13 Managing for Fire in the Interface: Challenges and Opportunities

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13.1 INTRODUCTION

Fire managers define the wildland–urban interface as all areas where flammable wildland fuels are adjacent to homes and communities. With this definition, the wildland–urban interface may encompass a much broader landscape than traditionally perceived. For example, the Tunnel Fire in the Oakland hills in 1991 included a large area that, for practical purposes, could be considered truly urban — the edges of the fire were not far from either downtown Oakland or Berkeley. At the other end of the spectrum, wildland fires also threaten or destroy rural

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homes far from the closest population center. No longer is the evening news coverage of subdivisions overrun by wildfire unique to southern California. Today, this is an all-too-common occurrence throughout the U.S. from Washington to Florida and Maine to Arizona. It is also a significant problem in other countries, as demonstrated in Australia during the last two weeks of 2001 when more than 1.5 million acres and 140 homes and businesses were blackened by wildfire.

A curious question arises as we consider fire management and protection throughout this larger wildland–urban interface zone. Why should fire protection currently receive so much attention when the history of this country was a mosaic of small towns and isolated homesteads and cabins within a vast fire-maintained landscape? We believe the answer lies in the fact that fire was once such a common feature of rural life that it was accepted without question. Over the past century, however, technological advances coupled with the unrealistic expectation that humans can control nature led many to believe that this disruptive force could be eliminated from the landscape without dire consequences. Moreover, as our population shifted from a rural to an industrial lifestyle, people moved to cities where they quickly forgot their ancestral ties to fire. Now, as people are rediscovering the benefits of life in the wildland–urban interface, they have to reconnect with this awesome force, and it is a difficult transition (Figure 13.1). The transition is not back to some point in the past because virtually all ecosystems have been altered by human intervention, remarkably so in many instances. Following nearly a century of attempted fire exclusion, fire behavior is now considerably different than it was in the past. Both fire suppression and prevention activities have undergone continual modification in an effort to keep pace with these changes.

This chapter has two objectives: to provide the re with an overview of the fire-related challenges fa those who live in the wildland–urban interface and importance of cooperation between these residents the agencies/organizations charged with managing where people and wildlands meet, and to describe s emerging or current strategies these agencies and org zations are using to manage fire hazards and fire itsel the broadly defined wildland–urban interface. We emp size the importance of both community and indivi landowner responsibilities and actions in preparing for inevitability of fire in wildland ecosystems. A brief cussion of the ecological role and necessity of fire in f adapted ecosystems and the impacts of fire suppressio these functions will provide an important starting p for the rest of this chapter.

13.2 HISTORICAL BACKGROUND

13.2.1 Natural Role of Fire

Forest and grassland ecosystems throughout the U.S. adapted to periodic fires that were historically ignited lightning or Native Americans. The intentional use of was a necessity for these early Americans. They used i accomplish a wide range of tasks, from protection improving their standard of living. Where precipitation rivers, creeks, swamps, and rocky outcrops provided only barriers to the spread of fire, new ignitions of spread great distances.

In areas such as the Southeast, and especially Florida, fire undoubtedly spreads across the same piece ground several times a decade, sometimes as frequently every few years (Platt et al. 1991). Two important fact that presumably contributed to the fire history in t

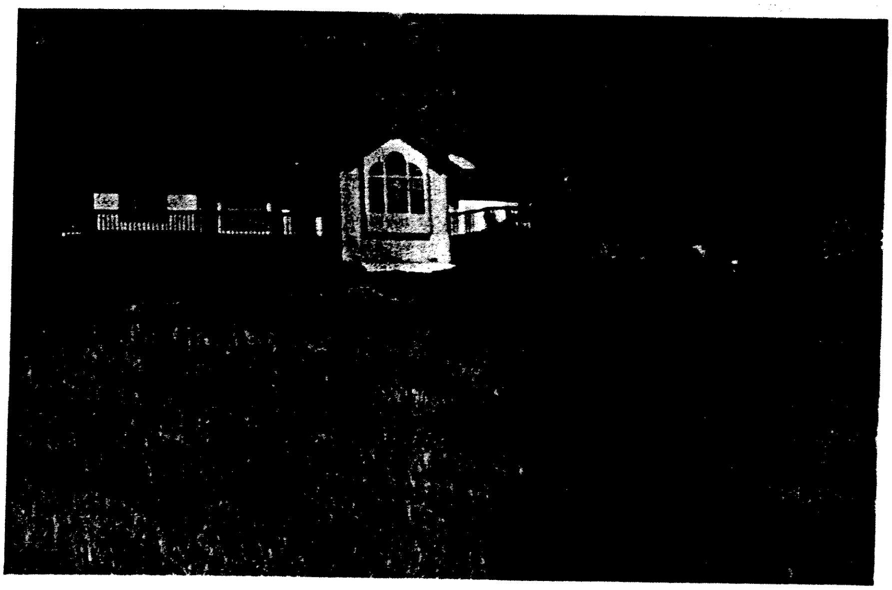

FIGURE 13.1 Typical wildland urban interface home near Santa Ros CA, located on a hillside with nearb grass fuels and with evergreen shrub around the home and beneath over hangs. (Photo by Alan Long.)

Southeast were a much higher lightning frequency than elsewhere in the country along with a large Native American population. Based on early written accounts and plant adaptations to fire, frequent fire must have also been the norm across much of the West, particularly where ponderosa pine (*Pinus ponderosa* Dougl. Ex Laws., the western equivalent to longleaf pine [*P. palustris* Mill.]) dominated vast landscapes. Under a regime of frequent fire, woodlands were open and typically characterized by large pines and a ground cover composed mainly of grasses and forbs (Figure 13.2). To thrive in such an environment, plants had to possess adaptations to frequent fire. For example, longleaf pine, which is thought to have dominated 70 to 95 million acres in the South, is multinodal (having more than one growth spurt during a growing season). It has thick bark, long needles that are concentrated in tufts at the branch tips where they protect a huge bud (high heat capacity) from radiant heat and keep heat from being trapped at the base of the crown, seed germination in the fall as soon as environmental conditions are favorable, the ability to resprout when very young, and a juvenile grass-like stage that can survive periodic fire while developing a good root system until it puts on a burst of height growth to quickly raise the terminal bud above the flames. The grasses and shrubs that characterize these frequent fire regimes also have flowering, seeding, and sprouting capabilities that provide a quick response and recovery after fire.

Because of their frequency, fires were generally of low intensity whether ignited by lightning or Native Americans. These fires served several important ecological functions and maintained open woodlands by preventing the development of dense brush and hardwoods (in the South) or conifers (in the West) that would soon shade out the species-rich groundcover. This frequent thermal decomposition prevents the accumulation of hazardous fuel levels in the understory as well as on the forest floor. Chronic fire regimes helped prevent the invasion of woody plants into grasslands, prairies, and marshes. The regular resprouting of grasses and shrubs using recycled nutrients provides succulent, more palatable,and nutritious wildlife food than would occur in the absence of fire, and this new growth is within easy reach of browsers and grazers.

At elevations above the ponderosa pine zone in the West, the Upper Piedmont of the South, and across much of the Lake States and Northeast, conifer, hardwood, mixed conifer, and conifer/hardwood stands were subject to periodic although less frequent fire. Under hot, dry, windy conditions, fires in many of these plant communities often turned into intense stand-replacing events. Some coniferous species, such as lodgepole pine (*P. contorta* Dougl. ex Loud.) in the West, jack pine (*P. banksiana* Lamb.) in the Lake States and Northeast, sand pine (*P. clausa* [Chapm. ex Engelm.] Vasey ex Sarg.) in Florida, and table mountain pine (*P. pungens* Lamb.) in the Southern Appalachians are well adapted to such stand replacement fires. In fact, fire ecologists have concluded that virtually every terrestrial ecosystem in North America (mangroves and northeastern beech/sugar maple are two exceptions) is characterized by periodic fires, albeit centuries apart in some cases.

13.2.2 Effects of Fire Suppression on Natural Communities

In the late 1800s and early 1900s, severe fires occurred in every region of the country, often started by steam-driven logging equipment operating in forests that had heavy accumulations of residual slash. This debris from logging

FIGURE 13.2 Old-growth ponderosa pine near Bend, OR, where frequent fires have maintained a low, open understory of grasses, shrubs, and herbs. Forest structure is similar to original longleaf pine stands and other ecosystems around the country where fire was a regular ecosystem process. (Photo by Alan Long.)

and/or land clearing played a major role in most of our nation's worst conflagrations between 1840 and 1940. In response to this threat to our natural resources, the federal government set a high priority on reducing these losses through new fire control programs. A policy of complete fire suppression was initiated on public lands by government agencies and was supported on private lands through federal funding of state programs and cooperatives.

Since the 1920s and 1930s when the majority of these programs were initiated (or became effective because of the bulldozer), the area burned by wildfires steadily declined until near the close of the 20th century. Unfortunately, as we applauded these efforts, the composition and stature of our natural ecosystems were changing in response, ever so gradually, yet predictably. Shade-tolerant shrubs and trees began to appear in the understory, shading out the herbaceous groundcover, which in turn resulted in changes in the local fauna. These successional trends have profound fire management implications; they inevitably result in deepening layers of decaying plant material that is colonized by overstory tree roots that are susceptible to drought season fire. In addition, an aboveground woody understory and midstory develops, which provides a combustible ladder for fire to reach treetops (Figure 13.3). These increased live and dead fuel loads have the potential for much more intense and severe fires. Similar forest structures have also resulted from many of our forest management schemes over the past 50 years. The wildland–urban interface is expanding into these significantly modified landscapes, and it is imperative that landowners understand the basic ecology and fire management ramifications of their natural surroundings and the associated risks of living in these areas.

