TREES AS LIVING INFRASTRUCTURE

ECOSYSTEM SERVICES AND LONG-TERM VALUE OF ASPEN'S URBAN FOREST

DOCUMENT NAVIGATION

WHY TREES MATTER

Aspen's urban forest is a critical component of the community's environmental infrastructure. Beyond their aesthetic and cultural value, trees provide a wide range of ecosystem services that support public health, environmental quality, and long-term community resilience.

Understanding these benefits helps inform how trees are managed, protected, and integrated into the built environment.

KEY ECOSYSTEM SERVICES PROVIDED BY TREES

Climate Moderation and Cooling

Trees moderate local climate conditions by providing shade and cooling the surrounding air through evapotranspiration. Tree canopy reduces surface and air temperatures in streets, parks, and developed areas, improving thermal comfort and supporting outdoor activity. In mountain communities like Aspen, these cooling effects also help reduce energy demand for buildings and infrastructure during warmer periods.

Carbon Storage and Air Quality

Trees store carbon in their wood, roots, and surrounding soils while also filtering air pollutants such as particulate matter and ozone. As trees grow, their capacity to store carbon and improve air quality increases. Large, established trees therefore provide a disproportionate share of these regulating services, making their protection especially important at the community scale.

Hydrology, Soils, and Watershed Function

Trees play a key role in regulating how water moves through the landscape. Canopy cover, roots, and associated soil systems help slow runoff, increase infiltration, and support gradual water release over time. In snow-dominated mountain environments, trees also influence the timing of snowmelt and help buffer peak flows. Belowground, roots and soil organisms improve soil structure, water-holding capacity, and nutrient cycling, supporting long-term watershed function.

Stormwater Management and Soil Stability

Within developed areas, trees provide important stormwater management benefits by intercepting rainfall and reducing the volume and velocity of runoff. Root systems stabilize soils, reduce erosion, and help protect waterways from sediment and pollutants. These services are especially valuable in areas with steep slopes, compacted soils, or high levels of impervious surface.

Biodiversity, Habitat, and Forest Succession

Urban forests support biodiversity by providing habitat, food, and shelter for birds, pollinators, and other wildlife. Beyond individual species, tree communities function as dynamic systems shaped by growth and succession. Maintaining a mix of tree ages and species supports structural diversity, ecological stability, and the long-term continuity of ecosystem services as forests mature, regenerate, and adapt over time.

Cultural and Social Ecosystem Services

Trees also provide important cultural and social benefits that contribute to community well-being. Tree-lined streets, shaded parks, and forested viewsheds support recreation, mental and physical health, and social connection. In Aspen, these landscapes help define community character and sense of place, supporting both resident quality of life and the visitor experience.

The Value of Established Trees

Ecosystem services increase as trees mature. Larger trees provide more shade, store more carbon, manage more water, and offer more complex habitat than younger trees. Because these benefits develop over decades, the loss of mature trees represents a long-term reduction in ecosystem services that cannot be quickly replaced through new plantings. Protecting established trees is therefore one of the most effective ways to sustain community-scale benefits.

STRATEGIES TO SUPPORT LONG-TERM FOREST HEALTH

To sustain Aspen's urban forest and the benefits it provides, the following strategies are especially important:

- Protect established trees by prioritizing soil health, minimizing root disturbance, and supporting deep, resilient root systems.
- Plant for resilience by increasing species diversity and selecting drought-tolerant, climate-adapted trees for future conditions.
- Use water efficiently by prioritizing irrigation where it delivers the greatest long-term ecological benefit, particularly for mature trees.
- Invest in diversity and transition to ensure ecosystem services persist even as climate conditions continue to change.

A LIVING SYSTEM

Trees are not static features of the built environment; they are part of a living, evolving system shaped by growth, disturbance, and succession over time. The ecosystem services Aspen's urban forest provides—cooling, air quality, soil stability, habitat, and carbon storage—emerge gradually and strengthen as trees mature and as forest structure becomes more complex.

Managing urban forests with a long-term perspective means recognizing the value of trees at all life stages, protecting healthy soils, and supporting gradual transitions rather than abrupt canopy loss. When forest systems are allowed to grow, adapt, and renew over time, ecosystem services remain reliable and resilient.

By stewarding trees as living infrastructure within a connected ecological system, Aspen can continue to support environmental health, community well-being, and the natural processes that sustain the urban forest for generations to come.

RESOURCES

CAVENDER-BARES, J., ET AL. (2022). ECOSYSTEM SERVICES OF TREES ACROSS THE UNITED STATES. NATURE REVIEWS SUSTAINABILITY.
FOUNDATIONAL RESEARCH DOCUMENTING HOW TREES CONTRIBUTE TO CARBON STORAGE, AIR QUALITY, CLIMATE REGULATION, AND OTHER ECOSYSTEM SERVICES AT NATIONAL AND REGIONAL SCALES.

NOWAK, D.J., & DWYER, J.F. (2007). UNDERSTANDING THE BENEFITS AND COSTS OF URBAN FOREST ECOSYSTEMS.
A WIDELY CITED SYNTHESIS EXPLAINING HOW URBAN TREES PROVIDE MEASURABLE ENVIRONMENTAL AND SOCIAL BENEFITS.

USDA FOREST SERVICE – URBAN FORESTRY PROGRAM
GUIDANCE ON URBAN FOREST STRUCTURE, ECOSYSTEM SERVICES, AND LONG-TERM MANAGEMENT STRATEGIES.
HTTPS://WWW.FS.USDA.GOV/MANAGING-LAND/URBAN-FORESTS

I-TREE TOOLS (USDA FOREST SERVICE)
A SUITE OF TOOLS USED NATIONWIDE TO QUANTIFY ECOSYSTEM SERVICES SUCH AS CARBON STORAGE, AIR POLLUTION REMOVAL, AND STORMWATER INTERCEPTION.
HTTPS://WWW.ITREETOOLS.ORG

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA). GREEN INFRASTRUCTURE AND URBAN TREE CANOPY
RESOURCES ON HOW TREES CONTRIBUTE TO STORMWATER MANAGEMENT, SOIL HEALTH, AND WATERSHED PROTECTION.
HTTPS://WWW.EPA.GOV/GREEN-INFRASTRUCTURE

COLORADO STATE UNIVERSITY EXTENSION – TREES & SOIL HEALTH
APPLIED GUIDANCE ON SOIL STRUCTURE, ROOT SYSTEMS, AND LONG-TERM TREE PERFORMANCE IN COLORADO CONDITIONS.
HTTPS://EXTENSION.COLOSTATE.EDU

U.S. FOREST SERVICE – TREE SPECIES DIVERSITY AND URBAN FOREST RESILIENCE
RESEARCH AND GUIDANCE ON HOW SPECIES DIVERSITY SUPPORTS RESILIENCE TO PESTS, DISEASE, AND ENVIRONMENTAL STRESSORS.
HTTPS://WWW.FS.USDA.GOV/RESEARCH