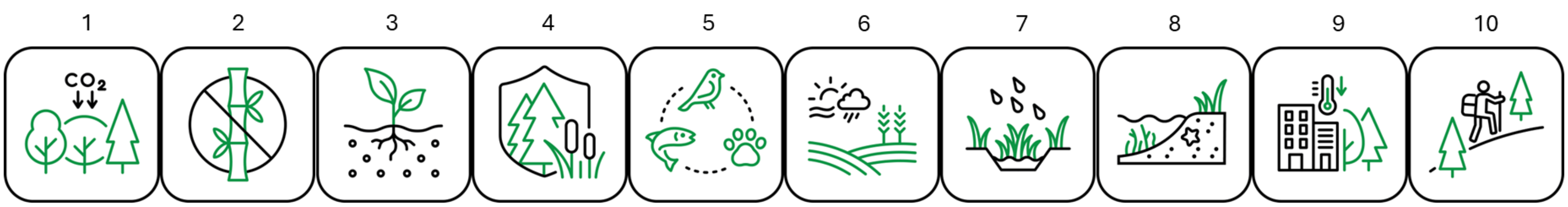
II. NBS Practices in PA 25-125 with CT Examples

Section 12(a) of P.A. 25-125 requires DEEP to evaluate how to integrate and advance nature-based solutions that support climate change mitigation and adaptation as well as ecosystem resilience and biodiversity, and Section 12(b) requires DEEP to consider the following 10 best practices as part of its evaluation:

1) Increase carbon sequestration through increased forest acreage, including reforestation,
2) Control invasive species,
3) Encourage soil health across all landscapes,
4) Protect carbon stocks through avoiding the conversion of forests and wetlands to other purposes,
5) Restore habitats to improve biodiversity,
6) Increase climate-smart agriculture and soil conservation to reduce greenhouse gas emissions while improving habitat and protecting biodiversity,
7) Increase community resilience by improving water quality and addressing flooding and drought through nature-based stormwater management,
8) Increase community resilience by improving water quality and addressing flooding and drought through shoreline protection that uses nature-based approaches such as living shorelines,[5]
9) Improve air quality and reduce urban heat island effects through urban forestry and increasing green spaces, and
10) Increase access to open space for public health benefits.



In this chapter, DEEP provides the following for each of these 10 NBS practices:

- Background describing each practice.
- Citations to relevant scientific research and multi-stakeholder reports.
- Connecticut examples of successful applications of each practice.

In this introduction, we emphasize that these 10 practices are broad and include a wide variety of sub-practices that may or may not be suitable based on many site-specific, species specific, and many other variables and conditions. At the same time, the focus on these 10 practices should not imply that other NBS practices that address the challenges of climate change, biodiversity, and ecosystem resilience should not also be priorities worthy of consideration.

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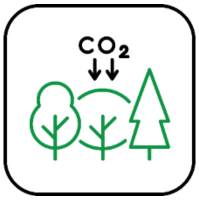
[5] Although they are combined into one practice in the text of Section 12(b) in P.A. 25-125, practices 7 and 8 listed above are presented as two community resilience practices throughout the report – one focused on stormwater management and one focused on shoreline protection.

A. Increase carbon sequestration through increased forest acreage



Background: Trees and forests are known to remove atmospheric carbon and sequester it in their wood and roots, also contributing to the deposition of carbon into stable soil sinks through their roots.

Forests account for 56-58% of Connecticut's land cover, sequestering approximately 4.9 MMTCO2e between 2022-2023.[6] Connecticut statewide maintains the most carbon-dense forests in the Northeast, in terms of aboveground carbon storage on a per acre basis.[7]

As climate-driven disturbances such as drought and wildfire continue to intensify in the state, it will likely become more difficult for Connecticut's forests to naturally sequester and securely store carbon.

Forests, and the increase of forested acreage, present an opportunity to leverage natural processes for amplifying long-lasting and stable carbon sequestration and storage so that Connecticut may achieve its goal of reaching emission levels below 2001 levels by 2030 – and ultimately, net zero levels by 2050.

Best Management Practices (BMPs): Due to the significant variations between forested sites, the following set of BMPs (with citations to the best available science wherever possible) are not intended to be fully comprehensive or necessarily applicable to all sites:

Promote tree species diversity: increases niche partitioning across soil types and topographies;[8] promotes diversified growth forms and canopy stratification amidst varied precipitation and soil moisture conditions;[9] increases post-disturbance successional forest regeneration potential;[10] localized species diversity promotes resilience to insects and pathogens through negative density dependence.[11]

Maintain and/or increase "redundancy" *(whereby multiple species are available to fill the same ecological function)*: evidence suggests that Connecticut's historically high redundancy is beginning to waver (e.g., the historic loss of chestnut trees have been compounded by the more recent declines in elm, ash, beech, hemlock, and oak). As such, there is need to ensure that

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[6] Forest Inventory EVALIDator web-application Version 1.8.0.01. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. http://apps.fs.usda.gov/Evalidator/evalidator.jsp

[7] Northeastern states include the six New England states, New York, New Jersey, and Pennsylvania.

[8] Canham, C.D., Papaik, M.J., Uriarte, M., McWilliams, W.H., Jenkins, J.C. and Twery, M.J. "Neighborhood analyses of canopy tree competition along environmental gradients in New England forests." 2006. https://doi.org/10.1890/1051-0761

[9] Liptzin, D. and Ashton, P.M.S. "Early successional dynamics of single-aged mixed hardwood stands in a southern New England forest, USA." 1999. https://www.sciencedirect.com/science/article/pii/S0378112798004484

[10] Lorimer, C.G. and White, A.S. "Scale and frequency of natural disturbances in the northeastern US: implications for early successional forest habitats and regional age distributions." 2003. https://www.sciencedirect.com/science/article/abs/pii/S0378112703002457

[11] Jactel, H., Brockerhoff, E. and Duelli, P. "A test of the biodiversity-stability theory: meta-analysis of tree species diversity effects on insect pest infestations, and re-examination of responsible factors." 2005. https://link.springer.com/chapter/10.1007/3-540-26599-6_12

multiple species and multiple unrelated genera are retained to ensure species can fill roles previously held by those now in decline.[12]

Disincentivize high-grading practices: by extensively high-grading stands or selecting with too-extreme a preference for individual species, there is potential to unsustainably reduce the structural and species diversity of harvested stands.[13] As climate disturbances intensify, retaining diversity is key to future forest resilience.

Promote landscape-scale heterogeneity in stand age and structure: this includes retaining legacy structures such as snags and deadwood, which promote biodiversity.

Leverage disturbance events to promote emergence of new age classes: disturbances alter the successional trajectory of affected areas, including the species, age, and structural diversity of remaining vegetation communities. In some instances, depending on disturbance intensity and extent, some areas may be managed to promote landscape heterogeneity and the long-term creation of old-growth characteristics.[14]

Implement silvicultural biocontrol: as invasive species persist in Connecticut, including both plants and insects, it is important to monitor and mitigate these disturbances through active intervention using biocontrol.

Encourage long-term transition of edge habitats back to more intact forested areas when possible: in moderate amounts and when not permanent, edge habitats can increase local and landscape scale biodiversity by opening niches less or unavailable in core forest areas, such as nesting and flowering conditions. Though temporary edges may provide unique habitats that can boost biodiversity, permanent edges can invite invasives and disturb other intact habitats. Managing edge forest as part of a long-term transition across a variety of tree ages back toward an intact forest can make that forest more resilient and diverse.

"Keep Forests as Forests" and mitigate future fragmentation: the state should disincentivize development in core forest areas to reduce fragmentation, especially for mature or designated old-growth stands. Furthermore, when acquiring lands for protection, the state should focus on areas that pose opportunities to create increased connectivity and corridor potential, such as areas abutting lands already under conservation easements or otherwise protected areas.

Balance active and passive management strategies: depending on site-specific characteristics and long-term objectives for a given stand, science-informed passive management may be important for achieving mature and old-growth characteristics over time.[15]

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[12] Johnson, D.J., Beaulieu, W.T., Bever, J.D. and Clay, K. "Conspecific negative density dependence and forest diversity." 2012. https://pubmed.ncbi.nlm.nih.gov/22605774/
[13] Canham, C. D. "Forests Adrift-Currents Shaping the Future of Northeastern Trees." 2020. https://yalebooks.yale.edu/book/9780300238297/forests-adrift/
[14] Catanzaro, P. and D'Amato, A. "Restoring Old-Growth Characteristics to New England's and New York's Forests." 2022. https://portal.ct.gov/-/media/DEEP/forestry/Restoring-Old-Growth-Characteristics.pdf
[15] "Southern New England Forest Management in an Era of Climate Change. A Position of the Yankee Division of the Society of American Foresters." 2020. https://newenglandforestry.org/learn/initiatives/ex

Increase carbon sequestration through increased forest acreage

Recognize uncertainty when managing forests for the future: Many factors, such as the interacting drivers of change, varying time scales of ecological response, time lags and legacy effects, temporal and spatial heterogeneity, variable species specific responses, and human influences, are imperative to consider, but nearly impossible to include when estimating northeastern forests' response to climate change. It is crucial for policy makers, landowners, and all invested stakeholders to take note of the changing forested ecosystem dynamics as influenced by our changing climate. If climate change significantly alters the ability of northeastern forests to provide their multitude of ecosystem services, upon which humans are reliant, the Northeast is at risk of severe social and economic impacts. It is therefore important to understand carbon sequestration dynamics, one of the greatest ecosystem services forests provide, so landowners and managers can effectively work to mitigate threats by managing for high-magnitude long-term carbon storage.[16]

CT Example: **DEEP Management of State Forests**

DEEP manages approximately 250,000 acres of public land, of which approximately 175,000 acres is designated as state forests. In general, DEEP's management of state forests is focused on achieving forest health and resilience. Through science-based data collection and analysis, DEEP constantly monitors tree growth and projected tree cover on DEEP-managed public forests to track forest health and resilience over time.