13.3 THE CHALLENGE OF FIRE IN THE WILDLAND–URBAN INTERFACE

13.3.1 Case Studies and General Principles

Two examples of interface fire will demonstrate sc important principles that fire suppression agencies acc and landowners should understand. The first principl that fire is inevitable. We have no control over lightni little control over arson, and only moderate control, e after substantial education, over human carelessness.

On October 20, 1991, the Tunnel Fire in the hills n to Oakland, CA, burned only 1500 acres, but consun over 3000 homes with the loss of 25 lives. The hills were old residential area for both Oakland and Berkeley. Ma homes were at least 30 to 50 years old with wood roofs a siding, and with the only access by narrow winding roa It was much more urban than the typical wildland–url interface we often see on the news. In many ways, it lool just like a suburb of Oakland, except for the dense, a often natural, cover of pines, eucalyptus, and shrubs many lots. The Tunnel Fire resulted from an apparent ac carelessness and a rare weather event in which hot winds poured over the hills from the east. One local re dent described the morning (before the fire began) as v eerie, perhaps a harbinger of what was to come.

In contrast, northeast Florida was subjected to m than 2000 fires over a 2-month period in 1998, started both people and lightning. These fires burned 500,000 ac of uninhabited woodlands, pasture, and wildland–urb interface, damaging or destroying 330 homes and bu nesses in the process. An entire county was evacuated one point and some towns were evacuated several times. the end, over 100,000 people were evacuated and 214 pe ple were injured; but remarkably, no lives were lost.

FIGURE 13.3 In the absence of fi this ponderosa pine forest near M Shasta, California, developed into much denser mixture of pine and oth conifer species, with substantial ver cal structure. (Photo by Alan Long.)

Up the Atlantic seaboard to the Northeast, westward through the Lake States to the Pacific Northwest, down the Pacific Rim into the Southwest, and then eastward through the Gulf Coast, numerous other examples of wildland–urban interface fires could be presented. A common feature of almost any of these catastrophic interface fires is a rapid rate of spread due to topography, wind, or both, often but by no means always after a prolonged dry season or drought.

Another important principle, well illustrated by comparing the Oakland and Florida fires, is that fire intensity, acreage, and life/resource loss are not well correlated. Natural resource losses from wildfire can be roughly estimated from acreage and fire intensity, but losses at the wildland–urban interface often bear little relation to actual fire size.

One final principle, which must be understood by landowners, is that protection of all structures in the interface may not be possible. Although fire suppression organizations routinely set their highest priority for action on saving lives and property, in areas with many homes and a fast-moving fire, there may not be enough suppression units to protect every home. Vehicular access may be limited, too. Difficult decisions about what to protect have been, and will continue to be, necessary. In such situations, total loss of some homes is almost inevitable.

13.3.2 Fire Suppression in the Interface

One of the most significant features of fire control in the interface is that suppression crews are often faced with fire in both wildland and structural fuels. Fire behavior in the two systems is very different and crews trained for either wildland or structures are often not adequately prepared for dealing with the other. Structural fires are usually fought at close range, often in confined spaces with high concentrations of noxious gases. These superheated combustible gases can literally explode when forced out a doorway by a suddenly introduced stream of water. Structural firefighters thus wear heavy protective gear and self-contained breathing apparatus, which wildland firefighters find too cumbersome and energy-sapping. Wildland fires are usually unconfined and burn in an unrestrictive atmosphere, thereby making it necessary for suppression forces to move along the fireline, sometimes at a very rapid pace in order to make progress. Water is the principal method for suppressing structural fires, but is often unavailable to wildland firefighters in the quantities needed, especially in rugged terrain.

Given the differences in fire behavior, control methods, and protective equipment, suppression of interface fires requires either crews that are trained for both types of fire or close coordination between crews from different organizations. A common ingredient in all fire control organizations is the priority placed on protecting lives and ensuring firefighter safety.

Wildland fire suppression tactics typically focus on surrounding a fire with control lines and using a variety of methods (machines, hand tools, water, foam, retardants, and burning out) to break the fire triangle by removing fuel, oxygen, and/or heat. These tactics usually focus on minimizing acres burned and resource losses. In contrast, fire suppression tactics in the interface often dictate that available equipment and personnel be positioned at threatened homes to knock down the fire as it reaches the residence and put it out if the home ignites. The overall strategy is to protect homes first, rather than minimizing burned acres. Consequently, interface fires can often reach larger sizes than they would if they were burning strictly in wildland fuels. This generally translates into significantly higher suppression costs and can also result in a higher number of homes being affected.

13.3.3 Landowner Expectations in the Interface

Landowners who move from metropolitan areas to the interface have generally enjoyed a variety of services, from police and fire protection to road repair and municipal water systems. Even though most of these services are now more distant or nonexistent, these new interface residents still expect some local or state agency to provide them. In the case of fire protection, they assume the same quality and response time even though narrow, winding, poorly marked roads may prevent fire trucks from reaching their destination or may limit landowner escape routes.

An extreme example of this expectation was demonstrated at a rural hotel outside Bend, OR, which had the protection of 15 fire engines during a 1990 interface fire that burned 22 homes. When the owners were asked subsequently to clean some of the shrubs from their property and needles from the roof, their response was that they did not need to do that since the fire agencies "would protect them again" in the event of another fire (Tom Andrade, Oregon Department of Forestry, personal communication, August 2001).

As naive as this response may seem, it characterizes the expectations of many landowners. They moved to the interface to enjoy "nature," and they place substantial value on their surroundings and privacy (Figure 13.4). They may even build their homes or decks around trees to accentuate the forest ambience. Their values often do not include significant changes in that ambience, and their thinking tends to fall into three possible responses about fire: they will rely on being protected by fire crews; they trust that "it won't happen to them"; or they assume that they can rebuild with insurance money if something does happen.

13.3.4 The Challenges: A Synopsis

The challenges to managing fire in the interface are diverse: vegetative communities that are prone to intense

FIGURE 13.4 Homeowners in wildland–urban interface value ambience and privacy of their roundings and often do not appre their fire risk or are unwilling to rect the potential problem. (Phot Alan Long.)

fires under severe environmental conditions; suppression tactics that focus on protecting structures rather than restricting the spread of fire; homeowners who are reluctant to modify the natural conditions that attracted them to the interface but still expect to be protected; and the necessity of diverse suppression forces to handle structural and vegetative fires simultaneously.

These challenges are being addressed creatively, energetically, with persistence, and with substantial funding. The rest of this chapter describes some of the approaches being used for preventing and managing wildfires. We emphasize the potential of prescribed fire as a fuel mitigation tool in the interface. We give examples of agency and community activities and programs that address these challenges but stress the fact that landowners must ultimately shoulder substantial responsibilities. Public education will play a crucial role in assisting landowners with their responsibilities.

13.4 MEETING THE CHALLENGE

13.4.1 Hazard Assessment

Central to any approach to fire management in the interface is an evaluation of the differences in hazard and risk across vegetation communities and property boundaries. Such assessments are a basic requirement for establishing priorities for allocating fire suppression resources, planning educational programs and fuel modification treatments, and assisting landowners with their landscaping and home design.

Fire risk is simply a quantitative or qualitative evaluation of the likelihood that a particular home or community will be subjected to a wildland fire in the foreseeable future. Fire hazard describes the fuel complex in terms of type, volume, condition, arrangement, and locatior determines the ease of ignition and difficulty of supp sion of a wildland fire. Important components of risk hazard include:

- Types, patterns, and conditions of vegetatior and fuels
- Likelihood of an ignition by lightning, humans or equipment (basic factor affecting risk)
- Design and construction materials of individua homes
- Infrastructure such as roads, signs, water sources, and utilities
- Topography and related environmental factors
- Resource or asset values that would be affected by a fire
- Frequency of adverse weather or climatic conditions.

Depending on the purpose of a particular assessme these components are used individually or in some co bination. Several examples will demonstrate the use a variability of assessments.

California was one of the first states to develop statewide assessment of fire hazard, with special inter in those communities and watersheds that could be clas fied as "very high fire hazard severity zones" (Figu 13.5). Vegetation, topography, and asset value in t above list were the primary criteria, along with the pote tial for extreme fire weather (dry air and strong wind component 7). The entire state was mapped by t California Department of Forestry and Fire Protecti (CDF) using these criteria in a geographic informati system (GIS) (California State Board of Forestry 1996). they accept the CDF classification, communities in ve

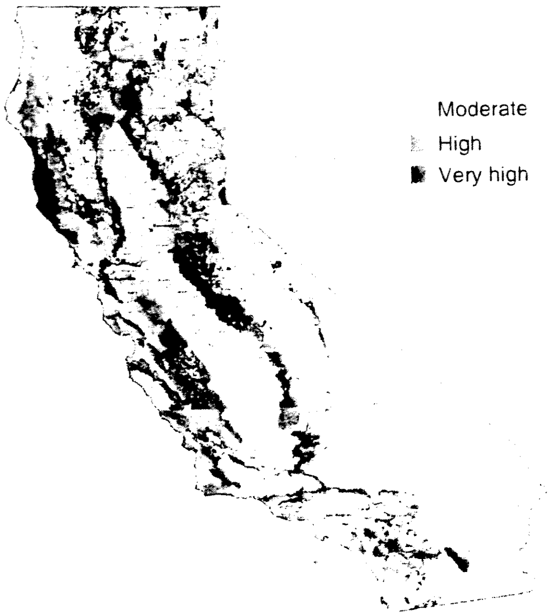

FIGURE 13.5 Statewide hazard assessments such as California's GIS-based system are usually based on vegetation, topography, ignition sources, and population densities. (From California State Board of Forestry 1996.)

high severity zones are required by state law to take appropriate actions to mitigate hazards, reduce risks, and increase fire prevention programs.

