussed with respect to the Dolan case. n92 For example, a performance standard that regulated dust and "objectionable noise" coming from a coal operation was upheld because the ordinance was reasonable and closely related to the legitimate state goal of protecting the public from offensive land uses. n93

Finally, cities can use interim planning overlay districts to protect areas from development under current zoning when necessary to prevent unwanted environmental and social consequences. Such an interim planning district was used in an urban context to control development on a large, abandoned brownfield site in Chelsea, Massachusetts. n94 The site, a 38-acre commercial parcel that abuts an urban creek, is currently a sea of parking, along with several small retail shops and a now out-of-business large, anchor store. n95 The city discovered that a "big-box" retailer was looking

to move onto the site, against the wishes of both the city government and a very active environmental community group, the Chelsea Green Space and Recreation Committee. n96 With the support of the Green Space Committee, the city adopted the Shopping Center Interim Planning Overlay District, suspending the current zoning on the parcel until a planning study was completed. n97 The overlay district prohibited the building inspector from issuing any permits to "use, alter, construct, reconstruct, or expand any buildings, structures or land" within the study area "unless such use, alteration, construction, reconstruction, or expansion is equal or less than a total gross floor area of eight thousand (8,000) square feet." n98 To justify this overlay district, the city indicated that it was necessary in order to

assure that: the visual, traffic, and noise impacts on residential neighborhoods and historic resources are managed; the desires of the City's residents not to be subject to poorly planned large-scale development; the intent of the City's residents to reclaim reasonable public and visual access to [*341] its waterfront resources; the need to preserve and protect the City's natural resources; and the need to encourage an economically sound mix of commercial, residential, and light industrial uses; are all taken into greater account in future land use decisions. n99

Obviously, not all of these interests are environmental. However, when using zoning ordinances to effect positive ecological change, it is important to remember that quality of life in an urban setting includes economic, as well as environmental prosperity.

E. Other Local Tools

Zoning is only one way for municipalities to protect and improve the conditions of their ecosystem. In Massachusetts, the State Executive Office of Environmental Affairs has given municipalities tools to plan for and improve their local environment. Signed into law by Governor Cellucci on September 14, 2000, the Community Preservation Act (CPA) n100 is statewide legislation that enables cities and towns to exercise control over local planning decisions. n101 The CPA provides new funding sources, through a surcharge on real property, "which can be used to address three core community concerns:

<box4> Acquisition and preservation of open space

<box4> Creation and support of affordable housing

<box4> Acquisition and preservation of historic buildings and landscapes." n102

At least ten percent of the money raised through the surcharge on real property must be used on each of the three priorities noted above. n103 The remaining seventy percent of the money raised may be divided among these as the community sees fit. n104 In each town that votes to accept the provisions of the CPA, a community preservation committee is established in order to study the needs, possibilities, and resources of the community regarding community preservation. n105 This committee then makes recommendations to the legislative body:

[*342]

For the acquisition, creation and preservation of open space, for the acquisition and preservation of historic resources, for the acquisition, creation and preservation of land for recreational use, for the creation, preservation and support of

community housing, and for rehabilitation or restoration of such open space, historic resources, land for recreational use and community housing that is acquired or created [in accordance with section five of the CPA]. n106

In this way, decisions are made on the basis of a complete knowledge of both the natural and historic resources that exist within a municipality.

The CPA authorizes municipalities to raise local money and to plan for open space acquisition, historic preservation, and the creation of affordable housing. Each community may develop a needs assessment procedure under the Act and can develop a plan to respond to the identified needs. n107 Combining this approach with true planning based on natural resources would complete a municipality's ecological land use planning.

In the first five months after the CPA became law, fifty-two Massachusetts communities held ballot votes on the issue, with thirty-one - or sixty percent - voting to adopt it. n108 Recently, North Andover, a town just north of Boston, became the first community in the Commonwealth to use CPA funds to preserve land. n109 The town purchased a twenty-seven acre tract of land that will contribute to water quality by providing a buffer for the town's sole source of drinking water. n110

F. State Environmental Law: Wetlands Protection Act

Urban natural resources can also be protected by using state laws that apply without the requirement of local adoption. The protection of wetlands in Massachusetts is an example of a combination of state oversight and local implementation. The state Wetlands Protection Act (WPA) n111 establishes a permit system in [*343] which the state sets uniform standards that local conservation commissions are empowered to implement. A municipality may also choose to adopt its own wetlands ordinance, which must be at least as stringent as the state act. n112 Having a uniform statewide standard avoids problems that may occur in the context of zoning, where one municipality can adopt radically different standards from a neighboring town in order to manage growth and resources differently. This problem is known as exclusionary zoning.

The authority of local conservation commissions derives from a delegation of the state police power to cities and towns. In Massachusetts, the state constitution provides that:

A city or town may, by the adoption, amendment, or repeal of local ordinances or bylaws, exercise any power or function which the general court has power to confer upon it, which is not inconsistent with the constitution or laws enacted by the general court in conformity with powers reserved to the general court ... , and which is not denied, either expressly or by clear implication, to the city or town by its charter. n113

This article of the Massachusetts Constitution gives local governments authority to exercise broad police powers over local matters, including environmental and land use law.

Thus, local governments can protect wetlands using a general ordinance that is more protective of natural resources than the WPA. A municipality may "impose more stringent controls than those established [by the WPA], and, in proper cases, may even 'prohibit outright any disturbance of covered lands.'" n114 Allowing a town to regulate wetland use by means of a local bylaw eliminates the opportunity for Department of Environmental Protection (DEP) review of its decision. n115 If a decision made under a local bylaw is appealed, the only recourse is to the Massachusetts courts. n116 Indeed, towns must be careful when adopting wetlands protection bylaws if they wish to avoid DEP review of

disputes under the bylaw. If the local bylaw simply reproduces the WPA, the final arbiter of any dispute will be the DEP. If, however, the [*344] local bylaw is more stringent in some way than the WPA, the local commission will make the decision, which can be appealed only in the courts. n117

In addition, regulating wetlands through a non-zoning bylaw is sometimes preferred "because zoning acts do not allow a conservation commission to administer zoning bylaws." n118 These bylaws allow a town to customize protection to its own needs, such as adding protection for aesthetic beauty, limiting exemptions found in the WPA, or requiring contractors to post a bond as insurance against a permit violation. n119 A non-zoning bylaw could potentially also address non-point source pollution. n120

Although wetlands loss in Massachusetts is still occurring, primarily due to urbanization, the rate of loss has slowed in the last twenty years. n121 This indicates that the WPA is having some influence over land use decisions and has been somewhat effective in controlling wetlands loss. n122 Because urbanization is the largest contributor to wetlands loss in Massachusetts, n123 it is particularly important to be vigilant in the application of the WPA to projects in cities and at the edges of urban sprawl.

The WPA requires a permit for any work in a resource area that is named in the act. n124 The WPA has a larger scope than just the protection of wetlands. It is intended to protect those resource areas that contribute to the following interests: "protection of public and private water supply; protection of ground water supply; flood control; storm damage prevention; prevention of pollution; protection of land containing shellfish; protection of fisheries; and protection of wildlife habitat." n125 These resource areas are protected [*345] through performance standards that have been promulgated by the Department of Environmental Protection. The performance standards ensure that projects proposed in these resource areas will not have a significant adverse impact. n126

A developer wishing to complete a project in any of these resource areas must apply to the local conservation commission for an Order of Conditions. n127 The developer submits a Notice of Intent, describing the project and the safeguards in place to protect the resource area. n128 After notice and a public hearing, the conservation commission can either permit the project as proposed, decline to permit the project, or permit the project with conditions designed to protect the functions of the resource. n129 Regulations promulgated by the Department of Environmental Protection provide performance standards, environmental criteria that must be met to minimize the impact of the project on the resource area, which the conservation commission uses in making its permitting decision. n130 Decisions of the conservation commission can be appealed to the Department of Environmental Protection, as well as to the Superior Court. n131

As noted above, urbanization is the leading cause of wetland loss in Massachusetts. This dynamic suggests that the WPA should be used to slow the rate of sprawl, and that conservation commissions in communities on the urban fringe should be diligent in protecting wetlands in their communities. Further, there may be an opportunity to create a wetlands banking program at the state level, allowing a developer who wishes to proceed with a project on wetlands to purchase and protect wetlands at some other location in the watershed so that there is no net negative impact as a result of the project. This type of program would need to be implemented very carefully to ensure that there is no resulting loss of capacity for wetlands to perform important ecological services such as flood control and water quality protection.

Though many of the underlying principles are the same across the country, wetlands protection is dealt with differently in each state. New York, in contrast to Massachusetts, regulates wetlands through several statutes designed to address the specific issues [*346] associated with different types of wetlands. n132 Unlike Massachusetts, the state is responsible for identifying and mapping both fresh-and salt-water wetlands, giving notice to owners of property containing wetlands, and providing for a public hearing before publication of a final map. n133 New York's Freshwater Wetlands Act applies to wetlands and adjacent areas where the wetland is 12.4 or more acres, wetlands of unusual local importance, or wetlands of an acre or more in size that are located next to a stream or lake within the Adirondack Park. n134 Local governments may regulate smaller wetlands areas and may control all of their wetlands under local law, as long as the regulation is at least as protective of wetlands as the Freshwater Wetlands Act. n135

G. The Public Trust Doctrine

The public trust doctrine obliges each state to administer particular lands, waters, and resources in trust for the benefit of all its citizens, and this obligation endows the public with a right to utilize these assets for specific purposes. Justinian was among the first to articulate the notion of the public trust, and the character of these assets and public purposes has been filtered through English common law. n136 American courts interpret the doctrine as applicable to at least all shorelands and navigable waters, and have defined the public purposes at issue as including at least fishing and navigation. n137 Restrictions on the private use of these assets, as well as constraints on the ability of each state to transfer interests in them, are implied by the public trust doctrine, particularly if such transfers will undermine public use. Such limitations make the public trust doctrine a potentially important tool for the promotion of healthy urban environments.

[*347] Individual states may interpret the public trust doctrine within their borders, subject to any limitations of federal law. In New Jersey, the public trust doctrine is deeply ingrained in the common law. n138 In Neptune City v. Avon-by-the-Sea, the court held that the public trust doctrine may extend beyond the wet sand of the shore to the dry upland area if the dry area is owned by a municipality. n139 The court was also quite sweeping in its endorsement of the open-ended nature of the public trust doctrine, stating that "the public trust doctrine, like all common law principles, should not be considered fixed or static, but should be molded and extended to meet changing conditions and the needs of the public it was created to benefit." n140

Over a decade later in Matthews v. Bay Head Improvement Association, the same court went further and removed the restriction that the dry upland area must be publicly owned, implying that the public trust doctrine should apply at least to some privately owned land when the demand for public beaches makes the use of the dry upland area "reasonably necessary" for purposes of public access and recreation. n141 Despite its breadth, the court also held that the public use of this extended area is "subject to an accommodation of the interests of the owner." n142

Recently, the state of New Jersey and environmental groups sought to use the public trust doctrine to secure public access to the Hudson River across shoreside lands, and were challenged on constitutional grounds. n143 In Home Builders, the federal district court considered whether a taking arose from a state law requiring landowners to permit a public path along a 17.4 mile piece of land bordering the river, approximately eleven percent of which was "non-public trust property." n144 Reaffirming the vitality of Matthews, the federal district court concluded that Matthews' "reasonably necessary" test remains the standard for public trust cases, and does not include the individualized "rough proportionality" determination contemplated by Dolan v. City of Tigard n145 for dedications or exactions [*348] of private land. n146 Therefore, the state requirement, under the public trust doctrine, that developers construct an approved public access walkway on "their" waterfront property as a condition of obtaining necessary waterfront permits did not amount to an unconstitutional taking of private property because (1) the developer never had a right to exclude the public from the property, and (2) the costs to the developer were merely routine and incidental to the State's administration of the public trust. n147 As a result of this decision, fences along the Hudson are being removed, the waterfront is opening up to the public, and a coalition of non-profit organizations remain actively involved in the use of the public trust doctrine to ensure the well-being of the Hudson-Raritan estuary. n148

