The State of the HUDSON 2009

New York State Department of Environmental Conservation

www.dec.ny.gov
The Hudson River Estuary Program: Making a difference together for the river and valley we share.

The Hudson River Estuary Program leads a unique regional partnership to restore the Hudson and support the quality of life so valued by Hudson Valley residents. Its mission is to conserve the natural resources for which the Hudson is legendary, promote full public use and enjoyment of the river and clean up the pollution that affects our ability to use and enjoy it.

The Estuary Program implements the Hudson River Estuary Action Agenda with partners, including the Hudson River National Estuarine Research Reserve; Hudson River Valley Greenway; New York-New Jersey Harbor Estuary Program; New York State’s Office of Parks, Recreation and Historic Preservation and the departments of State, Health, Transportation and General Services; the U.S. Environmental Protection Agency; U.S. Geological Survey; U.S. Department of Commerce/NOAA; and many municipal governments, non-profit groups, academic institutions and private sector organizations.

For more information, visit www.dec.ny.gov/lands/4920.html
Four centuries ago, native tribes along the Hudson River were careful observers of nature. One of their names for the river was Mahicantuck, translated as “great waters in constant motion” or “river that flows both ways.” Mahicantuck is an apt description of this estuary—a long arm of the sea in which salt and fresh water are sloshed back and forth by tidal currents.

These tribes had to possess practical knowledge of this environment because their lives depended on it. The same was true for the crew of the Half Moon which, on September 11, 1609, entered the river later named for its captain, Henry Hudson. In his journal, crew member Robert Juet recorded the river’s physical characteristics—its depths, shoals, winds, tides and currents. He noted a rich array of fishes, “...they took four or five and twenty Mulletts, Broames, Bases, and Barbiles...” and trees, “…goodly Oakes, and Wal-nut trees, and Chest-nut trees, Ewe trees, and trees of sweet wood in great abundance...” Describing an exploration of the Kill Van Kull between Staten Island and Bayonne, Juet wrote, “The lands they told us were as pleasant with Grasses and Flowers, and goodly Trees, as ever they had seen, and very sweet smells came from them.”

Now tank farms and shipyards line the Kill Van Kull, and the dominant smells come from petrochemicals. Along much of the river, a sailor from 400 years ago or even 40 years ago would find the river very different today.

This State of the Hudson report documents the status of and trends in the estuary’s water quality, its natural communities and inhabitants and the health of the landscape that cradles and nurtures the Hudson. Today that knowledge may not be of immediate personal concern, but it is critical. We do depend on long-established patterns in the natural world and should consider how our society benefits from the Hudson River, its tributaries and its watershed.

The river shaped our past; we now shape its future. Much of the beauty Robert Juet recorded is still to be seen, but some trends described in this report are troubling. Others show how decisions based in ecological science can repair past damage and prevent future lapses. Our power to shape the Hudson must be informed by striving to understand—as did Juet and the Native Americans—the vital role the river plays in our lives.

Manhattan Then and Now

Combining information from old maps and natural history accounts with modern technology and understanding of landscape ecology, the Mannahatta Project has recreated the landscape of Manhattan as Henry Hudson saw it 400 years ago. These images show Manhattan’s Hudson River shoreline at the present-day sites of Battery Park City and Tribeca.
**HUDSON RIVER BASICS**

**A few definitions…**

What is an Estuary? A body of water, partly enclosed by land, in which fresh water running off the land meets seawater. In the Hudson estuary, diluted seawater is often found as far north as Newburgh.

What is a Tributary? A stream that flows into a larger stream or river. The Mohawk River is the Hudson’s largest tributary.

What is a Watershed? The area of land from which water drains into a stream, river, lake or other water body. The Hudson drains a watershed equal in size to Massachusetts and Connecticut combined.

**…and river facts**

- The Hudson River flows from the Adirondack Mountains to New York Harbor. Lake Tear of the Clouds, located high on Mt. Marcy, New York State’s tallest peak, is considered to be the Hudson’s source. However, the name Hudson River first appears on maps in Newcomb, where the outlet from Henderson Lake joins Calamity Brook.
- Measured from Lake Tear, the Hudson is 315 miles long. It is widest at Haverstraw Bay—about three and a half miles from Havenstraw to Croton-on-Hudson—and deepest at West Point—175 feet. In shallow reaches, engineers maintain a channel 32 feet deep to allow large vessels to get to Albany.
- At the base of the Troy Dam, the river’s surface is only five feet above sea level. From this point south, the waters of the Hudson rise and fall to the rhythm of tides originating in the Atlantic Ocean. The tides cause the river to flow two ways: its current alternates between an ebb running south toward the sea and a flood running north toward Troy.
- The salt front—the leading edge of diluted seawater—typically pushes upstream to the Newburgh Beacon Bridge by late summer. In droughts, the salt front may reach Poughkeepsie. During the spring thaw and after major storms, freshwater runoff can push the salt front well south of the Tappan Zee Bridge.
- Poughkeepsie is one of five river communities with water systems that draw directly from the Hudson. Because salt in drinking water can be a public health concern, water is released from the Great Sacandaga Lake reservoir in the Adirondacks to push the salt front south of Poughkeepsie when needed. This reservoir can also hold water back to prevent flooding in Albany, Troy and other communities along the upper river.
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- During a dry summer, swimmers enjoying a cooling swim in Beacon’s floating river pool might taste a bit of salt in the water.

The Hudson River watershed covers nearly 13,400 square miles.

Located 153 miles north of New York Harbor, the federal lock and dam at Troy marks the northern limit of tidal influence in the Hudson estuary.

