Kevin C. Ryan
Cassandra L. Koerner
Kristine M. Lee
Nelson Siefkin

Chapter 1:

Effects of Fire on Cultural Resources—Introduction

The world's diverse cultures have their varying creation stories (Moyers and Campbell 1988; UGA 2000). Many of these stories contain physical features: the mountains, hills, plains, and rivers of their native lands that are integral components of cultural traditions (Berkes and others 2000; Goetcheus 2002; King 2003; Martin 2002; Parker 1993; Parker and King 1990; Smythe and York 2009; Stoffle and others 1997). Fire figures prominently in the traditions of most cultures, both in their beliefs and their practices (Lewis and Ferguson 1988; Stewart 2002; Williams 2001, http://www.wildlandfire.com/docs/biblio_indianfire.htm). Before modern civilizations developed, early civilizations existed for millennia sometimes in urban settings, sometimes in pastoral or agrarian settings, and sometimes in hunter-gather settings, but always in close association with fire as a fuel for light, warmth, cooking/food preservation, security, and industry (Arnold 1961; Brown and others 2009; de Lumley 2006; Gowlett 2006, 2010; James 1989; Webb and Domanski 2009). Indeed, it is argued that before there were hunter-gatherers there were gatherers. Human physiology and anatomy suggest that mastery of fire must have predated specialized hunting (Sussman and Hart 2008). To early cultures, control and use of fire increased their survival through manipulation of habitats to promote desired foods, materials, and medicines. For millennia, bands of hunter-gatherers roamed the land following the rhythms of the seasons—ripening of plant resources and animal migrations. The advent of agriculture roughly 8,000 years ago is widely understood to have caused major changes in land use (c.f., Diamond 1997, 2005; Thomas 1956). In recent years there has been considerable debate as to the role of aboriginal people in altering the landscape (c.f., Boyd 1999; Denevan 1992; Stewart 2002; Vale 2002). It is, however, increasingly understood that those who came before us—whether hunter-gatherer or agricultural-urban dweller—have been major agents of land change through their burning practices (Abrams and Nowacki 2008; Fesenmeyer and Christensen 2010; Nowacki and Abrams 2008; Scharf 2010a,b; Springer and others 2010; Thomas 1956). It is becoming increasingly apparent that the combined effects of agriculture and fire have affected not only the vegetation but also atmosphere and climate (Carcaillet and others 2002; Ruddiman 2003, 2007). Thus, fire and culture are inexorably intertwined, all part of the human experience. We are a fire people and this is a fire planet (Pyne 1982, 1995, 2001, 2004).

> … scholars have wasted (in my view) too much time and effort on a science versus traditional knowledge debate; we should reframe it instead as a science and traditional knowledge dialog and partnership. (Fikret Berkes 2009)

Aboriginal people adapted their tools and fire use to meet the needs of their environment. The details of fire use by various Native people are beyond the scope of this volume. Readers are directed to the archaeological libraries for exploration of those relationships. However, cultural resource management in fire prone environments requires knowledge both of the people who inhabited those lands, historic fire regimes, and current fire activity (fig. 1-1).

Knowledge about the role of fire in the earth's vegetation-climate system and of people's use of fire for a variety of cultural purposes has grown tremendously in the past two decades. Much of this new knowledge stems from the innate desire to understand our origins and more recently from the quest for greater understanding of climate change science and feedback mechanisms within the climate system, including the role humans have played in affecting vegetation and climate (Brown and others 2009; Carcaillet and others 2002; Ruddiman 2003, 2007). The recognition of fire's integral role in the maintenance of many "fire dependent" plant communities (Brown and Smith 2002) and the development of healthy landscapes has also fueled recent research, and led to greater understanding. The preponderance of evidence suggests that the role and use of fire in the United States and Canada have changed markedly since Pre-Columbian times (Abrams and Nowacki 2008; Fesenmeyer and Christensen 2010; Nowacki and Abrams 2008; Scharf 2010a,b; Springer and others 2010; chapter 2; and many others). The 20th century—the era of wide spread cessation of aboriginal burning practices, landscape fragmentation and fire suppression—is the most recent human influence on fire as a natural process in the development of vegetation. The area burned declined for decades in the 20th century (Agee 1993; Leenhouts 1998) but has been increasing since about 1970 (Agee 1993; Westerling and others 2006) (fig. 1-2). With this increase in area burned comes an increased risk of damage to cultural resources. Further, public concern for the impacts of increasingly large (fig. 1-2), damaging, and costly fires has led to greater emphasis on fire management programs, particularly fire use. Wildfires, as well as suppression efforts, hazardous fuels treatments, and post-fire restoration projects all differentially pose a risk to cultural resources (mechanically, chemically, functionally, and aesthetically).

Cultural Resources

What are cultural resources and why should we be concerned about protecting them during fire management activities? Cultural resources are material and non-material items that represent physical and spiritual presence and practices of society throughout its development. Cultural resources are important resources that bind those of us living today with our ancestors, traditions, and histories. They are generally viewed as non-renewable resources. They are often fragile tangible objects susceptible to thermal damage during wildland fires (wildfires and prescribed fires), and physical damage from management-related disturbances. Others, in particular indigenous peoples, view cultural resources as encompassing all the elements of the environment that sustain culture. From this perspective, living organisms (plants, animals, fungi, etc.) and the condition of sites or areas are considered as potential cultural resources. Ethics argue that cultural resources should be protected for their value to this and future generations, and they are protected by numerous laws. Discussion of the many laws is beyond the scope of this review. A primer on the important laws for the United States and Canada may be found at http://www.nps.gov/history/laws.htm and http://www.pc.gc.ca/eng/docs/r/pfa-fap/index.aspx, respectively. Specific laws will be mentioned as needed by the chapter authors.

In the United States, cultural resources generally fall into three types:

1. Prehistoric—As defined in the 1979 Archaeological Resources Protection Act (ARPA), the term "archaeological resources" means "Any material remains of past human life or activities which are of archaeological interest…" and include human remains; burial sites; weapons, tools, vessels (baskets, ceramics, etc.); lithic scatters; milling and quarry sites; refuse or debris piles; middens; rock shelters; temporary camp sites; house, village, ceremonial sites; and sacred places.
2. Historic—As defined in the 1976 National Historic Preservation Act, "historic" includes buildings (cabins, houses, barns, businesses, churches); settlements; improvements (corrals, water works), sites of important events (e.g., battlegrounds, treaties); passageways (canals, trails, roads, railroads, tunnels); refuse piles; cemeteries; distinct districts or communities; and unique landscaping, architecture or construction.
3. Contemporary—National Register of Historic Places has guidelines and procedures for determining places that qualify for inclusion. These include traditional cultural properties (Parker and King 1993); locations of important events; traditional resource collection locations; religious or spiritual sites; sacred places; sites with valued vistas; recreation sites; and cemeteries.