In Massachusetts, the public trust doctrine is codified in Massachusetts General Laws Chapter 91. n149 Under this doctrine, "the sea and with it the shore of the sea" are the common property of all people. n150 "The public has the right to fish, hunt waterfowl, and navigate in or on the land between high tide and low tide<elip>." n151 In Massachusetts, the government acts as trustee for the citizens of the Commonwealth. All decisions made by the government with respect to land that is subject to Chapter 91 are therefore made for the benefit of the public. n152

Chapter 91 and its regulations set forth standards for development projects that occur on areas that are currently, or used to be, tidelands. n153 Much of Boston was created by filling in marshland. Filling in a piece of property does not take away the public's interest in that property. A key purpose of the law with respect to uses [*349] on filled tidelands is to "promote public use and enjoyment of such lands to a degree that is [consistent with the public's rights to such

land], and which ensures that private advantages of use [of such land] are not primary but merely incidental to the achievement of public purposes<elip>." n154

In order to fulfill this objective, the regulations provide for open space and public access on all projects located on tidelands or former tidelands. They also set specific limits on the height of buildings, as well as mandating setbacks from the water. n155 In order to determine how much open space is required, one must determine how much of the property is subject to Chapter 91 jurisdiction. The process for determining Chapter 91 jurisdiction requires looking up old licenses that have been issued for particular sites, or, if none exist, finding maps which show the historic mean high water mark on the site. This mark determines how much of the site is subject to Chapter 91's requirements. n156 Once this is known, the regulations provide specific requirements for open space and public access. n157

Chapter 91 encourages the owners of waterfront property to develop "water-dependent uses," which need to be located on the water. n158 These uses are generally considered to serve a proper public purpose. n159 The leverage point for a community group trying to create open space in its community comes when a project proponent wants to build a non-water-dependent use on property subject to Chapter 91. When a project proponent wants to build on tidelands, a Chapter 91 license must be secured from the Department of Environmental Protection. For a non-water-dependent use project, a proponent submits an appropriate application to the DEP, which holds a public hearing and issues a license after making a written determination that:

<box4> The project serves a proper public purpose;

<box4> The benefits of the project for the public outweigh the detriment to the public that is caused when tidelands are used for non-water-dependent private development; and

[*350] <box4> The project is consistent with a series of policies that the Massachusetts Coastal Zone Management program has adopted governing the use and management of the land and water that make up the state's coastal zone. n160

Given Boston's proximity to the water and history of creating property by filling in historic tidelands, there are many projects in the Boston area that are subject to the requirements of Chapter 91. Community groups can use this statute to leverage open space and more ecologically sensitive designs for such projects. For example, former tidelands located along small waterways are not generally susceptible to water-dependent use. Therefore, developers are likely to propose a non-water-dependent use for these sites, thereby triggering Chapter 91's most generous open space and public access requirements. n161 Community groups can use the licensing process to ensure that the access and open space requirements are met when new developments are proposed.

H. Protection of Rivers and Riparian Areas

In Massachusetts, riparian areas are protected under the Massachusetts Rivers Protection Act (RPA), n162 signed into law by then-Governor William Weld on August 7, 1996. n163 The RPA regulates virtually all activities along rivers and other flowing bodies of water. In Massachusetts, this means that roughly 9,000 miles of riverbank are covered. n164 The RPA operates by adding a new resource area to those already protected by the Wetlands Protection Act, thereby expanding the jurisdiction of that Act. This new resource area is called the "riverfront area." n165 This "riverfront area" encompasses the land extending 200 feet on each side of a river or stream. The RPA is the result of a six-year debate among environmental groups, legislators, land trusts, and watershed associations, and it is very explicit. The advantages of the Act are that it makes the permitting procedures predictable, announces [*351] clear approval criteria, and went into effect immediately. n166 A major goal of the RPA is to protect drinking water and recreational areas.

Any activity within the new resource area (dredging, filling, or altering) requires an Order of Conditions from a local conservation commission after the filing of a Notice of Intent. n167 Appeals are made to the regional DEP office upon request for a Superseding Order. An adjudicatory hearing in Boston is available after the matter is considered by the regional DEP office. n168

An applicant for an Order of Conditions must prove, by a preponderance of the evidence, that there will be no significant adverse impact on the "Riverfront Area." n169 A new activity should not significantly interfere with the stated purposes of the Act: "to protect the private or public water supply; to protect the groundwater; to provide flood control; to prevent storm damage; to prevent pollution; to protect land containing shellfish; to protect wildlife habitat; and to protect fisheries." n170 Further, an applicant must show that there is no practicable and substantially economically equivalent alternative to the proposed project with fewer adverse impacts on such purposes. n171

In urban areas, the Massachusetts RPA defines the riverfront area as the land situated between the river's mean annual high water line and a parallel line located twenty-five feet away (rather than two hundred feet as in other areas). n172 In addition to the ecological value derived from protecting riparian corridors, such as increased wildlife habitat and buffers for surface water and flood protection, studies have shown that a shoreline buffer can increase the value of adjacent property. For example, housing prices in Colorado were found to be 32% higher if they were located next to a greenbelt buffer. n173 Having riparian corridors in an urban area can contribute to wildlife habitat, as well as improved water quality. n174 Depending on the adjacent land uses, it may be important for the riverfront area to be increased from twenty-five feet in order to [*352] have the desired impact on water quality or habitat. A complete understanding of how an urban area functions is important in helping community groups advocate for these types of policy changes.

I. Brownfields

The Environmental Protection Agency defines brownfields as "abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination." n175 Since 1980, when Congress passed the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), n176 contaminated properties, particularly those in urban centers, have been accumulating and sitting idle. CERCLA created a "strict liability" scheme for hazardous waste sites - imposing liability on virtually anyone associated with a site, no matter how tangentially. n177 A party in any one of the four statutory categories n178 is liable regardless of whether its actions were unlawful or negligent. Courts have also interpreted CERCLA as imposing joint and several liability unless the defendant can show that its contribution to the harm is divisible. n179 Therefore, any party can be held responsible for the entire cost of the cleanup.

These liability rules are practically mirrored in many states' hazardous waste laws, including those of Massachusetts. Massachusetts created its own "superfund" statute in 1983, the Massachusetts Oil and Hazardous Material Release Prevention and Response Act. n180 This statute seeks to promote the cleanup and redevelopment of contaminated areas in Massachusetts, many of which are located in urban centers. However, its imposition of strict liability on "potentially responsible parties" and its lack of clarity in designating cleanup duties and standards have discouraged potential owners, investors, and lenders from developing contaminated [*353] lands. n181 In fact, the Massachusetts statute is even more broad than the federal act, imposing liability for releases of oil and hazardous materials (where the federal act exempts petroleum products) and including in the category of potentially responsible parties those who "caused or [are] legally responsible" for the release. n182

The broad liability schemes in the federal and state Superfund statutes were intended to create a regime that ensured that all parties that benefited from the improper disposal of hazardous waste were held liable for the cleanup. In fact, the current owner or operator of the site could be held liable even if he or she were not a contributor, on the theory that he or she would benefit from the cleanup. Unfortunately, the strict liability imposed on virtually any party associated with a contaminated site has had the unintended consequence of providing a disincentive to owners and developers to get involved with these sites. n183 Further complicating the cleanup problem is the fact that there are no clear standards in the state hazardous waste law for declaring a site "clean" and terminating potential liability associated with the site. This

uncertainty as to continuing liability has rendered many sites unmarketable, which has left them idle and abandoned in the inner city. Moreover, difficulty in quantifying the extent of contamination and liability has led developers to purchase and develop "clean" sites at the edges of current development, thereby contributing to urban sprawl.

It has been estimated that there are more than 500,000 brownfields sites nationwide. n184 According to a report released by the U.S. Conference of Mayors, lack of funds, liability stemming from Superfund legislation, and requirements for expensive environmental assessments are three major obstacles to redeveloping [*354] these sites. n185 Despite these obstacles, there are many potential benefits of brownfield redevelopment: the creation of new jobs, increased tax revenues, the ability to support an increase in population without stressing existing infrastructures, and the creation of "extra" green space by preserving existing farmland and open space. It will be a challenge to apply the Massachusetts statute to advance the goal of developing healthy urban ecosystems. A contaminated site that is left dormant may develop into high quality habitat by virtue of being that rare commodity in an urban area: a site that is left to nature. Nonetheless, it is critical to use brownfields laws in the context of ecological restoration by linking redevelopment to ecological goals through overlay zoning, permitting, and so forth - so that at least some ecological goals are achieved as sites are redeveloped. The purpose of brownfields legislation in Massachusetts and other states is to achieve these goals by encouraging brownfields redevelopment, which can contribute to creating a healthy urban ecosystem.

The Brownfields Act significantly amended Massachusetts' hazardous waste law. n186 This Act seeks to facilitate the redevelopment of urban industrial and commercial sites that have been contaminated by oil or other hazardous materials in order to stimulate economic growth in distressed areas and reduce urban sprawl in the suburbs. n187 Specifically, the Brownfields Act seeks to establish requirements and procedures for preventing contamination, notifying the DEP of contamination, assessing the extent of contamination, evaluating alternatives for remedial action, promoting public involvement in response actions, and recovering cleanup costs paid by the Commonwealth of Massachusetts. n188 Finally, the Brownfields Act attempts to infuse more clarity and flexibility into the assessment and cleanup process by allowing the cleanup process to be directed and managed by private Licensed Site Professionals (with audit oversight by the DEP) and by offering different standards for cleanup depending on the intended use of the property. n189

The Brownfields Act employs two main tools in its efforts to promote the cleanup and redevelopment of contaminated properties: [*355] liability relief and financial incentives. The Brownfields Act creates a class of "eligible persons" who are exempt from liability, provides for activity and use limitations on the property, and creates a "Covenant Not to Sue" program in coordination with the state attorney general's office. n190 These programs are designed to clarify and reduce the liability associated with owning a contaminated site. Such initiatives are emerging in many states as interest in brownfield redevelopment increases.

The financial incentives created by the Brownfields Act are intended to alleviate the costs of environmental cleanup of brownfields and encourage redevelopment. Incentives include a loan program under which the borrower and lender contribute equal amounts to a reserve fund, and the state makes a matching contribution to the fund. n191 There are also low-interest loans and grants to developers that can be used in economically distressed areas. n192 By encouraging the redevelopment of these contaminated sites, not only is the health of the urban ecosystem improved, but sprawl is contained by creating a disincentive towards development of "clean" parcels on the urban fringe.

