THE VALUE *of* Nature

massaudubon.org/valueofnature

#1 OF 5

Forests

Forests are the defining feature of New England's landscape. In Massachusetts, upland forest habitat can range from northern hardwoods like beech and maple, to softwoods like spruce and pitch pine.

Eastern moose

CLEAN AIR & WATER

FORESTS CLEAN THE AIR. Forests in New England remove an estimated 760,000 tons of pollutants every year that cause smog and ground-level ozone.[1]

FORESTS ARE NATURAL WATER FILTRATION SYSTEMS. Each forested acre that drains into a public water source filters 543,000 gallons of drinking water per year, meeting the needs of 19 people, with an annual value of $2,500 per acre.[2]

ECONOMIC & HEALTH

THANKS TO THEIR AIR FILTRATION FUNCTION, New England's forests provide health benefits like reductions in respiratory illness, asthma, and hospitalization valuing $550 million per year.[3]

$3B
GROSS OUTPUT OF MA FOREST PRODUCTS/YR[10]

Responsibly-sourced wood is a climate-friendly alternative to steel and concrete, and sourcing wood products locally reduces transportation emissions and supports local economies.[11]

CARBON CAPTURE & STORAGE

~7%
OF MASSACHUSETTS' ANNUAL CARBON EMISSIONS ARE ABSORBED BY OUR 3M ACRES OF FOREST,[4,5] AND THE AVERAGE ACRE STORES ABOUT 103 TONS OF CARBON.[6]

The healthier a forest is, the better it sequesters carbon,[7] and mature forests are particularly important for carbon storage.[8]

53,000
AUTOMOBILE TANKS OF GASOLINE contain the same amount of carbon as a 40-acre forest in New Hampshire stores.[9]

CLIMATE RESILIENCE

Massachusetts' forests are already home to

209
SPECIES OF THE GREATEST CONSERVATION NEED, INCLUDING THE WOOD THRUSH.[12]

Hermit thrush

20%
POTENTIAL DECREASE IN FLOOD HEIGHT IN TOWNS DOWNSTREAM BY STRATEGIC PLANTING OF TREES ON FLOODPLAINS.[13]

Protecting forested floodplains is critical for controlling erosion and buffering against flooding.[14]

KEY TERMS

Ecosystem Services: Nature provides countless benefits to people, along with intrinsic values. These components of nature are enjoyed, consumed, or used by humans to support our wellbeing.

Climate Resilience: The ability of a natural or human community to prepare for and respond to the impacts of climate change.

Mass Audubon

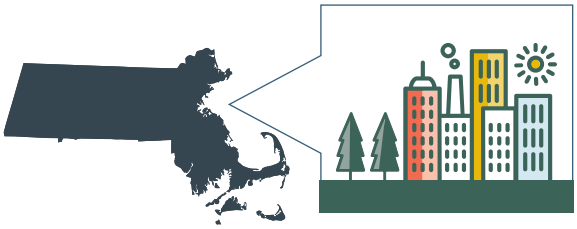
Forests

INDIGENOUS PEOPLES

One of the clearest examples of the cultural value of forests is within indigenous communities. Indigenous peoples have lived among the forests of Massachusetts and New England for thousands of years. They managed the forests for food, medicine, and ceremonial purposes, and some tribes have continued this tradition despite challenges brought on by colonialism and ongoing native land loss.

The indigenous value of forests can be incorporated into decision-making by involving tribal members in projects and plans that impact their traditional landscapes.[15]

URBAN FORESTS IN FOCUS



IN THE 15 COMMUNITIES OF METRO BOSTON ALONE, URBAN FORESTS:

- **Remove 1.75 million** pounds of air pollutants annually, worth $11 million.[17]
- **Store 962,000** tons of carbon, worth $125 million,[18] and capture an additional 23,000 tons of carbon per year, worth nearly $3 million.[19]
- Help those communities **avoid 527 million gallons** of stormwater runoff every year, worth $4.7 million.[20]

600K TONS OF CARBON

sequestered/year by northern New England's urban and community forests, a $38m value.[21]

RECREATION & TOURISM

$2.2B PER YEAR generated by Massachusetts' forest-based recreation economy, supporting 9,000 jobs.[16]

LET'S GET SOLAR OFF THE GROUND

A new form of development — large-scale, ground-mounted solar photovoltaic arrays — is converting thousands of acres of forest and farmland.[22]

Threats

Climate change and development are two of the biggest threats facing forests.