Similar criteria apply in the Canadian Provinces with local variations.

a

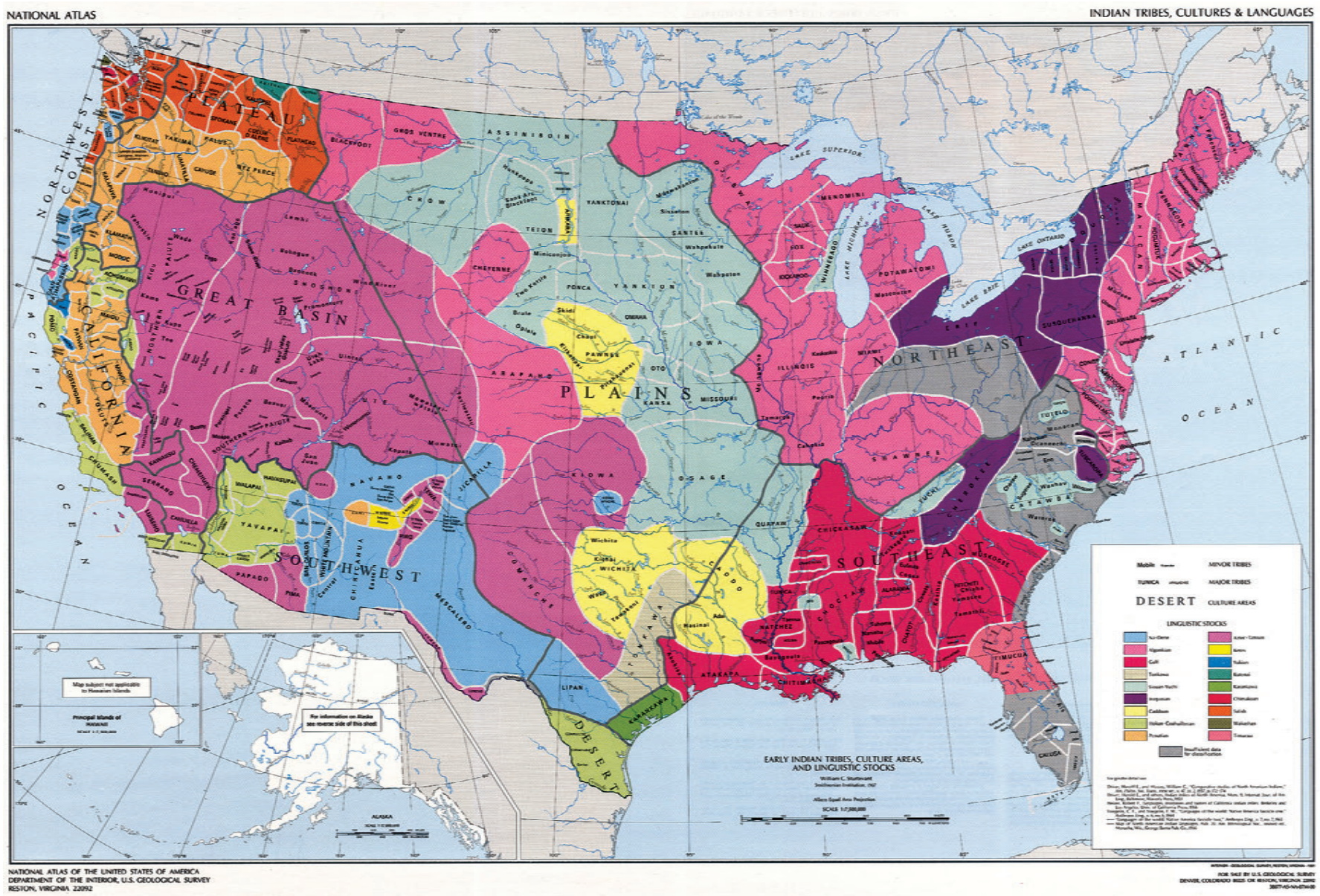

Figure 1-1—(a) Early Indian tribes, cultural areas, and linguistic stocks (Sturtevant 1967) and (b) current probability of fire occurrence (shown on next page) (Finney and others 2011).