Recently, New Mexico prepared a similar GIS-based statewide hazard assessment that utilized vegetation, likelihood of an ignition, and asset value as the main components (Lightfoot et al. 1999). Vegetation communities were classified according to standard fuel models and were assigned low, medium, or high values based on the rate of spread and resistance to control. Ignition probabilities were based on fire statistics for the last 10 years, and asset values were derived from census statistics for population density. The latter two components were also assigned low, medium, and high values, and the actual fire risk was based on these three sets of values, closely following a system used in Virginia (Virginia Department of Forestry 1997) and elsewhere. The state map of fire risk depicts the regions where fire resources will be concentrated for fire suppression and fuel hazard reduction and where fire prevention programs will be increased.

Florida has just completed a similar but much more in-depth statewide assessment that includes most of the components above as well as information about fire history and suppression resources. In addition, the state was divided into 20 weather influence zones and four weather scenarios were used to predict potential fire behavior on each quarter-acre pixel. Then, the proportion of fires over the 20-year database that occurred under each scenario was determined. This information was used to develop a Wildland Fire Susceptibility Index for each quarter-acre pixel statewide. The resulting GIS maps will be used for purposes similar to those of New Mexico as well as to set priorities for mitigation teams that are working on fuel reduction projects around the state.

At a community level, the National Fire Protection Association (NFPA) (1997) publication titled "299 Standard for the Protection of Life and Property from Wildfire" has probably been the most commonly used model or set of guidelines for evaluating wildfire hazards. NFPA 299 recommended a numerical rating system to define the relative contributions to hazard severity of numerous factors, ranging from home construction to weather (Table 13.1).

The NFPA Standard 299 was revised and released as NFPA Standard 1144 in 2002 (NFPA 2002). A similar rating system has been developed by the International Fire Code Institute (IFCI) (2000). Like the NFPA Standards, the IFCI Code provides specifications for water supplies, defensible space, and access in wildland–urban interface areas, and includes a table for rating the severity of the hazard based on vegetation, slope, fire and weather frequency, and fuel models. However, the IFCI Code has not yet been adopted by any jurisdiction because it lacks the flexibility of a standard (Jim Smalley, personal communication, November 2001).

In the last 10 years, a number of states and organizations have developed their own hazard assessment systems, based on the 1991 or 1997 NFPA 299 Standards, the IFCI Code, or their own experience. For example, in 1996, California produced two documents that have been the basis for community and regional programs governing the assessment of wildfire hazards and execution of mitigation projects (California State Board of Forestry 1996; Slaughter 1996). Based on these two broad documents,

TABLE 13.1
NFPA 1144 Hazard Rating System

Possible Points	Contributing Factors
0–25	Roofing materials
	Siding/deck construction
	Vegetation types
	Defensible space
	Slope
	Water sources
0–7	Road width and grade
	Access routes
	Turnarounds
	Signs
	Utility placement
0–10	Topography
	Weather conditions

Source: National Fire Protection Association (1997).

more recent publications were developed for assessing individual properties: "Structural Fire Prevention Field Guide for Mitigation of Wildland Fires" (California Department of Forestry and Fire Protection 2000a) and "Property Inspection Guide" (California Department of Forestry and Fire Protection 2000b). In Colorado, where interface fires have increased along the Front Range (east slope of the Rocky Mountains), risk assessment procedures have been developed by Boulder County (Boulder County Wildfire Mitigation Group 2001) and the Colorado State Forest Service (1997). Similar programs exist in every other region of the country (e.g., Great Lakes Forest Fire Compact 1996; Virginia Department of Forestry 1997; Florida Division of Forestry 2002).

All of these methodologies have been summarized and compiled into a general assessment procedure that can be used around the country, titled *Wildland/Urban Interface Fire Hazard Assessment Methodology* (National Wildland/Urban Interface Fire Protection Program 1998). Sponsors of this document, which is an important resource for Firewise Communities workshops (described later) and other multiagency planning programs, include the National Association of State Foresters, National Fire Protection Association, U.S. Forest Service, four agencies in the U.S. Department of the Interior and the Federal Emergency Management Agency. The guide is designed to "help users assess the potential of a structure located in a wildland environment to withstand an approaching forest fire without the intervention of fire-fighting personnel and equipment. [It] focuses exclusively on proactive, prefire preventative actions … ." The guide also points to important considerations and actions at the community level.

Many homeowners in the interface may want to see fire risk decreased throughout their community, but they have little control over what is done beyond their property boundary. Thus, their foremost concern should be protection of their own home and property. They can assess their risk, focusing on components 1 and 3 in the list at the beginning of this section (vegetation patterns and building materials) and rating them according to any of the systems listed above. Many states and local organizations or agencies have landowner brochures or publications that do not directly describe risk assessment but list many things a landowner can do in landscaping or home construction to reduce hazardous conditions.

In the wake of the 1998 and 1999 wildfires, University of Florida personnel developed a very simple landscape assessment procedure that landowners can use to determine whether they are at a low, medium, or high level of risk should a wildfire approach their home (Monroe and Long 2000). The assessment only requires a look around their property at the density and continuity of shrubs, grass, young pines, and ladder fuels such as vines, and an evaluation of whether they can see through the vegetation on adjoining properties. For many landowner such simple procedures may be an important education method to encourage them to assess their risk and tal action to reduce it.

As important as hazard/risk assessment is to all oth fire management strategies in the interface, there is inherent danger in overstressing its utility. The problem that in any given fire incident, individual properties with generally low hazard rating may still be at risk in extren fire situations. Landowners who determine that they are n in a high-risk situation may decide that other landscapin objectives (e.g., backyard wildlife, natural trees and shru next to the house, energy conservation) are more importa to them. They may, therefore, not carry out some of the sir ple procedures that would significantly improve protecti of their home in case of a fire under unusual circumstance

Two examples will demonstrate this issue. As t Cerro Grande fire burned through Los Alamos in M 2000, individual homes with wood siding were oft ignited by low-intensity surface fires burning through pi needles, dead leaves, or wood piles on the ground next the structure (Cohen 2000a). Moreover, during the sprin 2001 fire season in Florida, the majority of homes th burned were lost in a single afternoon in what is normal considered a low-risk situation: low grass cover with fe if any trees or shrubs around the homes. They just ha pened to be in open areas caught in a series of fast-movi grass fires on a very windy day. In both instances, t majority of these homes could have been saved by an abl bodied person with a garden hose and adequate water o prefire scratch line that reduced the hazard by removi fuels from the base of the structure. In Australia, fire co trol agencies offer basic fire suppression and survival trai ing to property owners and encourage them, if they a able-bodied, to stay with their homes when threatened b wildfire rather than evacuate. They have generally fou that this is much safer than trying to evacuate everyone a has resulted in significantly fewer homes lost or damage

13.4.2 Suppression Strategies and Tactics

Wildland fires, particularly in the interface, usually do n stop at political or fire agency boundaries. Thus, any give fire may cover jurisdictional lines for city, county, state, a volunteer fire departments. In such situations, timely a effective coordination of suppression activities is depende on prefire planning among agencies and communicatio systems that allow different agencies to maintain contact.

Prefire planning takes many forms, but most typical includes mutual agreements on who will respond to fires intermediate areas, compacts to provide mutual suppo upon request, and lists of equipment and resources avai able from different agencies. Following the 1998 fires Florida, the Governor's Wildfire Response and Mitigatio Review Committee submitted 90 recommendations th addressed significant issues in wildfire response, recovery, and mitigation/prevention (Governor's Wildfire Response and Mitigation Review Committee 1998). Some of the recommendations relevant to suppression strategies include:

- Prepositioning wildfire suppression resources based on criteria such as drought conditions, wildfire activity, and available resources.
- Adequately equipping rural fire departments for wildland fire.
- Upgrading communications systems for the Division of Forestry and other agencies.
- Increasing wildland fire training for structural and volunteer firefighters.

The emphasis on increasing equipment and training for volunteer departments is especially noteworthy. According to the National Volunteer Fire Council, nearly 23,000 of the 31,000 fire departments in the country have no paid employees and another 5000 use mostly volunteers led by a few paid staff members. Many interface developments and residences are beyond the jurisdiction of municipal fire departments and are dependent on these volunteer suppression crews. Unfortunately, as the number of interface homes and developments is increasing, the general trend for volunteer departments is a decrease in size. This decrease over the past 10 to 20 years is primarily due to a lack of new volunteers to fill the empty spots left by trained volunteers who have been able to find full-time fire/rescue positions. This is a significant nationwide issue.

Some of the reduction in available fire-fighting crews created by the loss of volunteer fire department staff has been compensated for by cross-training structural and wildland fire crews. Increasingly, traditional fire agencies are training their crews in wildland fire behavior and control, and are outfitting them with brush trucks and wildland personal protective equipment. For example, more than 20 percent of the City of Albuquerque, New Mexico, Fire Department staff have been through the suite of basic federal land management courses in wildland fire behavior and suppression. The department has three task forces, all with brush trucks and ATVs for the three major wildland vegetation systems that occur within their jurisdiction (Don Shainin, Battalion Commander and Wildland Coordinator, personal communication, August 2001). The Alachua County, FL, Fire/Rescue Department has similarly cross-trained many of its staff and has equipped them with brush trucks and wildland fire gear (Will May, Alachua County Fire Chief, personal communication, February 2002). This trend will undoubtedly expand in the future, with not only more individuals trained for both structural and wildland fuels but many of those individuals trained at higher levels in the Incident Command System, which is used by many organizations to coordinate emergency response activities. Many other local, state, and federal agencies charged with emergency management in Florida (and elsewhere) are finding advanced-level federal fire management courses valuable for all staff involved with any type of emergency, ranging from hurricanes to citrus canker outbreaks.

Another critical aspect of planning and readiness for interface fires is the prepositioning of suppression and prevention crews before fires break out. As more states complete state- or regionwide risk assessments like those in Virginia, New Mexico, and Florida, they will use the assessments to prioritize the placement of crews and equipment. For example, since the 1998 fires, Florida has been very proactive during the spring fire season, accelerating initial response to most fires and moving prevention crews around the state in response to changes in fire danger. These prevention crews are primarily responsible for reducing the possible sources of human ignitions using techniques such as door-to-door contacts, school programs, displays, and handouts at fairs and malls, but they also have the latitude to undertake other initiatives they deem important for the types of ignitions that might occur in different areas.