The Hudson River enters New York Harbor at the Battery, the southern tip of Manhattan.

The Hudson River is a long arm of the sea subject to the pulse of the tides. Traces of salty seawater can often be found as far north as Newburgh, making the lower Hudson an estuary.
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How Is the Hudson Doing?

Is the river clean? Swimmable? Will it ever again be what Henry Hudson experienced? The answers are mixed. Water quality has improved since the 1960s. Some noxious discharges have ceased, but new pollutants are becoming evident. In the bottom of the river and some tributaries lie leftovers of past pollution.

Should the River Run Clear?

Was the pristine river on which Hudson sailed transparent? The record of his voyage doesn’t say, but the river probably looked muddy in 1609, as it does now. Murky conditions are common even in healthy estuaries. Sediment eroded in the watershed washes into estuaries. Tidal currents rush back and forth, stirring up mud. Salt water pushing in from the ocean traps and suspends sediment. An abundance of algae and other tiny organisms can color and cloud the water. The Hudson may look brown or green, but that does not mean it is unhealthy. Even clear water may not be clean; bacteria and other organisms that cause disease are invisible. These microorganisms are usually associated with untreated sewage.

Can I Swim in the Hudson?

As cities grew along the Hudson, their sewage discharges increased, especially at New York City and Albany. In 1965, New York State voters passed a billion dollar Pure Waters Bond Act to fund sewage treatment. In 1972, the federal Clean Water Act made cleanup a national priority, providing billions more, and the Hudson benefited. Off Manhattan, 150 million gallons of raw sewage had entered the river daily until 1986, when the North River sewage treatment plant began operating. Afterward, bacteria concentrations dropped significantly.

Does this mean you can dive into the Hudson on a hot summer day? Generally, yes (see map). However, official swimming beaches are scarce. At other sites, debris, tidal currents and boat traffic pose dangers. Near Albany, swimming in the Hudson was not foreseen when sewage plants were constructed. Thus they do not disinfect their discharges, raising the risk of disease. In New York and other cities, rainfall enters storm drains and then flows to sewage treatment plants. Added to sewage, the total volume may exceed plant capacities, causing overflows of untreated or poorly treated waste into the Hudson.

Can Fish Survive?

In recent decades, conditions have improved for fish and other river creatures. Before cleanup, sewage and other organic wastes—tannery and paper mill discharges, for example—fed bacteria, increasing their populations. High bacteria populations consume dissolved oxygen that fish need to breathe. Near Albany in summer, 1970, a study found so little dissolved oxygen that the few fish seen were “swimming slowly at the surface, gulping air, and disturbing an oil film which covered the water surface.” After treatment plants came online, 3,314 fish representing 27 species were collected there in the summer of 1973. In addition to requiring sewage treatment, the Clean Water Act limited discharges from factory waste pipes. In the years following the law’s passage, pollutants gradually came into compliance. The Hudson’s color at Tarrytown once matched the paint applied to vehicles at a General Motors plant there; now such scenes are unthinkable.

Today, pollution in runoff is the bigger problem. Rain sweeps automotive fluids and trash from parking lots into the nearest storm drains and eventually the river. Fertilizers, pesticides and animal wastes wash off lawns and farm fields. Soil left bare by construction erodes into streams. Controlling this pollution requires diverse and coordinated efforts by all levels of government and by private citizens.

For much of the Hudson, New York State’s Health Department recommends that children and women of child-bearing age eat no fish and advises other people to limit their fish consumption.

Levels of PCBs have declined since discharges ceased in 1977, but concentrations in fish, birds and mammals remain high enough to affect survival, growth and reproduction. The risks to wildlife and people who eat contaminated fish led the U.S. Environmental Protection Agency to require a cleanup in the Hudson north of Troy. Removal of PCB-laden sediments, beginning this year, should reduce PCB levels in river food chains. Large amounts of persistent contaminants such as PCBs also end up in New York Harbor sediments, creating problems for shipping. The operation of the Port of New York and New Jersey, which generates billions of dollars of economic activity and supports more than 228,900 jobs, requires dredging to deepen channels and berths. Disposal of dredged sediment becomes very costly when it is contaminated.

Looking Ahead

More cleanups are necessary to deal with existing contamination but will not completely eliminate the problem. Having a cleaner river in the future requires prevention—keeping toxic chemicals out of the estuary. Strategies for doing this include altering manufacturing processes, redesigning products, improving industrial maintenance and housekeeping and reusing and recycling potential pollutants. Unfortunately, researchers are finding worrisome new contaminants in the river, among them antibiotics and hormones from birth control pills. Scientists are just beginning to look at how these substances affect fish and public health. In addition, regulations must be updated to deal with potential impacts of new chemicals now in common use.

Finally, our sewage treatment infrastructure needs attention. Plants built in the 1970s are nearing the end of their design life, while population growth stresses their capacity. Statewide, over the next 20 years, an investment of $36 billion will be needed to maintain water quality.
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Sewage treatment has reduced annual fecal coliform levels which indicate bacterial contamination that makes swimming risky—have declined, and levels of dissolved oxygen—which fish need to breathe—have risen.

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Toxic Leftovers

While there has been progress in reducing discharges, a legacy of past pollution remains in the estuary’s sediments. Most infamous are polychlorinated biphenyls (PCBs), mainly from General Electric plants in Washington County. These toxic chemicals move through food chains and concentrate in fish at levels much higher than are found in the water. Swallowing a few mouthfuls of river water does not significantly expose a person to these pollutants, but regularly eating fish may.