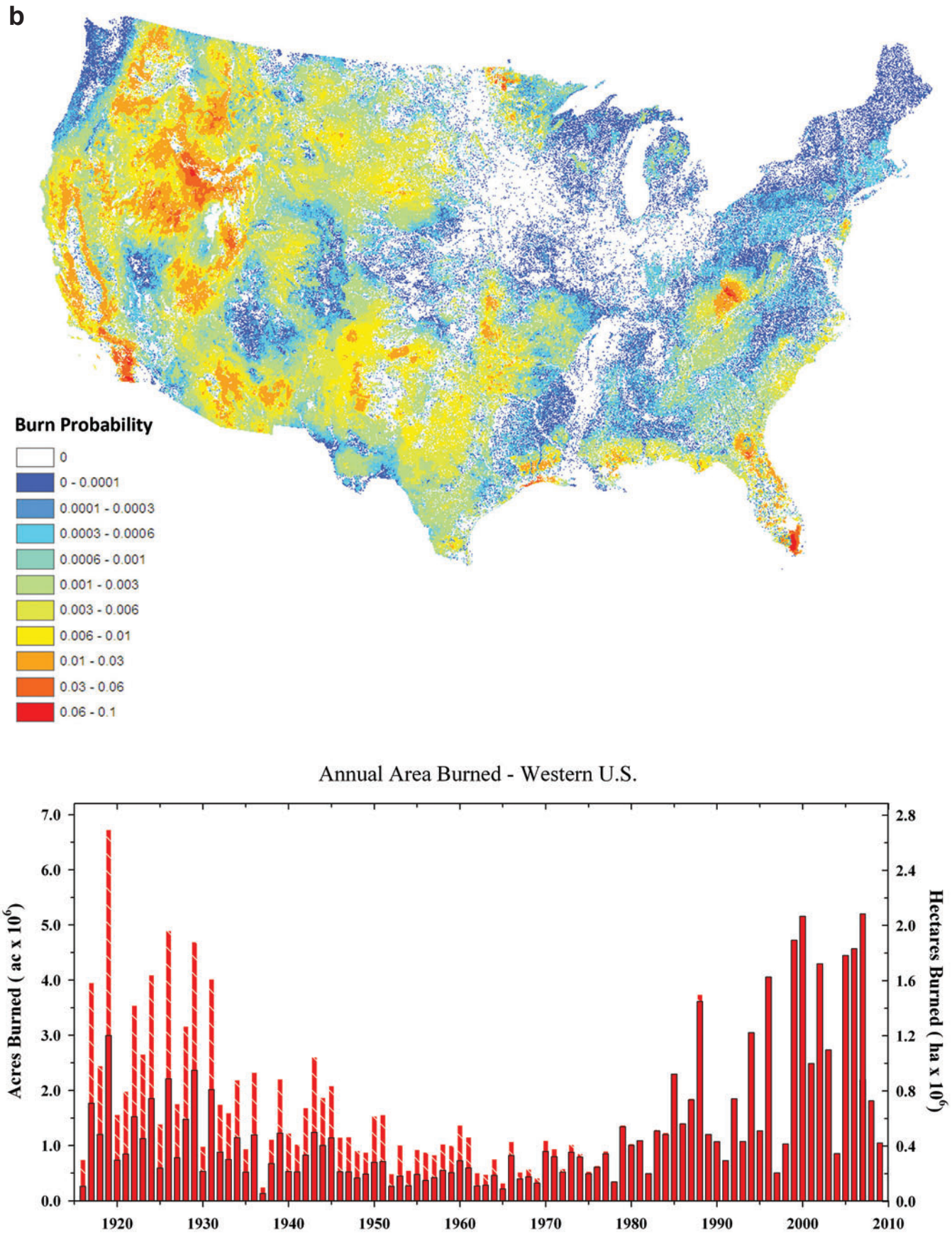

Figure 1-2—Observed and reconstructed area-burned comparison. Time series of observed total wildfire area burned for 11 western U.S. States for the period 1916–2009 (bars, adjusted for area reporting bias) (from Littell and others 2009).

The term "cultural resource" is used throughout this volume because it is the common vernacular used by Federal or State/Provincial land management agencies in the United States or Canada, respectively. Other organizations, governmental bodies, and individuals also use the terms "heritage resources" or "archaeological resources." The three terms—cultural resources, heritage resources, and archaeological resources—may have some unique legal implications but from a fire and materials effect perspective they are indistinguishable and are synonymous herein unless specifically noted by an author.

From an ecological perspective, fire is a process necessary for the maintenance of viable populations of many species because of its direct effects, as well as the creation of landscape mosaic of essential habitat conditions (Brown and Smith 2002; Smith 2000). Although fire is a vital ecological process, the historical archaeological record of many tribes' cultural and social achievements is increasingly threatened by recent increases in fire intensity, frequency, size, and subsequent management activities.

Pre-historically, landscapes typically experienced systematic fire return intervals and fires were routinely set by indigenous people worldwide for various reasons (Denevan 1992; Kay and Simmons 2002; chapter 2). Research has documented the wide ranging use of fire by Native Americans to manipulate the landscape, prepare open areas to plant crops, and increase forage for roaming megafauna, such as buffalo, elk, and deer (Stewart 2002; Williams 2000). In both written and oral histories of many tribes, fire is spoken of as an instrument in bringing in animals and new growth, thus helping to increase food availability and economic security.

> *Indigenous people's detailed traditional knowledge about fire, although superficially referenced in various writings, has not for the most part been analyzed in detail or simulated by resource managers, wildlife biologists, and ecologists…Instead, scientists have developed the principles and theories of fire ecology, fire behavior and effects models, and concepts of conservation, wildlife management, and ecosystem management largely independent of native examples.* (in Stewart 2002:4)

Studying ancient cultures and their practices may help to identify fire use tactics and recognize preservation techniques of both tangible and intangible resources that have stood the test of time. Only by looking to the past, can we truly prepare for the future by ensuring that history does not repeat itself through catastrophic events that could be prevented. Thus, the study of traditional cultural knowledge and its integration into land and resource management is increasingly recognized as a valuable contribution (Berkes 2009; Berkes and others 2000; Kimmerer and Lake 2001, 2007). Current research has also shown a close link between the frequency and intensity of anthropogenic and lightning caused fires and the amount of woody fuel accumulation. For example, in long-needled coniferous forest, particularly in the southeastern and western United States, these frequently recurring fires thinned out the trees, pruned the survivors, and kept fuel load low, leading to open grasslands and park-like tree stands (Brown and Smith 2002).

In 1905, the United States Congress created the United States Forest Service (USFS). Several large fires early in the century put fire suppression in the forefront of Forest Service fire management. Following severe fires in Idaho and Montana, the Chief of the Forest Service established in 1935, a "10 a.m." policy (http://www.fs.fed.us/fire/people/aboutus.html). The goal of the 10 a.m. policy was to plan and manage each fire so as to control the fire by 10 a.m. of the next day (Pyne 1982). The 10 a.m. policy became the dominant strategy during much of the rest of the 20th century. Although somewhat less aggressively due to limited resources, other State and Federal agencies also attempted to implement this strategy. In a parallel way, Canadian managers sought to limit fire in much of Canada. This effort across North America effectively lengthened the fire return interval and fostered the accumulation of fuels for many forests, woodlands, shrublands, and grasslands. The results of this fire exclusion policy unwittingly led to hazardous fuel levels, fires of ever increasing size and severity, and a general decline in ecosystem health (Kaufmann and others 2004; Keane and others 2002).

Although the attempted exclusion of fire was debated throughout the 1940s and 1950s, particularly in the academic literature, it was the dominant philosophy. In 1963, the Leopold Committee issued its report to the U.S. National Park Service regarding wildfire management issues (Leopold Report, http://www.nps.gov/history/history/online_books/leopold/leopold.htm). This report identified the importance of fire in restoring and maintaining habitat for several species. Throughout the 1970s and 1980s, research continued to define the importance of fire in ecosystems and the Congress passed several environmental and cultural resource protection laws.