CLIMATE CHANGE

- **2.9°F RISE IN TEMP** since 1895
- **11" SEA LEVEL RISE** since 1922, as measured in Boston Harbor
- **55% STRONGER STORMS** since 1958[23, 24]

Rising temperatures, more rainfall and flooding, periods of drought, and pest outbreaks are all expected to stress trees.

DEVELOPMENT

The smaller fragments that remain after forest development are less viable for ecosystem services,[25] and this decreased connectivity limits species' ability to migrate as their ranges shift from climate change.

See our Losing Ground report and community planning resources for ways to reduce development impacts.

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THE VALUE *of* Nature

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#2 OF 5

Coasts

Massachusetts has the second-longest coastline in the eastern United States, including extensive beach and dune systems. Coastal habitats like salt marshes and estuaries are among the most productive ecosystems on earth.

Piping plover, left
Snowy egret, right

CLIMATE RESILIENCE

New England's coastal ecosystems provide a buffer against the ocean, reducing wave height and impact.[1] Opting for nature-based solutions when planning for climate change, like protecting and restoring coastal habitats, often saves money long-term.

16%

REDUCTION IN ANNUAL FLOOD LOSSES in the northeast due to salt marshes. The greater the extent of a wetland, the more protection it provides.[2]

89K

HOMES

in Massachusetts - totaling $63 billion in value - are threatened by high tide flooding primarily driven by climate change.[4]

$625M

SAVED IN FLOODING DAMAGES FROM HURRICANE SANDY BY COASTAL WETLANDS IN THE NORTHEASTERN U.S.[3]

COASTAL HABITATS IN MASSACHUSETTS ARE HOME TO

132 species

of the greatest conservation need, including saltmarsh sparrows and beach-nesting birds like the piping plover.[5]

CLEAN WATER

Coastal wetlands like sea-grass beds act as filters, removing nutrients from sediment and the water column.[6]

$18M

Potential increase in home values in coastal communities along the Narragansett Bay thanks to reductions in nutrient loads and improved water quality.[7]

ECONOMIC

COASTAL AREAS ARE AMONG THE MOST ECONOMICALLY VALUABLE AND ECOLOGICALLY PRODUCTIVE IN THE U.S.[8]

87K jobs in the seafood industry in Massachusetts in 2016, the second highest in the U.S., contributing $7.7 billion in sales, the third highest in the U.S.[9]

$403.1M

DECREASE IN HOME VALUES due to tidal flooding from sea level rise from 2005-2017 in MA, ME, NH, and RI, with Massachusetts coastal homes hit hardest.[10]

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Mass Audubon

Coastal

CARBON CAPTURE & STORAGE

Although the global area of vegetated coastal habitats is one to two orders of magnitude smaller than that of terrestrial forests, their contribution to long-term carbon sequestration is similar.[11]

10x greater

ANNUAL CARBON SEQUESTRATION RATE BY VEGETATED COASTAL ECOSYSTEMS IN THE WORLD (SALT MARSHES, MANGROVES, AND SEAGRASSES) THAN TERRESTRIAL FOREST SYSTEMS.[12]

Salt marshes are one of the most productive ecosystems in the world, sequestering millions of tons of carbon annually.[13] Rapid loss of blue carbon sinks like salt marshes could release large amounts of stored carbon into the atmosphere, further accelerating climate change.[14] Protecting coastal areas helps prevent this by leaving room for salt marsh migration.

RECREATION & TOURISM

$48/day
BEACH DAY

Estimated value (town fee revenue and consumer Willingness to Pay) for a New England beach without closure history from poor water quality – $22/day for a beach with closure history.[15]

81%

OF NEW ENGLAND RESIDENTS PARTICIPATE IN SOME FORM OF OCEAN RECREATION.[16]

$488M +

Annual value of direct spending on marine recreational boating in Massachusetts in 2012 – the second highest in the U.S. behind NY.[17]

COMMUNITY SPOTLIGHT

Through 2050, the Damde Meadows and Broad Meadows salt marsh restoration projects in Hingham and Quincy are projected to result in increased carbon burial equivalent to avoiding the combustion of over 800,000 gallons of gasoline.[18]

Threats

Climate change and development are two of the biggest threats facing coastal areas.

CLIMATE CHANGE

- **2.9°F RISE IN TEMP** since 1895
- **11" SEA LEVEL RISE** since 1922, as measured in Boston Harbor
- **55% STRONGER STORMS** since 1958[19, 20]

Sea level rise and stronger storms are flooding and eroding coastal and salt marsh habitat, and warmer water temperatures are disrupting food webs and the integrity of coastal ecosystems.

