National Capital Region Network

National Park Service
U.S. Department of the Interior

Species Shifts in Maturing Forests *Resource Brief*

Importance

In forests, the tree species present and their relative abundance (number of individuals per species) can have strong effects on the biodiversity of forest animals and the functioning of the whole forest ecosystem. Changes in the abundance of certain forest trees, therefore, can have ripple effects on things like bird habitat, food availability for wildlife, and carbon storage.

Monitoring

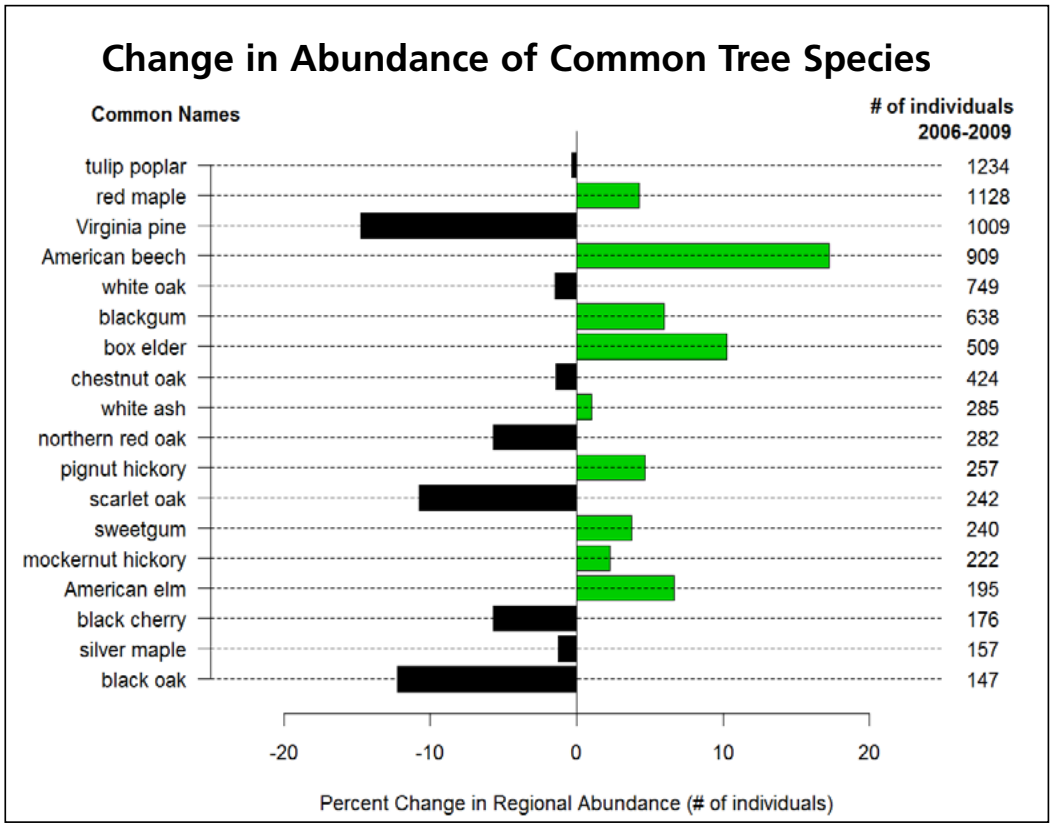
As part of a larger program of forest vegetation monitoring, the National Capital Region Network (NCRN) monitors trees in 400+ plots across the region. Species identity, size, and health are recorded for all trees. Any woody stem measuring 10cm or more in diameter at breast height (1.37m)—about as big around as a compact disc—is considered a tree. (For a complete description of the NCRN forest vegetation monitoring methods, see Schmit et al. 2009.)

The NCRN has completed two rounds of forest monitoring; 396 forest plots have now been sampled twice. It takes four years to complete one round, and the first round (2006-2009), established baseline data on the composition and structure of NCRN forests. Data from 2010 to 2013 show us how the forests are changing.

Forest Succession in the NCRN

Trees change the environment in which they live, and in doing so, they alter the availability of resources like light and water. Certain changes make it easier for some species to survive than others, resulting in a gradual shift in forest species composition. This process is called forest succession.