In December 2000, the General Accounting Office produced a report (GAO report) summarizing the characteristics and results of large or unique brownfields programs in five states: Massachusetts, Michigan, New Jersey, Pennsylvania, and Wisconsin. n193 All five states shared some basic similarities in their approaches to evaluating and cleaning up sites contaminated with hazardous materials, but some approaches were relatively unique. The GAO report covered several aspects of each program, including funding, liability, and the cleanup standards that each state uses. n194

All five states have some degree of funding available in the form of grants and/or loans for assessment and cleanup activities. However, eligibility for these funds varies from state to state depending on whether they will be used for

evaluation or remediation and whether a public or private entity will be using the funds. Some types of funding are available only for public entities. For example, in Michigan, both grants and loans are available for assessment and [*356] cleanup, but only for public use, on publicly owned sites. n195 In contrast, Pennsylvania provides both types of funding for either public or private parties for both assessment and remediation. n196 Under Pennsylvania's Industrial Sites Reuse Program, loans for cleanup activities may be forgiven if agreed-upon performance measures are met. n197

All five states, except Pennsylvania, offer some type of tax incentive for redevelopment of brownfields. n198 These tax incentives vary from state to state. n199 Several states reimburse or provide tax credits for cleanup costs incurred by public entities based on the increase in tax revenues generated by development of the sites. n200 A few allow abatement of real property taxes, either prospectively or retroactively. n201 Both Massachusetts and Wisconsin give county and/or city governments the authority to reduce or eliminate delinquent real estate taxes on brownfields properties for developers who clean up and redevelop them. n202 Massachusetts provides income tax credits to private entities of up to fifty percent of their cleanup costs. n203

Massachusetts is the only one of these states that has developed an environmental insurance program. n204 The state negotiated with an insurance company to provide such insurance policies to developers and lenders at reasonable premiums. n205 Under the program, even parties potentially responsible for contamination of the sites are eligible for an environmental insurance policy. n206 The policies cover all or part of unanticipated cleanup costs (including those related to unknown pollution conditions discovered during cleanup), property damage and personal injury claims, losses from business interruption, and legal defense costs. n207 Secured creditor policies protect lenders against defaults on cleanup and related construction loans. n208

[*357] There is no consistent pattern for the application of cleanup standards among the five states studied. While some consider site-specific factors, such as the planned future use of the site, n209 in determining acceptable levels of contaminants, others rely on numeric, statewide standards. n210 Pennsylvania's application of statewide standards has been popular among developers, who prefer them to conducting costly, detailed assessments of sites prior to commencing remediation. n211 In addition, under certain circumstances, Pennsylvania allows a more relaxed cleanup standard that requires only the removal of contaminants that pose an immediate, direct, or imminent threat to public health. n212

All five states provide some release of liability for contamination once remediation is complete. Massachusetts gives the Attorney General authority to release liability during the cleanup. n213 However, in addition to liability for state claims, developers, owners, and lenders may be liable from third parties for damages related to contamination. Furthermore, contamination discovered after the initial assessment (e.g., during cleanup) may pose additional liability issues. Massachusetts and Pennsylvania both provide protection against third party claims once cleanup is complete. n214 In addition, they both allow the liability protection to be transferred along with the property to subsequent owners. n215 New Jersey and Wisconsin protect innocent owners from liability for contamination discovered after assessment. n216

As a further incentive to brownfields redevelopment, Pennsylvania and Wisconsin have each implemented a list of brownfields sites within the state that is available to potential developers. n217 Municipalities in Pennsylvania are encouraged to add sites to the Pennsylvania Brownfields Directory and receive a $ 1,000 grant from the state for each site they list. n218

In addition to these state programs, the federal government, specifically the EPA, has a Brownfields Economic Redevelopment Initiative (Brownfields Initiative) that "is designed to empower states, [*358] communities, and other stakeholders in economic redevelopment to work together<elip>to prevent, assess, safely clean up, and sustainably reuse brownfields." n219 The EPA funds pilot programs and other research efforts, enters into partnerships, conducts outreach activities, develops job training programs, and addresses environmental justice concerns. n220 Communities with brownfields sites often face other concerns such as unemployment, substandard housing, outdated or faulty public infrastructure, crime, and a poorly-skilled local workforce. These concerns might be of higher priority than

redeveloping contaminated property. Therefore, the Brownfields Initiative provides an opportunity for federal agencies to work together in a more integrated fashion toward sustainable redevelopment.

Through the Brownfields Initiative, communities can leverage both public and private sources of capital and technical support that can ensure successful redevelopment. Brownfields assessment and cleanup activities can be linked to health and workforce development programs through the creation of temporary and permanent jobs. Brownfields projects can be coordinated with transportation planning to ensure access to transportation for new workers in redeveloped areas. Reuse options can include not only new economic and industrial opportunity, but also development of urban agriculture and green spaces. Close cooperation from the beginning of a Brownfields pilot may also decrease the likelihood that agencies will duplicate efforts, work at cross purposes, or confuse community leaders and civic groups.

J. Massachusetts Watershed Initiative

The Massachusetts Watershed Initiative (MWI) is an innovative state program that "protects and restores natural resources and ecosystems on a watershed basis." n221 The MWI is a "broad partnership of state and federal agencies, conservation organizations, businesses, municipal officials, and individuals." n222 The state has been divided into twenty-seven watersheds, each represented by a watershed team, and having its own team leader. n223 These watershed [*359] teams coordinate the watershed protection activities in each of the state's twenty-seven watersheds. The stated goals of the MWI are to "(a) improve water quality, (b) restore natural flows to rivers, (c) protect and restore [biodiversity and] habitats, (d) improve public access and balanced resource use, (e) improve local capacity to protect water resources, and (f) promote shared responsibility for watershed protection and management." n224

The MWI achieves these goals by

(a) finding the sources of pollution and taking cooperative action to clean them up, (b) teaching and helping groups and communities to protect and restore their local waters, (c) expanding communication among local, private and public partners so everyone works together to solve water resource problems, (d) improving coordination among government agencies, and (e) directing resources to critical needs so that limited dollars go further to resolve the most important problems. n225

The MWI has been important in helping to restore urban systems by creating a team of representatives from state, local, and federal agencies working together to tackle the issues that arise in urban areas. In addition to providing much needed funding for specific watershed improvement projects, the MWI provides technical expertise and knowledge of state and federal regulations that can be applied in the urban context. n226 Having a team of professionals from different agencies working together on the same problem is invaluable to resolving issues efficiently and effectively.

IV. Federal Regulatory Programs: Introduction

As with the state and local regimes, the role of federal regulatory schemes in protecting and restoring an urban ecosystem is defined by the unique elements of urban ecological advocacy: the commitment to systemic research and management and the city's status as a forgotten environmental zone. Though each unique attribute creates challenges in utilizing federal environmental regulations, neither is ultimately a roadblock. Creative use of existing federal regulatory schemes can result in advocacy specifically tailored for urban places and urban systems.

[*360] The federal environmental regulatory structure is built on statutes that focus on specific media. The relevant statutes for our purposes are the Clean Air Act and the Clean Water Act. These two schemes share a common

general architecture. The EPA establishes national standards for clean air and clean water, and then states propose regulatory programs for achieving those standards. Once the EPA approves a state program, the state is primarily responsible for the regulatory landscape. The state must report to the federal government on its progress, and the federal government shares the power and authority with the state to enforce environmental laws.

Within each of these federal schemes are specific tools or mechanisms that can be used to protect ecological systems in the urban context. Environmental agencies at both the federal and state level have been working for some time to manage environmental resources systemically. The state and federal watershed programs provide a model for using media-focused statutes to protect regions, places, and environmental systems.

## V. Clean Water Act

### A. Clean Water Act Overview

Though the federal efforts to prohibit dumping in navigable waters trace back to the Rivers and Harbors Act of 1899, n227 the 1972 amendments to the Federal Water Pollution Control Act provide the modern framework for managing water pollution in this country. n228 The goal of the Clean Water Act (CWA) is the restoration and maintenance of the chemical, physical, and biological integrity of the nation's waters. n229 The interim goal is to achieve water quality throughout the country that provides for the protection and propagation of balanced populations of fish and wildlife and supports recreation in and on the water. n230

The CWA's regulatory scheme provides discrete programs for different sources of water pollution. The CWA establishes a mechanism for managing pollution from "point sources," which are entities that purposefully discharge into the waters of the United States. n231 Over time, amendments to the CWA have established [*361] regulatory mechanisms for managing spills of oil and hazardous waste, n232 non-point source pollution (in its simplest terms, runoff of rain water from a place on which it may pick up pollutants), n233 and sewers that are combined with storm water. n234 The Act also establishes a water-quality system for all water bodies. Under this system, each state must designate uses for all water bodies within the state that are subject to the water quality standards. n235 The EPA will review these designations every three years. n236

These programs will be discussed in more detail below. Each provides some opportunities for input from local governments, organizations, and individuals concerned with the protection and restoration of urban natural resources. A threshold question, however, may be how water quality affects urban ecology as a whole. In other words, why might we care about water quality in the context of restoring and protecting urban ecosystems?

### B. Urban Water Quality and Healthy Urban Ecosystems

Urban communities across the country have begun to restore and revitalize their rivers and riverfronts. There are large scale projects underway in Los Angeles, New York City, Milwaukee, Boston, Detroit, San Antonio, and many other cities. n237 Revitalized urban rivers provide a number of benefits to urban ecosystems and for human and non-human populations in those ecosystems.

With respect to the non-human communities within the ecosystem, improved water quality means increased biodiversity within the rivers themselves. Decreases in the central pollutants governed by the CWA improve the quality of the river as habitat for fish and shellfish, as well as the quality of this element of the urban ecosystem.

Focusing on water quality can have important implications for the quality of the upland portions of the ecosystem as well. Controlling, [*362] managing, or improving the quality of runoff will have an effect on the quality of the plant communities on any particular site. Similarly, strategies for managing and controlling runoff may lead to improvements in the riparian corridor. n238 This habitat, along with wetlands, may be the most important habitat in an urban region. From an ecological perspective, both riparian corridors and wetlands are rich communities. These areas also may

provide the greatest opportunity for creating habitat corridors in an urban context, for the banks of rivers may be underdeveloped or may be already preserved. Such corridors can improve the value of otherwise isolated pockets of habitat by providing a natural highway through which species may travel from one urban pocket to another. n239

Improvements in urban water quality can also provide a series of important benefits to the human communities in the ecosystem. These improvements to the quality of life of the dominant human species can be highlighted to encourage human communities to protect and restore urban water quality in ways that benefit the other species in the ecosystem.

Specifically, improved water quality has implications for public health, recreation, economic development, and overall well-being of urban communities. The link to public health is neither illusory nor attenuated. In July 2001, scientists at Johns Hopkins reported that more than half of all waterborne disease outbreaks in the United States in the last half-century followed a period of heavy rainfall and subsequent runoff. n240 With respect to recreation, there is little doubt that rivers and riverfronts may be the most important recreational resources in the urban context, for they provide opportunities for fishing, boating, passive and active (e.g., sports fields) green spaces, and swimming.

Improving public health and increasing recreational opportunities improve the overall quality of life in an urban area, which can increase the economic success of that urban community. Corporate Chief Executive Officers surveyed ranked quality of life as the third most important factor in locating a new business. n241 Protecting [*363] rivers and their riparian zones can increase adjacent property values, reduce maintenance costs for landowners, and provide opportunities for small business development. n242 The potential for small business development may be greater than is presently understood. Improved water quality in the urban context could lead to water-based businesses such as fishing and boating operations, improve tourism, and could also lead to valuable improvements in businesses that abut an urban river.

For all of these reasons, a number of urban communities have launched programs to improve conditions in and along their urban rivers. Nonetheless, conditions in urban waterways remain poor.