13.4.3 Prevention Strategies

The Florida Division of Forestry is convinced that the positioning of fire prevention teams in areas of high fire danger has substantially reduced the number of human-caused fires, but this is only one aspect of fire prevention strategies that range from landowner education to zoning and regulations.

13.4.3.1 Landowner Education

Fire prevention in and around homes has been a traditional message of municipal fire departments and some state forestry organizations for decades. Common venues for these fire prevention programs/displays have been schools, fairs, malls, television and radio public service announcements, and door-to-door contacts. Emphasis has been on preparations for fires started within the home as well as various home exterior and landscape maintenance projects to reduce personal fire risks in case a wildfire threatens. As interface areas expand, these traditional approaches face significant limitations. For instance, municipal agencies often cannot reach new developments outside their jurisdiction where landowners need in-depth information regarding the role of fire and landscaping options that help fireproof their homes while being in harmony with interface ecosystems. Educational programs are needed that explain how to landscape for diverse, and often conflicting, objectives ranging from water and energy conservation to fire preparedness to wildlife habitat improvement in the wildland–urban interface.

In the last two decades, and especially in the last 10 years, fire prevention education has expanded substantially in terms of content, delivery methods, and organizations involved in the programs. State forestry and wildlife organizations have been especially active in developing new programs and materials, often in conjunction with other organizations such as the Cooperative Extension Service, The Nature Conservancy, and various regional cooperatives. Examples of educational materials include:

- *Living with Fire: A Guide for the Homeowner*, a 12-page newsletter that was initially designed by the University of Nevada, Reno, Cooperative Extension Service, which has now been adapted by many western and southern states (Figure 13.6). The major focus of the publication is on making homes defensible in design, construction, and landscaping, but it also includes articles on the role of fire in natural ecosystems, fire behavior in local ecosystems, and what to do when a fire approaches (Smith and Skelly 1999).
- *Creating Wildfire-Defensible Zones* and *Fire Wise Plant Materials*, two landowner publications (eight pages each) prepared by the Cooperative Extension Services in Colorado and New Mexico. Similar brochures in many other states outline details for landowners to follow in home construction, landscaping, and plant selection in interface developments (Dennis 1999a,b).
- *Wildland Fire Education Handbook* (Monroe et al. 2000), a manual with supporting materials (slides, videos, and PowerPoint presentations) created by the University of Florida, Florida Division of Forestry, and The Nature Conservancy for use by extension agents, staff foresters, and fire prevention agencies in programs for landowners. The handbook includes a number of short publications on landscaping, considerations for subdivision development, prescribed burning, and the role of fire.
- *Fire Safe California Community Action Guide* (California Department of Forestry and Fire Protection 1996), produced with the assistance of the Western Insurance Information Service and the California Fire Safe Council. This publication is designed to help interface communities understand why they are at risk and develop recommendations for reducing that risk.

Every one of these educational materials stresses the fact that homeowners must assume responsibility in preparing for the inevitability of a wildland fire and each includes guidelines for carrying out that responsibility through the creation and maintenance of defensible home and landscape conditions. The materials are handed out through agency and extension offices, distributed landowner/homeowner association meetings and f booths, and available on many Internet web pages. Th are also used as resources for many other newslett (such as "Creating Fire-resistant Landscapes" in the Sa Fe, New Mexico, Botanical Garden Fall 2000 Newslett and media releases. The result is that fire prevention inf mation is much more diverse and more widely distribut today than it was in the past.

Making this information most meaningful for, adapting it to, particular audiences requires that educat in any organization must understand what landown already know and what their perceptions and attitudes toward risk, fire, and prevention options. "Needs asses ments" of landowners and the general public were hig lighted in the 2001–2002 National Fire Plan as a hi priority for additional research and application, a efforts are under way across the country to conduct su assessments. Recent homeowner surveys have alrea demonstrated additional issues that should be consider in future educational programs. Landowners in Michiga who experienced several devastating interface fire including one escaped prescribed burn, were very sus cious of prescribed burning as a legitimate fuel reducti method (Winter and Fried 2000). They also tended believe that nonresidents were responsible for most of t escaped backyard burns, when in reality most wildla fires result from negligence by permanent residen These attitudes indicate the importance of education programs that include not just one-time exposure to fi prevention messages at teachable moments, but repeat descriptions of successful prescribed burns and causes local wildfires. Fire should be a constant part of the inte face landowner's mindset. The lead article in the fall 20 issue of the Forest Trust Quarterly Report states that it much more practical for us to learn to live with natu disturbances and become a fire-adapted society than it to try to change this natural process (Foster 2001).

A survey of 675 people in Florida indicated that high percentage of both rural and urban homeown understood that fire is a natural environmental factor Florida, but they had questions about its effect on wildli and air quality and were concerned about the effects of a quality and smoke in their immediate vicinity (Monr et al. 2000). Those issues became focal points for sever of the publications and presentation topics in the *Wildlan Fire Education Handbook* described previously, and the illustrate the importance of adapting educational pr grams to audience concerns. A second recent survey Florida also demonstrated the importance of education programs for increasing public acceptance of prescrib fire (Loomis et al. 2001).

The increasing role of the Cooperative Extensio Service in wildland and interface fire education benefi traditional fire prevention organizations as well a

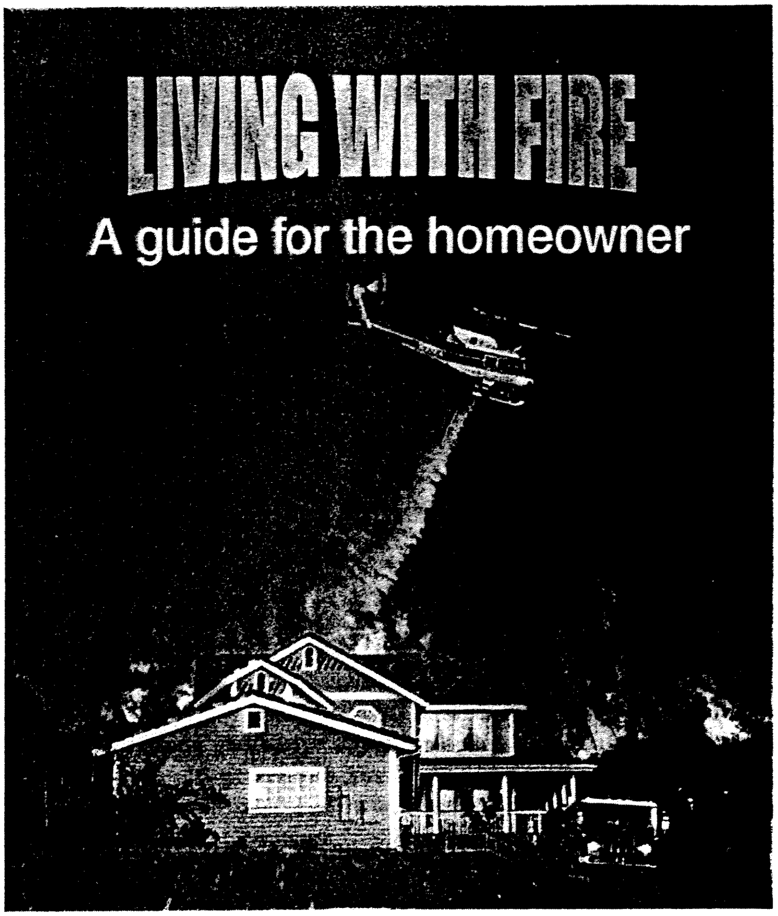

FIGURE 13.6 "Living with Fire — A Guide for the Homeowner" was originally produced by the University of Nevada Cooperative Extension Service and has since been adapted by a number of other states as a primary educational tool for homeowners. (Adapted from Smith and Skelly 1999.)

landowners. Extension agents and offices are located in practically all counties in the country and they have a well-established rural landowner network. They have a long history of assessing landowner needs and experience with diverse program delivery systems from workshops and demonstrations to one-on-one problem solving. One of the strengths of local extension programs in other disciplines has been backstopping by a variety of state specialists. Although universities may not generally have the same level of expertise in wildland fire as in many agricultural arenas, specialist assistance to extension programs is available through a variety of interagency cooperatives and agreements. One of the things extension does best is provide locally specific education on important public issues. Interface fire management is one such issue, and extension programs nationally and at state levels should continue to play a key role in interface fire education.

13.4.4 Local Policies and Regulations

The ultimate goal of any educational program should be landowner actions that will mitigate risk and enhance firefighting efforts. Integral to these objectives is expanding landowner awareness of the role and effects of fire in natural ecosystems and the ways in which we have affected that role through management and interface development. Such an increased awareness will be invaluable in helping formulate local policies that influence fire management while benefiting landowners at the same time. Local policies may take the form of growth management planning, homeowner association specifications, and/or ordinances that regulate what can and cannot be done on private properties. They counter the only major disadvantage to educational programs, which is that landowner response to those programs is voluntary.

Residential developments frequently have specifications for home design, construction, and landscaping in order to maintain a certain character to the development (Figure 13.7). For example, the Genesee development near Golden, CO, and several communities outside Bend, OR, initially required wood roofs and siding on new homes to fit with the natural surroundings. Each of these communities experienced interface fires directly or nearby in the 1980s or early 1990s. Recognizing that wood roofs may be responsible for a high percentage of

FIGURE 13.7 Home const near Boulder, CO, with a nur high fire risk features, includin roof, siding, and overhangs, a fine fuels and evergreen trees i ately adjacent to the structures ordinances and homeowner ass standards now require much attention to reducing these f (Photo by Alan Long.)

home ignitions, they have replaced the requirements for wood roofing with fire-resistant roof materials. Other examples can be found around the country where subdivision development guidelines either encourage or discourage fire prevention through green space, landscaping, home construction, or other requirements. If community covenants and restrictions prevent homeowner or association actions that would reduce fire risk, they need to be exposed as a public safety liability. Numerous examples exist by now that demonstrate the fallacy of ignoring the risk and hoping that nothing happens. Homeowner associations, developers, and insurance companies must be involved in any educational programs that focus on interface fire management.