The 1960s and 1970s began a period of transition in fire policy. Sequoia-Kings Canyon National Park in California created the first prescribed natural fire program in 1968 (Stephens and Ruth 2005). In 1977, the Forest Service changed their fire policy to emphasize a balanced fire control program, provide for natural and planned prescribed fires, and to incorporate fire planning into the land management planning process (Nelson 1979). Forest managers, on the other hand, were fighting a battle against fire

and major fuel accumulation from over half-a-century of suppression efforts on Federal, tribal, and private lands (Nelson 1979; Stephens and Ruth 2005). It wasn't until years later after several catastrophic fire events that the *Federal Wildland Fire Management Policy* was adopted in 1995 (amended in 2001). The *Policy*, its 2001 revision, the 2003 *Healthy Forests Restoration Act*, and the sequence of costly fire seasons that spurred these developments made it clear that fuels reduction would remain the driving issue in forest management in the United States for the foreseeable future (Franklin and Agee 2003). Finally, fire management included more agencies than just the Forest Service; the National Park Service, Bureau of Indian Affairs, Bureau of Land Management, United States Fish and Wildlife Service, and the National Biological Service all became active participants under the Federal Wildland Fire Management Policy. Additionally, non-governmental organizations (NGOs) (e.g. The Nature Conservancy) developed national, regional, and local programs to address the need for increased fire use for protection of lives, property, and to promote resource benefits (fire@tnc.org).

Under this new policy, managers are expected to reintroduce fire on millions of acres per year to reduce hazardous levels of fuel throughout the landscape and create healthy ecosystems with fire-adapted species. The central message embedded in this policy shift is that the foregoing century of fire suppression and other management practices have disrupted the balance between land and resource use and have also changed people's sense of place and their reliance on public and tribal lands for their livelihood (see Karjala and Dewhurst 2003; Moseley and Toth 2004). It is ironic that, in many cases, frequent past burning may have helped preserve artifacts in the cultural context, while today's wildland fires and prescribed burns are impacting and destroying the artifacts and evidence of their cultural significance.

Legal Protection

The Federal/Provincial, tribal/First Nations, and local governments in the United States and Canada have played a major role in determining the legal protections given to the many different classes of cultural resources. Cultural resource specialists, with the help of local communities, can interpret and apply these legal protections using standards recognized in both the United States and Canada. Tribal governments' primary role in the creation of legal protection for cultural resources is to be consulted by government officials for establishing proper means of protection, conservation or mitigation (for the United States see E.O. 13175: Consultation and Coordination with Indian Tribal Governments). The United States Congress passed the National Historic Preservation Act (NHPA) in 1966. Although not the first Federal historic preservation law in the United States, the NHPA, unlike earlier legislation, such as the Antiquities Act (1906), Historic Sites Act (1935), and Reservoir Salvage Act (1960), very specifically defined what forms cultural resources can take and criteria by which their significance is measured (King 2008; National Park Service 2006).

Section 101 of the NHPA authorized creation of a National Register of Historic Places (NRHP), the official list of significant cultural resources in the United States worthy of preservation. The NRHP includes criteria to evaluate properties for the National Register (http://www.achp.gov/nrcriteria.html). These consist of the following:

> The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and
>
> **(a) that are associated with events** that have made a significant contribution to the broad patterns of our history; or
> **(b) that are associated with the lives of persons** significant in our past; or
> **(c) that embody distinctive characteristics** of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
> **(d) that have yielded, or may be likely to yield, information** important in prehistory or history.

To become a historic property, a cultural resource must satisfy several requirements:

- Classifiable as a site, building, structure, object, or district (aggregates of one or more of these categories) (table 1-1);
- Except under unique circumstances, achieved significance 50 or more years ago;
- Assigned definitive geographic boundaries;
- Meet one or more of four NRHP criteria for evaluation;
- Possess and exhibit integrity of location, design, setting, materials, workmanship, feeling, and association.

Section 106 of the NHPA requires U.S. federal agencies to take into account the effects of their management actions on historic properties. Simply put, without a historic property designation, a potential cultural resource is not provided assurances by Federal policy as an important cultural resource,

Sidebar 1-1—La Mesa Fire Study

La Mesa Fire, Bandelier National Monument, New Mexico, June 16–22, 1977
References: Traylor and others (1990)

General Information

- Elevation: 1,981.2 to 2,743.2 m (6,500 to 9,600 ft)
- Vegetation: 75% ponderosa pine or spruce fir and aspen forest; 25% pinyon-juniper
- Topography: canyons, drainages and mesas
- Type of study: post-fire qualitative analysis of surface materials

Fire Description

- Temperature range: temperature not recorded but may have reached a maximum of 800 °C (1472 °F). Estimated temperature of top 2 inches (5.1 cm) of soil: well below 100 °C (212 °F) with maximum temperature. Fire sustained for 10 to 15 minutes.
- Duration: 7 days
- Relative humidity: 8 to 25%
- Fuel: variable
- Type of fire: wildland
- Energy release component (ERC): 74 to 80
- Burning index (BI): 60 to 104

The La Mesa Fire study in Bandelier National Monument was the first major post-fire investigation of fire effects on heritage resources. The La Mesa Fire started June 16, 1977, and burned uncontrolled for 7 days. This was a high intensity wildfire, burning more than 60 km^2 (15,000 acres) of forest and pinyon-juniper woodland. It was the first burn in which archaeologists were enlisted to help firefighters avoid damage to archaeological sites.

After the fire, archaeologists surveyed handlines and bulldozer lines to record site disturbances caused by the fire suppression activities. Pre-burn wildlife transects were also surveyed archaeologically to evaluate fire effects on sites within a variety of ecological zones. Post-burn surveys covered only a small sample of the previously unsurveyed burn area. Survey crews encountered 99 archaeological sites, 54 of which were burned (Traylor and others 1990). Fire effects were recognized at 51 of these 54 sites (Traylor and others 1990). Major impacts of the fire included spalling and crumbling of tuff masonry. Increased soil erosion was also recorded as a major indirect fire impact. Fire effects on surface artifacts included color change, breakage, and the adherence of residues and sticky adhesions.