C. Urban Water Quality

Section 305(b) of the Clean Water Act requires states, tribes, territories, and interstate commissions to report on the quality of their rivers, lakes, wetlands, estuaries, coastal waters, and ground water. n243 The twelfth biennial National Water Quality Inventory, completed in 1998, indicates that about 40% of U.S. streams, lakes, and estuaries assessed are not clean enough to support fishing and swimming. n244 The most prevalent pollutants are siltation, bacteria, nutrients, and metals. n245 The primary sources of these pollutants are urban runoff and runoff from agricultural lands. n246

Through the Nationwide Urban Runoff Program studies, the EPA found that storm water runoff from urban areas contributes heavily to the impairment of aquatic ecology, chemical makeup, and physical characteristics of local waters. n247 According to the 1998 National Water Quality Inventory Report, urban runoff and municipal point sources were responsible for nearly 25% of the impaired river miles and lake acres in the United States. n248 Taking [*364] the Charles River in Boston, Massachusetts, as an example, before the EPA launched a concerted effort to improve conditions through the Clean Charles 2005 Initiative (an effort to make the Charles River fishable and swimmable by the year 2005), the River met water quality standards for swimming 19% of the time and water quality standards for boating 39% of the time. n249

Perhaps most disturbing is the effect that municipalities are having on the nation's estuaries. There are 90,465 square miles of estuaries in the United States. n250 Estuaries are bodies of water where rivers meet oceans, such as bays and harbors. As with any boundary between habitats (in this case between salt water and fresh water), estuaries are extremely rich ecological zones, and serve as nursery areas for many commercial fish and for virtually all the shellfish populations in the United States. n251 According to the EPA, 44% of the country's estuarine square miles are impaired, with urban runoff, municipal point sources, and storm sewers as the primary sources of degradation. n252

As outlined above, urban rivers, estuaries, and lakes are critical to the overall health of an urban ecosystem. At the same time, urban communities are a primary source of degradation for these resources across the country. Clearly, there are challenges ahead for improving urban water quality and for protecting and restoring urban ecosystems. The CWA provides municipalities and community organizations with a number of tools that can be used in unique and creative ways in the urban context to begin the process of restoration.

D. The Clean Water Act in the Urban Context

Each of the Clean Water Act's central elements can be or has been modified such that it can be an effective tool in the fight to restore urban ecosystems. However, adequate data to support these unique and creative applications of national regulatory tools is necessary. Certainly the rapid assessment model outlined in the first section of this paper is a crucial starting point for urban ecological advocacy that uses the CWA regulatory scheme.

[*365]

1. Controlling Water Pollution Through the National Permit Program

The National Pollution Elimination Discharge System (NPDES) is the centerpiece of the CWA regulatory system for controlling pollution from "point sources." Point sources typically include sewage and industrial pipes, but courts have also classified channelized stormwater runoff, bulldozer-filled wetlands, unintentional overflow from a hazardous waste site lagoon, and a culvert from a landfill leachate pond as point sources. n253

Under the CWA, no person may "discharge" any pollutant into the "navigable waters" of the United States without an NPDES permit. n254 All of the terms under the Act have been broadly interpreted, and thus the phrase "navigable waters" has not been limited to waters that are, strictly speaking, navigable. The term includes tidal zones, wet meadows, wetlands, and any other water body that can be used for recreation, tourism, or commercial activity. n255 NPDES permits limit discharges from point sources so that the discharges do not threaten human health or the environment. n256 Permit holders must report their discharges to the EPA. n257 Violations of permits are enforceable under the CWA. Under the CWA, the EPA may authorize states to operate their own NPDES programs, as long as the state programs meet certain minimum standards. n258 As of February 1998, forty-two states had authorized NPDES programs. n259

Over the past thirty years, through a combination of federal enforcement and rigorous citizen enforcement under the citizen suit provisions of the CWA, this system has produced a dramatic improvement in water quality. n260 Standing alone, however, the NPDES program is not an effective strategy for restoring urban ecological integrity because the permit system examines each discharge on its own terms. In order to harness the NPDES program [*366] to the larger goal of restoring an ecological system in an urban area, the permit program must be incorporated into a regional watershed-wide or ecosystem-wide strategy. Under this approach, responsible agencies and/or local residents examine all permits in a particular ecological system. By coordinating enforcement and inspections within an ecosystem, an agency can have a significant impact on the underlying resource. In addition, such action can create a community of interest among permit holders in a particular ecosystem. As this occurs, that community of interest may become a collective stakeholder in the restoration and protection of an ecosystem.

The framework for such an approach already exists. In the early 1990s, the EPA embarked on a Watershed Protection Approach, which represented a "renewed emphasis on understanding and addressing all surface water, ground water, and habitat stressors within a geographically defined area, instead of viewing individual pollutant sources in isolation." n261 In 1994, the EPA committed to integrating its NPDES Program with the watershed approach. n262

EPA-Region I's success with the Charles River provides an excellent example of the potential impacts of bringing an ecosystem-wide perspective to an enforcement program. n263 As part of its campaign to make the Charles River fishable and swimmable by 2005 (Clean Charles 2005), the regional EPA undertook an enforcement sweep of all the

major corporations and institutions along the river, with a particular focus on those corporations and institutions that held permits to discharge into the river. n264 The sweep generated specific enforcement outcomes, such as Supplemental Environmental Projects in lieu of fines, that certainly reduced pollution into the river. n265 Perhaps much more exciting is the impact that the enforcement sweep and the ongoing Clean Charles 2005 project had on this community of stakeholders. As a result of the sweep and the larger project, these institutions launched the Clean Charles Coalition (the Coalition). n266 As of 2001, the coalition has sixteen members committed to heightening [*367] appreciation for the Charles, bringing public attention to the efforts of others in restoring the Charles, participating in various small scale cleanup efforts, promoting better stormwater management by member institutions, and educating smaller institutions in the watershed on stormwater management. n267

Thus far, the Coalition has established a webpage through which it has disseminated general information on the Charles, as well as a series of stormwater management best management practices. n268 The Coalition has hosted a series of meetings to develop stormwater management strategies for each of their facilities. Using their shared knowledge, the Coalition is planning a series of workshops for the regulated community in the Charles River watershed, including small businesses, to provide strategies for stormwater management. n269

The Coalition is also working with the EPA to develop a voluntary pollution prevention program that will target companies in the Lower Charles River watershed and will provide technical assistance through workshops and instructional materials. n270 The Coalition will encourage businesses to adopt specified water quality practices to improve pollution prevention and will provide participants with public recognition for their participation through certificates, decals, website listing, and a clean business directory. n271

In sum, the CWA's enforcement provisions, while not designed for urban ecosystem restoration, can be powerful tools when married to a watershed-wide or ecosystem-wide approach.

2. Water Quality Standards

Section 303 of the CWA requires that each state establish water quality goals for all water bodies in the state. n272 One purpose of this provision of the Act is to ensure that, wherever possible, water bodies are, or will be, used for fishing and swimming. n273 In addition, the Act requires that each NPDES permit include necessary limits to ensure that water quality goals are met. n274 These standards [*368] are, thus, an important element of the overall permitting process. The process by which a state proposes these goals, and by which the EPA reviews them, can be an opportunity for a community group or local government to participate in establishing aspirations for an urban ecosystem and its water bodies.

Specifically, each state develops water quality standards applicable to each of its water bodies. n275 The state must review those standards every three years, and must provide for public notice and a public comment period any time it revises its water quality standards. n276 Perhaps most importantly, any segment of a water body that is not classified as fishable or swimmable must be re-examined every three years. Furthermore, if a state decides that the fishable/swimmable standard is not attainable in a particular water body or segment of that water body, then the state must prepare a scientific analysis to justify this determination. n277 In addition, each state must establish an "antidegradation policy," indicating that it will maintain and protect existing uses and maintain and protect any water that is fishable and swimmable. n278

Finally, the CWA requires that, every two years, states provide the EPA with a prioritized list of all their waters that are not meeting water quality standards (also known as "impaired waters"). n279 For the highest priority water bodies, states are required to establish Total Maximum Daily Loads (TMDLs), which involve a calculation of how much of a pollutant a water body could receive and still meet the water quality standard. n280 For an impaired water body, the TMDL will represent a reduction in the pollutant load and will allocate pollution reduction across all the sources in a watershed. n281 This powerful restoration tool has not been fully implemented across the country. In July 2000, the EPA issued a rule to revise the TMDL program in order to implement it more broadly. n282 That rule is the

subject of some controversy and is the target of a number of lawsuits. While it was scheduled to go into effect in October 2001, the EPA suspended the rule for eighteen [*369] months, effective August 2001. n283 The National Academy of Sciences has reviewed the June 2000 version of the rule and the EPA is now considering the NAS report. n284 In whatever form it takes, however, it is clear that the TMDL program will encourage and, in fact, require an ecosystem approach to both data collection and pollution prevention. Community groups and local governments will want to ensure that crucial urban resources are included on the section 303(d) priority lists and that these crucial resources are included in the TMDL program.

Any program to protect or improve an urban ecosystem will want to take account of the regional water quality standards in that ecosystem. The water quality program will have developed significant data on the status of crucial water resources. Furthermore, to the extent that urban water quality standards are below fishable/swimmable levels, these standards, as set by the state and approved by the EPA, will serve as a limitation on the future improvements in the ecosystem. Providing for the level of water quality necessary for a fully functioning ecosystem may require advocacy in favor of fishable/swimmable standards for all crucial water resources during the triennial state review.

3. Non-Point Source Pollution Control: Storm Water Runoff

Although the original NPDES program helped to improve water quality around the U.S., studies done in the 1980s indicated that storm water runoff - especially in urban areas - contributes heavily to the impairment of the aquatic ecology, chemical makeup, and physical characteristics of local receiving waters. n285 Congress responded to this by amending the CWA in 1987, to authorize the EPA to create a comprehensive program to manage storm water runoff. The EPA decided to implement its program in two phases.

[*370] The EPA enacted the first phase of the storm water program (Phase I) on November 16, 1990. n286 In essence, Phase I expands the CWA's coverage. The Phase I program is an effort to manage pollution coming not only out of pipes but also from precipitation that runs off the land and into receiving waters. Whereas the original NPDES permits cover only industrial and municipal wastewater, Phase I focuses on storm water runoff from "medium and large" municipal separate storm sewer systems (MS4s) (sewer systems located in an area with 100,000 people or more) and runoff from eleven categories of industrial activity, including "large" construction activity (construction that disturbs five or more acres of land). n287 The Phase I permitting system requires these groups to work with their local NPDES permitting authority n288 to develop and implement storm water management programs (SWMP) for MS4s, or storm water pollution prevention plans (SWPPP) for the specified eleven industrial activities. n289 The primary purpose of these plans is to determine and implement best management practices (BMPs) for each operator that will reduce pollutants in the operator's storm water runoff to the maximum extent practicable (MEP). n290 The permit process is strict to ensure nationwide uniformity, but also allows a degree of flexibility so that local operators and permitting authorities can customize permits to meet their specific needs and the needs of the surrounding watersheds. n291

The expansion of the Act under Phase I, however, did not adequately address all of the EPA's storm water management concerns. The EPA inventories and local watershed studies done in the 1990s (including one involving the Green River in Massachusetts) showed that waterways were still being impaired in significant numbers as a result of small MS4s and construction activities [*371] that were not covered by the Phase I permits. n292 Also, in 1992, the Ninth Circuit Court of Appeals held that the EPA had acted arbitrarily and capriciously by excluding from its Phase I program construction activities that disturb less than five acres. n293 The court held that the EPA had not shown any justification for regulating large construction activity (i.e., activity disturbing five or more acres) under Phase I, while excluding small construction activities from regulation, and remanded the case so that the EPA could amend its regulations accordingly. n294

The EPA then developed the Phase II storm water regulations, which were implemented on December 8, 1999. n295 Like Phase I, Phase II is an expansion of the permitting system; Phase II reaches out to cover "small" MS4s (regulated sewer systems not already covered by Phase I) and "small" construction activities (construction disturbing less than five acres of land). n296 Similar to Phase I, Phase II attempts to allow local operators a great degree of

flexibility in complying with the NPDES permit requirements. n297 Phase II requires operators of MS4s to develop and maintain six types of programs (called Minimum Control Measures (MCMs)) n298 in order to satisfy the national NPDES permit standards. These six programs are public education/outreach, public involvement, detection and elimination of illicit discharge, construction site runoff control, post-construction runoff control, and municipal pollution prevention/good housekeeping. n299

To assist operators, the EPA has promulgated a "Menu of Best Management Practices" (BMPs) for each program, suggesting ways in which operators can best meet the goals of the MCMs within a designated time frame. n300 Similarly, operators of small construction sites must develop and implement a SWPPP to satisfy the NPDES permit national standards. To help the operators, the EPA [*372] has promulgated a menu of BMPs, detailing ways in which the operators can best attain an effective SWPPP before, during, and after construction activities. n301

Although it has many characteristics in common with Phase I (e.g. flexibility, use of BMPs, development of SWMPs for MS4s, and development of SWPPPs for construction activities), Phase II is different in several respects. Perhaps most importantly, Phase II has a special focus on small MS4s and small construction in "urbanized areas" (UAs), as designated in the most recent U.S. census. n302 This program is therefore specifically designed to foster the protection and restoration of water bodies in urbanized areas.