In eastern deciduous forests which include NCRN forests, an important resource that changes with forest age is light availability. After a disturbance from fire, a hurricane, or a plant disease outbreak, the newly recovering forest is very sparse and light is abundant since it is not blocked by a canopy. These young forests are often colonized by species that grow best in a high-light environment. As these trees grow, they create a denser canopy and a lower-light environment. Eventually, a different suite of tree species, better adapted to



Changes in abundance of NCRN's most common tree species: Colored bars show the percent change in the number of monitored individuals of each species. Species that increased in total number of individuals between the first and second monitoring period are shown in green. Those with shrinking numbers are shown in black.

The total number of individual trees monitored during the first period (2006-2009) is listed on the right.

Between 2006-2009 and 2010-2013, numerous trees died (mortality) and many saplings grew large enough to qualify as trees (recruitment). Overall, the number of trees increased by 1% from the first monitoring period.

this low-light environment begins to out-compete the early colonizers. We see evidence of successional changes like this in NCRN forests.

Virginia Pine (*Pinus virginiana*) is a short-lived, early successional species that has decreased in abundance since NCRN's first monitoring period. Without disturbances to create high-light environments, this pioneer species will likely continue to decrease in abundance in the upland forest habitat where it is found. This pattern is also evident in the decline of black cherry (*Prunus serotina*), another common light-loving tree species.

In contrast, the early successional species, **box elder** (*Acer negundo*), has increased in abundance. Box elder is common in the floodplain forests of the NCRN, where periodic flood disturbances maintain patches of early successional forests.

Red maple (*Acer rubrum*), **American beech** (*Fagus grandifolia*), and **black gum** (*Nyssa sylvatica*) are shade-tolerant tree species that are increasing in abundance in the NCRN. This is consistent with larger documented trends throughout eastern North America, in which many forests are shifting towards a closed canopy dominated by shade-tolerant and late successional species, especially maples and beeches (Nowacki and Abrams 2008; McEwan et al. 2011). A variety of factors may contribute to this shift including fire suppression, climate change, land-use change, and positive feedback cycles in which local conditions (deep shade, cool wet forest floors, and less flammable fuels) continually improve for shade-tolerant, late successional species and deteriorate for shade-intolerant and fire-adapted species (a process termed "mesophication" [Nowacki and Abrams 2008]). Many of these factors are likely contributing to the increased abundance of shade-tolerant species in NRCN forests.

Oaks are another group of canopy tree species whose abundance is changing. The most common oak species in NCRN forests include **white oak** (*Quercus alba*), **chestnut oak** (*Q. prinus*), **northern red oak** (*Q.rubra*), **scarlet oak** (*Q. coccinea*), and **black oak** (*Q. velutina*). All have decreased in abundance since the first monitoring period. This pattern has also been widely documented in eastern forests, where oak decline has been primarily attributed to fire suppression (Nowacki and Abrams 2008). Acorns are an important food resource for wildlife, so a decline in oak abundance could affect wildlife populations, from small rodents to larger white-tailed deer.

Other compositional changes in NCRN forests. Exotic pests and pathogens can have strong impacts on forest composition. The emerald ash borer (EAB; *Agrilus planipennis*), for example, is an exotic insect native to Asia, which has been responsible for the death of millions of ash trees in the northeastern US and Canada since its introduction in North America in the 1990's (Poland and McCullough 2006). Although the abundance of the most common NCRN ash species (white ash; *Fraxinus americana*) did not change substantially between NCRN's two monitoring periods, we might expect future declines in this canopy tree if EAB has the same impact in the mid-Atlantic region that it has had elsewhere. The decline of this important canopy species could have ripple effects throughout the forest ecosystem, analogous to the changes observed following the loss of another important canopy species: the American chestnut (*Castanea dentata*) in the 1930s. Following decline of the chestnut, for example, chestnut oak, red maple, and hemlock became more important in southern Appalachian forests (Elliott and Swank 2007). Early reports from forests that have been devastated by EAB suggest that maples and elms may respond with increased growth (Flower et al. 2013).

References

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