Four prehistoric sites, consisting of small (1 to 2 room) masonry structures were excavated to further assess fire effects on artifacts, architecture, plant and animal remains, and dateable materials. Two of the sites were moderately burned and two had been burned severely. Structures were excavated to a floor-depth of about 30 cm (11.8 in). Sub-floor test pits were also excavated inside the rooms. Laboratory analyses of macrobotanical remains, pollen, soil, and faunal remains were conducted to assess fire effects at surface and subsurface levels. Samples for obsidian hydration, tree ring dating, archeomagnetic dating, and radiocarbon dating were also collected and analyzed (Traylor and others 1990).

In addition to fire impacts, damages caused by fire suppression and rehabilitation activities were also common. Forty-four of the sites surveyed exhibited some suppression impact (Traylor and others 1990:100). Bulldozer impacts to archaeological sites were the most severe. Although archaeological monitors worked with hand crews and bulldozer operators during the fire suppression, miscommunications caused some sites to be damaged. Fire lines were sometimes widened and large safety areas bladed without archaeological consultation. Also, bulldozers used for rehabilitation work were not monitored by archaeologists. Due to these problems, bulldozers completely leveled eight sites and caused significant architectural damage to seven sites (Traylor and others 1990).

Table 1-1—Comparability of U.S. Department of the Interior, National Park Service, National Register of Historic Places and Canadian Register of Historic Places Cultural Resource Categories.

USDI, National Park Service	National Register of Historic Places	Canadian Register of Historic Places
Archeological resources	Site Structure Object District	Archeological site District
Structures	Building Structure Object District	Building Structure District
Cultural landscapes	Site District	Landscape District
Ethnographic resources	Site Building Structure Object District	Archeological site Building Structure District
Museum objects	N/A	N/A

Adapted from USDI, National Park Service (1997), National Register of Historic Places (NRHP); Parks Canada 2003.

and therefore afforded no consideration under the NHPA. However, as seen in table 1-2, museum objects, though not on the list of NHPA approved fields, contain elements of other entities and are often considered outside of their NPS grouping as a structure or object.

Owing to the circumstances of history and the benefits of hindsight, historic preservation in Canada has taken a different trajectory than in the United States. Only recently has the Canadian Federal government taken a major role in establishing uniform nationwide preservation standards. Rather, it is provincial and territorial governments that have the most explicit laws related to historic preservation, albeit they vary from one another and are restricted to archaeological resources (Parks Canada 2000). The Canadian Federal government currently has no umbrella legislation akin to the NHPA, relying instead on various policies and directives that support the preservation of cultural resources, as well as the Canadian Environmental Assessment Act (CEAA) (Canadian Environmental Assessment Agency 1996), which is effectively the counterpart of NEPA.

In an effort to promote a standardized approach to cultural resources management, Federal, Provincial, territorial and local governments launched the Historic Places Initiative in 2000 (http://www.pc.gc.ca/progs/plp-hpp/plp-hpp1_E.asp). Two important consequences of this initiative were the Canadian Register of Historic Places (http://www.historicplaces.ca/) and *Standards and Guidelines for the Conservation of Historic Places in Canada* (Parks Canada 2003). The Canadian Register lists those cultural resources, called "historic places," formally recognized as significant by Federal, Provincial, territorial and local governments. The *Standards and Guidelines* define historic places as structures, buildings, groups of buildings, districts, landscapes, and archaeological sites possessing heritage value.

In some respects, the Canadian concept of cultural resources, as portrayed in law, policy, directives, guidelines, and philosophy, is what many practitioners of cultural resources management in the United States wish was more explicitly reflected in the NHPA, NRHP, and other key components of historic preservation. For example, cultural landscapes are recognized as a formal resource type in Canada, whereas in the United States the nexus between landscapes and the NRHP can be awkward, particularly with respect to those associated with traditional socio-cultural groups (for example, Evans and others 2001; Goetcheus 2002; King 2003).

Table 1-2—Cultural resource categories of the United States.

Category	Definition	Examples
Archeological resources	The material evidences of past human activities. Comprised of materials of prehistoric and historical origin deposited by individuals of any ethnic affiliation, indigenous and other. Classified and managed as discrete archeological sites comprised of a combination of artifacts, ecofacts and/or features.	Prehistoric: structural remnants, burials, fire hearths, midden (Ch 7), storage facilities, flaked and ground stone tools (Ch 4), ceramics, caves and rock shelters, rock images (Ch 5), and raw material sources (such as lithic quarries or culturally modified trees). Historic (Ch 6): structural ruins, minor features, artifacts and ecofacts associated with homesteads and other occupation sites; industrial complexes related to mining, logging, fishing, and agriculture; battlefields, refuse dumps, trails, roads, and railroad grades.
Structures	Constructed and usually immovable works intended to serve human activities in prehistory and history. Prehistoric and some historic structures are also archeological resources, the structural designation often being applied in cases where a structure is actively maintained to a pre-determined condition*	Dams, millraces, ditches, canals, reservoirs, bridges, roads, trails, forts, defensive works, fences, corrals, rock cairns and earthworks. *Some publically-accessible prehistoric cliff dwellings in the American Southwest. See also Ch 6
Cultural landscapes	Geographic areas containing both cultural and natural resources associated with events, activities, or people that reflect human social and ecological adaptations and perceptions. Characterized by the way humans settle, divide, utilize and circulate through them.	Historic sites or landscapes (cemeteries, battlefields, rural communities); historic designed landscapes (gardens, parks, estates); vernacular landscapes (farming, ranching, mining, and ethnic districts, ghost towns); ethnographic landscapes (massive geologic structures; festival, spiritual, ceremonial grounds; sacred sites).
Ethnographic resources	Variations of natural resources, standard cultural resource types, and intangible attributes assigned importance by traditional users and seen as vital for cultural perpetuation.	With regard to tangible manifestations, in addition to landscapes, ethnographic resources are comprised of culturally-important objects, plants and animals, archeological sites and structures.
Museum objects	Comprised of prehistoric and historic materials obtained from archeological investigations, natural resources such as plant specimens and geological samples, and archival documentation such as field notes and maps, photographs, and electronic files. Displayed or stored in facilities where environmental conditions are strictly regulated, such as public museums and curation buildings or may be found in outdoor exhibits, historic structures, or exposed through excavation and left in place.	Museum objects include specimen, archival, and manuscript collections relating to archeology, ethnography, history and natural history.