Cities subject to Phase I of the Program have developed a number of interesting and potentially powerful tools that could both reduce runoff in urbanized areas and protect or restore urban habitat. Accordingly, urbanized areas in the process of developing their Phase II Programs have a number of sample projects from which to choose as they try to meet the March 10, 2003, deadline for compliance with Phase II. n303 Community organizations and local governments will want to learn about the various programs that Phase I cities have implemented and may want to advocate certain types of Phase II programs in each category, particularly those programs that combine landscape and habitat protection and runoff control. Even after the March 2003 deadline has passed, the Phase II program provides an explicit regulatory link between landscape management and water quality. The program will, therefore, be a unique opportunity to combine habitat protection and water quality improvement. As an urbanized area launches an urban ecosystem study and begins to identify priority resources, local community organizations will want to share that data with the local Phase II permitting authority in the hopes that Phase II permits can be drafted, or redrafted, to utilize habitat restoration as an important tool for water quality improvements.

With respect to public education and outreach, there are certain model programs that may be of particular interest. A number of cities launched storm drain stenciling projects, developing kits for volunteers and working with local community groups and schools [*373] to stencil a "Don't Dump" message on the city's storm drains. n304 Sacramento, California, focused its efforts on those industry sectors likely to have the largest impact on storm water quality, such as auto cleaning operations, car lots, and carpet cleaners. n305 While these are innovative and potentially quite effective programs, there are other model programs that offer a greater opportunity to combine habitat restoration with runoff control through public education and outreach. With voter approval of over 60%, Portland, Oregon, passed a $ 135.6 million bond bill to acquire up to 6000 acres of land to protect its urban waterways from runoff. n306 Implicit in this ambitious undertaking is the link between the protection and restoration of riparian (riverfront) habitat, the resulting natural filtering of runoff, and improved water quality. n307

Similarly, with respect to the public involvement components of a Phase II plan, the options range from a more generalized citizen outreach program and workshop series n308 to a program like the one developed in Milwaukee that targets riparian landowners. The Milwaukee project works with riverfront landowners to improve their management and care of riverfront property to minimize erosion and improve the ecological value of the waterway. n309 Again, the Milwaukee program integrates the storm water runoff goals with efforts to understand and to improve the ecological value of the city's rivers.

A third element of the Phase I and Phase II programs is the identification and elimination of illicit connections to the storm sewers. Cities across the country have launched inspection programs, using both city personnel and

volunteers, to identify illegal connections of wastewater pipes into the storm sewer system. n310 Eliminating such cross connections can significantly improve water quality in urban areas. n311 Undertaking these programs against the backdrop of an ecosystem-wide study of natural resources will [*374] allow cities to quantify the ecological gains of these programs, will encourage targeted enforcement to protect critical water bodies, and perhaps will provide incentives for continued improvements.

The construction and post-construction elements of the storm water programs also provide significant opportunities for habitat restoration and for integrating ecosystem restoration and protection with management of runoff. The bulk of the construction programs center on education and training of contractors and developers, and increased inspections. Community groups and local governments will want to advocate for complete training programs and for increased inspections at constructions sites.

More promising still are model programs developed to manage runoff from new development or redevelopment. Grand Traverse County, Michigan, adopted an ordinance requiring on-site retention of all storm water for all commercial developments and new subdivisions. n312 The city of Maplewood, Minnesota, avoided high assessments for new gutters and storm sewer systems and improved habitat at the same time by developing a system of swales planted with native species to control storm water. n313 In Austin, Texas, developers can either install on-site water quality controls to manage runoff, or they can pay an ordinance fee calculated on the basis of the amount of impervious surface (surfaces that water cannot penetrate) they will create. n314 The city of Austin is using these funds to develop restoration programs to improve storm water control, including a series of interconnected ponds that will reduce pollution from runoff. n315 Prince George's County, Maryland, and Portland, Oregon, are developing new site design processes called Low-Impact Development (LID). n316 LID programs seek to protect the local stream ecology by maintaining the watershed's pre-development hydrological patterns. n317 In short, the design process centers on avoiding runoff altogether by limiting impervious surfaces and limiting the impact of runoff through on-site infiltration of storm water. n318 The net effect of this approach could be to create or improve green space in the context of development or redevelopment, and, thus, it could link upland ecological restoration with storm water control.

[*375] Even the municipal good housekeeping section of the Phase II program provides opportunities for innovative programs that can protect or restore habitat and other upland ecological values. For example, the Howard County, Maryland Parks and Recreation Division found that wildflower meadows are twenty times less expensive to maintain than conventional turf. n319 This new approach reduces storm water pollution by drastically reducing the amount of pesticides and fertilizers on county land. n320 The ecosystem effects of this approach to park design and maintenance are profound, as meadows will attract and support significantly more complex animal, bird, and insect communities. n321

Thus, every element of the storm water pollution program launched by the EPA provides opportunities to improve and protect both urban water quality and urban habitat and biodiversity. Local community groups and local governments that undertake an urban ecosystem study and restoration program will want to integrate Phase I and Phase II storm water projects with the larger ecosystem restoration program.

## VI. Clean Air Act

### A. Clean Air Act Overview

The Clean Air Act (CAA) n322 operates in many ways on the same model as the Clean Water Act. As a general matter, the CAA establishes a level of air quality that the states are required to achieve. That level of air quality is meant to protect human health and the environment. A state has the authority to allocate emissions to individual sources (which collectively represent the commons) such that the total emissions meet the air quality goal.

Specifically, the CAA establishes National Ambient Air Quality Standards (NAAQS) for certain "criteria pollutants" (namely those pollutants that Congress found to be of greatest concern). n323 The CAA includes various

mechanisms for achieving those standards, depending on the type of pollution source being regulated: stationary sources (mostly smokestacks), mobile sources (such as cars and trucks), and new sources (stationary sources built after the [*376] CAA came into effect). In 1990, the CAA was amended to step up regulation on sources of hazardous air pollution. n324

With respect to stationary sources, the Act requires each state to submit for approval by the EPA a State Implementation Plan ("SIP"). The SIP identifies how the state will regulate stationary sources in order to achieve the NAAQS. The EPA must approve the SIP or draft its own Federal Implementation Plan. n325 In order to avoid a race to the bottom, with states seeking to entice industry through lax air quality laws, the CAA requires that new sources of pollution (built after the regulations for a specific pollutant go into effect) use the best available technology for air quality control. n326

In addition, each state is divided into a series of Air Quality Control Regions (AQCR), each of which must achieve the NAAQS. n327 Since the enactment of the CAA in 1970, Congress has modified the system in recognition of the fact that meeting NAAQS would be virtually impossible in certain regions of the country, in certain AQCRs. In such areas, termed "non-attainment areas," the state has to achieve "reasonable further progress" by requiring all new stationary sources to offset their new pollution by an even greater reduction from existing pollution sources. n328 Furthermore, in areas that have achieved NAAQS, states must regulate new sources in a way that achieves Prevention of Significant Deterioration. n329 In order to avoid the chaos of having each state regulate mobile sources in a different way, the CAA provides direct federal management of mobile source pollution. The CAA authorizes the EPA to establish across-the-board standards for tailpipe emissions from motor vehicles. n330

As scientists and ecologists have provided a clearer picture of the specific environmental and public health effects of air pollution, Congress has modified the Clean Air Act to tackle specific environmental problems that stem from air pollution. Perhaps the best examples of this targeted regulatory approach are the so-called "acid rain" provisions of the CAA. These provisions actually target acid deposition in all forms of precipitation (rain and snow) that contain elevated levels of chemical contaminants, primarily [*377] sulfur dioxide (SO<2>) and nitrous oxide (NO<x>). n331 These chemical contaminants react with water and oxygen in the atmosphere to form acidic compounds (sulfuric acid and nitric acid). About two-thirds of the SO<2> and one-fourth of the NO<x> in this country come from electric power plants that burn fossil fuels, especially coal-burning plants. n332 Acid rain created by these contaminants can damage soil, fish, forests, human health, and even buildings on which it falls. Precipitation with elevated levels of chemical compounds can have profound and complex impacts on ecosystems far from the source of the pollution. For example, research in the Rocky Mountains has linked acid rain to the steep decline in the bighorn sheep population through a complex chain of reactions in soil and plant life that deprives baby sheep of a crucial nutrient. n333 With respect to public health, the acid rain itself is not a threat, but the particulates that cause it have been linked to illness and death from heart and lung disorders, asthma, and bronchitis. n334

The EPA's acid rain program tackles the problem through a combination of a cap on emissions and an emissions allowance trading system. Specifically, EPA's program caps SO<2> emissions nationwide at 8.95 million tons. n335 Each source of SO<2> pollution is given a permit that includes an allowance of a certain number of tons of emissions. n336 Sources of pollution can trade or sell those allowances, with entities able to sell their excess allowances to other entities that fail to meet their limits. n337 A similar system exists for NO<x> emissions. n338 Any person can participate in this market: school groups and environmental organizations have bought emissions allowances and simply mothballed them to prevent the pollution from occurring. This market-based approach has worked extremely well, as SO<2> emissions have been cut 30% faster than expected. n339

[*378] As with the Clean Water Act, and for that matter the state and local regulatory schemes discussed above, the Clean Air Act must be utilized in innovative ways for the restoration and protection of urban natural resources. However, the Clean Air Act's regulatory scheme does provide some specific tools that can be part of an urban ecosystem protection program.

B. State Implementation Plans

One area for further study is the State Implementation Plans (SIP). Whenever the EPA finds that an existing plan is inadequate, or in response to revisions in the NAAQS and/or new technologies for meeting NAAQS, the EPA may require a state to revise its SIP. n340 The state must provide an opportunity for public comment on any revisions. n341 Community groups and local governments armed with data on the ecological resources in an urban area and on those pollutants for which a city is a non-attainment zone could advocate for certain types of emissions control plans and goals. The mechanisms that a state uses to meet the NAAQS may also have an impact on the local ecosystem. For example, some states have implemented parking bans in certain cities in an effort to meet NAAQS. n342 Such transportation-based mechanisms could affect land use and development and may offer opportunities to protect critical resources.

In addition, community groups and local agencies concerned with urban ecological resources will want to research whether a city is a non-attainment area for certain criteria pollutants. Where a city is a non-attainment area, the existing air quality conditions will certainly have an impact both on public health and on the local ecology. Researching those impacts will allow community groups and cities to work with states to bring the state into compliance with the NAAQS. For example, Massachusetts is a non-attainment area only for carbon monoxide and ozone. n343 Pending the final approval of a new ozone standard by EPA, the Commonwealth has developed, and continues to develop, specific strategies to address the ozone problem, each of which may have implications for urban [*379] ecosystems. The Commonwealth is working to meet the ozone NAAQS by:

Reducing Volatile Organic Compound (VOC) emissions from industrial sources;

Reducing the VOC content of certain products;

Implementing more stringent emissions standards for cars and increasing inspections for trucks;

Reformulating gasoline;

Reducing vehicle miles traveled by encouraging employee rideshare programs;

Improving mass transit, adding HOV lanes, and funneling transportation dollars to those projects that provide quantifiable air quality improvements. n344

Some of these strategies have no apparent benefits for the larger urban ecosystem. In fact, a number of these strategies seek to meet the ozone standard not by limiting or reducing the number of cars on the road or the number of roads built (which would limit runoff, fragmentation of habitat, and destruction of landscape), but by reducing the impact of each car or truck. Other strategies on the list would help to meet the ozone standard, while at the same time protecting ecological resources and habitats. Chief among these are incentives for mass transit and programs that reduce vehicle miles traveled.

