

Northern Research Station

Rooted in Research

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Where Humans and Forests Meet: The Rapidly Growing Wildland-Urban Interface

People love to live near forests, lakes, open space, and scenic beauty. These natural settings draw people to build homes in areas classified as the wildland-urban interface (WUI): spaces where human development meets the natural world. Although houses in the WUI are built on private land, they are often close to national forests, within inholdings (patches of private land within national forests), or close to other public land. Tracking and understanding WUI growth therefore has implications for forest health and management across public and private lands.

Miranda Mockrin, a research scientist with the U.S. Department of Agriculture Forest Service, Northern Research Station, and colleagues have mapped and analyzed changes in WUI areas in the continental United States. Between 1990 and 2020, the size of the WUI increased by 179,000 square kilometers, an area equivalent in size to the state of Washington. During the same 30-year period, the number of houses in the WUI increased by 46 percent, growing from 30 million to 44 million. And although the growth of the WUI slowed between 2010 and 2020, 2.6 million new houses were built in WUI areas during that decade. As of 2020, 9.4 percent of the land area and almost a third of all houses in the continental United States (32 percent) were in WUI areas.

KEY MANAGEMENT CONSIDERATIONS

- Between 1990 and 2020, the United States added 179,000 square kilometers of wildland-urban interface (WUI), an area equivalent in size to the state of Washington. During the same period, the number of homes in WUI areas of the United States increased by 47 percent.
- National forests are hotspots for WUI growth, with a 38 percent increase in WUI area and 46 percent growth in WUI houses from 1990 to 2010 for the area around national forests. Growth within national forests was higher than the surrounding area.
- Most houses exposed to wildland fire are in WUI areas. WUI expansion increases the number of houses at risk from wildland fire and makes it more likely that wildland fires will occur.



A new subdivision built on the edge of a natural area is one of many built within the wildland-urban interface in the last 30 years. Licensed photo by oldmn/Adobe Stock

As human populations expand, residential development increasingly encroaches upon undeveloped wildland areas, creating a dynamic interface where human communities intersect with natural ecosystems. As housing developments proliferate in proximity to wildland areas, they bring about many ecological changes, including alterations to biodiversity, habitat fragmentation for wildlife, increased wildfire risk, and pollution. These changes extend beyond the boundaries of privately owned lands, affecting neighboring public lands and ecosystems as well. Recognizing the importance of understanding WUI dynamics, researchers are interested in identifying patterns and trends that can inform land management practices and wildfire mitigation strategies.

In a recent study, Mockrin and her colleagues have gone beyond mere quantification by categorizing WUI types into intermix and interface categories. The study allows for a deeper understanding of the ecological and management implications associated with different forms of WUI development.

Intermix and Interface WUI Areas

Researchers have defined two primary types of WUI lands—intermix and interface.

Intermix areas have lower density housing intermingled with wildland vegetation and are often on large parcels of

private land. Houses are scattered and infrastructure, like long driveways break up wildlife habitat. Human development is also a source of noise disturbance, septic pollution, invasive plant spread, and other ecological disruptions.

In intermix WUI areas, fuel treatment, wildfire management, and evacuations can be expensive and challenging, especially when viewed at the landscape level. “There might be fewer homes to protect during a fire, but they are in a much larger area and in a remote setting,” Mockrin says. Cooperative strategies like managing fuels across ownerships can be helpful in reducing fire risk.

WUI areas in and around national forests and grasslands reported dramatic growth of intermix WUI areas in recent decades. Between 1990 and 2010, the number of houses in intermix WUI increased by nearly 50 percent, and the total WUI intermix land area expanded by nearly 40 percent, far more than WUI intermix expansion for other areas of the conterminous United States (32 percent growth WUI intermix houses and 36 percent in WUI intermix area).

Interface areas are densely developed neighborhoods that lack trees and other vegetation among the houses but are near wildland vegetation like forests or grasslands. Interface areas typically have larger and denser groups of houses and hard barriers like roads or paved surfaces that break the connection to wildland areas. Interface areas lack substantial vegetation after development, but effects from human disturbances like light and noise can be more pronounced.

Interface WUI areas may be especially vulnerable to wildfire because fires can spread quickly from house to house. More than half of the California buildings destroyed by wildfires between 1985 and 2013 were located in interface communities, even though these areas made up only 2 percent of the fire-impacted lands.

Heavily developed interface areas may have better access to firefighting resources and may be protected by fuel treatments along the boundaries between public lands and houses. Ordinances and regulations can reduce wildfire risk and reduce noise, light, and other disturbances that affect wildlife and habitat.

In both intermix and interface WUI areas, programs often run by homeowner associations, volunteer fire departments, or road associations help to educate and engage property owners in activities such as planting native species, reducing the risk of invasive species, and managing wildfire risk on their properties.

Looking to the Future

Mockrin and her colleagues call for additional research and monitoring into the future, stating that monitoring future WUI growth and its interaction with large-scale perturbations such as climate change impacts is crucial for understanding future ecological challenges. Additionally, the researchers call for efforts to focus on demographic and economic changes associated with WUI development and its implications for public land management.

Mockrin and her colleagues are currently updating the analyses of WUI areas within and around national forests to include the years 2010 to 2020.

In the long term, WUI expansion is likely to continue. Research can inform strategies for wildfire prevention, mitigation, and response, helping to minimize the impacts of wildfires on both WUI residents and adjacent wildland areas.

PROJECT LEAD

Miranda Mockrin is a research scientist with the Communities and Landscapes of the Urban Northeast research work unit, a part of the USDA Forest Service Northern Research Station.

FURTHER READING

Carlson, Amanda R.; Radeloff, Volker C.; Helmers, David P.; Mockrin, Miranda H.; Hawbaker, Todd J.; Pidgeon, Anna. 2023. [The extent of buildings in wildland vegetation of the conterminous U.S. and the potential for conservation in and near National Forest private inholdings](https://doi.org/10.1016/j.landurbplan.2023.104810). *Landscape and Urban Planning*. 237(5): 104810. 18 p. <https://doi.org/10.1016/j.landurbplan.2023.104810>.

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