DEVELOPMENT

In the northeastern U.S., coastal communities face some of the greatest pressure from continuing development.

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#3 OF 5

Wetlands & Waterways

Wetlands are among the most productive ecosystems in the world, and they often feed into local streams and rivers, playing important roles in water quality, surface and groundwater supplies, and prevention of flooding. These ecosystems range from vernal pools to large rivers.

COMMUNITY SPOTLIGHT

Wetlands can be so effective at filtering water that they are engineered by humans to treat stormwater and protect water quality. The City of Cambridge created the Alewife Stormwater Wetland to relieve community flooding problems and enhance local water quality. This project was part of a $117 million investment in ongoing construction that will reduce annual sewer overflows by 43.6 million gallons.[1]

CLEAN WATER

$157 million

Annual filtration cost savings to New England communities provided by wetlands and forests combined[2] – see our *Forests* fact sheet for more on their benefits.

FOR EVERY $1 SPENT ON SOURCE WATER PROTECTION

$27

SAVED IN WATER TREATMENT COSTS.[3]

CARBON CAPTURE & STORAGE

20-30%

of global soil carbon is held by wetlands,[4] despite their occupying only 5-8% of global land surface.[5] Wetlands in the conterminous U.S. store the equivalent of four years of annual carbon emissions by the nation.[6]

CO_2

Wetlands of the Eastern Mountains and Upper Midwest (includes Massachusetts/New England) store the most carbon, accounting for nearly half of the carbon stored in wetlands in the U.S.[7]

Painted turtle

RECREATION & TOURISM

Wetlands and waterways support diverse food chains, which are important for commercial and recreational fishing.

33%

INCREASE IN MONTHLY BROOK TROUT MORTALITY in New England if stream flows continue to decrease at current rates.[8]

$100M Wages, salaries, business earnings, and tax revenues brought in by Massachusetts freshwater fisheries, thanks to an enormous quantity and variety of fishing opportunities.[9]

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Mass Audubon

Wetlands & Waterways

CLIMATE RESILIENCE

Wetlands function like sponges, storing water and slowly releasing it. This reduces flood heights and allows for groundwater recharge, which is important for resilience during periods of drought that have become more frequent amidst climate change.[10]

Over 1M

GALLONS OF WATER CAN BE STORED IN ONE ACRE OF WETLAND.[11]

$450K

The highest estimated annual value of flood mitigation services provided by Otter Creek wetlands and floodplains to Middlebury, VT. The wetlands and floodplains have reduced damage in this community by 54-78% across 10 past flooding events.[13]

COMMUNITY SPOTLIGHT

In 2006, the Charles River Natural Valley Storage area significantly reduced flooding to a 2-year flood event while nearby rivers were suffering 40 and 100-year flood events. The storage area cost $90 million less than alternative built infrastructure projects and has provided additional recreational opportunities. Mass Audubon's Broadmoor Wildlife Sanctuary is part of this natural open space network.[14]

265 SPECIES OF THE GREATEST CONSERVATION NEED,

including the wood turtle and blue-spotted salamander, make their homes in Massachusetts' freshwater wetland and waterway habitats.[12]

Blue-spotted salamander

ECONOMIC & HEALTH

75% return on investment, for every $1 million spent, generated by the average Massachusetts Division of Ecological Restoration project to restore wetlands and waterways.[15]

38%

The cost savings to restore three culverts so stream flow could occur naturally, rather than replacing the culverts with identical structures and maintaining them over 30 years, according to one study of water quality improvement methods.[16]

Threats

Climate change and development are two of the biggest threats facing wetlands and waterways.

CLIMATE CHANGE

2.9°F RISE IN TEMP since 1895

11" SEA LEVEL RISE since 1922, as measured in Boston Harbor

55% STRONGER STORMS since 1958[17, 18]

Coldwater fish species are at risk from increased water temperatures and droughts drying out streams, and lakes may become stagnant and develop algal blooms more frequently.

DEVELOPMENT

The development of upland areas, and the new stream crossings to access them, are fragmenting and degrading wetlands, and can add to excessive water withdrawals and existing water pollution.

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#4 OF 5

Grasslands & Farmlands

In Massachusetts, grasslands are created and maintained by natural or human-caused disturbances. Grasslands provide crucial habitat for wildlife, including pollinators like bees, butterflies and birds. Farms and gardens support local food production.