The permitting program launched by the 1990 Clean Air Act amendments provides a specific vehicle for such coordinated efforts. The 1990 amendments added a Title V to the CAA that is similar to the NPDES permits under the Clean Water Act. Specifically, the regulated major sources of pollution are now subject to mandatory permits that include emissions standards, as well as monitoring and reporting requirements. n345 Organizations working on urban ecological restoration can now review permits and emissions monitoring data for a particular area and thereby participate in the efforts to manage air pollution impacts. Providing information on the urban ecosystem effects of non-attainment will be an important element of these efforts.

C. Particulate Pollution: The Link to Public Health

Particulate matter is one of the criteria pollutants for which the EPA has established NAAQS. The term describes a wide variety [*380] of liquid droplets or solids of different chemical compounds, including sulfur oxides, nitrous oxides, and VOCs. n346 Particulate matter has natural and human sources, including combustion of fossil fuels such as diesel fuel.

The EPA had established NAAQS for particulates in 1987, but a host of new epidemiological studies published in the early 1990s convinced the EPA of the need to review the 1987 standards. Specifically, a number of community epidemiological studies have found serious health effects in many urban areas, including increased mortality and morbidity from respiratory and cardiovascular disease, exacerbation of chronic diseases such as asthma, and increased hospitalizations, linked to ambient levels of particulate pollutants below those allowed by the 1987 standards. n347 The greatest risk seems to be to children, the elderly, and asthmatics. n348 The EPA's review of health data for two test cities found that for those two cities alone "the risk remaining after attaining the current [1987] standards was on the order of hundreds of premature deaths each year, hundreds to thousands of respiratory-related hospital admissions, and tens of thousands of additional respiratory related symptoms in children." n349

The earlier standards set limits on relatively large particles (PM10); because the studies showed that smaller particulate matter is of greater concern, the proposed 1997 NAAQS revised the PM10 standard and set new standards for smaller particulates (PM 2.5). n350 At the same time, the EPA Administrator revised the NAAQS for ground level ozone. The Administrator's announcement came after intensive lobbying from all sides of the issue; and, as expected, the new standards were challenged in court. A federal appellate court struck down the new standards, but ultimately the Supreme Court upheld the new particulate standards against a number of challenges. However, it struck down the new ground level ozone NAAQS, stating that the Agency's interpretation of [*381] the CAA to allow cost considerations was unreasonable. n351 In addition, the Bush Administration announced plans to continue stringent new standards for diesel trucks and buses first proposed under the previous administration. n352 As of the summer of 2001, the EPA was reviewing the new rules in order to establish a timetable for implementing them.

States will be required to revise their SIPs to meet the new NAAQS, and this will provide an opportunity for community groups and city governments to link this public health effort to urban ecological restoration. As previously noted, revisions to SIPs are subject to extensive public review and comment. Community groups and local governments will want to present data regarding critical urban ecological resources so that proposals for meeting the new NAAQS can promote both ecological and public health goals. For example, cities and states will most probably implement a variety of transportation-based proposals to manage particulates. These proposals should take account of how urban ecological resources could support the achievement of the NAAQS and also how the proposed revisions to the SIP might affect critical ecological resources.

D. Global Warming

At the turn of the 21st century, there is substantial agreement that human activities are contributing to changes in the global climate. Specifically, weather data indicates that the average surface temperature of the globe has increased by one degree Fahrenheit since the late 1800s, and suggests that temperatures will increase between two degrees and ten degrees Fahrenheit by 2100. n353 Research indicates that emissions of greenhouse gases (such as carbon dioxide (CO<2>)) from human activities are contributing significantly to the warming trend. n354 Due in large part to the burning of fossil fuels, and especially coal, the amount of CO<2> in the atmosphere has increased 25% since the late 1800s. n355

[*382] Climate change is likely to have a significant effect on ecosystems, water supplies, coastlines, and tropical agriculture, for it will change weather patterns and could affect the availability of water. n356 Changes in weather patterns and the water cycle could mean more extreme weather events, water shortages, increased flooding in coastal areas, and increased drought in dry areas. n357 Climate change will lead to substantial increases in sea-levels along the

coastlines of the United States. n358 In addition, increases in average global temperatures could have significant public health effects by increasing air pollution (ground level smog occurs more readily in hot temperatures), heat-related stress, and water-and vector-borne diseases. n359

All of these changes will have a dramatic impact on urban ecosystems, especially in coastal cities. The climate change itself will have a dramatic impact on terrestrial ecosystems through changes in ecosystem composition and differential rates of plant and animal adaptation to changing ecosystem structure. n360 By the same token, cities will be central in the struggle to manage global greenhouse gas emissions.

The 1997 Kyoto Protocol set out to tackle global climate change by requiring developed countries to limit their emissions of greenhouse gases. n361 In July of 2001, 178 countries signed an accord (the Bonn agreement) agreeing on the rules for the implementation of the Kyoto pact. n362 The United States did not sign the Bonn agreement because it did not set emissions targets for developing countries and compliance with the agreement would have damaged the U.S. economy. n363 The Bonn agreement calls for thirty-eight industrialized nations to cut their greenhouse gas emissions by a combined 5.2% below 1990 levels by 2012. n364 The Bonn agreement provides emissions reduction credits for protecting or planting [*383] trees because trees absorb CO<2>. n365 The Bonn agreement also imposes sanctions for failing to meet the targets and envisions an emissions trading system n366 like the one established under the Acid Deposition Program. Countries or companies could purchase emissions credits from countries that meet their targets. n367

As noted above, the United States has not joined the Bonn agreement, and the Senate has not ratified the Kyoto treaty. Nevertheless, a strong bipartisan contingent in the United States Congress has considered legislation that would set limits on CO<2> emissions in this country. n368 These limits would most likely be implemented as NAAQS through the SIPs with permit limits on major sources of CO<2> and a trading system. Despite the U.S. refusal to join the accord, U.S. multinational companies have already launched large-scale forestry projects around the world in the hope that the CO<2> absorption capacity of replanted forests might provide internationally tradable CO[in'2 ']credits or provide credits tradeable in markets that have adopted the Kyoto accord. n369

All of this may seem tangential to planning, researching, and protecting an urban ecosystem. Consider, however, the importance of cities to the problem of global climate change. Burning coal generates 56% of this country's electricity. n370 Combustion of other fossil fuels for electricity and by cars, as well as burning solid waste, accounts for a significant additional percentage of the nation's greenhouse gas emissions. n371 Tree cover, on the other hand, can serve as a sink for CO<2> emissions, absorbing tons of CO<2> emissions every year. The concentrated resources use, transportation needs, and solid waste disposal systems of the average American city are at the center of the global climate change problem. At the same time, as noted above, coastal cities especially have a great deal to lose over the next century.

A community group or a city government could engage the global climate change debate. Additionally, they could participate [*384] in the search for a solution and, for that matter, in the international emissions trading market by establishing an annual citywide CO<2> budget - an accounting of the city's contributions to both CO<2> emissions and to CO<2> emissions absorption or reduction. Every planning decision, from the decision to clear trees, to transportation programs, to solid waste disposal and handling, could be and perhaps should be assessed for its impact on the city's CO<2> budget. A city could set for itself a goal for CO<2> reductions, either through systemic changes or through planting and protecting urban forests. It is conceivable that some of those decisions could be rewarded with CO<2> emissions credits that could be sold or traded to fund the city's parks department. At a minimum, providing a city's residents with a concrete sense of their collective contribution to the problem of global climate change may be a crucial first step toward local advocacy on this issue. As it stands, the issue is seemingly too complex and too international in scope to be the subject of individual or even regional action. Establishing a regional CO<2> footprint, and better yet establishing a local annual CO<2> reduction target, provides a focal point for local advocacy and environmental education. Local targets bring the problem home and could provide a city with additional resources in the bargain.

VII. Conclusion

In the past several years the scientific community has embraced the emerging field of urban ecology as both valid and central to understanding the global environment. Given the concentration of human activity in urban centers, the fact that humans are the dominant species in all ecosystems, and the pace of environmental change, urban ecology is arguably one of the most important areas for environmental research for this century. In addition, understanding the ecological processes in, and ecological history of, an urban center can provide a slate of new and exciting tools for addressing the social and economic challenges endemic in most large urban centers. Understanding urban natural resources and urban natural systems has important implications for public health, economic development, education, and community development in urban areas.

A number of groundbreaking research projects are ongoing that will develop a comprehensive understanding of the city as an ecological unit. While these long-term studies continue to unfold, community groups, universities, and environmental organizations are developing community-based methods for stakeholder-driven [*385] urban ecological research and restoration. Together, these various efforts will provide a baseline methodology over the next five to ten years for understanding the city as an ecosystem and for linking research to advocacy and restoration in the near-term.

As with the research protocols, urban ecological policy and advocacy tools are in their infancy. In developing specific legal and policy tools for use in the urban context, community groups and their partners must address the unique nature of urban environmental advocacy: its focus on place, not on specific media, and the contingency of the science and the research. Despite these challenges, however, many local, state, and federal legal and regulatory schemes (most of which focus on a specific environmental medium) can be modified as tools to restore and protect urban natural resources. Perhaps the most exciting characteristic of this work is that it requires leadership and participation from urban residents and community groups. Almost all of the legal and regulatory tools that might be used to restore urban natural resources require some significant level of community involvement.

Using the urban ecosystem as an organizing principle, urban residents can now begin to reach across political and socio-economic divides to develop a cohesive vision of a metropolitan area. The very architecture of advocacy for urban ecosystems (its focus on a regional environmental system) pulls together community groups across traditional divides and provides the opportunity for community-based coalitions that transcend neighborhood-level parochialism. Furthermore, understanding an urban area as an ecological system provides such coalitions with a unifying theory for managing and restoring an urban area. Decisions such as where and what to build, how to manage private and public land, and whether and how to restore contaminated property, can now be assessed from the perspective of a regional vision or blueprint: the healthy urban ecosystem. The emerging science and advocacy of urban ecology are exciting in their implications for the global environment. In their implications for the social dynamics of metropolitan areas, and in their strength and power, they could provide to urban residents the means to create a neighborhood, a city, and a world of their own choosing.

**Legal Topics:**

For related research and practice materials, see the following legal topics:
Environmental LawZoning & Land UseConstitutional LimitsReal Property LawZoning & Land UseGeneral OverviewGovernmentsLocal GovernmentsGeneral Overview

**FOOTNOTES:**

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n60. See discussion infra Parts III.B-D.

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n64. See, e.g., Mass. Regs. Code tit. 105, 151.220 (2001) (requiring parking to adhere to provisions in local zoning ordinances and setting specifications for parking when constructing long term care facilities in Massachusetts); Mass. Regs. Code tit. 105, 141.299 (2001) (requiring parking to adhere to provisions in local

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No person shall remove, fill, dredge or alter any bank, riverfront area, fresh water wetland, coastal wetland, beach, dune, flat, marsh, meadow or swamp bordering on the ocean or on any estuary, creek, river, stream, pond, or lake, or any land under said waters or any land subject to tidal action, coastal storm flowage, or flooding ... without filing written notice of his intention to so remove, fill, dredge or alter, including such plans as may be necessary to describe such proposed activity and its effect on the environment and without receiving and complying with an order of conditions and provided all appeal periods have elapsed. Id.