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Humans have profoundly altered many Hudson wetland habitats. Still, given the scale of human impacts over time, it is virtually impossible for the variety and extent of the estuary’s natural habitats to ever again match what Hudson and his crew saw 400 years ago.

Beginning in the mid-1800s as engineers created a single, deep shipping channel through a complex of islands, shallows, and wetlands, between Catskill and Albany, nearly one third of the river has been filled in, starting in the mid-1800s as engineers created a single, deep shipping channel through a complex of islands, shallows, and wetlands.

In many places, bulkheads and piles of boulders called riprap have replaced the river’s natural shoreline. Riprap is common along the roadways that line the river’s banks. The construction of these tracks under the Clean Water Act has slowed the pace of wetlands loss. In 1985 the last major proposal (to fill in 200 acres of shallows for an interstate highway on Manhattan’s West Side) was blocked in large part by concern over destruction of habitat critical to the Hudson’s health in recent decades, riverfront lands have become desirable sites for development and for facilities that promote river access. Along with assessing the traffic, density and other impacts of such projects, officials should look at their effect on habitats in the adjacent river. These might include stormwater runoff from development, shade cast by docks and piers or disturbance to plant beds caused by boat propellers. As people are attracted to a cleaner river, it is important to develop in ways that conserve river resources.

A habitat is the environmental setting in which a given organism or a community of interacting organisms is found. Many factors shape habitats—depth, tides, bottom type, exposure to ice and waves and salinity, to name a few. The specific plant and animal communities of each habitat play a variety of ecological roles, such as contributing energy to food chains, producing oxygen or sheltering fish and other creatures.

### Changing the Shape of the River

Biologically, the Hudson’s shallow water habitats are especially significant. The river’s marshes, fertilized by nutrients swept in on the tides, are as productive as high-yielding corn fields. They provide little shelter for river creatures and often host different types of fish from unaltered shorelines. Sheds provide shelter for fish.

The Hudson’s tidal marshes support species that have adapted to the constantly-changing tide conditions and provide critical breeding sites for birds and mammals. They also benefit human communities by buffering damage from storms and floods, maintaining valuable fish stocks and offering recreation.

Mapping Habitat in Haverstraw Bay

New technology provides scientists with detailed information on the exact location and form of estuarine habitats, informing conservation efforts. For example, in comparing maps of depth and sediment type to survey and tracking data for juvenile Atlantic sturgeon, biologists found that these fish prefer deeper areas with soft, muddy bottoms. This information will help to refine sampling and identify underwater areas that are critical sturgeon habitat.

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### People have physically altered the river so that it will never again be what it was in Hudson’s time. Just south of Albany, engineers diked and dredged to cut a wide and deep main channel (dark blue) for navigation. These changes eliminated large areas of shallow water habitat. (Light blue). New land was created where dredged sediments were deposited.

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Researchers are using these new data about the river bottom and aquatic plant beds to improve understanding of the roles these habitats play in the estuary. The scientists’ insights will help those who manage the Hudson’s natural resources make better informed decisions to protect this ecosystem.

### The Challenges Ahead

Some of the most important decisions about conserving river habitats concern the impacts of climate change. As water levels in the Hudson go up with rising sea levels, plants of shallow water habitats may wind up in deeper water unfavorable to their growth. The plant communities could survive by moving landward into shallower water or newly flooded land. If space is set aside to accommodate that migration, such buffers might also help to protect human communities from flooding. However, in many cases that option is limited by the presence of buildings and other structures, steep natural riverbanks, and shores lined with piers or rexpand.

With the general improvement in the Hudson’s health in recent decades, riverfront lands have become desirable sites for development and for facilities that promote river access. Along with assessing the traffic, density and other impacts of such projects, officials should look at their effect on habitats in the adjacent river. These might include stormwater runoff from development, shade cast by docks and piers or disturbance to plant beds caused by boat propellers. As people are attracted to a cleaner river, it is important to develop in ways that conserve river resources.
ARE THE HUDSON'S HABITATS HEALTHY?

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Biologically, the Hudson’s shallow water habitats are especially significant. The Hudson’s marshes, fertilized by nutrients swept in on the tides, are as productive as high-yielding corn fields. They are critical breeding sites for birds and mammals. Marshes benefit human communities too, buff ering damage from storms and floods, maintaining valuable fish stocks and offering recreation. Beds of submerged aquatic plants, rooted in the shallows where sunlight can reach them, also contribute to the estuary’s food webs. In addition, these beds produce dissolved oxygen, provide spawning areas and serve as nurseries for young fish.

Humans have profoundly altered many Hudson River habitats. Approximately 25 percent of Manhattan’s land area used to be tidal wetland and shallow water habitat. Overall, New York Harbor has lost nearly 300,000 acres of such habitat to landfill and dredging since European settlement began. Between Catskill and Albany, nearly one third of the river has been filled in, starting in the mid-1800s greatly altered habitat, burying wetlands and cutting bays and coves off from the river. These bays and coves silted in and became new marshes and other wetland habitats.

Few of these habitats can be restored, so protecting what exists is a priority. A permitting system established under the Clean Water Act has slowed the pace of wetlands loss. In 1985 the last major proposal (to fill in 200 acres of shallows for an interstate highway on Manhattan’s West Side) was blocked in large part by concern over destruction of habitat critical...
During a visit to the Hudson’s shores, one might see eagles soaring overhead, herons fishing along the shore, fish jumping and plants growing in the shallows. This is just a hint of the estuary’s biological diversity.

