



FACING OUR FUTURE: Biodiversity & Habitat Adapting to Connecticut's Changing Climate

“The Millennium Ecosystem Assessment (2005) concluded that: ‘By the end of the twenty-first century, climate change and its impacts may be the dominant direct driver of biodiversity loss and changes in ecosystem services globally.’ Historically, habitat and land use change have had the biggest impact on biodiversity across biomes. However, climate change is increasingly affecting all aspects of biodiversity, from individual organisms, through populations and species, to ecosystem composition and function”. *6th Scientific Statement Impacts of Climate Change on Biodiversity*, Irish Committee on Climate Change, Royal Irish Academy

Implications for Biodiversity

Biodiversity can be defined as the sum of life and its processes including the variety of living plants, animals and other organisms, and the ecosystems in which they occur. In spite of its small size, Connecticut has a large diversity of plant and animal life, and it is the responsibility of the Connecticut Department of Environmental Protection (CTDEP) to be vigilant stewards in maintaining this diversity and the important habitats that support it. According to Connecticut's *Comprehensive Wildlife Conservation Strategy* (CWCS) dated October 1, 2005, Connecticut supports thousands of animal wildlife species, mostly invertebrates. Add to these an estimated 2,600 species of vascular plants and the biodiversity of such a small state is remarkable. This diversity is a reflection of the state's varied landscapes ranging from the coastal beaches and dunes bordering Long Island Sound to the summits along the Taconic range in the northwestern corner of the state. While the considerations herein are interrelated to the other fact sheets, this fact sheet focuses on how critical biodiversity and abundant habitat are to adaptation in a changing climate.

Habitats and species are always changing across time and landscapes. However, as a result of climate change, a ripple effect from a confluence of stressors may dramatically unfold in the region's habitats and within the variety of life

these habitats support. Invasive species, non-native or exotic plants and animals have the potential to significantly impact New England's native and most delicate flora and fauna as the climate is altered. Fragmentation of habitat, changes in biological timing known as phenology, and other disruptions to the food web are all threats to biodiversity. Climate change is expected to increase the rate of extirpations of rare and endangered species by altering their habitat.



Twin flower, a northern wildflower, will likely be extirpated from Connecticut as temperatures warm.

Since the end of the last glaciations 15,000 years ago, Connecticut has experienced dramatic climate and vegetation changes, with a northward progression of open woodlands of spruce and pine to the oak forests that dominate the landscape today. This occurred in a

landscape unaltered by man's presence. Given the predictions of a more rapid period of warming, there is no doubt that Connecticut will look very different to future generations. The challenge that Connecticut is facing today is to decide where rapid climate change will have undesirable environmental consequences and how to preserve and maintain our critical habitats to accommodate the inevitable change. The future of Connecticut's natural resources and biodiversity are tied to environmental planning and responsible growth.

Habitats in Connecticut – The landscapes of Connecticut are influenced by its geological past. Natural processes of many kinds have contributed to its present structure. In general, Connecticut can be subdivided into several geologic regions. The eastern and western parts of the state are characterized by wooded hills and low mountains underlain by acidic gneisses and schists. These two regions are separated by the Connecticut Central Valley, a younger region of sedimentary and igneous rocks. Here, the broad floodplain of the Connecticut River and a north-south-trending spine of basalt, or the trap rock ridges, are distinctive. On the northwestern border of the state is another prominent valley, here underlain by marble bedrock.

During the past glacial period, Connecticut was entirely covered by thousands of feet of ice. When the glacier melted, part of the debris was left in place as glacial till, and part was carried by glacial melt-water and deposited as stratified sand and gravel in the river valleys and lowlands. This debris provided the material in which the current soils have developed. Connecticut's landscapes are also influenced by climate. From the southeastern coastal region to the northwest corner, there is a progressive decrease in average temperature and length of growing season. This climatic transition and the regional variation in soils have had a major influence on the natural vegetation and the land-use history of the state.

From a regional perspective, the predominant vegetation of Connecticut today is forest mostly dominated by oaks, beech, birch, maple, and hickories. In northwestern Connecticut, these forests grade into a zone of northern hardwoods, composed primarily of sugar maple, beech, and

yellow birch. Hemlock and white pine are common and/or locally dominant throughout. The return of Connecticut to a forested landscape is a relatively recent event. As recent as the late 1800's, Connecticut's forests were mostly cleared, plowed, grazed, and clear-cut for charcoal production.