One of the primary goals is to maintain abundant tree cover so carbon sequestration is not diminished over time by loss of tree cover to forest health threats such as insects, disease, and invasive plants. The plan for each individual forest to maintain abundant tree cover and sustain carbon sequestration over time is explained at the state forest level through detailed forest management plans available online at Forest Management on State Lands. DEEP's forest management plans include robust input from various natural resource professionals and local and statewide stakeholders to achieve a balance of multiple benefits for the public -- forest health, recreational access, and vibrant wildlife habitat keeping common species common and protecting those species identified as endangered, threatened, or special concern. DEEP's forest management goals are congruent and complimentary to its statewide Forest Action and Wildlife Action Plans that are typically updated every five years with significant public input.

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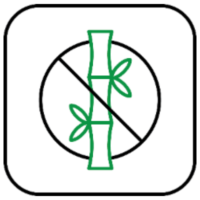
[16] 2020 Connecticut Forest Action Plan, page 50.

B. Control invasive species



Background: Invasive species are non-native species that exhibit an aggressive growth habit and can out-compete and displace native species. Invasive organisms can spread rapidly, disrupting ecosystems, and cause ecological and economic harm.

For plants, the Connecticut General Statutes (CGS § 22a-381b-d) defines invasive plants using nine biological criteria:

1. The plant is nonindigenous to the state.
2. The plant is naturalized or has the potential to become naturalized or occurring without the aid and benefit of cultivation in an area where the plant is nonindigenous.
3. Under average conditions, the plant has the biological potential for rapid and widespread dispersion and establishment in the state or region within the state.
4. Under average conditions, the plant has the biological potential for excessive dispersion over habitats of varying sizes that are similar or dissimilar to the site of the plant's introduction into the state.
5. Under average conditions, the plant has the biological potential for existing in high numbers outside of habitats that are intensely managed.
6. The plant occurs widely in a region of the state or a particular habitat within the state.
7. The plant has numerous individuals within many populations.
8. The plant is able to out-compete other species in the same natural plant community.
9. The plant has the potential for rapid growth, high seed production and dissemination and establishment in natural plant communities.

The law specifies that before listing a plant, the Invasive Plant Council will determine that the plant has each of the characteristics 1-5 and at least one of 6-9. and specifies that “no person shall move, import, sell, purchase, transplant, cultivate or distribute any reproductive portion of any invasive plant” for the listed plant species.

In addition to invasive plants, invasive animals, fungi, and other species also have spread rapidly and disrupted ecosystems across Connecticut. To name just a few, examples of invasive animals in Connecticut include emerald ash borer, spotted lanternfly, hemlock wooly adelgid, jumping worms, the nematodes causing beech leaf disease, and zebra mussels. Invasive fungi include the pathogens causing Dutch elm disease, chestnut blight, and beech bark disease, and also the white nose fungus is an invasive organism that is devastating multiple bat species.

The introduction, establishment and spread of invasive species is widely recognized as one of the most serious threats to native ecosystems. Globally, invasive species are involved in 60% of all species extinctions -- alongside land- and sea-use change, direct exploitation of organisms, climate change, and pollution -- and considered to be "primarily responsible" for 16 percent of extinctions.[17,18]

Invasive species can have direct effects on native species through competition or through predation, infection, herbivory, or parasitism, and they can also have indirect effects such as community interactions through intermediate species, changing habitat characteristics like litter deposition or fire susceptibility, or changes in interaction with soil biota and abiotic characteristics.

Climate change can exacerbate problems caused by invasives by disrupting the stability of environments and communities and proliferating the disturbed scenarios in which invasives thrive. Many invasives are able to tolerate or benefit from climate change variables like weather extremes and increasing temperatures, while native species suffer and are reduced in numbers.

Higher atmospheric CO_2 may accelerate vine growth. Warmer winters have enabled the spread and increased overwinter survival of invasive species (e.g., hemlock woolly adelgid). Climate-driven changes increase new arrivals and expansion risks due to delayed starts to winter and earlier springs. Invasive species are reducing the diversity of Connecticut forests and wetlands, key ecosystems for sequestering carbon and mitigating climate change. Efforts to control invasives can help maintain ecosystem structure and function which support biodiversity and resilience.

Best Management Practices (BMPs): A wide variety of best management practices related to "controlling invasives" utilize a hierarchy of intervention based on feasibility, cost-effectiveness, and progression of colonization by the invasive species. The hierarchy starts with prevention (highest value, lowest cost); next is early detection and rapid response; this is followed by containment, control and population management; and last is restoration following control.

The framework in the following table lays out best management practices across all interventions, drawing from the IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species (2000),[19] the CBD/IUCN Invasive Alien Species Toolkit for Kunming-Montreal Global Biodiversity Framework Target 6 (2025),[20] the IPBES Thematic Assessment on Invasive Alien Species and their Control (2023), and CT-specific program documentation from DEEP and the Connecticut Invasive Plants Council.

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[17] Summary for Policymakers of the Thematic Assessment Report on Invasive Alien Species and their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). 2023. https://www.ipbes.net/ias

[18] Schwindt, E., August, T.A., Vanderhoeven, S. et al. "Overwhelming evidence galvanizes a global consensus on the need for action against Invasive Alien Species." 2024. https://doi.org/10.1007/s10530-023-03209-x

[19] IUCN Guidelines for the Preservation of Biodiversity Loss Caused by Alien Invasive Species. 2000. https://portals.iucn.org/library/efiles/documents/Rep-2000-052.pdf

[20] CBD Toolkit for Target 6 Invasive Alien Species. 2025. https://www.cbd.int/invasive/cbdtoolkit

Control invasive species

Action	BMPs for Controlling Invasive Species
Actively prevent and manage potential invasion pathways	• Actively enforce and strengthen the CT Invasive Plants Council prohibited species list, including species identified by research to have high invasion potential. • Encourage watercraft inspection and decontamination at boat launches, and other practices to minimize aquatic invasive species spread (e.g. discouraging live bait transport across water bodies). • Leverage interactions between multiple invasive species, e.g. by removing tree of heaven from highways and public lands as a proactive spotted lanternfly habitat reduction measure.
Increase access to early detection and rapid response channels	• Expand and promote citizen science reporting infrastructure and integrate into a unified CT reporting interface. • Encourage invasive species surveys as part of state and federally funded restoration project site assessments.
Utilize species-appropriate integrated control methods (i.e., use the least-toxic effective methods, combine approaches, and monitor outcomes)	• For Terrestrial Plants: use mechanical removal for small infestations, herbicide for large monocultures, and biological control where approved agents are available. Always follow with native planting. • For Aquatic and Wetland Plants: use mechanical removal for water chestnut, aquatic herbicide for large infestations, open marsh water management for phragmites in tidal systems, and drawdown scheduling synchronized with native plant phenology generally. • For Forest Pests: use biocontrol for hemlock woolly adelgid and emerald ash borer, targeted insecticide for high-value individual trees, and salvage harvest and replanting for affected emerald ash borer stands. • For Aquatic Animals: use watercraft inspection and decontamination, and population management in line with the Atlantic Flyway management plan for mute swans.
Establish Native Species in Post-Control Restoration	• Include native species establishment plans in invasive control projects.

Control invasive species

	• Follow CT Wildlife Action Plan habitat-specific guidance. • Monitor for reinvasion for multiple years post-treatment and fund follow-up control as an eligible expense in grant programs. • Use competitive native groundcover establishment as a passive tool for suppressing reinvasion.
Coordinate at the Landscape Scale and Across Jurisdictions	• Organize invasive control efforts around watersheds and landscape units as opposed to individual project sites or grant cycles. • Establish cross-jurisdictional coordination mechanisms, including with neighboring states, to share survey data and avoid duplicative work. FL's CISMA model is an illustrative case study. • Prioritize control in and adjacent to CT Wildlife Action Plan Conservation Opportunity Areas and OSWA-protected lands.
Incorporate Measurable Outcomes and Adaptive Management	• Incorporate baseline ecological assessments and post-treatment monitoring into grant program guidelines. • Develop standardized invasive control project monitoring protocols consistent with the CT Wildlife Action Plan.