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n143. *Nat'l Ass'n of Home Builders v. New Jersey Dep't of Envtl. Prot., 64 F. Supp. 2d 354, 356 (D.N.J. 1999).*

n144. *Id. at 356, 358.*

n145. *512 U.S. 374 (1994).*

n146. *Home Builders, 64 F. Supp. 2d at 360.*

n147. *Id. at 358, 359 n.2.*

n148. See NY/NJ Baykeeper, Taking Back What is Rightfully Yours: An Owner's Manual for the Hudson-Raritan Estuary and Guide to the Public Trust Doctrine 6 (May 21, 2001), at http://www.nynjbaykeeper.org/photo/PTDMANUAL.pdf.

n149. Dept. of Envtl. Prot., Mass., Chapter 91: An Overview and Summary, at http://www.state.ma.us/dep/brp/waterway/about.htm (last visited Oct. 22, 2002).

n150. William D. Araiza, Democracy, Distrust, and the Public Trust: Process-Based Constitutional Theory, the Public Trust Doctrine, and the Search for a Substantive Environmental Value, *45 UCLA L. Rev. 385, 395 (1997)* (citing Justinian, The Institutes of Justinian, book 2, tit. 1, pts. 1-6, at 65 (J. Thomas trans. 1975)). See also Dept. of Envtl. Prot., infra note 156.

n151. Payne, supra note 116, at 538-39 (citing Alexandra D. Dawson & Sally A. Zielinski, Environmental Handbook for Massachusetts Conservation Commissioners 98 (7th ed. 1991)).

n152. See *Mass. Gen. Laws Ann. ch. 91, 2* (West 2001).

n153. See Mass. Regs. Code tit. 310, 9.04(2) (2001) (defining the geographic areas subject to jurisdiction as including all filled tidelands).

n154. Mass. Regs. Code tit. 310, 9.53 (2001).

n155. See Mass. Regs. Code tit. 310, 9.51(3)(d)-(e) (2001).

n156. Dept. of Envtl. Prot., Mass., Chapter 91: Frequently Asked Questions, available at http://www.state.ma.us/dep/brp/waterway/faqs.htm (last visited Oct. 22, 2002); see also Dept. of Envtl. Prot.,

Mass., BRP WW 04 Request for Determination of Applicability, available at http://www.state.ma.us/dep/appkits/forms.htm (last visited Oct. 22, 2002).

n157. Mass. Regs. Code tit. 310, 9.51 (2001).

n158. *Mass. Gen. Laws Ann. ch. 91, 2* (West 2001).

n159. See id. 2, 18; see also *Dept. of Envtl. Prot., supra* note 156.

n160. Conservation Law Found., Chapter 91: What You Should Know About the Public Waterfront Act, at http://www.clf.org/hot/Chapter 91.htm (last visited Oct. 22, 2002). See also *Mass. Gen. Laws Ann. ch. 91, 2* (West 2001).

n161. For non-water-dependent use projects located on tidelands, Chapter 91 regulations require that there be one square foot of open space for every square foot of building within tideland area containing non-water-dependent uses. Mass. Regs. Code tit. 310, 9.51(3)(d) (2001).

n162. Rivers Protection Act, ch. 258, 1996 Mass. Legis. Serv. 258 (West).

n163. Id.

n164. Mass., Mass. Rivers Protection Act, at http://www.state.ma.us/dep/consumer/rpa.htm (last visited Jan. 15, 2002).

n165. Id.

n166. See Mass. Regs. Code tit. 310, 10.00-10.60 (2001).

n167. Id. 10.05.

n168. Id.

n169. Id. 10.58(4).

n170. Id. 10.58(1).

n171. Id. 10.58(4).

n172. Id. 10.58(2)(a)(3).

n173. Mark R. Correll et al., The Effects of Greenbelts on Residential Property Values: Some Findings on the Political Economy of Open Space, 54 Land Econ. 207, 211 (1978).

n174. Mass., supra note 164.

n175. U.S. EPA, Brownfields, at http://www.epa.gov/epahome/hi-brownfields.htm (last updated Nov. 22, 2002).

n176. *42 U.S.C. 9601*-9675 (1994).

n177. Id. 9607. CERCLA 107(a) imposes liability on four categories of parties: (1) generators that arranged for the treatment or disposal of hazardous substances; (2) transporters that hauled hazardous substances for treatment or disposal at sites they selected; (3) current owners and operators of facilities where hazardous substances have been disposed; and (4) owners and operators of facilities at the time of disposal of hazardous substances. Id.

n178. See supra note 176.

n179. Charles de Saillan, Superfund Reauthorization: *A More Modest Proposal, 27 Envtl. L. Rep. 10,201, 10,203 (1997).*

n180. Mass. Gen. Laws Ann. ch. 21E, 1-19 (West 2000).

n181. See Mark Roberts & Andy Morgan, Cleaning Up, Redeveloping, and Reusing Contaminated Properties, *33 New Eng. L. Rev. 667, 669-670 (1999).*

n182. *Mass. Gen. Laws Ann. ch. 21E, 5(a)(5)* (West 2000).

n183. In her article on this subject entitled Addressing Morality in Addressing Urban Brownfield Redevelopment: Using Stakeholder Theory to Craft Legal Process, 15 Va. Envt. L.J. 37 (1995), Georgette Poindexter states, "Ironically, the legislative and policy initiatives designed to spur and facilitate environmental cleanup are one of the largest obstacles to remediating brownfields. Strict and mandatory adherence to arbitrary cleanup standards does not provide an incentive to remediate, to the contrary, it deters any cleanup efforts." Id. at 50.

n184. Elizabeth Glass Geltman, Recycling Land: Encouraging the Redevelopment of Contaminated Property, Nat. Resources & Env't, Spring 1996, at 3.

n185. U.S. Conference of Mayors, 3 Recycling America's Land: A National Report on Brownfield Redevelopment 11 (Feb. 2000).

n186. Mass. Brownfields Act, 1998 Mass. Acts. ch. 206

n187. See *Mass. Gen. Laws Ann. ch. 21E, 19* (West 2000).

n188. Mass. Regs. Code tit. 310, 40.0002(1)(a)(1)-(7) (2001).

n189. Mass. Brownfields Act 5.

n190. Id. 19.

n191. Id. 32.

n192. Id. 37.

n193. General Accounting Office, Brownfields: Information on the Programs of EPA and Selected States 3, GAO-01-52 (Dec. 2000).

n194. See generally id.

n195. Id. at 43.

n196. Id. at 54.

n197. Id. at 54-55.

n198. Id. at 35 (Massachusetts), 43 (Michigan), 49 (New Jersey), 61 (Wisconsin).

n199. Id.

n200. Id. at 35 (Massachusetts), 62 (Wisconsin).

n201. Id. at 37 (Massachusetts), 49 (New Jersey), 62 (Wisconsin).

n202. Id. at 37 (Massachusetts), 62 (Wisconsin).

n203. Id. at 36.

n204. Id.

n205. Id.

n206. Id.

n207. Id. at 39.

n208. Id.

n209. Id. at 47 (Michigan), 52 (New Jersey).

n210. Id. at 40 (Massachusetts), 58 (Pennsylvania).

n211. Id. at 58.

n212. Id. at 59.

n213. Id. at 41.

n214. Id. at 40-41 (Massachusetts), 59 (Pennsylvania).

n215. Id. at 40 (Massachusetts), 59 (Pennsylvania).

n216. Id. at 52 (New Jersey), 67 (Wisconsin).

n217. Id. at 55 (Pennsylvania), 67 (Wisconsin).

n218. Id. at 55.

n219. U.S. EPA, Brownfields Economic Redevelopment Initiative Fact Sheet, at

http://www.epa.gov/brownfields/html-doc/econinit.htm (last visited Oct. 21, 2002).

n220. Id.

n221. Executive Office of Envtl. Affairs, Mass., Massachusetts Watershed Initiative, at http://www.state.ma.us/envir/mwi/watersheds.htm (last visited Oct. 17, 2002).

n222. Id.

n223. Id.

n224. Id.

n225. Id.

n226. Office of Water, U.S. EPA, A Review of Statewide Watershed Management Approaches 53 (Apr. 2002).

n227. *33 U.S.C. 401*-466n (2000).

n228. *33 U.S.C. 1251*(a).

n229. Id.

n230. Id. 1251(a)(2).

n231. Id. 1311.

n232. Id. 1321, amended by Oil Pollution Act of 1990, *33 U.S.C. 2701* (2000).

n233. *33 U.S.C. 1329* (2000).

n234. Combined Sewer Overflow Control Policy, *59 Fed. Reg. 18,688* (Apr. 19, 1994).

n235. *33 U.S.C. 1313*(c) (2000).

n236. Id. 1313(c)(1).

n237. See, e.g., Jennifer Price, Paradise Reclaimed: A Field Guide to the L.A. River, In the Beginning, L.A. Weekly, Aug. 10, 2001, at 1 (noting projects in Chicago, Portland, San Antonio, Denver, Milwaukee, New York and Cleveland); Elisa Schement, Upgrades to Start Along San Antonio River, San Antonio Express-News, Aug. 8, 2001, at 6H; David Ferrel, LA River Defies City in Nurturing Wildlife, L.A. Times, Jul. 26, 2001, at B2; Tim Jones, River Churns Way to Comeback, Chicago Tribune, July 3, 2001, at N1; Dale Bowman, River Renewal Success Story Everyone Can Take Pride in, Chicago Sun-Times, June 24, 2001 (Sports Outdoors) at 119.

n238. The riparian corridor is the habitat along the edge of a river.

n239. Tom Schueler, The Economics of Watershed Protection, 2 Watershed Prot. Techniques 469, 471 (1997).

n240. See Frank C. Curriero et al., The Association Between Extreme Precipitation and Waterborne Disease Outbreaks in the United States, 1948-1994, 91 Am. J. Pub. Health 1194, 1197 (2001).

n241. See Schueler, supra note 239, at 470 (citing National Park Service, The Economic Impacts of Protecting Rivers, Trails and Greenway Corridors (1992)).

n242. See id. at 471 (citing Mark R. Correll et al., supra note 173); Wildlife Habitat Enhancement Council, The Economic Benefits of Wildlife Habitat Enhancement on Corporate Lands (1992).

n243. See *33 U.S.C. 1315*(b) (2001).

n244. Office of Water, U.S. EPA, Water Quality Conditions in the United States: A Profile from the 1998 Water Quality Inventory Report to Congress 2, EPA 841-F-00-006 (June 2000), available at http://www.epa.gov/305b/98report/98summary.pdf.

n245. Id.

n246. Id.

n247. Regulations for Revision of the Water Pollution Control Program Addressing Storm Water Discharges, *64 Fed. Reg. 68,722*, *68,725-68,726* (Dec. 8, 1999) (to be codified at 40 C.F.R. pts. 9, 122-124) [hereinafter Phase II Final Rule].

n248. Office of Water, U.S. EPA, The Quality of Our Nation's Waters, A Summary of the National Water Quality Inventory: 1998 Report to Congress 7-9, EPA 841-S-00-001 (June 2000), available at http://www.epa.gov/305b/98report/98brochure.pdf.

n249. New England Region, U.S. EPA, Charles River Fact Sheet (June 2002),

http://www.epa.gov/NE/charles/4 02Charles.pdf.

n250. See Office of Water, supra note 244.

n251. See Office of Water, supra note 248, at 9.

n252. Id.