County or other local ordinances are diverse in their detail and intent. After the Tunnel Fire in 1991, the City of Oakland adopted regulations for high fire hazard areas that require fire-resistant materials on new or replacement roofs and siding on new buildings with at least a 1-hour rating for resistance to flammability (Figure 13.8) (Ewell 1995). Along the Front Range in Colorado, building codes have been strengthened to institutionalize fire safety (Johnson and Mullenix 1995), and county governments require a Wildfire Mitigation Plan as part of the Site Plan Review for new development above the 6400-ft elevation contour (called the "Red Zone"). The new revisions for the Growth Management Plan for Alachua County, FL, include specifications for construction, streets and water supplies, and landscaping in high fire risk areas. Similar examples exist across the country for model codes developed at state levels and local ordinances regarding construction, landscaping, and development infrastructure. Less common today, but with considerable future value as prevention tools, are various types of insurance or other incentives (or disincentives) to encourage landowr take positive actions.

One advantage of the regulatory approach is assures fire prevention measures will be taken in with an identified fire risk. However, this approa also be loaded with pitfalls when uniformity is across different political jurisdictions. Californi probably dealt with this issue longer than any othe with regulations ranging from the California Bu Code Title 24 to many city and county codes and nances. Yet, a uniform approach to fire prevention i ing because of a lack of cooperation between sta local governments (Coleman 1995). Their expe should be an example, and a warning, to other stat fire prevention is a multiorganization effort tha require both educational and regulatory elements w together, as modeled in a number of recent comm education and action programs.

13.4.5 Community Action Programs

Interface fires threaten homes, businesses, services, a many natural resources that are part of ecosystems the interface. It is, therefore, not only appropria imperative that prefire planning involve all stakeh and interest groups, not just landowners and fire su sion agencies. Planning includes all the elements desc in this chapter: risk assessment, prevention strategie methods, subdivision development and construction dards, landowner and community education, fuel mod tions, and fire suppression strategies. We briefly de three examples of community-based programs below ognizing that other programs, or adaptations of these may be more appropriate in other situations.

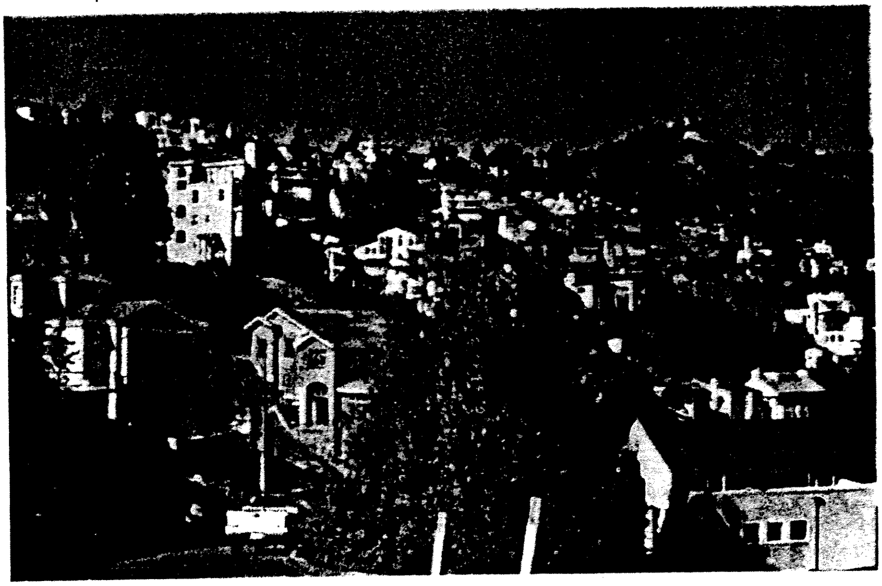

FIGURE 13.8 Home construction in the Oakland Hills, CA, following the deadly 1991 fire requires that exterior surfaces be constructed of fire-resistant materials. (Photo by Alan Long.)

Firewise Communities is a program developed by the National Wildland/Urban Interface Fire Program, which is sponsored by a number of state and federal agencies and associations and the National Fire Protection Association (see section on risk assessment). At the heart of the program are regional workshops that ideally include landowners, developers, realtors, and representatives from local government, insurance, banking, emergency management, fire agencies, extension and education, and other interested stakeholders. The goal of the workshops is to encourage the integration of Firewise concepts into community planning at all levels.

The first pilot workshop in the nation was held in Deerfield Beach, FL, in October 1999, under the direction of a national team of instructors and facilitators. The key activity in these workshops involves a set of case studies in which participants evaluate fire hazards, home construction and landscape issues, stakeholder concerns, strategic fuel reduction projects, and educational methods for involving the community in planning. Discussions range from the need for local ordinances to fire suppression coordination. Although the case studies are simulations, complete with GIS maps, the intent is that participants in each workshop should become planners and facilitators for future workshops in their home communities, developing solutions for their real-life situations. As an example, the Florida Division of Forestry has helped conduct workshops throughout the state since the Deerfield Beach workshop. They have been highly successful as judged by the fact that local groups are adopting the suggested methodologies and concepts. Regional workshops have also been held in many other states. The Firewise Communities web site provides information about the workshops, success stories that have followed workshops, and links to many related sources of information (National Wildland/Urban Interface Fire Program 2003).

The second example is the state of California, which has dealt with the specter of interface fires for over 40 years. During that period, fire agencies have used prevention programs, from guidelines for individual properties to large-scale fuelbreaks to building codes, with varying degrees of success. A statewide California Fire Safe Council was formed in 1993 with a mission to preserve California's natural and man-made resources by mobilizing all Californians to make their homes, neighborhoods, and communities fire safe. Through the 50 public and private organizations that make up its membership, it has distributed fire prevention education materials to industry leaders and their constituents, evaluated legislation pertaining to fire safety, and empowered grassroots organizations to spearhead fire safety programs.

The California Fire Plan was initiated in 1995 with the goal of turning fire prevention into a much more proactive and participatory process. The plan outlines a process that defines levels of service for each area of the state, considers values at risk, and includes the public in planning and taking actions before fires occur. Central to the Fire Plan is the formation of local or regional Fire Safe Councils to bring together all interested stakeholders to develop a fire prevention and mitigation strategy for their region or community. To assist the councils, a *Fire Safe California Community Action Guide* (California Department of Forestry and Fire Protection 1996) describes how councils might be formed and function, lists elements of fire-safe communities, neighborhoods, and properties, and presents several case studies. Activities promulgated by Fire Safe Councils include annual clean-up days for communities, fuel reduction in neighborhoods using portable chippers, media events and news releases, educational campaigns, landscaping demonstrations, and working with county officials to incorporate fire safe measures in county general plans (e.g., greenbelts, enforcement of building codes, development of emergency water systems). As of 2001, more than 60 Fire Safe Councils exist in California, with different levels of activity in each. An important element in the continued functioning of any individual council has been people who are willing to take on leadership roles.

The third example is the state of Colorado. The Front Range is home to many interface developments and has experienced a number of disastrous fires in what officials call the "Red Zone." A variety of programs and materials that address fire problems in this zone have been developed in the last 10 to 15 years by counties, federal agencies, and the Colorado State University Cooperative Extension Service. The Community Fire Prevention Partnership combined many of these materials into a FireWise notebook in 1999. The notebook is a primary resource for meetings with landowner associations, builders and developers, city and county officials, and other interested groups.

The above examples illustrate programmatic opportunities to increase awareness of interface fire and encourage actions to mitigate the danger, but an equally important prerequisite for effective fire management planning is the necessity of including all stakeholders, whether they are interested or not! Their ideas and concerns will undoubtedly reveal issues that traditional fire organizations have not considered and their involvement may well provide the support that those same organizations need as they promote the types of mitigation measures described in the following sections.

13.4.6 Landscape-Level Fuel Modifications

Risk assessment, prevention strategies, and community action programs all lead to the next critical aspect of interface fire management — the reduction of fire incidence and intensity. Most fire starts are the result of lightning, negligence and carelessness, or arson, although many other causes (e.g., sparks from equipment or brake shoes, hot mufflers, and spontaneous ignition) contribute to a small percentage of fires. The prevention programs described previously focus primarily on reducing human-caused fire starts, and we will not describe those efforts further here. Rather, we will turn our attention to the many opportunities to protect homes and property, especially by reducing fire intensity or blocking fire spread.

Fuel modification can be divided into two general types; linear and landscape. Linear firebreaks create a relatively narrow break in the path of a fire and are a common feature around many private forests and pastures in the South, where soils are sandy. They are less commonly used elsewhere, except during fire suppression operations. Linear firebreaks are usually created by plows, disks, or bladed tractors that leave mineral soil exposed and all face fuels pushed to one side or covered by a dirt b They will stop many fires, but they lose their effective as fireline intensity increases. Putting in multiple pa lines will halt most wind-driven fires unless long-dist spotting is a problem. When spotting is a problem only effective solution is to rapidly widen the control by burning out between the line and the approaching before the wildfire reaches the line. Disked or bladed provide access to brush trucks and ATVs that are equipped with drip torches allowing rapid ignition a the upwind side of the prepared break. When used preventive measure, linear breaks should be retre annually, at least in the South, to remove dead fuels fall on the line as well as to remove anything that seeded in or resprouted.