CT Example: **Control of invasive plants in multiple State Forests**

DEEP's Forestry Division implemented several projects in the Centennial Watershed, Natchaug, Naugatuck, and Pachaug State Forests involving various treatments to control previously popular landscaping plants such as Japanese barberry, winged euonymus, multi-flora rose, and others that had spread from nearby plantings to become considerable invasive species problems throughout hundreds of acres of forest. Some populations, such as the winged euonymus documented in the Wyassup block of the Pachaug SF, had spread and become established over decades with mature plants reaching 10-12' tall with spacing at moderate to high density.

In other sites, such as in the southern extent of the Natchaug SF in Hampton, DEEP responded on the early side of an invasive plant infestation in the wake of a considerable die-off of oaks and ash trees following spongy moth defoliation and emerald ash borer girdling. Invasive plant control was implemented through three treatments during 2023-2024 to reduce understory competitiveness of invasive plants by 95% and increase the likelihood of the forest regenerating to native tree and shrub species. Treatments have attained the 95% control target, and the site is now being used as a Connecticut Agricultural Experiment Station research plot to study the forest regeneration trends which occur under dying ash canopies with invasive understories when compared to those understories where invasive plants have been effectively controlled.

C. Encourage soil health across all landscapes

Background: Healthy soils are living, well-structured sponges full of organisms[21] that store water and carbon, cycles nutrients, and resists erosion. Healthy soils show good structure and aggregation (crumbly, stable aggregates), high biological activity and diversity (roots, fungi, microbes, fauna), strong infiltration and water-holding capacity, as well as active nutrient cycling with balanced fertility.

There are a multitude of soil types in Connecticut. When healthy, these soils exhibit low bulk density and compaction; plenty of pores for air and water circulation, and adequate amounts of organic matter.

These characteristics make the soil more resistant and resilient to drought, heavy rain, contamination, and disturbance; as well as more capable of sustaining biodiverse life both within it and aboveground, and ultimately able to be a “sink” for carbon storage and sequestration.

The soil is one of the largest sinks for atmospheric carbon, and one that may be managed economically to mitigate the effects of climate change. Improving soil health in agricultural fields, forests, and urban open space (fields, parks, urban gardens, lawns) increases atmospheric carbon sequestration and reduces emissions.

Globally, protecting or restoring soil carbon can provide 3 billion tons of cost-effective climate mitigation each year. This represents 25% of the potential of natural climate solutions -- of which 40% is protection of existing soil carbon and 60% is rebuilding depleted stocks. Soil carbon comprises 9% of the mitigation potential of forests, 72% for wetlands, and 47% for agriculture and grasslands. Overall, soil carbon is important to land-based efforts to prevent carbon emissions, remove atmospheric CO_2, and deliver ecosystem services in addition to climate mitigation.[22]

Soil health supports climate mitigation by (1) preventing CO_2 emissions by conserving soil organic carbon (SOC), (2) increasing removal of atmospheric CO_2 by building SOC through sequestration, and (3) reducing non-CO_2 greenhouse gases (N_2O and CH_4) through improved management of natural and working lands. This is achieved through practices that avoid land conversion and erosion, reduce nutrient losses, and build organic matter and soil biodiversity.[23]

Soil health supports resilience/adaptation because it improves the physical, chemical, and biological properties that determine how all landscapes respond to heat, drought, intense rainfall, flooding, and disturbance. Soil health promotes climate resilience by increasing water infiltration and storage, strengthening soil structure and erosion resistance, supporting plant rooting and biological function, and improving recovery after disturbance—reducing vulnerability to drought, flooding, extreme rainfall, and heat.

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[21] Food and Agriculture Organization of the United Nations webpage content. 2026. https://www.fao.org/global-soil-partnership/resources/highlights/detail/en/c/1309274/.

[22] Bossio, D.A., Cook-Patton, S.C., Ellis, P.W. et al. “The role of soil carbon in natural climate solutions.” 2020. https://www.nature.com/articles/s41893-020-0491-z

[23] Ibid.

Encourage soil health across all landscapes

Best Management Practices (BMPs): BMPs for soil health in all landscapes (agricultural lands, forests, wetlands, developed lands, and recreational spaces) may include a combination of the following practices:

Protect, restore, and steward

- Restore degraded soils and habitats (wetlands, forests, agricultural and urban open space; afforestation/reforestation where suitable)
- Use locally adapted native plant material; encourage nurseries to supply local genetics
- Protect core natural areas and connectivity to reduce fragmentation

Minimize disturbance

- No/low/reduced till (incl. strip-till); controlled traffic; avoid work on wet soils
- Plan & protect during projects: limit disturbance, distribute loads, keep soils covered; decompact & compost only where disturbance is unavoidable
- Low-impact forestry/rec access: follow site-appropriate BMPs; reuse skid trails/landings if well sited; enforce on-trail use; use low-impact harvesting equipment

Maximize soil cover and living roots

- Multispecies cover crops and conservation cover
- Perennial land covers (perennial crops, meadows, native groundcovers)
- Intercropping/polyculture and crop rotation
- Mulch; retain crop residue/leaf litter/woody debris (snags, slash, stumps where safe)
- Intensive/managed rotational grazing
- Soil-friendly mowing (e.g., conservation mowing; improved hayland practices that preserve cover and structure)

Water Management

- Green stormwater infrastructure: rain gardens, bioswales/grass swales, tree trenches, permeable pavements, green roofs, xeriscaping, no-mow zones
- Protect hydrology: maintain riparian buffers; restore wetlands; reduce alterations to site drainage

Nutrient Management

- Compost and manure additions; manure systems enabling timely, low-pressure, low-disturbance application
- Nutrient management emphasizing slow-release/organic sources matched to crop need
- Integrated Pest Management (IPM) to minimize pesticides/biocides while protecting beneficials and soil biota

Maximize Biodiversity

- Agroforestry (hedgerows, riparian buffers, alley cropping), silvopasture, and urban/peri-urban trees & plantings (drought-tolerant where appropriate)
- Pollinator/field-edge habitat strips and native plantings across landscapes

Encourage soil health across all landscapes

Minimize Contamination

- Use/test for clean fill/topsoil/compost; specify PFAS-free, low-plastic amendments.
- Use IPM/pesticide stewardship plus 4R nutrient management (Right Source, Rate, Time, Place) and safe manure systems.
- Control invasives using least-toxic methods; and do periodic soil testing.
- Stop pollutants at the source via water, sediment, and site stabilization controls.
- Where contamination exists, remove/replace the topsoil, install raised beds (for safer growing), and apply in-situ treatment/immobilization.

CT Example: **CT Soil Health Initiative (CT RC&D)**

The CT Soil Health Initiative is a long running program of the Connecticut Resource Conservation and Development Area, Inc. (CT RC&D) program focused on improving soil health through hands on education and practical demonstrations, including rolling cover crops, soil pit investigations, and rainfall simulations comparing healthy and degraded soils.

The CT Soil Health Initiative highlights how healthy, organic matter rich soils improve drainage, increase disease resistance, and enhance water holding capacity. CT RC&D hosts workshops, educational events, and pilot programs across Connecticut typically on working farms in partnership with USDA NRCS staff, who provide technical expertise, and instruction. These well attended events bring together agricultural producers alongside nonprofit, federal, and university partners to promote the adoption of effective soil health practices statewide.

D. Protect carbon stocks through avoiding conversion of forests and wetlands

Background: There are an estimated 220,000 acres of wetlands in Connecticut (~7% of the state's land area) and approximately 1.8 million acres of forest (~56% of the state's land area). There is some overlap between these two cover types, especially in forested wetland areas.

For many decades in Connecticut, forests and wetlands have shared a common threat – fragmentation or parcelization due to sprawling development including associated infrastructure and roads – which has contributed to several other challenges that nature-based solutions are trying to address, such as the proliferation of invasive species into fragmented habitats, compacting of soils, creation of heat islands, and more. That is why opportunities to develop compactly and re-develop brownfields and other places that are already disturbed can be effective at avoiding additional conversions of forests and wetlands.

Studies have concluded that wetlands are critically important for storing carbon, especially in the top 1 meter of soil, when compared to other biomes.[24] Not coincidentally, the conversion of wetlands to other cover types leads to higher levels of carbon loss than the conversion of any other ecosystem type.[25] In addition to their mitigation potential in the form of high carbon sequestration and storage, wetlands can also provide adaptation benefits such as storm surge protection and rainwater collection for use during drought.[26]

Similarly, forests are known to sequester and store large amounts of carbon in both their above- and below-ground biomass, also increasing soil carbon pools through root respiration. In fact, avoided forest conversion and improved forest management, when considered together, have the potential to contribute as much as 50% of the total carbon sequestration possible globally.[27]

Connecticut's Inland Wetlands and Watercourses Act supported by a statewide policy goal of "no net loss of wetlands" provides a strong tool to municipal inland wetlands commissions to avoid conversion of wetlands. Forests are protected more by incentives such as the P.A. 490 program that offers property tax relief to large forest landowners (generally greater than 25 acres) who keep their forests as forest, outreach/training for individual forest landowners through extension and service foresters, and strong certification and continuing education programs for credentialled forestry professionals. Implementation of a "no net loss of forests" policy would also provide additional mechanisms to protect forests from conversion.