A Web of Life
A scoop of Hudson River water may contain millions of tiny, free-floating living things. Those that use sunlight to produce the food energy they need—algae, for example—are called phytoplankton. They, in turn, feed insects, crustaceans and other small creatures.

Rooted plants growing below the surface host an array of invertebrate animals, which attract wildlife and fish. The plants also help to maintain water quality by consuming excess nutrients and increasing oxygen levels in the river.

Invertebrates rank first in abundance and variety among the Hudson’s creatures. Mollusks, worms, insects, crabs, shrimps and other invertebrates have important roles in the ecosystem. Many of them subsist on living plants or their decaying remains and pass the energy available from these sources on to fish and other predators.

Fish Stories
More than 200 species of fish call the Hudson ecosystem home for some or all of their lives. Archeological evidence shows that the river’s fish have fed humans for thousands of years. American shad were a popular food through 1945; shad roe remains a delicacy today.

The numbers of fish in the Hudson fluctuate naturally and in response to human activity. Loss of habitat, overfishing and water intakes at power plants have taken a toll. Improvements in water quality have had a positive impact, as have conservation initiatives. Thanks to a fishing moratorium, Atlantic striped bass numbers—which plunged in the 1990s due to overfishing—now seem to be stabilizing.

Managing the Hudson fishery is complicated because many of its signature fish are migratory. American shad, striped bass and Atlantic sturgeon spend most of their lives at sea, moving along the Atlantic coast. Protecting them requires cooperation among many states. Coordinated management of striped bass fisheries led to recovery of striped bass populations along the coast and an increase in the Hudson’s spawning stock in the early 1990s. Striped bass numbers remain high today. However, American shad populations—fairly robust in the 1980s—have declined to historically low levels. Development of a shad recovery plan is a priority for New York fisheries managers.

Birds of the Estuary
Birds are a popular barometer of ecological health. Improved environmental quality has benefited a number of the Hudson’s bird species over the past twenty years. Bald eagle and peregrine falcon populations along the Hudson declined drastically in the 1950s and 1960s. Thanks to a ban on DDT use and release of young birds in suitable nesting sites, these raptors have returned to the estuary. Numbers of wintering bald eagles grew starting in the 1980s. In 1997, The New York Times announced the birth of the first bald eagle along the Hudson in a century. In 2008, 31 young eagles fledged from nests along the estuary. Since 2003, peregrines have been nesting on the river’s bridges from Albany south, as well as on skyscrapers and bridges in New York City.

During the late 1970s, long absent colonies of herons, egrets and ibises appeared on small abandoned islands in New York Harbor. In 1991, New York City established the Harbor Herons Wildlife Refuge to protect and manage these sites. More than 1,800 nests were counted in 2007.

Some fish-eating birds have responded dramatically to environmental improvements. Snowy egrets are among several heron species that have returned to nest on islands around New York Harbor. Improving water quality has increased the availability of fish and other food that egrets need to raise their young.
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During the late 1970s, long absent colonies of herons, egrets and Ibises appeared on small abandoned islands in New York Harbor. In 1991, New York City established the Harbor Herons Wildlife Refuge to protect and manage these sites. More than 1,800 nests were counted in 2007. Some alien species become “invasive,” causing undesirable ecological or economic impacts. Zebra mussels feed by filtering river water. In the process, they have reduced phytoplankton populations by 80 percent in the freshwater portion of the estuary. The Hudson’s native pearly mussels are being starved out, unable to filter water as efficiently as these invaders. Zebra mussels also clog water intakes; they have caused hundreds of millions of dollars in economic damage to industrial operations and boating since their arrival in North America in 1985.

We can expect more alien invaders in coming years. Studies show that about seven new species arrive in the freshwater Hudson per decade, of which one is likely to have damaging ecological impacts.

Conserving Species in Coming Years

Conserving fish and wildlife requires plans for individual species like the American shad, but broader measures can help too. For example, we must protect habitat like the wetlands where New York Harbor herons find their food for young. Maintaining water quality and addressing toxic contamination is also necessary. It is expected that PCB cleanup will reduce levels of these chemicals in wildlife, especially raptors and fish-eating mammals like mink, and in anglers who take river fish home to eat. Because invasives are difficult and expensive to control once established, preventing their arrival is key. Education and regulatory measures for that purpose need to be strengthened.

Eagles and egrets are up, shad and sturgeon are down, and alien invaders are here to stay. We must protect habitat, adopt stringent conservation measures and prevent the establishment of other invasive species.
These streams support fish and wildlife and provide water supplies and recreation for people, but they have suffered from sewage pollution, toxic discharges and habitat alteration. Along with changes in flow conditions, these impacts have reduced native fish diversity. However, tributaries once in sorry shape, like Albany’s Patroon Creek, now boast better water quality thanks to anti-pollution laws.

Critical Habitat

Tributaries provide essential habitat for migratory fish. In spring, herring enter the Hudson from the Atlantic Ocean and continue into these streams to spawn. Tiny glass eels—an early life stage of the American eel—also migrate from the ocean into Hudson River tributaries. Here they grow to adulthood, some spending over 20 years in fresh water before returning to the sea to lay their eggs. Some of the estuary’s freshwater fish make short spawning runs into the tributaries, among them the smallmouth bass. Others, notably the large-mouth bass, move into the tidal mouths of larger tributaries for the winter.

Once abundant, herring and eel populations are declining. Largemouth bass numbers also appear to be lower than they were in the 1960s. The reasons for these declines are unclear. However, protecting stream habitat is critical to sustaining these fish.