Modified from USDI National Park Service (1997a).

Cultural Resources Categorized

The USDI National Park Service (1997a,b) employs a classification system for cultural resources that is, with some clarification, well suited for the purposes of this volume. Specifically, five categories of cultural resources are recognized—none of which is mutually exclusive.

Canada has a similar system to categorically divide its resources, which is represented in table 1-3. We will use the NPS system described above for the purposes of this volume. For both United States and Canadian workers, it is important to understand the connections between the two groupings of historic places that are represented in table 1-1.

Tangible and Intangible Cultural Resources

While both tangible and intangible cultural resources can be affected by wildland fire and fire management actions, it is the culturally independent (not necessarily identified with a specific group of individuals) tangible attributes that are the primary focus of this volume (culturally dependent intangibles are addressed in chapters 8 and 9). Intangible resources are often overlooked because they are not clearly defined, may be difficult to place "value" on, and, therefore, are often given only limited protection.

All tangible cultural resources are ultimately comprised of materials—raw and synthetic, singular and composite, inanimate and living, prehistoric and historic—and it is those materials and their spatial associations, or context, that are altered by direct, independent, and operational effects. Importantly, as described in subsequent chapters, cultural resources display different vulnerability to those effects.

Traditional Cultural Properties (TCPs) are places eligible for inclusion on the NRHP based on associations with traditional living communities, and specifically those historically rooted in and important for maintaining the cultural identity of such communities (Parker and King 1990). TCPs were devised to account for the nexus between the tangible and intangible aspects of cultural resources that had generally been ignored, and included places of spiritual power, traditional practices, stories, therapeutic qualities, and remembrances (King 2003). The importance of such places was reconfirmed with the issuance of Executive Order (EO) 13007 in 1996, which explicitly addresses American Indian "sacred sites," and requires Federal agencies to accommodate access and ceremonial use of such sites to religious practitioners, avoid physical impacts to these sites, keep the locations of sacred sites confidential, and ensure consultation with tribal governments regarding sacred sites.

Fire Management

In the United States, the 2001 Federal wildland fire management policy recognizes three types of wildland fire: *wildfire*, *prescribed fire*, and *wildland fire use* (National Wildfire Coordinating Group 2006, http://www.nwcg.gov/pms/pubs/glossary/w.htm). Wildland fires are non-structure fires that occur in

Table 1-3—Cultural resource categories of Canada.

Category	Definition
Archeological sites	Physical evidence of past human activity found in a specific location on or below the ground, or underwater.
Landscapes	Exterior spaces that have been assigned cultural—including spiritual—meaning or have been deliberately altered in the past for aesthetic, cultural or function reasons. Landscapes include land patterns, landforms, spatial organization, vegetation, circulation systems, water features, and viewsheds.
Buildings	Constructed works created in the past to shelter activities related to habitation, business or social functions.
Structures	Engineered works created in the past primarily for purposes other than habitation, including transportation, energy development, communications, industry, resource extraction and processing, flood control and irrigation, and defense.

Adapted from Parks Canada (2003).

wildlands—tracts with few or no developments—ranging from remote wilderness to the interface with suburban and urban areas (Canadian Council of Forest Ministers 2005; National Wildfire Coordinating Group 2006). Wildland fires can result from natural phenomena such as lightning, accidental or intentional human sources, or when managed wildland fires escape or exceed predetermined parameters. *Wildfires* are unplanned, unwanted wildland fires where the management objective is to suppress or extinguish the fire. *Wildland fire use* refers to naturally ignited (lightning-caused) fires managed to accomplish specific resource management objectives within predetermined locations. *Prescribed fires* are intentionally ignited to meet specific management objectives. These fires—usually set in the late fall or early spring, or when seasonal conditions are moist and relatively stable—are a primary means for fuel reduction. In addition to prescribed fire and wildland fire use, other techniques such as mechanical thinning and chemical treatments are also employed to achieve fuel reduction and resource management objectives.

In 2008, the Fire Executive Council (FEC), which is charged with providing interagency Federal executive-level wildland fire policy leadership, direction and program oversight in the United States, unveiled modifications to the 2001 policy to allow wildland fires on Federal lands to be managed with a full spectrum of response alternatives (also known as appropriate management response or AMR) (Fire Executive Council 2009). The changes include removing the distinction between wildfires and wildland fire use, calling both wildfires, and allowing all naturally ignited wildfires to be simultaneously managed for multiple objectives (for example, protection *and* resource benefits). Federal wildland fire policy will now recognize *two*, rather than three, categories of wildland fire—wildfires (unplanned ignitions) and prescribed fires (planned ignitions). The Canadian Council of Forest Ministers (2005) also recognizes these two terms and uses similar definitions.

Categories of Effects

For the purposes of this volume, the term *effects* simply refers to the observable alterations—permanent or temporary, reversible or irreversible—to the tangible or intangible attributes of cultural resources resulting from wildland fire or fire management actions. In most contexts, observable changes will have a negative connotation with respect to the "pristine" pre-disturbance conditions where an artifact, feature, site, or landscape presumably had its maximum value as a cultural resource for purposes of meeting the intent of various laws. However, in some cases fire or fire management may play a positive role in restoring or maintaining a cultural landscape or Traditional Cultural Property (TCP). Likewise it may be instrumental in the application of Traditional Ecological Knowledge (TEK) in the maintenance or restoration of cultural traditions (c.f., Kimmerer and Lake 2001; Lake 2007; Stewart 2002). The purpose of the following classification is to attempt to develop an objective, non-value-laden perspective on fire effects. The classification attempts to isolate observable, measureable effects (i.e., tangible fire effects) from those that involve one's inner relationship with the cultural resource (i.e., intangible fire effects) (fig. 1-3).

The classification emphasizes the distinction between biophysical processes and human actions/reactions. Biophysical processes are further distinguished by the time of occurrence: those that occur at the time of the fire (First-Order) vs. those that act upon the fire-altered biophysical system after the fire (Second-Order). The classification is intended to emphasize the interdisciplinary nature of the relationship of cultural resources to fire and fire management. It is recognized that the classification stems from a western scientific perspective. It is argued, however, that the knowledge, skills, and methods applied to understand each component of the classification are substantially independent. Earlier volumes of the "*Rainbow Series*" provide substantial synthesis and review of tangible fire effects on fauna (Smith 2002), flora (Brown and Smith 2002), air (Sandberg and others 2003), soils and water (Neary and others 2005), and exotic-invasive plants (Zouhar and others 2007).