In the Southwest, especially the chaparral regio California, wider control lines, ranging from several y to over 500 ft wide, called fuelbreaks, stretch for n along ridgetops (Figure 13.9). They are created by ren ing all the brush along the corridors, and in those c where trees are present, thinning the overstory to l widely spaced trees. Interestingly, the extra growth on residual trees may have compensated for at least part o cost of creating the fuelbreaks (Grah and Long, 19 National Forests in California began creating these in 1950s to provide major barriers to fire spread and to suppression forces a baseline from which to work. In following decade, this technique was expanded to rem understory vegetation and thin the overstory along r ways through many of the National Forests in Californi nontimbered areas, fuelbreaks may be created by remo all or most of the shrubs along the corridors, leaving herbaceous and grass cover. There is much current inte in utilizing this methodology for manipulating fuels aro interface developments nationwide, but it is a costly op and should only be contemplated where recent fire his strongly suggests its potential usefulness.

Greenways, greenstrips, or greenbelts are a form fuelbreak in which the natural groundcover vegetatio replaced with species that will stay green during the season, or that are more resistant to fire spread than natural cover (Davison and Smith 1997). Perhaps, the u mate greenway is a golf course around an interface co munity. But even golf courses may not stop a worst-c conflagration because of the plethora of long-dista firebrands. They will, however, break up the head of fire and serve as an anchor line for suppression forc Whenever high-intensity fires are forced to the ground fairly sparse fuels, they lose their ability to produce lo distance firebrands, which is a prerequisite to stopp them as long as unburned fuels are present downwind.

The other general fuel modification technique is la scape-level fuel modification, where large continu areas of vegetation are substantially altered. Unlike lin

FIGURE 13.9 A ridge-top fireline and fuelbreak in the central California Coastal Range provides protection to wildland–urban interface homes on both sides of the line and a control line for fire suppression crews. (Photo by Alan Long.)

firebreaks, these techniques substantially reduce fire intensity across a large area, and provide an opportunity to correct one of the most important current issues in forest health — the undesirable ecological effects that decades of attempted fire exclusion have wrought. Millions of acres across the country now contain unprecedented forest floor accumulations and overly dense understories and overstories that are prone to insect and disease epidemics. Reducing the stature and/or density of the understory, sometimes in combination with a reduction in overstory density, will not only improve forest health but also remove ladder fuels that allow a fire to reach from surface fuels to overstory tree crowns. Correcting the dense stand conditions may improve both forest health and reduce fire intensities, but to do so requires an immense commitment of time and resources. Priorities for this commitment will undoubtedly favor interface communities in many places because of the high values of property and life in the wildland–urban interface.

13.4.7 Protecting Individual Properties

It is almost always the homes in the interface that result in the huge value losses from wildfire; they are also the asset on which suppression forces generally focus their attention, at the expense of other resources. When faced with an interface fire, suppression crews are often forced into triage because there are more homes threatened than there are suppression forces on the scene. The inevitable result is that some structures are left unprotected. Once homeowners accept this fact, the solution is obvious. The probability of individual homes surviving a wildfire intact is in large part dependent upon what homeowners choose to do to protect their property. It is thus incumbent upon homeowners to plan and carry out protective measures on their property that will improve access, increase defensible space and fire resistance of their home, and maintain those conditions over time. Where lots are less than several acres in size, the probability of a home surviving a wildfire is usually somewhat dependent upon the condition of adjacent properties. It is thus prudent for homeowners to undertake protective activities in concert with their neighbors, either informally or formally through a subdivision or county ordinance. Guidelines for these protective measures are available in brochures (e.g., Federal Emergency Management Agency 1993; Lippi and Kuypers 1998) or on Internet web sites through state, county, and local agencies (e.g., Dennis 1999a; Minnesota Department of Natural Resources 2003; National Wildland/Urban Interface Fire Program 2003). Specific technical help is almost universally available from state and local fire management agencies, and financial help is sometimes available through the types of programs described earlier in this chapter. Key points are summarized below, recognizing that the relative importance of a specific point will vary from region to region.

13.4.7.1 Access for Fire-Fighting Equipment

Provisions for fire-fighting equipment access are critical parameters in risk assessment protocols and community educational programs; if suppression forces cannot quickly reach threatened structures, they cannot adequately protect them. The NFPA 299 Standard (National Fire Protection Association 1997) provides criteria for fire agencies, land-use planners, architects, developers, and local governments for fire-safe development. Local jurisdiction authorities may adjust these criteria (usually more stringently) depending on local conditions. Important features include:

- Road widths that allow two-way traffic
- Vertical clearance above roads and driveways that allows passage of suppression equipment
- Road surfaces and bridge weight limits sufficient for large trucks
- More than one ingress/egress route, with access through unlocked gates
- Road grades, curves, and turnarounds that will accommodate large trucks
- Well-marked roads with clearly visible signs and house numbers
- Water supplies (wet or dry hydrants, reservoirs, storage tanks, swimming pools).

Once suppression equipment gets to an individual property, it is often necessary to move that equipment off the driveway and around structures. Locations of septic tanks, underground water pipes, and other structures such as fences and walls may limit the ability to position equipment where it can be most effective. Where natural gas is available, buried service lines are a significant problem.

13.4.7.2 Home Design and Construction

The second major protective measure, which is dependent upon builders and developers as well as the landowner, is the design and construction of homes and other structures. Many fire-prone interface communities have ordinances that dictate or ban specific building materials, especially roofs and siding. Although wood is often the material of choice for building exteriors in the interface, it is also the most flammable alternative. Wood used for siding, shingles, shakes, and decking can be treated to reduce flammability for a period of time, but brick, stucco, fiber-cement panels, metal, and even logs will be much more resistive to ignition (Slack 1999). However, if heat impinges on metal sheathing long enough, it can cause wood supports behind the siding to ignite. To prevent this, use gypsum sheathing between the siding or roof and the wood supports. New home construction and retrofitting older buildings in many interface developments now requires nonflammable exterior construction. Experience in Florida has shown that fire enters many homes because the fiberglass roof soffits melt (Abt et al. 1987; DeWitt 2000). Slack (1999) gives additional design and construction features to help provide structure protection:

- Noncombustible fine-mesh screens or skirts for subfloor vents, decks, and mobile homes
- Fire-resistive deck construction and roofing materials
- Flat rather than sloped soffits with quart inch or smaller wire mesh screening vent openings
- Thermal (double) paned windows w exterior window covers or shutters
- Simple roof lines and walls or landsca features that will block the direct imping ment of radiation or convective gases the structure and vents
- Spark arresters on chimneys and flues.

In addition to building design and construction rials used, building location on the site and placem adjacent structures will influence protection from Homes should be set back on slopes so that they are the direct path of convection rising from a fire low the slope. Fences, outbuildings, woodpiles, and pr tanks should be located well away from the house the case of fences, detached from the house if constr of wood.

13.4.7.3 Defensible Space

Defensible space is the area between a house a oncoming wildfire where the vegetation has been mo to reduce fire intensity, thereby providing safer oppo ties for firefighters to defend the house. Although the certain common parameters in most publications defensible space, precise specifications vary conside across the country (e.g., Foote et al. 1991; Gresham 1997; Smith and Skelly 1999; Dennis 1999a; F Division of Forestry 2000). Landowners can acces information through local agencies and the Internet.

Whether explicitly described or not, defensible usually includes at least three zones, each design serve a slightly different function. The "structure p tion zone" (Zone 1, Figure 13.10) is usually the im ate 10 to 15 ft next to the house. Within this zone flammable material (dry grass, pine needles, mulches, and so on) should be replaced with ground ers (stone to green plants) that will stop ground before they reach or go under the house or mobile h Unfortunately, many interface homes have ignited burning pine needles or dry grass next to the stru rather than by intense heat or flames burning in fuels. Other tasks within this zone include removin branches (dead or alive) from within 10 ft of chim keeping debris such as pine needles off roofs and d and removing stacked firewood from porches or under the roof eaves.

The "defensible space zone" (Zone 2, Figure 1 is the next 20 to 100 ft around a building, with the dimensions dependent on slope, vegetation types, prevalent weather. This is the area in which fire-fig crews will be able to position themselves to knock

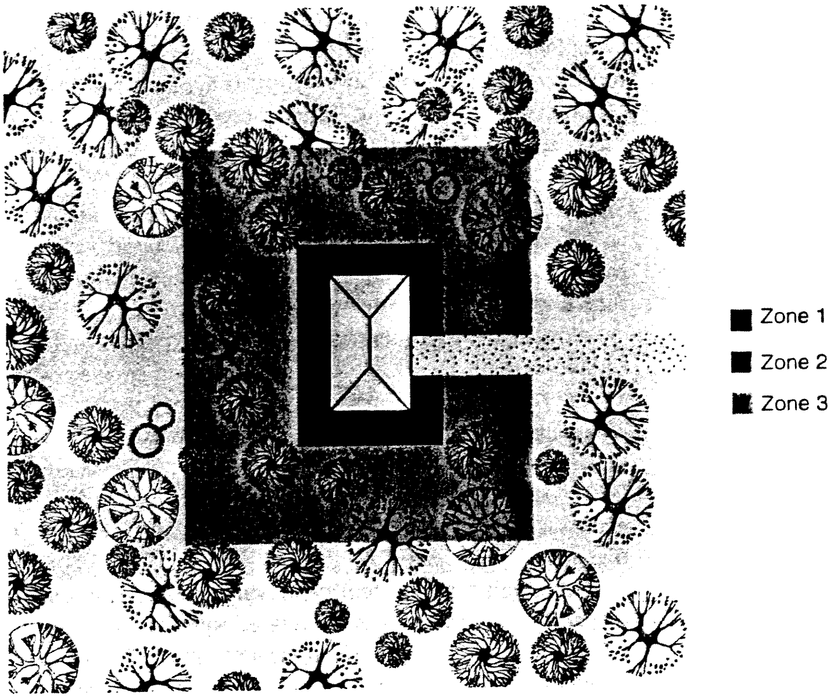

FIGURE 13.10 Defensible space around wildland–urban interface homes is generally designed with at least three zones: Zone 1, immediately adjacent to the structure, contains no flammable fuels; Zone 2 may contain widely spaced hardwood or conifer trees and even a few shrubs in small groups, but it must provide access for fire control crews; Zone 3 allows trees to be more closely spaced, but understory plants are still reduced enough to lower the intensity of approaching fires.