Many animals depend on both streams and the lands that border them—the riparian zone. Adult northern red salamanders and wood turtles, for example, annually move between streams and adjoining lands. Brook trout, New York State’s official freshwater fish, require cold, clear water maintained in part by trees in the riparian zone. Their leaves provide shade that cools streams, while their roots stabilize banks and reduce erosion of water-clouding sediment.

Blocking the Road to Recovery?

Dams and other blockages in streams are a problem for fish and wildlife. Many species must move up and downstream to find feeding and spawning areas suitable temperature and oxygen levels, while other species—such as lawn grasses—may be impacted by invasive species, such as Japanese knotweed, that are not good buffer species.

Dams can prevent fish from moving among the variety of stream habitats they need to survive. Brook trout may swim downstream when a stream is high and cold in spring but retreat to cooler headwaters in hot summer weather. Dam removal projects are ongoing across the region.

Tributaries transport carbon, nitrogen, phosphorus and other biologically vital substances to the Hudson. Most of the food energy available to the estuary between Newburgh and Troy comes from the decaying remains of leaves and other organic material that tributaries bring from the watershed. Their waters also carry problematic substances—sediment from cropland and construction sites and pesticides and excess fertilizer from farms and lawns.

From Westchester to Troy, blue and white sturgeon marks highway crossings of Hudson River tributaries. Sturgeon are not necessarily present at these locations; rather, the signs signify that these streams contribute to the well-being of sturgeon and other creatures in the Hudson.

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Signs like this appear along the Hudson’s tributaries as a reminder that protecting water quality in these streams is key to preserving the estuary’s health.

Brook trout are very sensitive to rising water temperatures and increased sediment in streams they inhabit. Such changes are often associated with deforestation and urbanization.

Wood turtles have large home ranges that include streams and adjacent forests or meadows. Habitat loss in riparian zones is a major threat to this declining species.

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Blocking the Road to Recovery?

Dams and other blockages in streams are a problem for fish and wildlife. Many species must move up and downstream to find feeding and spawning areas suitable temperature and oxygen levels.

Dams are the most obvious barriers, but culverts and poorly designed road crossings can also be problematic. The flow of water from a culvert perched a few feet above a pool may not allow brook trout to make the leap necessary to reach the headwaters.

In Orange County’s Moodna Creek watershed, aerial surveys revealed 204 dams. Including other types of obstacles like perched culverts the surveys found over 1,000 possible barriers in this watershed alone. Many no longer serve any practical purpose and could be removed. Among those that meet a real need, some might be replaced or modified—fish ladders, for example—to reduce environmental impacts.

Absorbing Environmental Impacts—Streamside Buffers and Floodplains

While we tend to look upstream and downstream for factors that impact streams and the organisms they support, the adjoining watershed and riparian zone are also crucial to these ecosystems. For example, the Louisiana waterthrush, a songbird, requires a ribbon of flowing water and a forested corridor at least 300 feet wide to provide optimal feeding and nesting habitat.

Native trees, shrubs and grasses growing along streams act as a buffer to protect water quality. This vegetation filters and slows runoff, prevents soil and bank erosion and shades water, keeping temperatures low. However, plants with weak root systems—such as lawn grasses—may be impacted by invasive species, such as Japanese knotweed, that are not good buffer species.

Floodplains protect human communities. As high water spreads on floodplains, its speed and rate of rise slows, reducing flood damage. Intense rainfall and severe floods are expected to become more frequent due to climate change. Keeping development out of floodplains will minimize loss of lives and property.

Stormwater Runoff

In undisturbed watersheds, rain soaks into soil and is stored as groundwater that seeps slowly and steadily into streams. In the Hudson’s watershed, new buildings, highways and parking lots cover land with surfaces that prevent water from entering the ground. Instead, it runs into streams as stormwater from downspouts, driveways and catch basins, carrying trash, oil, pet wastes, road salt and other pollutants with it.

Stormwater’s sheer volume can erode banks and sweep away aquatic animals or smother them with mud. These creatures are further stressed as stream flows diminish from flood to trickle. And when rain runs off instead of soaking into soil, there is less groundwater to recharge streams in dry weather. These impacts become apparent when impervious surfaces cover about 10 percent of a watershed.

Looking Around the Bend

In recent decades, pollution-control efforts have helped tributaries with poor water quality. However, the accumulating small impacts of land-use changes—stormwater from a new mall here, a riparian woodland cut down for houses there, salt spread on new roads nearby—are harming water quality in streams once in excellent shape.

Halting this decline depends on decisions made in hundreds of towns and cities throughout the Hudson’s watershed, choosing development options that protect stream health as well as property and quality of life in these municipalities.

Since 1972 we have cleaned up the most degraded tributaries, but now healthy streams are stressed by runoff and the pollutants it carries, while floodplain development and dams compromise stream habitat. Further improvements will depend on decisions made by hundreds of communities and thousands of landowners.
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Population Growth and Sprawl

Geology and climate shaped human settlement patterns as well as the evolution of ecosystems in the Hudson Valley. Now human settlement shapes the landscape and its health.

Except during the Great Depression, census figures show that the Hudson Valley’s population has grown continuously for at least 200 years. Early population growth was greatest in the metropolis around New York Harbor. Farther north along the Hudson, small cities flourished to take advantage of river transportation and commerce.

Now the region is one of the nation’s most densely populated areas. Development patterns have changed; most growth occurs outside traditional city centers. In Albany, Kingston and Hudson, population has decreased since 1990 while increasing in the valley overall. At the same time, the land area covered by suburban development is increasing more than three times faster than population is growing.