Best Management Practices (BMPs): There are several recommended BMPs related to avoiding the conversion of forests and wetlands in the GC3 Forests Sub-Group Report (2020), GC3 Wetlands Sub-Group Report (2020), Policy on Resilient Forests for Connecticut's Future (PRFCT Future,

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[24] Villa and Bernal. "Carbon sequestration in wetlands, from science to practice." 2017. https://www.sciencedirect.com/science/article/pii/S0925857417303658?via%3Dihub

[25] Zhang et al. "Impact of land use type conversion on carbon storage in terrestrial ecosystems of China: A spatial-temporal perspective." 2015. https://www.nature.com/articles/srep10233

[26] Jeethu J. C. & Kaladevi V. "Wetlands and Climate Change Resilience, and Enhancing Ecosystem Services for a Sustainable Future." 2025. https://cspub-jcc-submission.org/index.php/jcc/article/view/197/278

[27] Kaarakka, L., Cornett, M., Domke, G., Ontl, T., & Dee, L. E. "Improved forest management as a natural climate solution: A review." 2021. https://doi.org/10.1002/2688-8319.12090

2021), and Taking Action on Climate Change: Building a More Resilient Connecticut for All: Phase I Report, Near-term Actions (2021).

Retaining forest and wetland ecosystems, either through acquisition and protection or through low-impact development, is like purchasing an insurance policy for a resilient future. Avoiding conversion helps to both preserve existing carbon stores as well as the potential for long-term sequestration and storage. Allowing conversion and loss of forests and wetlands can take away that metaphorical insurance policy and put additional pressure on remaining natural resources to provide adequate ecosystem services to keep communities resilient.

CT Example: **Tri-Lakes Property Acquisition**

DEEP acquired 642.9 acres of important wildlife habitat and wetlands in Killingly to establish a new Wildlife Management Area (WMA). The property has a varied landscape, encompassing forests, wetlands, and four lakes ranging from 7 to 41 acres and supporting a rich array of plant and animal species.

This significant land purchase for residents and visitors (one of the largest acquisitions by DEEP in the past decade) was largely funded by a federal U.S. Fish & Wildlife Service Pittman-Robertson Grant.

Source: OSWA Report, April 2025

E. Restore habitats to improve biodiversity

Background: Habitat degradation has reduced the capacity of Connecticut's ecosystems to sequester carbon, support biodiversity, and buffer communities against climate impacts. Restoration rebuilds that capacity by leveraging natural ecological processes: after an initial investment removes stressors and reestablishes native communities, landscape regeneration may be designed to proceed with reduced ongoing management inputs.

Habitat restoration refers to facilitating recovery of ecosystems that have been degraded, damaged, or destroyed, and adding resilience in ecosystems that are still intact. Key approaches for habitat restoration in Connecticut include:

- Protection and restoration of riparian buffers
- Removal of obsolete dams and stream crossing rightsizing to restore natural stream function
- Coastal and tidal habitat restoration for degraded salt marshes, dunes, and estuaries
- Peatland and wetland rewetting to restore hydrological function
- Forest and shrubland restoration to support seedling dispersal and recruitment on rewilded or successional lands
- Landscape-scale ecological corridor maintenance and restoration
- Invasive species management to ensure the long-term resilience of native species in restored habitats

Habitat restoration is also one of the most multi-beneficial NBS interventions available: a single well-designed project can simultaneously improve carbon storage, recover biodiversity, reduce flood risk, and increase community resilience, generating returns across multiple NBS practices emphasized in Public Act 25-125.

Best Management Practices (BMPs): Following are several ecological and technical best management practices which can guide how habitat restoration programs are implemented on the ground. This framework draws from standards documents from the Society for Ecological Restoration (SER) and International Union for Conservation of Nature (IUCN).

Ecological & Technical Best Management Practices	
Ecosystem Attribute	Associated Best Management Practices
Absence of Threats	Conduct a pre-restoration threat assessment to identify active stressors to target for control. Remove or right-size barriers to aquatic connectivity, such as obsolete dams or undersized culverts, before or concurrent with carrying out in-stream habitat work.

	Implement targeted invasive species control before planting native species. Install deer exclosures where browsing would impede native vegetation recovery. Identify if there are upstream or upland water quality threats which need to be addressed for restored aquatic habitats.
Appropriate Physical Conditions	Restore natural hydrology, such as by reconnecting tidal flow to degraded salt marshes and reestablishing water table levels in drained or filled freshwater wetlands. Remediate compacted or contaminated soils prior to revegetation of target plant communities. Reestablish natural stream channel geometry and bankfull dimensions using natural channel design principles. Restore natural sediment dynamics and coarse woody debris recruitment in forest and riparian systems. Minimize soil disturbance by using low-impact equipment where possible.
Appropriate Species Composition	Use native, locally sourced, and genetically appropriate seed and plant material. Prioritize species assemblages that support Species of Greatest Conservation Need identified in the Connecticut Wildlife Action Plan, such as native milkweeds for monarch butterflies, or native oaks for specialist woodland birds. Cross-reference the relevant CT DEEP habitat profile in the Connecticut Wildlife Action Plan (Chapter 2 for the specific site). Account for climate-driven range shifts in species selection.

Restore habitats to improve biodiversity

Structural Diversity	Incorporate into projects both vertical and horizontal complexity of vegetation, substrate, and physical features. For terrestrial projects: retain and recruit coarse woody debris such as snags, logs, and brush piles as structural habitat for birds, reptiles, and invertebrates. For wetland projects: maintain open water, emergent marsh, scrub-shrub, and upland buffer as a structural mosaic. For tidal projects: allow salt marsh migration landward under sea level rise scenarios for long-term structural habitat capacity.
Healthy Ecosystem Function	Restore natural disturbance regimes where appropriate, such as floodplain inundation, forest gap creation (e.g. through selection harvest), and prescribed fire (in fire-adapted communities such as pitch pine-scrub oak barrens). Support pollinator communities by having diverse bloom periods across native flowering plants. Restore fish passage to reconnect migratory corridors. Promote passive regeneration where seed sources and conditions allow. Retain coarse woody debris and leaf litter on restoration sites to support decomposer communities and nutrient cycling.
Connectivity with Other Habitats	Design restoration projects to enhance landscape connectivity, prioritizing Conservation Opportunity Areas identified in the Connecticut Wildlife Action Plan. Restore and buffer riparian corridors to facilitate wildlife movement to and from upland habitats.

	Protect intact upland buffers around restored wetlands and riparian areas to minimize edge effects and recolonization by invasive species.

CT Example: **CT's 2025 Wildlife Action Plan – the Blueprint for Biodiversity**

Connecticut's 2025 Wildlife Action Plan (WAP) sets forth a shared vision: to conserve the state's diverse native fish, wildlife, and plant species, along with the habitats they depend on, for both their intrinsic value and the ecological and social benefits they provide. The WAP is the state's blueprint for achieving six broad goals ranging from restoring and maintaining resilient species and ecosystems to implementing, monitoring, and evaluating conservation actions, as well as expanding public engagement in wildlife protection.

Developed through extensive coordination with tribal nations, conservation partners, municipalities, state and federal agencies, and the public, the WAP reflects an inclusive perspective of the conservation needs of Connecticut over the next decade. While DEEP facilitates the planning process for the WAP as a state agency; it is a plan for all of Connecticut shaped by and designed to support the collective work of the people, organizations, and communities committed to the stewardship of the state's natural heritage.

Connecticut's 2025 Wildlife Action Plan Vision and Goals
Vision: *Connecticut's diverse native fish, plants, wildlife species, and associated habitats are conserved for their intrinsic value and the ecological and social benefits they provide.*
Goal 1: CT has healthy and resilient populations of native fish, wildlife, & plants.
Goal 2: CT has healthy and diverse habitats and ecosystems supporting native species.
Goal 3: Issues impacting CT's native species and their habitats are identified, understood, and addressed.
Goal 4: Actions are taken to protect CT's native species & their habitats.
Goal 5: CT's native species and their habitats, associated threats, and actions taken to minimize threats are monitored and evaluated to ensure goals and objectives are being met.
Goal 6: People are informed about and engaged in protecting CT's native species & habitats.

F. Increase climate-smart agriculture and soil conservation

Background: Climate-smart agriculture and soil conservation refer together to the advancement of agricultural systems that both mitigate and adapt to climate change and provide overall resiliency to our food and fiber systems and communities.

Climate-smart agriculture and soil conservation includes farming and land management practices designed to protect and restore soil health, protect water resources, biodiversity and resiliency of working lands involved in food production. It also includes practices that support water conservation and energy efficiency.

As noted earlier in the practice focused on "soil health," soil is a dynamic resource that is comprised of mineral, air, water and organic material. A major component of restoring soil health is increasing and maintaining carbon/organic matter in the soil. Soil organic carbon is one of the more stable forms in which carbon can be stored. When practices that increase soil carbon storage are applied at scale, they can lower atmospheric CO_2 growth.