a fire and/or protect the home. This is the most critical zone for protection of structures in the interface. It is one of the main factors that firefighters will consider if they have to make a triage decision as to which structures to protect. The condition of this zone coupled with the exterior home construction materials used often determines whether a home can withstand a fire threat in the absence of fire crews. In addition to providing access, landscaping in this zone should be designed to significantly reduce the amount of radiant heat and convective gases that would impinge on the structure, either of which can lead to ignition of flammable building materials (Cohen 2000b). Common features within this zone include:

- Thinning trees and pruning dead or lower branches to eliminate crown-to-crown contact and foliage near the ground
- Removing ladder fuels (vines, shrubs, and smaller trees that can carry fire into the crowns of the larger trees)
- Removing flammable shrubs (chaparral, eucalyptus, saw palmetto [*Serenoa repens* (Bartr.) Small], wax myrtle [*Myrica cerifera* L.], and gallberry [*Ilex glabra* (L.) A. Gray]), or reducing them to small isolated islands and pruning them to maintain low stature
- Maintaining green lawns or other live ground cover under 6 to 8 in. tall
- Constructing walkways, driveways, fences, or walls with nonflammable materials that provide fuelbreaks of different sizes.

The "forest–woodland zone" (Zone 3, Figure 13.10) extends from the defensible space to property boundaries and beyond. The major purpose of manipulating vegetation within this area is to reduce fuel loading and/or flammability, thereby decreasing potential fireline intensity and production of firebrands. Secondary benefits include biodiversity, wildlife habitat, and soil and water protection. Fuel reduction measures in this zone focus mainly on reducing shrub density and height, thinning dense tree stands, and removing unhealthy and dead trees (although a few dead trees are often left for aesthetic and wildlife purposes). Similar tree and shrub removals should also be considered along power lines, trails, and fire access routes. As in the defensible space zone, slash created by these operations should be chipped, lopped, and scattered, or removed. Leaving large piles of debris simply creates an additional fire hazard, although a few small piles are sometimes left to provide cover for wildlife. Fuel reduction is accomplished with various mechanical tools and equipment, chemicals, prescribed burning, and grazing animals. The benefits and disadvantages of each will be discussed in the next section.

Within each of the three zones, landscaping guidelines often refer to planting or favoring fire-resistant plants. Although there are a few exceptions (such as some succulents), most plant species are potential fuel for fire after prolonged drought. "In fact, where and how you plant may be more important than what you plant" (Dennis 1999b). Many agencies will provide lists of species that have fire-resistant characteristics, but of perhaps more importance are lists of species to avoid. Fire resistance and flammability may be a function of age and size, branching patterns, foliage size and thickness (especially surface area to volume ratios), seasonal changes in foliage, live fuel moisture content, and chemical content. Groups of plants that are more flammable than others include conifers with resinous foliage such as some pines and junipers, shrubs that contain waxes or oils (wax myrtle, gallberry, and saw palmetto) or have aromatic leaves (eucalyptus [*Eucalyptus* sp.] and melaleuca [*Melaleuca quinquenervia* (Cav.) Blake]), shrubs that accumulate large amounts of dead foliage (many chaparral species), plants with high foliar surface-to-volume ratios (sagebrush, bitterbrush [*Purshia tridentata* DC.]) or hairy leaves, and grasses, especially those that grow tall and dense. Less flammable groups include most deciduous hardwoods and succulents, and many annuals and perennials with open branching patterns. For many landowners, however, plant selection is dictated by other objectives such as soil protection, wildlife or human food sources, shade, water conservation, and aesthetics. They can accomplish fire management objectives through the vertical and horizontal distribution of plants (planting pattern) in the landscape rather than by species choice.

It is important that homeowners recognize that the above home protection measures are not one-time projects. Fuels accumulate as vegetation resprouts, continues to grow, or dies. As an example, consider the annual fall of pine needles and other foliage onto roofs and into yards. Without regular maintenance, hazardous conditions are quick to return. Defensible space and homes must be regularly checked and treated to maintain protection from the inevitable fires.

13.4.8 Vegetation Management: Opportunities for Natural Resource Managers

Vegetation management and manipulation in the interface is an exciting, if not daunting, challenge to natural resource managers. As if the many social, cultural, and political issues and conflicts were not enough of a challenge, decisions pertaining to vegetation pattern and ecosystem health result in a whole new arena of resource conflicts and tradeoffs. For example, although fuel reduction is the most crucial step in home protection, as well as necessary to maintain/improve forest health, if not done correctly it may create opportunities for invasive species, increase soil erosion, and degrade water quality. Vegetation management can also be obtrusive to neighbors. Thus, resource managers must determine not only how they need to manipulate ecosystem communities to best reach their objectives, but they must also sel acceptable method for doing so (which may not b most appropriate from an ecological standpoint). I section, we describe the benefits and disadvantag mechanical, chemical, biological (grazing), and scribed burning methods to modify fuels.

Throughout this chapter, we have referred to the to manipulate fuels and vegetation on a large sc restore ecosystem health, reduce fire intensity, and r fuel loads. Resource managers should collaborate developers, home owners, nearby public agencies, ar service organizations to be sure that ecological as as anthropogenic objectives are considered and to advantage of the economies of scale that may be po with treatments applied to larger areas. These colla tions will also help in hazard or risk assessments th necessary to determine problematic fuel types and p tize areas to be treated.

Although problem fuel types vary across the co one similar characteristic in many ecosystems is a c uous and dense shrub layer, often with ladder fuels (or young trees) bridging the gap between surface and the overstory. The gallberry–saw palmetto cor provided much of the fuel in the 1998 wildland– interface fires in Florida (Figure 13.11). Both sp grow back rapidly after all but the most severe Frequent low-intensity fires historically perpetuated ecosystem, confining these woody shrubs to the gro cover that was dominated by wiregrass. With atten fire exclusion, these shrubs have proliferated to the where even annual dormant season fires have no in on their density, and high-intensity fires can result w 4 to 5 years. Periodic fire has also maintained the ch ral brush fields of southern California, except that sites can also experience substantial soil erosion i brief months before hillsides are revegetated. In the Basin, bitterbrush burns intensely but does not respro readily after a fire as gallberry and chaparral spe Bitterbrush is a critical browse species for mule deer since this plant species recovers slowly after fire, b that cover large areas could seriously deplete the d winter range. These three examples illustrate although the need for fuel reduction might be a f straightforward decision, treatment methods must acc modate other concerns.

Four general methods are potentially available to resource manager to modify vegetation structure and c position: prescribed burning, machines, herbicides, livestock grazing. They may be used as single treatmen applied as combination treatments. The applicabilit these alternatives is currently the focus of numerous stu nationwide (e.g., Brose and Wade, 2001), but few re have yet emerged.

Prescribed burning is preferred by many landow because it is the method that historically maintained t

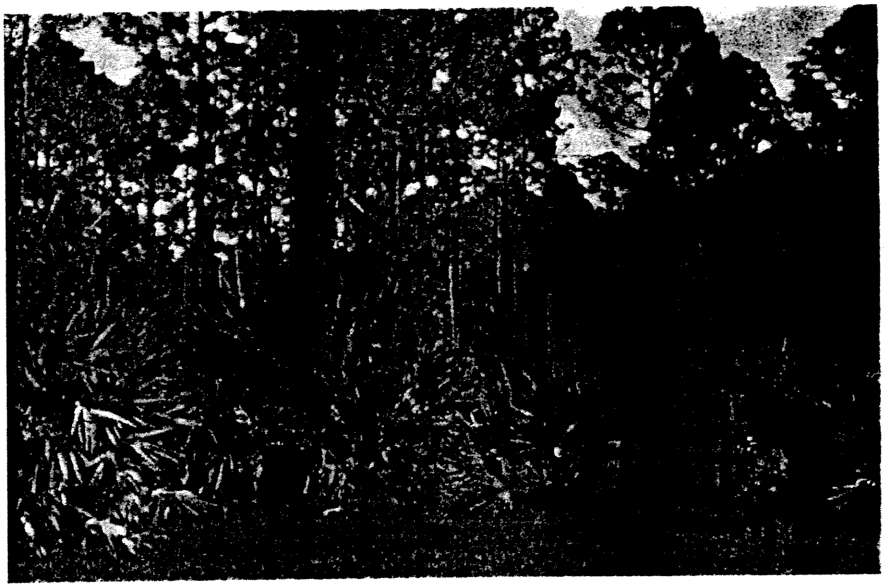

FIGURE 13.11 Dense shrubs and saw palmetto characterize empty lots and adjacent woodlands in many wildland–urban interface communities in Florida. (From Monroe et al. 2000.)

ecosystems. Ideally, forest health will be restored and maintained over the long run by reintroducing fire at frequencies, seasons, and intensities that resemble its natural historical regime. Using prescribed fire, fuels can be significantly reduced over large areas, but this reduction is only temporary. Many examples can be cited where recent burns have dramatically reduced wildfire intensity (Cumming 1964; Helms 1979; Wagle and Eakle 1979; Outcalt and Wade 2000; Thorstenson 2001). In addition to reducing fuel loads, prescribed fire results in numerous other benefits including: wildlife habitat improvement; increased amount, palatability, nutritional quality, and availability of forage; increased fruit and mast production; preservation of endangered plant and animal species; nutrient cycling; disease, insect, and pest control; the ability to time burns to minimize detrimental effects such as air quality or game bird nesting and optimize desired effects such as control of shrub sprouts; slash disposal and site preparation prior to afforestation; improved accessibility; enhanced aesthetics and flowering of groundcover species; reduced suppression costs; reduced firefighter risk; and facilitation of harvesting (Wade et al. 2000). Not only can prescribed fire accomplish multiple benefits, it can generally do so at a cost lower than other vegetation treatments.