Often called sprawl, this type of land-hungry development covers the soil, reduces recharge of groundwater, raises the likelihood of flooding and increases runoff that carries pollutants to local streams and the Hudson. This settlement pattern also separates housing from workplaces and stores, demanding more driving that leads to greater fuel consumption and air pollution while discouraging community interaction.

Sprawl also threatens the Hudson Valley’s regional identity. Traditional land uses such as agriculture and forestry and the presence of “wild” and scenic open spaces have long been recognized as important components of this landscape. While preserves and parks offer some protection, over 80 percent of the region’s land is privately owned. Conserving the landscape, its ecosystems, scenic vistas and traditional ways of life requires cooperation from many different organizations and individuals. And given local control of land use, hundreds of municipalities must be involved in the process.

Clearing the Air

Drifting down from the atmosphere is another threat to the health of the Hudson’s watershed. Tailpipes, smokestacks and agricultural operations spew pollutants into the atmosphere, eventually to drift to the ground or fall with precipitation. This atmospheric deposition is particularly troublesome given its wide reach and impacts on landscapes otherwise protected by law or by their remoteness. Being downwind from large industrial and urban pollution sources outside the watershed, the Hudson Valley is especially at risk.

Mercury is one of the chief concerns. This toxic metal comes mainly from coal-fueled power plants and cement factories. Current levels of mercury deposition are four to six times higher than in 1900. Many water bodies in the Hudson’s watershed are subject to advisories that people limit or avoid consumption of fish due to mercury contamination. Bald eagles in the Catskills do eat fish, and have especially high levels of mercury.

The Hudson River is the centerpiece of a landscape stretching from the Adirondack Mountains to New York Harbor. Ecologically, this landscape is the Hudson’s watershed—the area of land from which water runs into the river. Historically, it shaped Revolutionary War strategy and linked the port of New York to the Great Lakes via the Mohawk Valley and Erie Canal. Culturally, this setting inspired artists who made its scenery world famous and nurtured the idea that such beauty should be preserved.

Our Natural Heritage

The Hudson Valley’s varied topography—the Walkill River’s flat floodplains, Westchester’s steep hills and valleys, the Catskills’ peaks—was shaped by geological events hundreds of millions of years before the Half Moon’s visit. Glaciers further sculpted the landscape tens of thousands of years ago, establishing the Hudson’s present course.

This landscape’s rich and varied natural heritage provided resources essential to early settlement and economic growth—fertile farmland, wild game to eat and wood for energy and construction. As settlements expanded, healthy natural areas continued to play critical roles in protecting water supplies, public health, outdoor recreation and scenery—roles they still play today.

New York has long recognized the importance of preserving natural landscapes. Over 100 years ago, the state created the Catskill Forest Preserve, an action that benefits millions of residents to this day. The water in New York City’s Catskill reservoirs is filtered by the forests and streams of these watershed lands. By maintaining the ecological health of this landscape, the city avoids spending billions on a giant filtration plant.

Cluster development (top) is one example of smart growth. As an alternative to more traditional sprawling development (bottom), clustered lots provide an equal number of houses while reducing impacts on habitat. Stream corridors are protected, and a large portion of the property is set aside as a natural area or for farming. Clustering also reduces road construction cost.

The Hudson is one of the world’s most beloved rivers, famous for its scenic beauty. Frederic Edwin Church, one of the best-known artists of the Hudson River School, made many landscape paintings of the world-famous scenery visible from Olana, his home south of the city of Hudson.

Frederic Edwin Church, Catskill Mountains from the Home of the Artist, 1871, oil on canvas, 22 1/8 x 36 1/8 in., OL.1981.13 Courtesy of Olana State Historic Site, New York State Office of Parks, Recreation and Historic Preservation.

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Shaping the Future

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Greenway Connections, Dutchess County Department of Planning and Development.
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Sprawl also threatens the Hudson Valley’s regional identity. Traditional land uses such as agriculture and forestry and the presence of “wild” and scenic open spaces have long been recognized as important components of this landscape. While preserves and parks offer some protection, over 80 percent of the region’s land is privately owned. Conserving the landscape, its ecosystems, scenic vistas and traditional ways of life requires cooperation from many different organizations and individuals. And given local control of land use, hundreds of municipalities must be involved in the process.

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Shaping the Future

The range of issues covered above demonstrates the connections between communities within the Hudson’s watershed and beyond its borders. We must recognize connectivity and take action at the appropriate level. Addressing sprawl requires local measures; curbing airborne contaminants requires national emission-reduction plans.

The Hudson Valley’s celebrated scenery and the strong sense of regional identity built around its landscape are at great risk. In response, many towns and cities now use smart-growth planning to direct growth into higher-density urban centers and clustered developments that consume less open space. They are revising laws and codes to reduce the amount of pavement and other impervious surfaces—promoting green roofs and rain gardens for instance. These efforts will help maintain the region’s diverse economic base and quality of life, as well as its scenery and unique character.
Our varied landscape supports a corresponding diversity of natural communities, each with a unique suite of plants, animals and other organ-
isms. Woodland dominates; well over half of the Hudson’s watershed is forested. A close look reveals many kinds of forests, including a
spruce-fir community atop the Catskills, a pitch-
pine community near Albany and a hickory-northern hardwood community high in eastern Rensselaer County. Similar variety occurs within
the region’s grasslands, wetlands and other natural communities.

A<div class="image"></div> LIVING LANDSCAPE

In 1609, the Hudson’s watershed was almost entirely tree covered, though Native Americans’ cleared woodlands to plant crops, improve hunt-
ing and create small settlements. The forested
wilderness was daunting to European settlers; it
was inhabited by large predators and difficult to
clear and farm.