Currently, the major causes of changes in Connecticut's plant patterns are fragmentation by residential development, the infestation of invasive species, and imbalance of certain key species such as whitetail deer. The impacts to certain habitats can be quite dramatic. It is estimated that habitats such as pitch pine barrens and sand plain grasslands have been reduced to less than five percent of their pre-European settlement abundance. Both coastal beaches and dunes have been built upon, most of our tidal marshes have been ditched for mosquito control, and our rare, geographically restricted fens in the marble valleys have been over-run with invasive plants. In other parts of the state, the regeneration of forest trees has been significantly reduced by deer browse. In fact, there are forested areas in Fairfield County where the understory has been denuded of vegetation, with the exception of highly invasive plants such as garlic mustard and Japanese stilt grass. The negative impacts of deer over-browse on biodiversity and ecosystem health should not be underestimated. Wildlife and forest management are critical to the ability of habitats to adapt to rapid changes in climate. (Information about forest management can be found in the Forestry fact sheet. Additional related information can be found in the Fisheries, Natural Coastal and Wildlife fact sheets).



Pitch pine woodland in Hopeville Pond Natural Area Preserve under fire management restoration

Responsible Growth - Physical barriers for plant and animal migration once were mountains, oceans and unsuitable soil. Barriers now include urban, suburban and agricultural lands as well. As Connecticut's habitats change as a result of warming, maintaining connectivity for habitat is critical for plant and animal migration. Connecticut needs to manage biological corridors and link together large habitat blocks. This must be paired with early successional management, by maintaining shrub lands, grasslands, and other open habitats for colonization. Connecticut may have to create and/or allow space for the inland migration of tidal marshes as sea level rises. These decisions need to be made within a landscape context, across political boundaries, to allow plant migration and succession over time.

CTDEP's updated *Green Plan* (2007-2012), recommends better identification of sensitive ecological areas and unique features to help guide acquisition and preservation efforts by state agencies, regional planning agencies, local communities and nongovernmental organizations. Maintaining migratory links and conserving sensitive habitats must be made an integral component of land-use planning and development. This habitat specific planning must be coupled with the principles of responsible growth.

Grasslands – Connecticut grasslands are also under intense development pressure. These areas provide a breeding ground for migratory birds and habitat for a large number of State Endangered and Threatened species. Natural grasslands are undoubtedly one of the most imperiled habitats in Connecticut, experiencing a precipitous decline in their natural distribution and extent on dry, nutrient-poor sites. One of the long term projections resulting from climate change is expected to include periods of prolonged drought. Trees occurring on dry ridge tops and dry sandy soils may drop their leaves due to water stress and could be weakened and die. If this is the case, there may be an expansion of natural grasslands in these areas. Since native grasses are well adapted to habitats with high daytime temperatures and intense sunlight, there may be an expansion of warm-season grasslands, mitigating the dramatic losses that have occurred to this habitat over time. This however, depends on whether there is sufficient

foresight and planning within the state to retain adequate open space for this to occur. (See the Wildlife fact sheet for details on the CTDEP's Grassland Habitat Initiative).



Warm season grasslands are now confined primarily to small openings on dry, sandy soils.

Phenology – Phenology refers to the timing of biological events, including flowering, breeding, and migration; in relation to climate. With warmer winters, Connecticut is expected to experience progressively earlier spring flowering than in the previous century. Observations of plant phenology over the past 30 years already document earlier flowering in North American plants by an average of six days. The earlier onset of bud burst, flowering, and fruiting may have impacts on timing-sensitive relationships with pollinators, seed dispersers and herbivores. Events that have long occurred in synchrony may become decoupled. This will affect the timing of wild and agricultural fruit production, migratory species survival, and predator-prey relationships.

Many private organizations keep written logs of phenological observations. Formal records of flowering dates document the arrival of spring in New England three days earlier in recent years than it did in 1975. Since early spring migratory birds feed on the variety of insects that eat early emerging leaves and buds, this type of shift could take on some importance. At this point the shift is not great enough, within a two week window of observable record, to impact the relationship of migratory songbirds and the insects that they feed on. However, monitoring has already indicated that some early arriving warbler species are being weakened because they are lacking the typical fat reserves

necessary for their long flights. It is conceivable that if their food sources are not available within the right window of time, some warbler populations will diminish. The success of these migratory species correlates to the timing of leaf-out and the associated emergence of insect populations that occurs in spring. (For more related information see the Wildlife fact sheet where bees and other pollinators are discussed).