ECONOMIC & HEALTH

Community Gardens

help increase community cohesion, connecting people with nature and accessible, healthy food.[1] Additional benefits include their important role in stormwater management.[2]

POLLINATORS CONTRIBUTE

$24B

TO THE U.S. ECONOMY[3]

22-35%

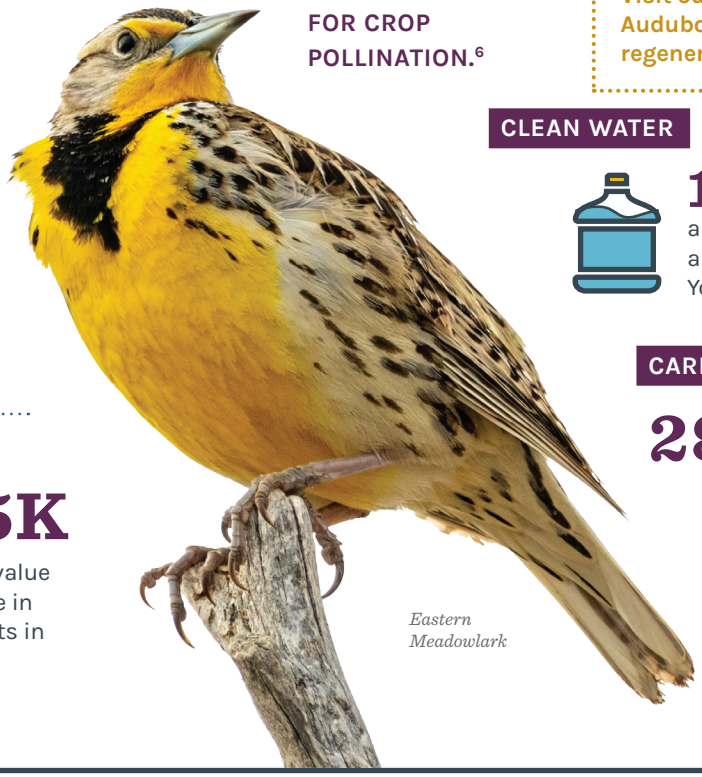
Profit increase from practicing organic farming instead of conventional, based on 40 years of studies covering 55 crops on five continents.[4]

$475K

Total market value for agriculture in Massachusetts in 2017.[5]

45%

OF OUR AGRICULTURAL COMMODITIES IN MASSACHUSETTS RELY ON THE RICH DIVERSITY OF POLLINATORS FOR CROP POLLINATION.[6]



Eastern Meadowlark

FARMING FOR THE FUTURE

Regenerative agriculture is a crucial piece of the sustainability puzzle. While conventional farming employs large amounts of pesticides, fertilizers, energy, and water, regenerative agriculture centers on soil health and productivity through methods like composting—minimizing environmental impact.[7] Regenerative agriculture often goes hand in hand with "carbon farming" to improve conversion of atmospheric CO_2 to organic material.[8]

Visit our website to read about how Mass Audubon's Drumlin Farm is employing regenerative methods.

CLEAN WATER

12M GALLONS Estimated amount of stormwater retained annually by raised beds alone in New York City's community gardens.[9]

CARBON CAPTURE & STORAGE

280M TONS Additional CO_2 stored by increasing perennial vegetable acreage from 3.3 mil. hectares today to 26 mil. hectares by 2050, the emissions equivalent of 60 million cars. Perennial agriculture is a particularly effective carbon farming practice utilizing crops that do not need to be replanted.[10]

KEY TERMS

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Climate Resilience: The ability of a natural or human community to prepare for and respond to the impacts of climate change.

Mass Audubon

Grasslands & Farmlands

CLIMATE RESILIENCE

Climate change threatens our ability to produce food, and food insecurity is already present in Massachusetts.[11]

$2.4B POTENTIAL SAVINGS/YEAR in medical treatment costs by addressing food insecurity in Massachusetts.[12]

Over $2M Benefit to participants in Massachusetts' Healthy Incentives Program (HIP) in the program's first seven months, demonstrating demand for healthy, local food. HIP makes buying fruits and vegetables from farmers markets and other qualified local vendors more cost-effective for eligible low-income residents.[13]

53 species OF THE GREATEST CONSERVATION NEED make their home in Massachusetts' grassland habitats, including the eastern meadowlark and bobolinks.[14] Maintaining agricultural lands benefits several species that have declined significantly in New England over the past 50 years.[15]