n253. *NRDC v. Train, 396 F. Supp. 1393 (D.D.C. 1975)* (stormwater), aff'd, *NRDC v. Costle, 568 F.2d 1369 (D.C. Cir. 1977); United States v. Weisman, 489 F. Supp. 1331 (M.D. Fla. 1980)* (wetlands); *Fishel v. Westinghouse Elec. Corp., 640 F. Supp. 442 (M.D. Pa. 1986)* (hazardous waste lagoon); *Dague v. City of Burlington, 935 F.2d 1343 (2d Cir. 1991)* (culvert).

n254. *33 U.S.C. 1311*(a) (2000).

n255. *40 C.F.R. 122.2 (2001).*

n256. Id. 122.41.

n257. Id.

n258. *33 U.S.C. 1342*(b) (2001).

n259. See Office of Water, U.S. EPA, Wastewater Primer 5, EPA 833-K-98-001 (May 1998), available at http://www.epa.gov/owm.

n260. Phase II Final Rule, supra note 247, at 68,725, 68,731-68,733.

n261. Office of Wastewater Management, U.S. EPA, Moving the NPDES Program to a Watershed Approach (Oct. 1994), available at http://www.epa.gov/npdes/pubs/owm0148.pdf.

n262. Id.

n263. See *New England Region*, *supra* note 249.

n264. Telephone Interview with Bill Walsh-Rogalski, Coordinator of Clean Charles 2005, EPA-Region I (May 10, 2002).

n265. Id.

n266. Id.

n267. See Clean Charles Coalition, at http://www.cleancharles.org (last visited Jan. 15, 2003).

n268. See id.

n269. Telephone Interview with Heather Langford, Urban Ecology Institute Representative to Clean Charles Coalition (May 12, 2002).

n270. Id.

n271. Id.

n272. *33 U.S.C. 1313*(a)(3)(A) (2000).

n273. Id. 1251(a)(2).

n274. Id. 1311(b)(1)(C).

n275. Id. 1313(a)(2)-(3)(A).

n276. Id. 1313(c)(1); State Review and Revision of Water Quality Standards, *40 C.F.R. 131.20(b) (2002)*.

n277. *40 C.F.R. 131.10(g) (2002)*.

n278. Id. 131.12 (2002).

n279. *33 U.S.C. 1314*(l) (2000).

n280. Id. 1313(d)(1)(A)-(C).

n281. Id. 1313(d)(1)(C)-(D).

n282. Darren Samuelsohn, Whitman Delays TMDL Rule, Spawning Renewed Debate, Env't & Energy Daily, Dec. 21, 2001.

n283. Id.

n284. Id. The NAS Report argues that "a more science-based approach is needed for states to set TMDLs for water pollution." Id.

n285. During this period, the studies done by EPA under the Nationwide Urban Runoff Program (NURP) from 1978-83 and by the U.S. Geologic Survey in 1985 focused on the effects of stormwater runoff from light industrial and residential sites in various parts of the nation. Critics of these studies claimed that EPA's efforts were too localized and sporadic and could not be used to infer typical stormwater runoff patterns for the whole nation. See Phase II Final Rule, supra note 247, at 68,725, 68,731-68,733.

n286. See National Pollution Discharge Elimination System Permit Application Regulations for Storm Water Discharges, *55 Fed. Reg. 47,990* (Nov. 16, 1990) (to be codified at 40 C.F.R. pt. 122-124); Office of Water, U.S. EPA, Phase I NPDES Stormwater Program Overview 1 (Feb. 21, 2000), at http://cfpub1.epa.gov/npdes/stormwater/swphase1.cfm?program id=6 [hereinafter Phase I Program Overview].

n287. See Phase I Program Overview, supra note 286, at 1; Office of Water, U.S. EPA, Eleven Categories of Storm Water Discharges Associated with Industrial Activity, at http://cfpub1.epa.gov/npdes/stormwater/swcats.cfm?program id=6 (last modified June 25, 2002).

n288. NPDES permitting authority can be delegated to a state, or may be administered directly by an EPA regional office. In Massachusetts, EPA's regional office for Region 1 is the permitting authority.

n289. See Phase I Program Overview, supra note 286, at 1-4.

n290. Office of Water, U.S. EPA, Permit Application Requirements for Medium and Large MS4s, at http://cfpub.epa.gov/npdes/stormwater/lgpermit.cfm (last modified June 25, 2002).

n291. Id.

n292. See Phase II Final Rule, supra note 247, at 68,726-32.

n293. *NRDC v. EPA, 966 F.2d 1292, 1310 (9th Cir. 1992).*

n294. See *id. at 1305-06.*

n295. Phase II Final Rule, supra note 247, at 68,722.

n296. See Office of Water, U.S. EPA, Storm Water Phase II Final Rule: Who's Covered? Designation & Waivers of Small MS4s 1-2, at http://www.epa.gov/npdes/pubs/fact2-1.pdf (last visited Jan. 15, 2003) [hereinafter Phase II Fact Sheet 2.1].

n297. See Phase II Fact Sheets 2.3-2.8 (Jan. 2000), available at http://www.epa.gov/npdes/pubs/fact2-3.pdf (last visited Jan. 15, 2003).

n298. Id.

n299. Id.

n300. Office of Water, U.S. EPA, National Menu of Best Management Practices for Storm Water Phase II, at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/menu.cfm (last modified Aug. 15, 2002).

n301. Office of Water, U.S. EPA, Construction Site Storm Water Runoff Control, at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con site.cfm (last modified Aug. 15, 2002).

n302. See Phase II Final Rule, supra note 247, at 68,722; Phase II Fact Sheets 1.0, 2.0, & 2.1, at http://cfpub.epa.gov/npdes/stormwater/swfinal.cfm (last modified June 25, 2002).

n303. See Phase II Final Rule, supra note 247, at 68,722.

n304. These cities include Santa Cruz, CA; Monterey, CA; and Miami Beach, FL. See Office of Water, U.S. EPA, Model Phase II Permit 9 (Oct. 2000) [hereinafter Model Phase II Permit].

n305. Id. at 10.

n306. Id.

n307. Id. at 9.

n308. Such options have been pursued by Tulsa, OK, and Riverside, CA. See also NRDC, Stormwater Strategies: Community Responses to Runoff Pollution (1999).

n309. Model Phase II Permit, supra note 304, at 10-11; see also NRDC, supra note 308.

n310. Model Phase II Permit, supra note 304, at 13-14.

n311. One illegal cross connection into the Boston system, for example, was pumping 70,000 gallons per day of raw sewage into the Charles River through the storm sewers. Id. at 14.

n312. NRDC, supra note 308, at 239.

n313. Id. at 230.

n314. Id. at 151.

n315. Id.

n316. Id. at 101.

n317. Model Phase II Permit, supra note 304, at 21-22.

n318. Id. at 22.

n319. NRDC, supra note 308, at 116.

n320. Id.

n321. Id. at 23.

n322. *42 U.S.C. 7401*-7641 (2000).

n323. See id. 7409.

n324. Id. 7412.

n325. See id. 7407, 7410.

n326. See id. 7411.

n327. Id. 7407.

n328. Id. 7501-7509.

n329. Id. 7470-7479.

n330. Id. 7521.

n331. Id. 7651a-7651o.

n332. See U.S. EPA, Clean Air Markets Program - Environmental Issues, Acid Rain, at http://www.epa.gov/airmarkets/acidrain/index.html#what (last updated Oct. 28, 2002).

n333. Gary Polakovic, Deaths of the Little Bighorns, L.A. Times, Aug. 29, 2001, at A1.

n334. U.S. EPA, Clean Air Markets - Environmental Issues, Effects of Acid Rain: Human Health, at http://www.epa.gov/airmarkets/acidrain/effects/health.html (last updated Oct. 28, 2002).

n335. *42 U.S.C. 7651b*, 7651d (2000).

n336. Id. 7651b.

n337. Id. 7651b-7651d.

n338. Id. 7651f.

n339. White House Climate Change Task Force, Greenhouse Gas Emissions Trading: A Country's and Company's Eye View (Oct. 1999).

n340. *42 U.S.C. 7410*(a)(2)(H), 7410(l) (2000).

n341. Id. 7410(l).

n342. See, e.g., Mass. Regs. Code tit. 310, 7.31, 7.33 (2001) (imposing parking freezes in South Boston and East Boston).

n343. Dept. of Envtl. Prot., Mass., Implementation of the 1990 Federal Clean Air Act Amendments: A Massachusetts Status Report (Apr. 2000), available at http://www.state.ma.us/dep/bwp/daqc/files/1990caaa.htm (last visited Jan. 15, 2003).

n344. See id. (describing measures taken by Massachusetts to achieve target level of emissions and control ozone levels).

n345. *42 U.S.C. 7661*-7661c (2000).

n346. EPA National Ambient Air Quality Standards for Particulate Matter, *62 Fed. Reg. 38,652, 38,653* (July 18, 1997) [hereinafter NAAQS for Particulate Matter].

n347. Douglas W. Dockery et al., An Association between Air Pollution and Mortality in Six U.S. Cities, *329 New Eng. J. Med. 1753, 1753-1759* (Dec. 9, 1993); see also NAAQS for Particulate Matter, supra note 346, at 38,655.

n348. NAAQS for Particulate Matter, supra note 346, at 38,656.

n349. Id.

n350. Id. at 38,665; see also, Jonathan M. Samet et al., Fine Particulate Air Pollution and Mortality in 20 U.S. Cities, 1987-1994, *343 New Eng. J. Med. 1742, 1742-1749* (Dec. 14, 2000).

n351. *Whitman v. Am. Trucking Ass'n, 531 U.S. 457 (2001).*

n352. Eric Pianin, EPA Links Lung Cancer, Diesel Exhaust; Study Says Long-Term Exposure Also Can Cause Respiratory Illnesses, Wash. Post, Sept. 4, 2002, at A2.

n353. Pew Center for Global Climate Change, The Basic Facts of Climate Change: Straight Facts, Innovative Solutions, Basic Facts, Science and Impacts Part 1 (2001), available at

http://www.pewclimate.org/policyguide/index.cfm (last visited Jan. 15, 2003) [hereinafter Basic Facts of Climate Change]; Andrew Revkin, Of Coals and Climates, N.Y.Times, Mar. 16, 2001, at A1.

n354. Basic Facts of Climate Change, supra note 353, at 1.

n355. Revkin, supra note 353.

n356. Basic Facts of Climate Change, supra note 353, at pts. II, III.

n357. Id; see also Kenneth D. Frederick & Peter H. Gleick, Pew Center for Global Climate Change, Water and Global Climate Change: Potential Impacts on U.S. Water Resources (1999).

n358. Basic Facts of Climate Change, supra note 353, at pt. II.

n359. Id. at pt. III. However, there is some evidence that the public works infrastructure in U.S. cities will be capable of managing or minimizing the water-related public health impacts. See Paul R. Epstein, Climate and Health, 285 Science 347, 347-348 (1999).

n360. Basic Facts of Climate Change, supra note 353, at pt. III.

n361. Andrew Revkin, 178 Nations Reach a Climate Accord, U.S. Only Looks On, N.Y. Times, Jul. 24, 2001, at A1.

n362. Id.

n363. Id. at A1, A11.

n364. Id. at A1.

n365. Id. at A1, A11.

n366. Id.

n367. Rana Foroohar, The New Green Game, Newsweek, Aug. 27, 2001, at 62.

n368. Katherine Q. Seelye, McCain and Leiberman Urban Emissions Limit, N.Y. Times, Aug. 4, 2001, at A16.

n369. Foroohar, supra note 367, at 62. Two native American tribes in Montana received money from a London company to replant forests devastated by forest fire. In exchange, the company received the rights to the 47,972 tons of CO<2> that the forests will absorb over the next 80 years. At a projected $ 70 per ton, those rights could be worth more than $ 3 million. Id.

n370. Revkin, Of Coals and Climates, supra note 353, at A1.

n371. Id.

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