Grassy glades such as this opening on a trap rock ridge have a large diversity of spring wild flowers.

Food Web – Nature’s food web could be described as beginning with plants’ usage of the sun’s energy and carbon dioxide to create organic matter through the process of photosynthesis. In a simple food web, plant growth is consumed by herbivores, which in turn are consumed by predators. As an example, oak trees produce acorns that are eaten by rodents that are food for hawks and owls. Acorns are also an important food source for white-tailed deer and wild turkeys that are eaten by humans. Oak leaves are also grazed by certain caterpillars that are necessary for the survival of various birds. This gives oak trees an important position in the local food web.

At some point, animals and plants die, and their remains decompose into nutrients that are incorporated into the soil to be used again by plants. Although it sounds simple, no food chain is completely independent of another. These interdependent food webs are the means in which energy is transferred from one trophic level to the next. A trophic level is the natural position of feeding structure in which all life exists. It takes a greater number of lower-level species of flora and fauna to support the energy needs of the higher trophic levels. Many of

these plant-herbivore relationships are unique, particularly among insects. As certain plants succumb to habitat changes altered by climate change, deer over-browse, and other stressors, the whole interconnected food web must adapt or risk the same fate.

In some instances, invasive plants, introduced by human activities and lacking natural controls, take advantage of the disturbances created by these stressors. Invasive species displace native species, change pollination relationships, and alter soil conditions. The Connecticut landscape is over-run with invasive plants such as garlic mustard, black swallow-wort, mile-a-minute and Japanese stiltgrass. Once established, many of these plants release chemicals into the soil, inhibiting the growth of native species, and allowing invasive plants to dominate the understory. Invasive plants do not provide food sources for wildlife and often form a monoculture that reduces the biodiversity of the forests. Numerous other invasive species that occur in warmer climates do not yet occur in Connecticut due to winter temperatures. With milder winters projected, many of these species could establish a foothold adding to the disruption of natural ecosystem function.



Mile-a-minute; a highly invasive plant newly introduced into Connecticut

There has also been a recent increase in forest pests such as woolly adelgid, an insect that is severely impacting our evergreen hemlock forests. The distribution of hemlock woolly adelgid seems to be limited by winter temperatures, but as the climate warms, the impacts to hemlock forests will progress northward. Connecticut’s current agricultural crops will likewise face different and sometimes

more difficult infestations. The impacts of climate change on these and other plant stressors will likely increase over time.

Ecosystems are fragile. Just how fragile can be seen in reports on the latest large-scale species die-offs such as bees' colony collapse disorder or bats' white-nose syndrome. The loss of native pollinators or bats would have serious ramifications in the food web, ripple effects throughout the ecosystem including degradation of the health of other species and habitats, and serious economic impacts. What is causing these changes is yet to be understood. However, Connecticut's changing climate has the potential to stress our ecosystem in similar ways, with acute stressors creating tipping points that cannot be recovered from and longer term insidious changes that may go unrecognized for decades. Whether to invest in keeping common species common is a choice associated with some risk. There will be some difficult decisions to make concerning adaptive management in the course of the next decade.

What Connecticut Is Doing

As we adapt to a changing climate, biodiversity and habitat protection are at risk. The actions we take today will be the key to conserving the wide array of life forms and habitats found in Connecticut tomorrow.

Endangered Species Protection – The CTDEP performs hundreds of environmental reviews each year to determine the impact of proposed development projects on state-listed species and to help landowners conserve the state's biodiversity. State agencies are required to consult with the Natural Diversity Data Base (NDDDB) to ensure that any activity authorized, funded or performed by a state agency does not threaten the continued existence of endangered, threatened, or special concern species.

Habitat Management – The CTDEP has been a national leader in tidal wetlands restoration, removing large infestations of common reed (*Phragmites*), a highly invasive plant, from this highly-altered ecosystem. By restoring these marshes to native plant populations, seed sources of native species will be naturally available for colonization of upland areas flooded by sea level rise. The CTDEP has also

been active in restoring and maintaining grassland habitats through prescribed burning and invasive species removal.

Information Management – The CTDEP is collaborating regionally to determine the best method to standardize the nomenclature used in defining habitats. In this way, scientists can more easily share data through computerized Geographic Information System (GIS) mapping, and work regionally to protect habitats that contain both endangered and threatened species as well as commonly occurring species. The ability to efficiently share data will become more critical as climate change occurs and data must be shared more broadly to help inform decision makers.