A NEW ENGLAND FOOD VISION, FOR 50 BY '60

Experts from universities around New England have created a plan to grow 50% of our food locally by 2060. The 2 million acres of farmland in New England provide only 12% of our food, while 10 to 15% of households report food insecurity. New England has the capacity to responsibly expand its farmland to 6 million acres while reducing our farm footprint and leaving 70% of the region forested.[16]

GREEN CITY GROWERS

*Green City Growers, an organization that converts unused spaces into urban farms, has grown more than **175,000 pounds of organic produce** over less than 2 acres. Based on these production levels, it is estimated that just **1.6% of Boston's 57,363 acres of land would be needed to meet the needs of at-risk Bostonians.**[17]*

RECREATION & TOURISM

Participants in agri-tourism (a growing trend) and wildlife observers interested in grassland species spend money on classes and programs in local communities.

$259K Amount spent annually by visitors to 611 acres of grasslands managed by Mass Audubon.[18]

125K people visit and participate in educational programs annually at Mass Audubon's Drumlin Farm.[19]

Threats

Climate change and development are two of the biggest threats facing grasslands and farmlands.

CLIMATE CHANGE

2.9°F RISE IN TEMP since 1895

11" SEA LEVEL RISE since 1922, as measured in Boston Harbor

55% STRONGER STORMS since 1958[20, 21]

Grasslands and agricultural fields are experiencing climate change impacts like summer drought, freeze damage to early buds, and faster spread of invasive species.

DEVELOPMENT

Grasslands and farmlands are often prime targets for development, since the land is open, relatively flat, and has soils that are easily manipulated.

See our Losing Ground report and community planning resources for ways to reduce development impacts.

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THE VALUE *of* Nature

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#5 OF 5

Urban Green Space

The value of green space and trees in cities should not be overlooked. Urban green space provides many ecosystem services, including improved health, and it is important to ensure that our most vulnerable communities have fair access to these benefits.

ECONOMIC & HEALTH

Marginalized and low-income urban communities are often farther away from green space and more negatively impacted by the urban heat island effect and air pollution.[1]

50%

REDUCTION IN INDOOR COARSE PARTICULATE MATTER concentrations observed in one study of roadside street trees' impacts on neighboring houses.[2] Another study found that a single tree lowered concentrations behind it by 15%.[3]

85%

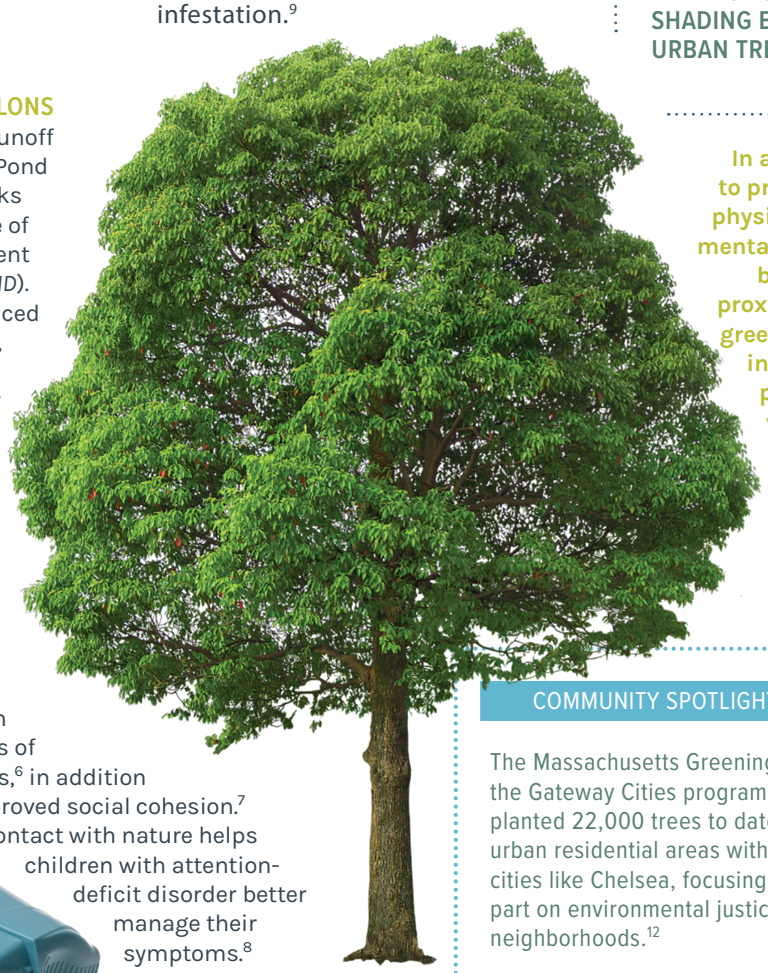
OR 10.5 MILLION GALLONS reduction in surface runoff entering Mashapaug Pond after three years thanks to Providence, RI's use of low impact development (*see below for more on LID*). The practice also reduced phosphorus pollution, which contributes to algal blooms, by 95%.[4]