But clear they did. At its peak in the 1800s, farming
covered nearly 70 percent of the landscape. To a
large degree, this pastoral landscape represented an
exchange of ecosystem types—grassland re-
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Diversity of Life

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amazing variety of life. The region is home to
more than 2,000 different kinds of plants, birds, mam-
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tant species of invertebrates, fungi and bacteria.

Biological diversity or biodiversity is the term used
to describe this variety of life. It applies to species,
the range of habitats and ecosystems that they
inhabit and their interactions with each other and
their surroundings. Ecosystems with high biodiversity tend to be
resilient. They persist over time and sustain ecological services
that benefit humans: cleaning air and water, breaking down
organic matter and providing plant pollination.

Though resilient, ecosystems with high biodiversity can be
damaged when urbanization fragments habitat, new inva-
sive species arrive and climate changes. These forces reduce
our rich heritage of native species. In this region, more than 150 native species are endangered,
threatened or of special concern.

Dividing Landscapes and Altering Habitats

The accelerating pace of suburbanization after
1950 resulted in increased loss of habitat, espe-
cially wetlands and grasslands. The mid-1900s to
mid-1990s saw an estimated net loss of 2,891
acres of freshwater wetlands in the Hudson
Valley. Grassland acreage also declined, as did nesting
populations of the eastern meadowlark and other
grassland birds.

A subterfuge of suburban sprawl is fragmenta-
tion of habitats into smaller isolated patches, affecting
animals that need extensive tracts of
one habitat type. The scarlet tanager is one of
many birds whose numbers may be declining with
fragmentation of large forests. Fragmentation
also severs links between different habitats that
animals need to complete their life cycles. The
marbled salamander, for example, spends much
of its life deep in the leaf litter of forests but must
migrate to woodland pools to breed. Buildings
and roads can block its journeys between these
two habitats.

Preventing fragmentation may have benefits
for humans as well as ecosystems. The rising preva-
lence of Lyme disease in the Hudson Valley
may be linked to forest fragmentation. Larger, healthy
forests support a highly diverse population of
small mammals. However, the adaptable white-
footed mouse, a prime host for the bacterium that
causes Lyme disease, often dominates in frag-
mented woodlands.

Some species thrive as the human imprint on the
land expands. Growing populations of Canada
goose and white-tailed deer have had major impacts on ecosystems and human communities.

Goose droppings can lead to bacterial contamina-
tion of ponds and reservoirs, while overabundant
deer can eat so many oak seedlings that oaks no
longer reproduce in some of the region’s forests.

Climate Change

Seasonal events—winter snows, spring fresh-
ets, warm summers, fall frosts—follow a familiar
though variable pattern year after year. Our
diverse plant and animal life has evolved around
these predictable patterns.

Now our climate is changing at an accelerat-
ing pace. During the last 30 years, the average
temperature in the Northeast has increased
by two degrees Fahrenheit. While this change may seem
minimal, current trends could alter the Hudson
Valley’s climate so that by 2070, it would match
what is found today between central Virginia
and southern parts of South Carolina. New York
is already seeing shorter, warmer winters with
less snow cover, earlier flowering of plants, more
intense rainstorms, rising sea level and elevated
carbon dioxide concentrations that allow some
invasive and nuisance plants to thrive.

Extensive, healthy, natural ecosystems may be
resilient enough to cope with climate change for
some time. But ultimately, their plants and
animals may need to establish viable populations
in other areas. To preserve biodiversity, adequate
open space must be available to allow such shifts.

This should include connections—wildlife cor-
rors, for example—through which species can
move to suitable habitats.

Coping with Change

People are beginning to address sprawl and adopt
measures to sustain biodiversity such as master
plans that direct development away from sensi-
tive habitats. More than 40 Hudson Valley com-
munities now have detailed maps of ecologically
significant habitats to aid in protecting plants and
animals.

Officials are also considering climate change and
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Measures might include limiting new develop-
ment in floodplains and encouraging tree plant-
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During the last 20 years, the Carolina wren’s
breeding range has expanded northward. According to The Second Atlas of Breeding Birds in
New York State, this may be due in part to patterns
of climate change. This data came from more than 1,400 volunteer ornithologists participating in the
New York State Breeding Bird Survey project.

Climate change is taking place in the Hudson Valley.

Winter low temperatures fluctuate greatly from year
to year, but looking back for a century, the long-term trend clearly shows warming. Overall this is part
of a pattern of change that will affect local farmers and winter recreation and force some species to move out
of our area while enabling new species to move in.
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Though resilient, ecosystems with high biodiversity can be damaged when urbanization fragments habitat, new invasive species arrive and climate changes. These forces reduce our rich heritage of native species. In this region, more than 150 native species are endangered, threatened or of special concern.

In 1609, the Hudson’s watershed was almost entirely tree covered, though Native Americans cleared woodlands to plant crops, improve hunting and create small settlements. The forested wilderness was daunting to European settlers; it was inhabited by large predators and difficult to clear and farm.

But clear they did. At its peak in the 1800s, farming covered nearly 70 percent of the landscape. To a large degree, this pastoral landscape represented an exchange of ecosystem types—grassland replaced forest, and meadowlarks took flight where cougars, wolves and bears once roamed. By the early 1900s, the trend of clearing land reversed. Farms were abandoned as soils became less fertile, and industry offered other employment. Within much of the Hudson Valley, the decline in small-scale farming resulted in an exchange of ecosystems, with forest reclaiming former range. This was not the same forest that existed before European settlement. It lacked old growth, and its once abundant American chestnuts fell victim to a fungus introduced from Asia. But by the late 1900s, bears had returned.

