



## Ecosystem Benefits and Risks in the Appalachian Region

This table summarizes key ecosystem services that have been the subject of research and assessment efforts in the Appalachian region. On the right, major risk factors are listed which may compromise the sustained flow of these benefits to people.

### Water

#### Water quality

The Appalachians provide clean water to millions of people within and beyond the region, and to many urban areas that are often distant from the water sources they depend upon. Forested landscapes in the Appalachian LCC are particularly important for their capacity to provide clean drinking water and high-quality habitat for freshwater fish and other aquatic organisms. Surface water quality and availability can be compromised by increases in impervious surfaces and forest loss associated with urbanization, energy development, and surface mining, and by point and non-point source pollution and increased sediment loads from these land uses as well as intensive agricultural land uses. The impact of climate change on water quality and availability is likely to vary regionally, but average temperature increases may broadly result in reduced availability. Forest and wetland restoration efforts can have strong positive effects when sited appropriately.

#### Risk factors

*Urbanization, surface mining, energy development, agricultural land use, climate change.*

(Merricks et al. 2007, Pond et al. 2008, US Environmental Protection Agency (EPA) 2008, Gardiner et al. 2009, Fritz et al. 2010, Lindberg et al. 2011, Wardrop et al. 2011, Zipper et al. 2011, Lockaby et al. 2013, Wickham and Flather 2013, Evans and Kiesecker 2014, Keyser et al. 2014)

#### Hydrology and stream flow regulation

The amounts, velocities, and variability of flowing water in streams and rivers—especially the ‘normal’ or base flow and peak storm flows—have a profound influence on how water is utilized and what societal benefits and risks are associated with the great abundance of Appalachian streams and rivers. The risk of flooding, what kinds of outdoor recreation and tourism are supported, and freshwater habitat quality are all affected by these streamflow characteristics. In turn, flows are strongly influenced by the surrounding landscape and by precipitation patterns. In particular, the loss of forest cover from urbanization, mining, forest pathogens and other factors can elevate runoff, increasing downstream discharge rates, peak storm flows, and stream velocity. The frequency of extreme precipitation events is also expected to change over time; the effects of these events on streamflow will depend heavily on impervious surface cover, vegetation cover and characteristics, forest management practices, and other land use factors.

*Urbanization, climate change, surface mining, forest pathogens*

(Ford and Vose 2007, Townsend et al. 2009, Ford et al. 2011, Zipper et al. 2011, Lockaby et al. 2013, Brantley et al. 2014, Keyser et al. 2014)



## Harvested species

### Nontimber

Nontimber forest products such as Ginseng and Ramps are widely harvested in the Appalachian region, and hunting and fishing are among the most important outdoor recreational activities. All of these practices have high cultural and economic value, and their sustainability depends on the capacity of rural and forest landscapes to support them. While landscape capacity meets societal demand for these resources in many areas, they may be overexploited in areas where harvesting activities are poorly regulated, and climate change effects may exacerbate declines. This may be especially true for nontimber forest plants, and these tend to be the least-studied among harvested species. Stream degradation from multiple causes, and toxic dissolved solids in watersheds with surface mines in particular, are associated with loss of fishing opportunities and represent a strong incentive for stream restoration.

*Overexploitation, stream degradation, surface mining, climate change*

(Cordell and Chamberlain 2004, Lindberg et al. 2011, Jackson et al. 2012, Chamberlain et al. 2013, Hitt and Chambers 2014, Souther and McGraw 2014, Villamagna et al. 2014, Daniel et al. 2015)

### Timber

The sustainable production of wood—from upland hardwood forests in particular—is a key economic activity across the Appalachian region, supporting rural livelihoods and supplying important products at regional, national, and even global levels. Timber markets also create an incentive to keep land forested, and working forests can supply many additional ecosystem services such as clean water, nontimber forest products, carbon storage, and wildlife habitat. Standing timber stocks and production have remained fairly stable in recent decades, but declines may be experienced over the long term. Urbanization and surface mining are expected to reduce the land area available to support working forests, while detrimental effects of invasive species, climate change, and wildland fire on high-value species may have more moderate long-term influences on forest productivity.