37%

Increase in electricity use for cooling following reduction in tree canopy cover by 30% in Worcester's Greendale neighborhood, prompted by an Asian longhorned beetle infestation.[9]

3.06 °C

AVERAGE MODELED *DECREASE* IN NEAR-SURFACE AIR TEMPERATURE OVER THE ENTIRE CONTIGUOUS U.S., THANKS TO THE SHADING EFFECT OF URBAN TREES.[10]



In addition to providing physical and mental health benefits, proximity to green space increases property values.[11]

670k

INSTANCES OF ACUTE RESPIRATORY SYMPTOMS, AND 850 HUMAN DEATHS, PREVENTED EACH YEAR NATIONWIDE BY TREES' AND FORESTS' ABILITY TO ABSORB AIR POLLUTION, FOR AN ANNUAL VALUE OF $7 BILLION.[5]

See our *Forests* fact sheet for more on their benefits.

Studies show a correlation between the proximity of communities to green space and lower levels of mental illness,[6] in addition to improved social cohesion.[7] Contact with nature helps children with attention-deficit disorder better manage their symptoms.[8]

COMMUNITY SPOTLIGHT

The Massachusetts Greening the Gateway Cities program has planted 22,000 trees to date in urban residential areas within cities like Chelsea, focusing in part on environmental justice neighborhoods.[12]

KEY TERMS

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Mass Audubon

Urban Green Space

CLIMATE RESILIENCE

Taking action in cities is recognized as essential for global climate change resilience,[13] and urban green space can play a key role.

LOW IMPACT DEVELOPMENT (LID) works to reduce impervious surfaces through techniques like good site selection and bio-infiltration—mitigating flooding, protecting water quality, and helping maintain a sustainable water supply. LID is increasingly important given the impacts of climate change:

For example, rain gardens allow for increased groundwater recharge and can help reduce vector-borne illnesses, since they prevent standing water that provides ideal conditions for mosquito breeding.[14]

For more see:
massaudubon.org/
LIDfactsheets

4x potential savings increase from avoided extreme weather damage thanks to upfront investments in resilience.[15]

CARBON CAPTURE & STORAGE

$166

ANNUAL VALUE PER ACRE OF FULLY VEGETATED GREEN INFRASTRUCTURE

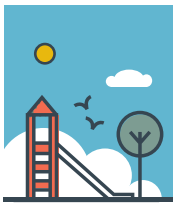
expected benefit in reduced CO_2 emissions thanks to NYC's green infrastructure plan to improve local water quality.[16]

I-TREE

The USDA Forest Service's free i-Tree toolkit allows you to explore the benefits of urban trees on scales including cities and neighborhoods. The "MyTree" tool even helps you analyze a single tree, providing the value in dollars for carbon dioxide sequestered, avoided stormwater runoff, and air pollution removed.[19]

itreetools.org

RECREATION & TOURISM



1 in 3 Americans in the 100 largest cities live more than a 10-minute walk from a park.[17]

BOSTON became the second major city in the U.S. to ensure that all residents have a park within a 10-minute walk from home.[18]

Red fox

URBAN GREEN SPACES CAN SERVE AS "STEPPING STONES" THAT INCREASE CONNECTIVITY BETWEEN NATURAL AREAS.

This is especially important given climate change and resulting shifts in distribution of many plant and animal species.[20]

Threats

Climate change threatens the health of urban communities, where development is high.

- **2.9°F RISE IN TEMP** since 1895
- **11" SEA LEVEL RISE** since 1922, as measured in Boston Harbor
- **55% STRONGER STORMS** since 1958[21, 22]

While their impacts are often linked, climate change and development in urban areas are particularly intertwined. Climate change will exacerbate heath impacts on urban populations, and urban areas with extensive impervious surface and compacted soils will be especially vulnerable to future flooding.[23] In the meantime, development is guaranteed to continue, and remaining urban green spaces and the services they provide are at risk.

See our Losing Ground report and community planning resources for ways to reduce development impacts.

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