Healthy soils provide a variety of functions that increase plant productivity while reducing the need for other inputs. Restoring and maintaining soil health increases plant and root functions, which both reduces the amount of fertilizer and need for pesticide applications. Soil health also increases the water-holding capacity of the soil, makes crops more resilient to drought, and reduces the need for irrigation. Reducing the need for fertilizers, pesticides, and irrigation directly reduces GHG emissions associated with these energy intensive agricultural inputs.

Climate-smart agriculture and soil conservation measures ensure that Connecticut is resilient to the impacts of climate change by providing a plentiful local food supply, clean and abundant drinking water, and has reduced risk for both flooding and drought.

Best Management Practices (BMPs): BMPs for climate-smart agriculture in Connecticut include the implementation across agricultural landscapes of the following depending on seasonal, soil, and other variations between sites:

- ✓ Soil health best management practices
    - Cover cropping
    - Reduced till/no till
    - Crop residue
    - Crop rotation
    - Rotational Grazing
    - Composting
- ✓ Pollinator habitat restoration
- ✓ Water conservation best management practices

Increase climate-smart agriculture and soil conservation

- Soil health practices that increase organic matter and water retention
- Drought tolerant species including use of native species
- Drip Irrigation
- Precision irrigation

✓ Energy efficient practices and infrastructure

- Energy efficient lighting
- Energy efficient irrigation
- Energy efficient heating and cooling
- On farm clean energy installations

Due to the variety of DoAg's Climate Smart Agriculture & Forestry grants, three diverse Connecticut examples are offered below that address climate, biodiversity, and resilience challenges in different ways:

CT Example: **Forestation in Bridgeport/Miyawaki Forest Project**

The *Forestation in Bridgeport* project was funded by the Department of Agriculture's Climate Smart Agriculture and Forestry Grant program as a demonstration of how the Miyawaki Forest Method could rapidly transform compact, degraded urban parcels into thriving native ecosystems. Working with seven Bridgeport Public Schools, Aspetuck Land Trust created densely planted micro-forests that now serve as living classrooms, carbon sinks, and natural habitats. Teachers, students, city partners, and community volunteers collaborated to heal the urban landscape while building climate literacy. Each forest followed the Miyawaki method of native-species selection, soil preparation, and dense planting to accelerate natural succession.

The ecological outcomes have been measurable and impressive: tripled carbon sequestration, nearly 4,000 gallons of additional storm-water infiltration annually, and an overall increase in native plant biomass of over 85%. Habitat for two vulnerable species was also restored within city limits. Equally significant are the human results. More than 250 students, families, and community volunteers helped plant and tend the forests, building civic pride and environmental literacy. As Connecticut's first urban Miyawaki forest project, *Forestation in Bridgeport* demonstrates how climate resilience and environmental equity can thrive side by side.

CT Example: **Silvopasture at Double A Ranch**

Double A Ranch Farm in New Fairfield restored approximately five acres of overgrown and underutilized farmland into a productive silvopasture system. Over a period of roughly twenty years, the area had become overtaken by invasive species including autumn olive, Russian olive, invasive brambles, and dense thorny brush, limiting agricultural use and productivity of the site.

The project began with the removal of invasive vegetation to restore access and prepare the area for future grazing. Following clearing activities, stumps, fallen trees, and other debris were removed to create safe and accessible grazing lanes for livestock. Once the site was stabilized, the farm established a silvopasture system by reseeding pasture and planting trees selected for both ecological and agricultural value. Species included oak trees to provide future acorn production for livestock feed, as well as serviceberry, apple, and pear trees to increase forage opportunities and nutritional diversity for cattle, pigs, and laying hens.

The project established five acres of silvopasture while improving the productivity, biodiversity, and long-term sustainability of the farmland. The restoration also stabilized soils and reduced erosion, demonstrating how working lands can integrate agricultural production, invasive species management, habitat enhancement, and climate-smart land stewardship.

CT Example: **Reducing the Carbon Footprint and Increasing Resiliency at Blackmer Farm**

Blackmer Farm in Thompson, installed a 22.04 kW roof mounted solar array marking a meaningful investment in long term sustainability and operational resilience for the farm. Designed to generate approximately 23,800 kWh of electricity each year, the system is sized to meet nearly 100% of the farm’s energy consumption, effectively transforming the farm into a near net zero energy operation.

This transition to on-site renewable power is expected to deliver about $6,000 in annual energy savings. Beyond the economic impact, the solar installation positions Blackmer Farm as a model for clean energy in Connecticut’s agricultural community. By reducing reliance on fossil fuel-based electricity, the farm is cutting its carbon footprint and contributing to broader regional sustainability goals. The project demonstrates how renewable energy can strengthen CT farms, support environmental stewardship, and create long lasting value for future generations.

This project was awarded to Blackmer Farm by CT RC&D through their DoAg Climate Smart Agriculture & Forestry Grant. When leveraged further with a Rural Energy for America Program (REAP) grant from USDA Rural Development, this funding has helped make the project financially accessible, lower upfront costs, and accelerate the farm’s path to energy independence.

G. Increase resilience through nature-based stormwater management

Background: Stormwater runoff is one of the primary drivers of water quality impairment, flooding, and aquatic (freshwater and estuarine/marine) habitat degradation in Connecticut. As development of impervious surfaces including roads, parking lots, and rooftops increases, rainfall that would otherwise infiltrate into soil or be taken up by vegetation is rapidly conveyed into storm drains and nearby waterbodies. More impervious surfaces result in increased runoff volume and velocity, mobilized pollutants, destabilized stream channels, and reduced groundwater recharge. Overall, this represents a cumulative negative impact on the natural systems that we all depend on for drinking water, wildlife, and recreation.

Nature-based stormwater management options and solutions address these challenges by restoring or mimicking the natural hydrologic processes that regulate water movement across the landscape. By using soils, vegetation, wetlands, floodplains, and other natural systems to absorb, store, filter, and slowly release water, nature-based solutions reduce pollutant loading, moderate flooding, and improve watershed resilience to drought and climate change.

NBS provide a multi-benefit approach to managing stormwater that addresses both environmental and community resilience challenges at a lower cost than engineered solutions.

Traditional stormwater systems are designed primarily to move water away from developed areas as quickly as possible. While effective for drainage, this approach can worsen downstream flooding, degrade water quality, stress stormwater and wastewater infrastructure, and disrupt natural hydrology. NBS instead focus on restoring natural water retention and infiltration processes that ultimately:

- Reduce nutrient and sediment pollution entering waterways
- Protect drinking water sources and aquatic habitats
- Reduce flood risks in downstream communities
- Improve groundwater recharge and drought resilience
- Enhance ecosystem health and biodiversity

Best Management Practices (BMPs): By integrating stormwater management into natural landscape systems, communities can achieve multiple environmental and climate goals simultaneously. There are several best management practices that are recommended for nature-based stormwater management:

Riparian Buffer Protection and Restoration

Vegetated buffers along rivers and streams are among the most effective natural stormwater management practices. Protecting existing riparian vegetation is often the most cost-effective strategy for protecting water quality and managing stormwater. Benefits include:

- Filtering sediment and nutrient pollution.

- Reducing flood water velocity limiting erosion and allowing for sediment deposition.
- Stabilizing stream banks.
- Providing shade that regulates water temperature.
- Improving aquatic habitat and biodiversity.

Wetland Protection and Restoration

Wetlands provide natural flood storage and water filtration. Wetland restoration projects can restore essential functions where they have been lost due to development or drainage. Key stormwater benefits include:

- Storing floodwaters during large storms.
- Moderating hydrologic flows.
- Removing nutrients and pollutants through natural biological processes.
- Supporting groundwater recharge.
- Providing critical wildlife habitat.

Floodplain Restoration

Reconnecting rivers to their floodplains allows stormwater to spread out and slow down during high flow events. Floodplain restoration is increasingly recognized as an important climate resilience strategy. Benefits include:

- Reduced downstream flood risk.
- Improved sediment deposition and nutrient retention.
- Enhanced habitat complexity.
- Increased groundwater recharge.

Soil Health and Landscape Practices

Healthy soils play a critical role in stormwater management. Good soil practices increase the ability of landscapes to absorb and retain water during storm events. Practices that improve soil infiltration and water storage include:

- Reduced soil compaction.
- Improving soil health by increasing organic material in soil through:
    - Mulching in leaves on lawns.
    - Adding compost.
- Native vegetation plantings.
- Conservation landscaping.

- Minimizing impervious cover.

Green Infrastructure

Green infrastructure captures and treats stormwater close to where it falls, slowing runoff, filtering pollutants, and increasing infiltration. Examples include:

- Rain gardens and bioretention areas.
- Vegetated swales and bioswales.
- Permeable pavement systems.
- Green roofs.
- Urban tree canopy expansion.