*Climate change, urbanization, invasive species, surface mining*

(Zipper et al. 2007, Lindberg et al. 2011, Zipper et al. 2011, US Department of Agriculture Forest Service 2012, Huggett et al. 2013, Miller et al. 2013, Wear et al. 2013b, Brandt et al. 2014, Butler et al. 2014, Keyser et al. 2014, Matthews et al. 2014)



## *Landscape values and sense of place*

### **Rural landscape values**

A large portion of the people who live in the Appalachian region live outside cities, and these rural communities often place high value on the unique sense of place that comes from living in rural, often largely forested, places. These same communities may also value the economic activity that comes with development and industry, and when these values compete, there is often an expectation that the quality of rural life need not be eroded as landscapes change. Nonetheless, the changes that come with urbanization, energy development including gas, wind, and surface mining, and even climate change can have negative impacts on the unique sense of place and quality of life of rural communities. Ensuring that these intangible, but often crucial, values are given consideration can help guide development in ways that do not erode the social fabric of Appalachian landscapes.

*Urbanization, surface mining, energy development, climate change*

(Wickham et al. 2007, Pond et al. 2008, Townsend et al. 2009, Cordell et al. 2011, Lindberg et al. 2011, Cordell et al. 2013b, Wickham et al. 2013, Brandt et al. 2014, Butler et al. 2014, Evans and Kiesecker 2014, Hitt and Chambers 2014, Keyser et al. 2014, Matthews et al. 2014, Zolkos et al. 2014, Daniel et al. 2015)

### **Outdoor recreation**

The abundance of natural areas, streams and rivers, and protected state and federal lands make Appalachian landscapes a prime destination for nature-based recreation activities, and nature-based tourism is a crucial economic activity in many Appalachian communities. As rural landscapes and water supplies are increasingly converted to more intensive uses with urbanization, opportunities for outdoor recreation are expected to decline. At the same time, demand for such opportunities will increase with population growth in the region and in nearby large cities, stressing the capacity of natural areas and water bodies to accommodate visitors without degrading natural characteristics. This should create incentives for freshwater stream and forest restoration to enhance the capacity of landscapes to support compatible activities.

*Urbanization, Overuse, stream degradation*

(Hayden et al. 1996, Lindberg et al. 2011, Cordell et al. 2012, Jackson et al. 2012, Bowker and Askew 2013, Bowker et al. 2013, Cordell et al. 2013a, Cordell et al. 2013b, Hitt and Chambers 2014, Keyser et al. 2014, Villamagna et al. 2014, Daniel et al. 2015)



## Forest carbon

### Carbon storage

The storage of carbon in forested landscapes, in the form of plant and soil biomass, is a crucial component of climate change mitigation. Appalachian forests provide this service in great abundance, with net carbon storage increasing (but at declining rates) in most sub-regions. However, forest losses from future urbanization and surface mining are likely to outstrip regional gains from forest growth. Such losses may be mitigated by changes in urban development policy and planning, significant new forest restoration efforts on mined sites, and timber markets that enhance the value of forest lands.

*Urbanization, surface mining, climate change*

(Zipper et al. 2007, Amichev et al. 2008, Zipper et al. 2011, Campbell et al. 2012, Huggett et al. 2013, Wear et al. 2013a, Wickham et al. 2013, Brzostek et al. 2014, Fox et al. 2014, Coulston et al. 2015)

## Soils

### Soil quality

Healthy, productive soils are a fundamental component of Appalachian landscapes supporting a wide variety of ecosystem services, including agriculture and silviculture, hydrological regulation, clean water, and carbon storage. Soil loss and compaction associated with surface mining and some reclamation practices can impede forest regeneration. Soil chemical properties, water content, and microbial communities are all negatively affected by some invasive plants across large areas, compromising native plant communities and restoration efforts.

*Invasive species, surface mining*

(Kourtev et al. 2002, 2003, Elgersma and Ehrenfeld 2011, Zipper et al. 2011, Miller et al. 2013, Wickham et al. 2013)



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