The effects of wildland fire, prescribed burning, and related fire management actions on cultural resources are divided into two major categories, direct and indirect:

- ***Direct effects*** are those caused by fire and its byproducts, such as smoke and ash. Direct effects result from the physical state of the fire environment (fuels, weather, terrain) and the ignition pattern (heading-fire, flanking-fire, backing-fire) (chapter 2). Direct effects are the result of combustion and subject to all the laws of physics and chemistry. Because temperature is a readily measurable metric, many direct effects are described as functions of the temperature and duration of heating (chapters 2, 3, 4, and 6). However, in most cases fire and cultural resource material temperature histories are unknown. Thus fire severity and direct effects are observed *ex post facto*. Cracking, crazing, spalling, pot-lidding, melting, smudging, and sooting are all direct effects that result from combustion, combustion byproducts, and heat transfer mechanisms acting upon various material artifacts, features, sites, or landscapes (table 1-4). Regardless of what role humans may have had in creating the fire environment (e.g., past cultural and management

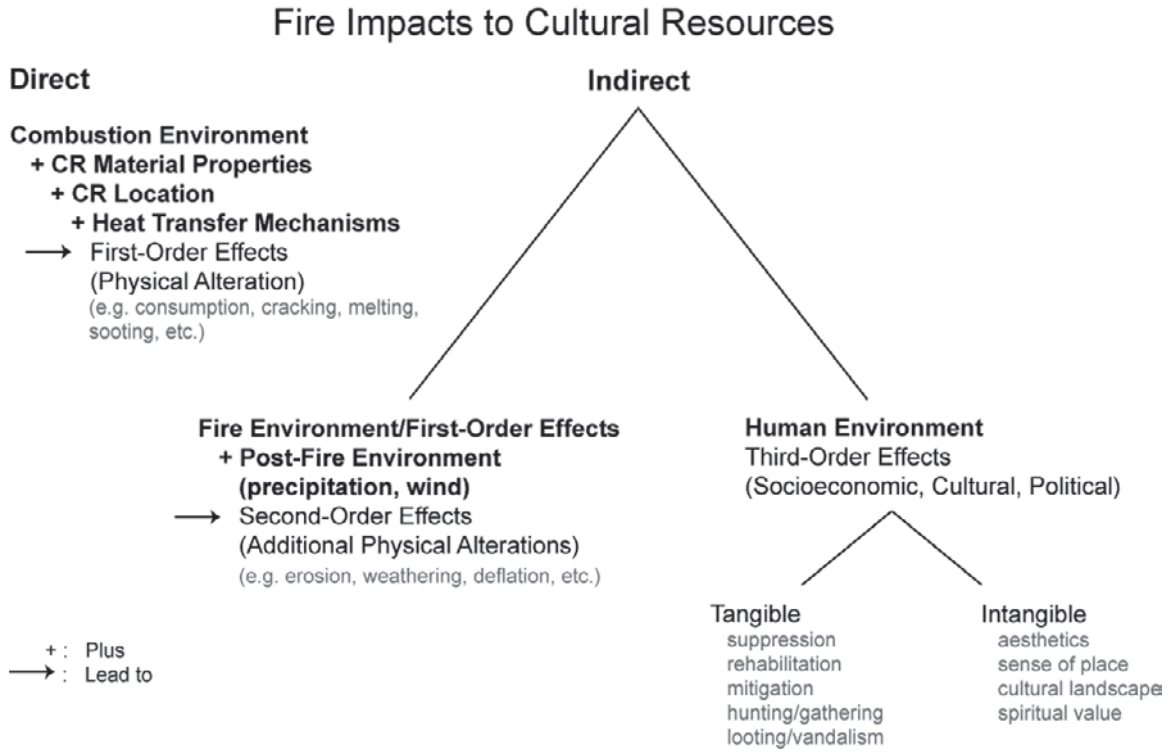

Figure 1-3—Fire impacts on cultural resources. Direct, First-Order effects result from biophysical processes related to the local combustion environment as it is juxtaposed to cultural resources and the physical properties of the resource. Indirect effects derive from biophysical processes following the fire (Second-Order effects) or human responses to fire (Third-Order effects) (synthesized from numerous sources).

practices), the direct effects would occur regardless of whether or not people were there to observe. The term "*First-Order Fire Effects*" is frequently applied to describe the direct effects, particularly in National Wildfire Coordinating Group (NWCG) sponsored fire effects training courses in the United States, (e.g., Rx-310 and Rx-510).

- ***Indirect effects*** are those effects that are derived from or dependant on the fire's occurrence. If the fire had not occurred indirect effects could not occur. Indirect effects are of two types: biophysical processes acting on the fire-altered environment and human responses. *Indirect effects* occur when wildland fire or associated fire management actions change the context in which a cultural resource is found, leaving it vulnerable to impacts. Common examples of indirect effects include post-fire erosion, carbon contamination in archaeological deposits, disturbances from fire-killed tree-fall (see for example sidebars on tree root burnout and retardants in chapter 9), and vandalism/looting (Christensen and others 1992). If fire occurred in the absence of human observation or intervention, post fire biophysical processes, such as erosion, weathering, succession, and herbivory would still take place following the laws that govern such processes. These effects are referred to as "*Second-Order Fire Effects*." Humans are affected by, and respond to, fire and the threat of fire in various ways that are as complex as the human experience. The impacts of fire on the human environment are defined as "*Third-Order Fire Effects*." Third-Order effects[1] may be *tangible* or *intangible*. *Tangible* effects are the purposeful, intentional, observable, measurable human responses to the perceived risks or opportunities presented by fire.

[1] The concept of Third-Order fire effects developed from discussions with Frank K. Lake while Ryan and Lake were on the Rx-510 Advanced Fire Effects Course cadre at the National Advanced Fire and Resource Institute, Tucson, AZ. Lake (2007) discusses Third-Order effects in the context of traditional ecological knowledge (TEK).

Table 1-4—Common nomenclature to describe the first order fire effects of fire on archaeological resources (adapted from Buenger 2003).