CT Example: **Hamden Town Center Park Bioretention**

The Clean Water Act Section 319 nonpoint source grant program funded a project to mitigate the impacts of stormwater pollutant runoff and flooding from a 74-acre urban watershed consisting of commercial and residential land use. The project was awarded to Save the Sound and the Town of Hamden, who also provided significant resources to support the project which is currently the largest known bioretention project in the state.

The watershed is approximately 21% impervious cover that discharges to a central location in Hamden’s Town Center Park. The project created a large stormwater bioretention system that includes a scour pool at the pipe outlet, planted slopes around the stormwater outfall headwall, a stormwater conveyance system - comprised of cobble steps and pools used to slow and infiltrate runoff, planted banks along the channel, and four bio-retention cells separated by cobble weirs, and two main overflow weirs. Total annual volume of stormwater managed by this project was calculated at over 96 million gallons per year.

CT Example: **Meriden Green Flood Control Project**

The Meriden Green, constructed using brownfield and economic development grants, is central to the revitalization of downtown Meriden that also includes mixed-use development related to the new Amtrak station. Harbor Brook was daylighted and its channel restored to its original location using nature-based solutions including the construction of pools and riffles using native stones and boulders. The stream channel's banks were stabilized and planted with native, low maintenance wetland species selected to promote riparian habitat, biodiversity, and nutrient assimilation. Within the Green, landforms were developed to contain a 100-year flood event while creating a natural appearance for the park and to provide space for civic events and free play. In addition to being a major park feature, a bridge connects the neighborhoods on one side of the park to the downtown and the rail-station even during flood events.

Design plans prepared by SLR Consulting were developed over a multi-year period through a thorough public vetting process. Regulatory permitting from federal, state and local agencies was a critical piece for driving this project to construction. It is one of the largest flood control projects that the state has permitted over the last 25 years and one of the first flood control projects to use nature-based solutions to achieve flood storage/ reduction. Construction materials for the Meriden Green are designed to withstand periodic inundation and can be easily cleaned after flood events. The regulatory approval process was one of the most complex in Connecticut, involving several federal, state, and local environmental agencies.

H. Increase resilience through nature-based shoreline protection

Background: A living shoreline is a form of “green” infrastructure that serves to protect and stabilize coastlines using plants, shellfish, sand, rock, wood, and other natural materials. Living shorelines use a combination of techniques that can include the creation or restoration of marshes, shellfish reefs, submerged aquatic vegetation, reef balls, low rock sills, and more. Living shorelines provide a cost-effective alternative for erosion protection to traditional hardened shoreline infrastructure, while also offering environmental benefits.

Living shorelines create habitat, supporting the needs of a variety of fish, birds, shellfish, and other species, thereby increasing biodiversity. Living shorelines improve coastal resilience to sea level rise by creating a contiguous land-water interface that allows for marsh migration further upland and reduced shoreline erosion.

Healthy tidal marshes are also an important element of shoreline protection. Approximately 15 feet of marsh can reduce intense wave energy by 50% in certain environments, which allows sediment to collect and stabilize the shoreline during storm events.[28] Tidal marshes are also one of the most efficient ecosystems for carbon storage in the world.[29]

Sea levels in Long Island Sound, as measured at Bridgeport, CT; New London, CT; Kings Point, NY; and The Battery, NY (which lies outside of Long Island Sound but its long history of data collection offers a point of comparison for Long Island Sound locations), are rising at a rate at least 33% higher than global sea level rise between 1970 and today.[30] The sea level in Connecticut is expected to rise by 20 inches by 2050.[31]

Living shorelines help to build resilience against increased storm events and associated erosion, infrastructure loss and damage, reduced water quality, and loss of wildlife. Unlike gray infrastructure like seawalls, living shorelines have some capacity for self-repair following storm disturbances, and can support adaptation to gradual sea level rise by allowing sediment to accumulate and anchor vegetation that keeps coastlines from receding. Coastal wetlands, including those that are part of living shorelines, provide $11,190 per acre in ecosystem services

[28] “Restore-Adapt-Mitigate: Responding to Climate Change Through Coastal Habitat Restoration.” *Restore America’s Estuaries*. 2012. https://estuaries.org/wp-content/uploads/2018/08/RAE_Restore-Adapt-Mitigate_Climate-Chg-Report.pdf

[29] Davis, J., C. Currin, C. O’Brien, C. Raffenburg, A. Davis, “Living Shorelines: Coastal Resilience with a Blue Carbon Benefit.” 2015. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0142595

[30] “Sea Level Trends.” *Long Island Sound Partnership*. 2026. https://lispartnership.org/ecosystem-target-indicators/sea-level-trends-for-kings-point/

[31] O’Donnell, J. “Sea Level Rise in Connecticut, Connecticut Institute for Resilience and Climate Adaptation.” 2019. https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/02/SeaLevelRiseConnecticut-Final-Report-1.pdf

annually.[32, 33] Based on this value assessment, Connecticut's roughly 14,836 acres of tidal wetlands and flats could deliver an estimated $166 million in ecosystem services each year.[34]

States are increasingly recognizing the importance of living shorelines and adapting their policies to prioritize them. In 2013 and 2020, respectively, Maryland and Virginia established that living shorelines are the preferred method of stabilizing and protecting shorelines, unless proven otherwise.[35]

Best Management Practices (BMPs): Several BMPs assist nature-based shoreline protection:

Prioritizing Planting of Native Species: Prioritizing native species in living shorelines offers benefits for erosion and flooding protection and wildlife habitats. East coast living shorelines should contain a range of native plants tailored to average high-water levels for maximum effectiveness: common species in Connecticut's coastal marshes include smooth cordgrass in low marshes and saltmeadow cordgrass in high marshes.[36]

Tailoring Living Shoreline Structures to Different Wave Energies: Where wave energy is low, living shorelines composed of just vegetation are optimal, offering the benefit of breaking up small waves and a buffer for marshes to migrate further upland. Except for where wave energy is high, living shorelines composed of vegetation and structural support in the form of sills or reef balls secure vegetation and break up incoming waves.[37]

Constructing Living Structure/Breakwater that Creates Habitat:

- *Oysters:* Responding to the dramatic decrease in eastern oyster populations in Long Island Sound, constructing regenerative oyster reefs serves benefits of reducing wave energy, enhancing wildlife habitat, and reducing shoreline erosion. Recruiting wild oyster larvae using, for example, reef balls and concrete oyster castles like in the Stratford Point project enables constructed reefs to self-expand with time, assuming that water salinity, temperature, and soil content are optimal for oyster survival. Bagged oyster shells are also used and can easily be removed to align with regulatory requirements. Research out of East Carolina University shows that living shorelines containing breakwaters that recruit oysters absorbed up to 15% more wave activity after two recruitment periods, with multiple rough vertical layers of oyster shells breaking up waves.[38] Additionally, studies show that one oyster can filter around 50 gallons of

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[32] FEMA Ecosystem Service Value Updates. 2022.

[33] Calculated as the sum of: $8,955 in value in 2021 USD: $1,648 per acre per year in aesthetic value, $125 per acre per year in climate regulation value, $2,420 per acre per year in habitat value, $1,624 per acre per year in recreation and tourism value, $1,035 per acre per year in flood and storm hazard risk reduction, $1,558 per acre per year in water filtration value, and $544 per acre per year in water supply value; adjusted for inflation to calculate 2026 value using the US Bureau of Labor Statistics' CPI Inflation Calculator: https://www.bls.gov/data/inflation_calculator.htm

[34] 2025 Connecticut Wildlife Action Plan.

[35] Living Shorelines." 2026. https://www.cbf.org/issues/living-shorelines/

[36] "Tidal Marshes." 2026. https://climate.uconn.edu/habitats-resources/coastal/tidal-marshes/

[37] "Understanding Living Shorelines." 2026. https://www.fisheries.noaa.gov/insight/understanding-living-shorelines

[38] Trista Talton. "Thriving Oyster Colonies on Living Shorelines Boost Protection." 2026. https://coastalreview.org/2026/01/thriving-oyster-colonies-on-living-shorelines-boost-protection/

water each day, if not more, thus enhancing water quality and reducing the risk of hypoxia and algal blooms.[39]

- *Fish:* Similar to structures that create habitat for oysters, living shorelines that create fish habitat also have benefits for local economies by creating opportunities for fishing.[40]
- *Horseshoe Crabs:* Oyster castles can also be used compatibly with young horseshoe crabs moving through living shorelines, as demonstrated in Delaware Bay.[41]

Beneficial Use of Dredge Material: Tidal marshes persist by trapping and accumulating sediment, which allows them to keep pace with sea-level rise, but human interventions (e.g., dams) trap and reduce the supply of sediment in river systems, which hinders marshes from building elevation and leads them to drown and disappear. Strategically placed dredged sediment in marshes can rebuild elevation, enhance resilience, and even create new marshland. Supplying sediment to these systems can enhance marsh health for wildlife that depend on this habitat, such as the threatened Saltmarsh Sparrow.