Land Acquisitions – The state's goal for open space protection, prescribed by statute, is to preserve 21% of Connecticut's land, or 673,210 acres, by the year 2023. As of January 2006, 70% of this goal had been achieved. The CTDEP, through its Land Acquisition Division, has two programs available to assist in achieving this goal: The Recreation and Natural Heritage Trust Program and The Open Space and Watershed Land Acquisition Grant Program. By revising the criteria used to select properties for acquisition, the CTDEP can utilize these programs to prepare for the impacts of climate change by acquiring critical habitat for species of greatest conservation need.

The Recreation and Natural Heritage Trust Program is the State of Connecticut's dedicated, permanent fund for acquisition of land as additions to the state's system of parks, forests, and wildlife, fishery and natural resource management areas. The Recreation and Natural Heritage Trust Program is intended to: (1) acquire land that represents the ecological diversity of Connecticut, (2) acquire land of unusual natural interest as additions to the system of parks, forests, wildlife and fishery management areas, natural areas and dedicated natural area preserves in the state, (3) acquire land identified as essential habitat for endangered and threatened species, (4) offset carbon dioxide produced through combustion of fossil fuels by preserving lands that naturally absorb it, and (5) establish a stewardship account to provide for the maintenance,

protection and management of lands and the species that inhabit them.

The Open Space and Watershed Land Acquisition Grant Program provides financial assistance to municipalities and nonprofit land conservation organizations to acquire land for open space and to water companies to acquire land to be classified as Class I or Class II water supply property. Grants may be for the purchase of land that is: 1) valuable for recreation, forestry, fishing, conservation of wildlife or natural resources, 2) a prime natural feature of the state's landscape, 3) habitat for native plant or animal species listed as threatened, endangered or of special concern, 4) a relatively undisturbed outstanding example of a native ecological community which is uncommon, 5) important for enhancing and conserving water quality, 6) valuable for preserving local agricultural heritage, or 7) eligible to be classified as Class I or Class II watershed land. All of these criteria have adaptation co-benefits.

Recent Acquisitions – The CTDEP acquired 195 acres of land abutting the Massachusetts border that was historically used for tobacco farming. Since the property consists of wide open fields, and is located near the Connecticut River, the land is perfectly suited for grassland bird habitat. The Commonwealth of Massachusetts is working to acquire an additional 250 acres that abuts this property to the north.

In addition, several parcels of land have been acquired by the CTDEP since December 2007 for the protection of the endangered timber rattlesnake. Ranging from two acres to 148 acres, the properties were all added to the Meshomasic State Forest in the Towns of Glastonbury, East Hampton and Portland. The total combined area of the land is nearly 313 acres.

Property Selection – To assist in the acquisition of these important locations, an evaluation system is necessary to ensure that the state acquires properties which are of exceptional value in each of the above categories, and to ensure reasonably equal distribution in functional ecosystems. This rating system is used to evaluate land offerings to the state and to prioritize the worth of prospective purchases. In conjunction with an assessment of statewide needs, this evaluation system is also used to develop acquisition plans that meet the environmental criteria for habitat and biodiversity conservation.

This is one of eight documents in the series *Facing our Future* concerning Connecticut's changing climate, www.ct.gov/dep/climatechange

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IMPROVEMENTS AND CHALLENGES FOR TODAY

Individual, Corporate, Municipal and State Stewardship

- Use a Geographic Information System (GIS) to view the University of Connecticut's Center for Land Use Education and Research (CLEAR) data that reveals land cover information from satellites and includes 11 cover types: developed, turf and grass, other grasses and agriculture, deciduous forest, coniferous forest, water, non-forested wetland, forested wetland, tidal wetland, barren and utility rights-of-way.
- Identify the location and quality of existing grasslands and lands suitable to create grasslands.
- Protect grasslands in order to reduce the number of state threatened and endangered grassland bird species.
- Support acquisition of wildlife habitat under CTDEP's Open Space Acquisition Plan.
- Submit a property for consideration for purchase by the CTDEP that is a unique, natural area or habitat http://www.ct.gov/dep/lib/dep/open_space/LandAcquisApp.pdf
- Improve the dissemination of information among state and local official and landowners.
- Support proactive management of invasive species by municipalities. Control at town facilities is our first line of defense. Housekeeping such as cleaning off equipment needs to be a routine practice.
- Provide educational outreach about simple methods to avoid the further spread of invasive species.