CB = Combustive Residue – The presence of tar deposits on the surface of a specimen formed as a by-product of the pyrolysis and combustion of organic materials. The residue is a by-product of combustion and is not composed of pure carbon, nor is it an intact organic compound (DeBano 1998). It is a highly nitrogenous condensate tar substance (Yokelson et al. 1997). The residue can be tacky or semi-solid immediately post-fire and generally appears as dark brown to black droplets on the surface of a specimen, may give artifacts a blackened appearance if sufficiently combusted.
CC/OX = *Color Change/Oxidation* – (1). An overall darkening or reddening of a specimen from its original color. It is generally the result of exposure to temperatures sufficient enough to alter the mineral composition of the specimen (this definition used to code sandstone blocks within architectural sample units) (i.e., Cliff House Formation Sandstone changing from its original orange-buff to a deep red color). (2). The presence of and orange/brown discoloration on an artifact. It is generally due to the presence of oxidized sediment on a specimen where sediment had adhered to its surface prior to exposure to heating. Heating of the sediment results in discoloration that adheres or permeates the surface of a specimen.
POX = *Paint Oxidation*– The oxidation of pigment (organic or mineral) on decorated ceramic specimens. Alterations can include a change in color from the original pigment (black to red), or the combustion of the pigment entirely.
CC = *Color Change* – (lithic specimens only) An observable color change of a specimen from original, pre-fire, color. Generally due to an alteration in the mineral composition of a specimen during exposure to heat.
CZ = *Crazing* – The presence of fine, non-linear or latticed cracks on the surface of a specimen.
SP = *Spalling* – The exfoliation of a portion of the original surface of exposed rock or a specimen due to differential heating and pressure release. It is generally the result of steam buildup in areas of the specimen that have impurities or elevated moisture content.
SPS = *Spall Scars* – The presence of concave depressions on the surface of a specimen where it is evident that a portion of the surface was exfoliated due to spalling, but the actual spall was not observed in situ. Over time, associated spalls have weathered or eroded.
PL = *Potlid Fracturing (lithic specimens only)* – Similar to spalling, but specific to lithic artifacts manufactured from cryptocrystalline silicate rocks such as chert. The fracture is characterized by a circular pit on the surface of the specimen. The pit represents the area in which the original portion of the surface has been exfoliated due to differential heating and pressure release. The exfoliated section is generally circular, flat on the dorsal side, and convex on the ventral side (resembling the lid of a cooking pot).
FR = *Fracturing* – The fracturing of a specimen into multiple pieces, and/or the presence of fractures or fissures that penetrate deeply into a specimen.
WFR = *Weathered Fracturing* – The fracturing of a thermally altered architectural block over time due to mechanical weathering. Fine cracks or fracture lines induced by exposure to heat become exacerbated due to mechanical weathering processes. Fracturing is often patterned and affects a large portion of the specimen.

These include suppression, rehabilitation, and mitigation about which volumes are written. These "real-time" active management-related effects are often referred to as *Operational Effects* because they are associated with typical fire management operations. Changes in recreational use, hunting, and gathering, for example, are observable and measurable and are, therefore, also *tangible* Third-Order effects. In contrast, the effects of fire, fire suppression, or fuels treatment-restoration activities on humans' spiritual or emotional sense of well being are intangible Third-Order fire effects. These intangible effects are a reflection of humanity's complex co-evolution with fire. Traditional Cultural Properties (TCP) are identifiable and documentable places and as such are tangible cultural resources (King 2003; Parker 1993; Parker and King 1990), but how a person or group of people feel about the impacts of fire or fire management on a TCP is an intangible fire effect. The development of intangible Third-Order fire effects knowledge can only be obtained through close communication and collaboration with cultural leaders of affected communities (chapter 8).

Material effects receive greater attention than operational and intangible effects in this Volume, particularly in chapters 2 through 7. The processes influencing direct effects are presented in chapter 2, while chapters 3 through 7 address those impacts with respect to specific materials. Operational effects resulting from activities associated with managing wildland fires, such as the construction of firelines, application of fire retardants, and vegetation clearing are discussed in "Management Implications," chapter 9.

What is the Objective of This Volume?

The main objective of this volume is to define cultural resources, provide information about the mechanisms that affect cultural resources, and identify management alternatives to prevent (or limit) adverse impacts within the proper legal framework. This basic information creates a level playing field in fire situations, where fire managers value cultural resources, cultural resource specialists understand fire, and both management groups comprehend what effects could occur without proper mitigation. Chapters 8 and 9 also identify techniques to facilitate better communication between groups to improve protection through consultation.

This volume is intended to be used as a reference for both cultural resource specialists and fire managers during their planning processes. The intended audience includes resource and fire managers employed by public, tribal, and private land management agencies, non-governmental organizations, private contractors, historic preservation officers, and researchers. Particular emphasis is given to providing guidance for those in the realm of cultural resource management (often called CRM), individuals actively engaged in identifying and managing cultural resources before, during, and after wildland fires, and preparing and reviewing fire-related environmental compliance and land management documents (for example, land and fire management plans, prescribed fire burn plans, and community wildfire protection plans).

We hope to inform the reader not only of the subject matter, but provide meaningful examples, legal implications, and a well defined connection between the effects of fire and cultural resources. In addition to understanding these connections, the reader can also understand their role in both planned and unplanned fire situations. Each chapter provides basic information and discussion that could be used for public education on the subject. This volume is also intended to provide direction for protection of cultural resources within the legal framework. Our hope is to bring both cultural resource and fire managers to a clear understanding of their mutual legal responsibility for the protection of cultural entities. Above and beyond legalities, this volume highlights the importance of working together with local communities.

This is the first comprehensive summary of fire and cultural resources inclusive of Canada and the United States, covering a wide range of cultural resource categories as well as describing the variability of fire on different landscapes. The United States Department of Agriculture (USDA) Forest Service, Rocky Mountain Research Station has produced a series of documents that assimilate current knowledge of wildland fire effects relevant to the management of ecosystems, including fauna (Smith 2000), flora (Brown and Smith 2000), air (Sandberg and others 2002), soil and water (Neary and others 2005) and non-native invasive plants (Zouhar and others 2008). Many of these same topics were addressed in the first version of this "Rainbow Series" volume that was published in the late 1970s and early 1980s. The Rainbow Series volumes encompass the United States and Canada in geographic coverage, but many of the principles can be applied to other regions of the globe where wildland fires occur.