This “beneficial use” of dredged material for marsh nourishment is an emerging climate adaptation strategy that turns a waste product into a restoration and coastal protection tactic. Using locally available dredged sediments to benefit marshes could also offset costs associated with dredged material disposal. Special Act 25-17 directs DEEP to develop a plan for beneficial use dredging by February 1, 2027. Additionally, the U.S. Army Corps of Engineers 70 by 30 goal seeks to increase beneficial use to 70% by 2030. Today, USACE utilizes 30-35% of available sediments dredged from federally overseen navigation routes for beneficial purposes.[42]

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[39] “Oysters - More Than Just Good Eats.” 2025. https://lispartnership.org/2025/11/oysters-more-than-just-good-eats/

[40] “The Living Breakwaters: A Model for Nature-Based Infrastructure - Tottenville, South Shore of Staten Island.” 2025. https://www.billionoysterproject.org/blog/the-living-breakwaters-a-model-for-nature-based-infrastructure

[41] James Miller. “Learning from a Living Shoreline in Delaware Bay.” 2021. https://www.fws.gov/story/2021-06/learning-living-shoreline

[42] “Discover, Learn, and Grow Beneficial Uses of Dredged Sediment.” 2026. https://budm.el.erdc.dren.mil/

<u>CT Example</u>: **Stratford Point Living Shoreline & Tidal Wetland Restoration**

Source: Sacred Heart University

This project initiated in 2014 utilizes artificial shellfish reefs (a.k.a. reef balls) to protect 750' of beach/shoreline at Stratford Point from coastal erosion while also supporting 4.5 acres of intertidal habitat, 1.5 acres of coastal dune habitat, and 25 acres of woodland/meadow mix. The effort, located alongside a designated "Important Bird Area" at the confluence of the Housatonic River with Long Island Sound, is coordinated by Sacred Heart University with funding from the U.S. Army Corps of Engineers In-Lieu Fee Program, CIRCA, and NOAA's Coastal Resilience program.

To adaptively manage the site, a second restoration project is being developed to extend the marsh seaward by 0.35 acres over an additional 250 feet of shore using bagged slipper shells and small, modular oyster castles near the marsh edge and cordgrass plantings in the intertidal zone. The site was recognized in 2020 as the "Best Restored Shore Area" by the American Shore and Beach Preservation Association.

I. Improve air quality and reduce urban heat islands through urban forestry

Background: Urban forests and green spaces are central elements of a community's green infrastructure that provide improved air quality, carbon storage and sequestration, enhanced biodiversity, absorbed emissions, and protection or buffering against climate change impacts.

Tree-lined streets; large, mid-sized, and smaller "pocket" parks; community, residential, and rooftop gardens; and green areas associated with residential properties are all part of this urban forest and green space network. Collectively, these forested and green areas help mitigate the impacts of increased ambient air temperature (i.e., the heat island effect), help to improve air quality by filtering and cleaning air through vegetative respiration, manage stormwater runoff through greater infiltration and absorption, enhance biodiversity, and provide recreational, public health, economic, and other community benefits.

Urban forests sequester and store carbon at significant levels. Results from a national study of urban forests in eight cities, including New Haven, CT, found carbon storage of up to 21.4-26.7 kg of carbon per square meter.[43] Results from a 2013 study on carbon storage in a select number of cities found that Hartford's trees store 10.89 kg of carbon per square meter (based on 2007 data) -- the third highest storage amount amongst surveyed cities.[44]

In addition to their direct effect on GHG emissions, well-positioned trees play an important role in reducing the impacts of heat and cold on both indoor and outdoor settings. In warm weather, trees

[43] Jevon, F., Crown, C. A., Clark, J. A. G., Doroski, D. A., Darling, L., Sonti, N. F., Yesilonis, I. D., Dietsch, G., Bradford, M., & Pregitzer, C. C. "Native trees are responsible for the high carbon density in urban natural area forests across eight United States cities." 2025. https://doi.org/10.1111/1365-2664.14823

[44] Nowak, David J., Eric J. Greenfield, Robert E. Hoehn, and Elizabeth Lapoint. "Carbon Storage and Sequestration by Trees in Urban and Community Areas of the United States." 2013. https://doi.org/10.1016/j.envpol.2013.03.019

can reduce air conditioning needs or prevent heat-related health emergencies, and in cold weather, trees can serve as a buffer against wind to reduce the need for heat.

A 2017 study suggested that nationally, the average reduction in residential energy use due to trees is 7.2 percent and that specific designs to reduce energy use using urban trees could increase these values and further reduce energy use and improve air quality. The study also estimated that in Connecticut, approximately $141.3 million/year in energy costs are being saved by trees positioned around residential buildings, although these modeled benefits were limited to urban tree cover and the broader effects in less urban areas were likely under-represented.[45]

Neighborhoods with 40% urban tree cover or more see temperature reductions of 7-9 degrees (F). During heat waves, this temperature differential can literally represent the difference between life and death.[46]

Urban green spaces also offer significant refugia and habitat for a number of wildlife species. In these more urbanized settings, it has been shown that increasing native vegetation from 10 to 30 percent can lead to a resulting increase in the occupancy of native species by 10 to 140 percent.[47]

Urban trees also can reduce flooding by helping to slow and absorb stormwater, with one study documenting up to a 25 percent reduction in runoff volume as well as a 25 percent reduction in peak flow.[48] In New York City, its trees reduce runoff by more than 516 million gallons of stormwater each year.[49]

Because of the many values provided by urban forests, Connecticut has a goal of increasing tree canopy cover in environmental justice communities by 5 percent by 2040 – in communities an existing tree canopy coverage of less than 40 percent – with a focus on also increasing equitable access to these trees and the benefits they provide.[50]

Best Management Practices (BMPs): BMPs comprehensively range from planning and maintenance to community engagement and conservation all with the intent of ensuring existing urban forest and green resources remain and are improved over time.

Planning and Inventory

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[45] Nowak, David J., Nathaniel Appleton, Alexis Ellis, and Eric Greenfield. “Residential Building Energy Conservation and Avoided Power Plant Emissions by Urban and Community Trees in the United States.” 2017. https://research.fs.usda.gov/download/treesearch/53420.pdf

[46] Orloff, Whitney. “Greening Without Displacement: The USDA’s Urban Forestry Approach.” 2025. https://www.eesi.org/articles/view/greening-without-displacement-the-usdas-urban-forestry-approach#:~:text=Today%2C%20over%2080%25%20of%20Americans,to%20all%20other%20land%20types

[47] Oliveira, Williams, Jéssica Luiza S. Silva, Marcelo Tabarelli, and Ariadna V. Lopes. “Benefits of Urban Trees to People and Their Potential Contribution to All the 17 Sustainable Development Goals.” 2026. https://www.sciencedirect.com/science/article/pii/S2666719326000543

[48] Alivio, Mark Bryan, Matej Radinja, Mojca Šraj, and Nejc Bezak, “An Evaluation of the Stormwater Runoff Reduction of Two Distinct Tree Species to Support Urban Greening as Nature-Based Solutions.” 2025. https://www.sciencedirect.com/science/article/pii/S1618866725001268

[49] NYC Urban Forest Plan 2026. https://www.urbanforestplan.nyc/

[50] Public Act 23-206: https://www.cga.ct.gov/2023/sum/pdf/2023SUM00206-R02SB-00896-SUM.pdf

- Fully recognize and incorporate existing urban forest and green space areas into land use and planning documents and reports within a given city or urban landscape; development of local policies such as tree ordinances; additional state-level regulatory incentives or availability of grant funding could facilitate planning efforts. As needed, look to engage with other professionals and networks (i.e., CT Urban Forest Council) to find planning document examples, approaches, and models to refer to that will help create greater consistency across municipalities in Connecticut.
- Define the current ownership, location, condition, and accessibility of the collective urban forest and green space resources and integrate information into a long-term, adaptive management plan to help improve key measurable metrics such as percent increase in urban tree canopy over time.
- Ensure urban forest and green space plans are supported by comprehensive Geospatial Information System (GIS) assessments that allow for the accurate inventory and tracking of urban tree health and species diversity with direct links to maintenance interventions in a respective master urban tree canopy plan.

Planting and Maintenance

- Planting efforts should account for proper site and species selection. Native species should be considered where conditions allow, especially native species that are resilient to urban heat island effects and other environmental challenges of urban landscapes. Be sure to encourage and engage residents in the planting efforts.
- Direct attention towards developing a mixture of age and size classes to help increase the ability of current and future urban tree canopies to withstand disease, pests and pathogen outbreaks, and other environmental disturbances.
- Work towards the 10-20-30 guideline for species diversity goals for a particular area of focus. The guideline prescribes that a sustainable urban tree population should contain no more than 10% of any single species, 20% of any genus, or 30% of any family.[51]
- Ensure that planting sites are prepared to accommodate additional trees through consideration of receiving soil conditions and adequate growing space. Receiving soils should be enhanced with the addition of nutrients and organic matter to help with fertility and soil moisture requirements. Tree pits should be as large as possible but no smaller than 4’ by 4’.
- Planting and post-planting require proper planting techniques that emphasize protecting root structure as well as regular watering of newly planting trees (particularly immediately after installation during the hotter/drier summer months) and structural pruning early on.
- Proactive maintenance and pruning of mature trees is critical to maintain health, improve structure, and minimize safety hazards over the long term.