Prescribed burning can be defined as the intentional application of fire in accordance with a written prescription under specified environmental conditions in a manner that ensures the fire will be confined to a predetermined area and accomplish planned resource management objectives. Besides describing why, when, where, and how the burn prescription should include a description of current stand and fuel conditions, a smoke management plan, mop-up and control standards, and evaluation criteria (Wade and Lunsford 1989). Tens of thousands of prescription fires are conducted safely to treat over 6 million acres annually across the U.S., including a small percentage in interface areas.

Because prescribed burning is as much an art as it is a science and burns are subject to abrupt unforecast changes in weather, the threat of fire escape or smoke intrusions into smoke-sensitive areas are ever present. Although good planning and prudent execution of the burn plan minimize these threats, a few fires each year experience such problems, sometimes coupled with poor decisions, which result in significant property loss and media attention (such as the 2000 Cerro Grande fire near Los Alamos, NM). These concerns multiply significantly when burning in the wildland–urban interface, which translates into tighter constraints on when fires can be conducted.

A common complaint voiced by prescribed burners is that there are not enough acceptable burn days in a given year. The added constraints at the wildland–urban interface exacerbate this situation, the result being that even if the burn manager effectively uses every acceptable day, only a small portion of the areas that have been identified as needing fuel reduction can be treated in a given year. Resource managers must rely on mechanical and herbicide treatments to treat the rest of the areas in need of fuel reduction.

Perhaps the two biggest drawbacks of prescription fire for experienced southern burners are the potential for unexpected smoke problems and the fact that the fuel reduction achieved is only temporary. Because most woody understory species rapidly resprout after fire, retreatment is necessary every few years. For example, the palmetto/gallberry fuel complex can regain its preburn stature on good sites within 5 years (Brose and Wade 2001). In the wildland–urban interface, where additional resources are generally required to conduct and mop up the burn, costs can be prohibitive unless specific funding for treating wildland–urban interface fuels is available. The only way such funding may materialize is for constituents to apply unified pressure on their county, state, and federal representatives. But first, property owners at risk from wildfire must recognize that they are at risk and that this risk can be mitigated.

Irrespective of any leverage the public might exert, it is incumbent upon organizations charged with fire management in the wildland–urban interface to take a proactive approach to increase landowner knowledge regarding the differences between wildfire and prescription fire and the pros and cons of various fuel reduction treatment options. Public education programs through fire service agencies, extension service offices, and landowner associations will help landowners understand the nature of the ecosystems in which they live and the necessity of periodic fire to sustain them. Public media announcements prior to, during, and after a scheduled interface burn will alert landowners that a burn will occur, provide them with written, verbal, and/or visual information demonstrating that the burn crew can accomplish stated fuel reduction objectives safely and efficiently, and keep the landowners informed of recovery after the fire (Figure 13.12). Small demonstration burns conducted by local and state fire organizations can further serve as an educational program while accomplishing fuel reduction on the demonstration

FIGURE 13.12 Public education is critical for the continued use of prescribed burning as one of the management tools for reducing hazardous fuel levels. This prescribed burn manager is sharing current burn status "live" with a local TV station news crew. (From Monroe et al. 2000.)

areas. Some agencies have gone so far as to tran interested individuals to a site on the day an operat burn is scheduled, where they are briefed by a memb the burn crew and can see firsthand the compl involved and the professional manner in which the bu executed. Because of the inherent complexity of land–urban interface burns and the resource valu stake, only experienced burners who have had addit training should conduct such burns.

Herbicides are attractive to managers because the be formulated to kill selected species and they are effective, especially since retreatment may not be nece for much longer periods than the other vegetation ma ment methods. They can also be applied on steep sl often with helicopters, where machines cannot operat where hand-held cutting tools are expensive and dang from an operator safety standpoint. However, chemica reduction also has several shortcomings: herbicides only be applied during the growing season; there 18–24-month period after treatment when the dead w shrubs remain standing and pose an extreme fire ha their use is not acceptable to many landowners; and h cides do nothing to reduce the forest floor. Herbicide ments provide some protection from soil erosion in terrain because the root systems remain in place for se years, and once the dead material falls over, it slows ru On flat or gently sloping, ground application methods include tractor or ATV-mounted equipment, aircraf backpack sprayers. Costs are generally reasonable competitive with mechanical or fire treatments.

Mechanical reduction of fuel loads is frequently sen in interface ecosystems because a variety of me nized and hand-held equipment can be used withou weather constraints or potential off-site problems as ated with prescription fire or the seasonal limitation herbicides. Mechanical methods range from hand- saws, loppers, and other cutting implements to thin equipment that cuts and removes trees from a sit machines with rotating blades, chains, or rollers that c and chip everything in their path (Figure 13.13). mechanized equipment varies from small tractor-mou implements such as mowers and bush hogs to fe bunchers and large machines specifically designed for purpose. As with prescribed burning, there is an immec reduction in understory stature and potential flame hei Mechanical treatment is more acceptable to landow who worry about fire or chemicals. Treatments can applied year-round at a reasonable cost in many situati at least for the smaller equipment. On the other hand, n equipment is limited to slopes less than 30 to 40 perc large equipment can be expensive, and safety issues high with hand-held equipment, especially when it is u on steep slopes. There are also weather constraints on use of heavy equipment to avoid soil compaction or e sion. To the extent that vegetation is pulled or plowed

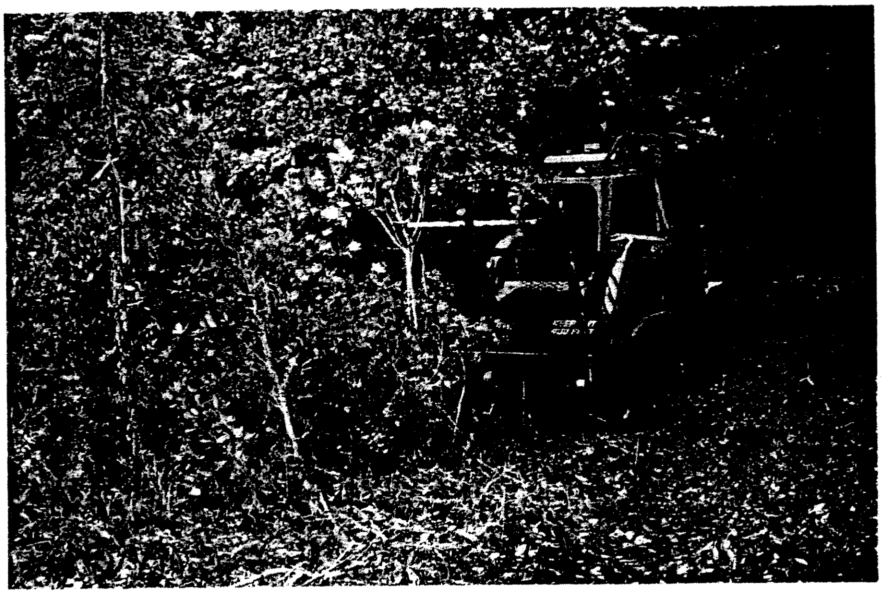

FIGURE 13.13 The Gyrotrac® mowing machine, with teeth mounted on a rotating cylinder, is capable of reducing shrubs and small trees to ground mulch. (Photo courtesy of Larry Korhnak and Florida Division of Forestry.)

of the ground, bare soil can lead to increased soil erosion for a period of time; however, if vegetation is only chopped or cut, it often resprouts, requiring periodic retreatment. Although the fuel is no longer standing, it remains on site as a fire hazard. Disposal of the cut materials can also be a problem unless they are chipped and spread out or burned on site. Fuel reduction projects in interface developments often include an arrangement by which merchantable logs and chips are removed to reduce the cost of treatment.

Livestock grazing is probably the least used method of fuel reduction, although it is also probably the least expensive and most benign in terms of effects on the landscape. There has recently been some renewed interest in this option, and it is currently being field tested in New Hampshire, FL, and elsewhere. Cattle, sheep, and goats can all be used, although their effects will vary depending on the plant species present on the site, slope steepness, and duration of grazing. Goats are notorious for eating almost anything, while cattle and sheep may be more selective, especially if a site is not overgrazed. Plants will resprout after they have been grazed, but livestock can be rotated back onto a site to maintain the vegetation at a low level. Costs associated with livestock include fencing, water sources, supplemental feeds if necessary, and caretakers for the livestock; but many of the costs can be offset when the livestock owner sells animals or when the landowner receives money for grazing lease arrangements with the livestock owner.

13.5 CONCLUSION

Fire is as responsible as any other factor for bringing many issues of the wildland–urban interface into sharp focus. Key issues from a fire management standpoint are vegetation characteristics and fuel loads in interface ecosystems, problems with trying to protect homes, lives, and resources at the same time, landowner values and expectations for services they will receive, and the infrastructure (or lack thereof) to supply those services. A variety of mechanisms is necessary for coping with fire in the interface: risk/hazard assessment, landowner and community education, zoning ordinances and related regulations, cross-training and multiagency cooperatives for fire-fighting organizations, and fuel modifications. Examples of how these mechanisms are administered around the country are many and varied.

No matter what is done to manage fuels, fires are inevitable. There is no silver bullet. Decisions during home construction and landscaping, particularly adopting Firewise recommendations such as defensible space, will help protect individual homes. But the much larger landscapes with continuous fuels in and around interface developments must also be treated. Fuel reduction is possible with various combinations of prescribed fire, mechanical implements, herbicides, and livestock. Each method has a different set of benefits, tradeoffs, and appropriate applications. Prescribed burning is preferred in many situations because it can lead to the reestablishment of natural ecosystem processes, but it presents its own set of challenges to fire management in the interface.

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