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**Ongoing threats to the Hudson Valley’s biological diversity include climate change and sprawl that fragment habitat, promotes the spread of pests, and disrupts natural processes sustaining people and wildlife. It is crucial that more municipalities and landowners adopt new patterns of development.**

Climate Change

Events—winter snows, spring freshets, warm summers, fall frosts—follow a familiar though variable pattern year after year. Our diverse plant and animal life has evolved around these predictable patterns. Now our climate is changing at an accelerating pace. During the last 30 years, the average temperature in the Northeast has increased two degrees Fahrenheit. While this change may seem minimal, current trends could alter the Hudson Valley’s climate so that by 2070, it would match what is found today between central Virginia and southern parts of South Carolina. New York is already seeing shorter, warmer winters with less snow cover, earlier flowering of plants, more intense rainstorms, rising sea level and elevated carbon dioxide concentrations that allow some invasive and nuisance plants to thrive.

Extensive, healthy, natural ecosystems may be resilient enough to cope with climate change for some time. But ultimately, their plants and animals may need to establish viable populations in other areas. To preserve biodiversity, adequate open space must be available to allow such shifts. This should include connections—wildlife corridors, for example—through which species can move to suitable habitats.

Coping with Change

People are beginning to address sprawl and adopt measures to sustain biodiversity such as master plans that direct development away from sensitive habitats. More than 40 Hudson Valley communities now have detailed maps of ecologically significant habitats to aid in protecting plants and animals.

Officials are also considering climate change and how cities and towns can adapt to its impacts. Measures might include limiting development in floodplains and encouraging tree planting, especially along waterways, to increase shading and to absorb carbon dioxide. To reduce emissions responsible for climate change, communities can make municipal buildings and operations more energy efficient and purchase energy from renewable sources.

**During the last 20 years, the Carolina wren’s breeding range has expanded northward. According to the Second Atlas of Breeding Birds in New York State, this may be due in part to patterns of climate change. This data came from more than 1,400 volunteer birders participating in the New York State Breeding Bird Atlas project.**
A POSITIVE TREND – CITIZEN PARTICIPATION

How is the Hudson doing? There is no simple answer. Water quality is not as good as it was when the Half Moon sailed up the river 400 years ago, but it has improved greatly over the lifetimes of Hudson Valley residents born 40 years ago. The American shad is in trouble, but bald eagle numbers are increasing. The Hudson offers plenty of fish to anglers, but PCB contamination makes eating these fish risky.

One trend promises future improvements in the Hudson's health—growing numbers of concerned citizens, organizations and institutions are participating in efforts to address river concerns. Students, kayakers, amateur naturalists and planning board members have become personally committed to taking action to solve problems. Citizen science and volunteer projects are on the rise. The following are just a few examples from the many initiatives underway.

How you can help the Hudson

• Participate in a clean-up day. Active watershed associations often need volunteers to help remove the debris that accumulates in rivers and along their banks.

• Don’t plant invasive or potentially invasive species. Some may still be available in nurseries—Japanese barberry, autumn olive, oriental bittersweet and Japanese honeysuckle to name a few. Burning bush may also be invasive.

• Talk to your local officials about your concern for clean water and open space. A few persistent citizens can motivate local officials to do a better job of protecting natural resources.

• Come down to the Hudson and enjoy it firsthand. Celebrate progress in cleaning it up! Be inspired to do what’s needed to sustain that progress.

For more tips, visit DEC’s Make a Difference webpage www.dec.ny.gov/public/337.html

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Growing numbers of citizens, organizations and institutions are taking action to improve the health of the Hudson and its watershed and to build knowledge of this ecosystem.

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Placing stream buffers: Community groups are planting young trees along Hudson River tributaries. These plantings will grow into buffers that help protect water quality in those streams.

Tracking stream health: Organized by groups like Hudson Basin River Watch, citizens are keeping track of water quality in streams throughout the Hudson’s watershed. Their work can pinpoint problems that need to be addressed.

American eel surveys: In Poughkeepsie, high school students collect data on glass eels—young American eels freshly arrived from the ocean. With eels in decline, information about their presence in Hudson tributaries is important for developing strategies for recovery.
ACKNOWLEDGEMENTS

The State of the Hudson 2009 was produced by the Hudson River Estuary Program of the New York State Department of Environmental Conservation, in partnership with the New York State Water Resources Institute at Cornell University and the New England Interstate Water Pollution Control Commission. It was written by Steve Stanne, Elizabeth Roessler and Kristin Marcell and designed by Bob DeVilleneuve. Except as noted, all maps were prepared by Clare Dunn and Lana Lau. Preparation of the report was greatly assisted by DEC’s Division of Public Affairs, the Hudson River Estuary Management Advisory Committee and Hudson River Estuary Coordinator Frances Dunwell and her staff at the Estuary Program. Thanks to Commissioner Pete Grannis and Assistant Commissioner Jim Tierney for their leadership in accomplishing the program’s goals.

For more information on subjects covered, please visit the Hudson River Estuary Program pages on DEC’s website at www.dec.ny.gov/lands/4920.html. A virtual tour, fact sheets, lesson plans and the Hudson River Estuary Action Agenda can be found there, as well as links to other programs and organizations working to improve the Hudson and tell its stories. The Hudson River Estuary Program: Making a difference together for the river and valley we share.

Printed on FSC certified paper containing 100% post-consumer waste.
Cover art: Chance of Indian Summer by Andriano Manocchia