Community Engagement and Outreach

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[51] Michael R. Freiburger, Colleen Murphy-Dunning, Danica A. Doroski, P. Mark Ashton, Jacob D.J. Peters, “The 10/20/30 planting rule aligns with traditional plant diversity metrics across spatial scales.” 2025. https://www.sciencedirect.com/science/article/pii/S1618866725004467

- Conduct community-based efforts that focus on opportunities for residents to help with tree planting and care such as watering, which will help with greater community awareness and foster stewardship in the immediate and long-term life cycle of urban tree canopies. [52]
- Assess and justify planting efforts to reduce the inequitable distribution of urban tree canopy in cities in Connecticut.
- Identify other local efforts (e.g., land trust community-based efforts to map conserved lands) that may be natural partners with tree planting and care.

Leadership, Governance, and Funding

- Secure commitment of leadership to require the incorporation of these BMPs into new redevelopment or development projects, launching and protecting policies, regulations, by-laws that favor urban forest management, community engagement and public support, and identification and application of funding for Urban Forestry and Green Space maintenance and improvements.
- Establish and strengthen partnerships between municipal staff with local and state-wide non-profit organizations to advance local Urban Forestry and Green Space maintenance, improvements, and plans.

CT Example: **DEEP's Urban and Community Forestry (UCF) program**

DEEP's UCF program assists municipalities, non-profits, and community groups throughout the state in caring for and increasing their urban and community forests. Urban trees deliver key benefits to residents, including mitigation of extreme heat, improved air and water quality, and increased access to green space in communities disproportionately affected by climate change. Two recently funded projects through DEEP's UCF Program exemplify these benefits.

Bridgeport has the lowest tree cover in the state, leaving residents disproportionately exposed to extreme heat. To address this, Groundwork Bridgeport launched a tree planting and stewardship program in partnership with Emerge, a local workforce development organization. In addition to planting new trees, crews provide ongoing care for existing trees, recognizing that mature trees deliver greater cooling, air quality, and stormwater benefits than young trees alone. Groundwork Bridgeport also conducts inventories of existing trees and monitors their health, enabling strategic management of urban forests to maximize climate mitigation benefits.

South Norwalk is a low-canopy, high-impervious-surface neighborhood near a Norwalk Housing Authority complex. The Norwalk River Watershed Association, in partnership with the Norwalk Land Trust, is removing 7,000 square feet of pavement and replacing it with densely planted native trees and shrubs. By converting paved areas into green space, this initiative demonstrates how nature-based solutions can be implemented in highly developed neighborhoods where existing planting space may be limited.

These projects were funded through one-time resources made available by the Inflation Reduction Act; DEEP's Urban Forestry Program currently has no long-term funding to sustain these initiatives.

[52] Wirtz, Zach, Shannon Hagerman, Richard J. Hauer, and Cecil C. Konijnendik. "What Makes Urban Forest Governance Successful?" 2021. https://www.sciencedirect.com/science/article/pii/S1618866720307184

J. Increase access to open space for public health benefits

Background: For a relatively small state, Connecticut offers an amazing diversity of activities that are central to a $6 billion outdoor recreation economy (the second largest in New England) sustaining an estimated 50,275 jobs.[53] Ensuring access to open space sustains economic as well as significant public health benefits. Of course, the green spaces and recreational lands themselves provide for many additional ecosystem services discussed earlier in this chapter.

Access to open spaces provides significant physical and mental health benefits across all demographics. Several studies highlight the following advantages:

1. Physical Health Benefits: [54]
    - Improved sleep quality, reduced blood pressure, enhanced immune function, and increased physical activity.
    - Urban open spaces mitigate heat island effects, reduce pollution, and provide opportunities for outdoor activities, improving overall physical health.
2. Mental Health Benefits: [55]
    - Reduced stress, anxiety, and depression.
    - Enhanced cognitive function, attention span, emotional regulation, and mood.
    - Long-term benefits include improved academic performance and social cohesion.
3. Demographic-Specific Benefits:
    - <u>Children</u>: Nature exposure fosters curiosity, resourcefulness, and cognitive development while reducing screen addiction.[56,57]
    - <u>Adults</u>: Stress relief and improved mood, especially for those affected by urbanization and sedentary lifestyles.
    - <u>Seniors</u>: Accessible open spaces promote physical activity and mental well-being.[58]
    - <u>People with Disabilities</u>: Accommodations in parks enable equal access to nature's benefits. Experiences in nature help build self-confidence and self-reliance.[59]

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[53] U.S. Dept of Commerce: Bureau of Economic Analysis. "2024 Outdoor Recreation Economic Statistics for Connecticut." https://apps.bea.gov/regional/outdoor-recreation/pdf/Connecticut2024.pdf

[54] Jimenez MP, DeVille NV, Elliott EG, Schiff JE, Wilt GE, Hart JE, James P. "Associations between Nature Exposure and Health: A Review of the Evidence." 2021. https://pmc.ncbi.nlm.nih.gov/articles/PMC8125471/

[55] Bo-Yi Yang, et al. "Greenspace and human health: An umbrella review." 2021. https://www.sciencedirect.com/science/article/pii/S2666675821000898#abs0020

[56] Tillmann S, Tobin D, Avison W, et al. "Mental health benefits of interactions with nature in children and teenagers." 2018. https://jech.bmj.com/content/jech/72/10/958.full.pdf

[57] Lomax T, Butler J, Cipriani A, Singh I. "Effect of nature on the mental health and well-being of children and adolescents: meta-review." 2024. https://www.cambridge.org/core/journals/the-british-journal-of-psychiatry/article/effect-of-nature-on-the-mental-health-and-wellbeing-of-children-and-adolescents-metareview/CDFA53EA8BEFFDA0613B80632F3FB18B

[58] Bole A, Bernstein A, White MJ. "The Built Environment and Pediatric Health." 2024. https://pubmed.ncbi.nlm.nih.gov/38105697/

[59] Movahed M, Martial L, Poldma T, Slanik M, Shikako K. "Promoting Health through Accessible Public Playgrounds." 2023. https://www.mdpi.com/2227-9067/10/8/1308

Increase access to open space for public health benefits

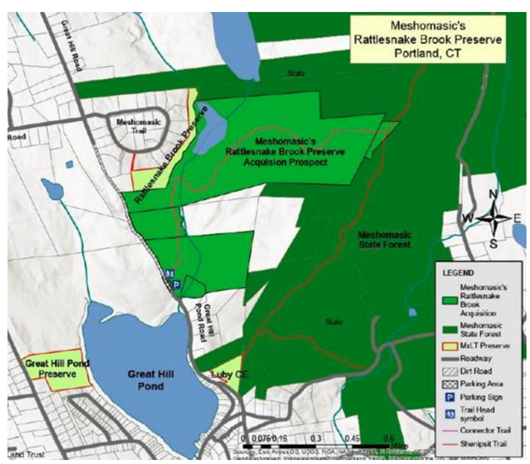
Best Management Practices (BMPs): There are several BMPs and policies to maximize the health benefits of open spaces:

1. **Ensure Equal, Accessible, and Safe Green Spaces**:
    - Develop parks within walking distance of neighborhoods, especially underserved areas.
    - Improve safety with solar lighting and community involvement.
    - Remove barriers such as limited hours, high costs, or transportation challenges.
2. **Integrate Nature into Schools and Daily Life**:
    - Incorporate nature-based learning in school curricula and create green schoolyards.
    - Schedule regular outdoor activities during school hours and encourage outdoor play at home.
3. **Support Nature-Based Programs**:
    - Fund community and school-based outdoor learning initiatives.
    - Train educators in nature-based teaching methods.
    - Partner with local organizations to provide guided outdoor activities.
4. **Promote Urban Planning for Open Spaces**:
    - Implement "15-minute city" concepts to ensure proximity to parks.
    - Engage community members in the design and maintenance of green spaces.

CT Example: **Meshomasic Rattlesnake Brook Preserve (OSWA) Grant**

There are many examples of projects that receive matching funds through the OSWA grant program that can be highlighted here. In May 2025, OSWA supported a grant to the Middlesex Land Trust (MLT) to acquire a 145.08-acre property that buffers and expands upon MLT's existing Rattlesnake Brook Preserve and the 15,000+ acre Meshomasic State Forest greenway. The acquisition protects the area's water quality and habitats, expands upon existing passive recreation with additional hiking trails, bird watching, fishing and improved access to hunting opportunities on State lands.

MLT will add a public access trail that connects to the Shenipsit Blue-blazed Hiking Trail, securing a key ridgeline section of the trail. The purchase will protect an existing wildlife migration corridor, a ridgeline forest, a large wetland and a stream corridor. Many habitats at risk from climate change will be better protected: forested swamps, core forests and riparian lands adjacent to cold water streams (Rattlesnake Brook). In addition to providing significant recreational and public health benefits, this acquisition will protect habitats of several threatened and rare species.



OSWA Report, May 2025