National Park Service Fire Management Program
Pacific West Region
Washington, Oregon, Idaho, California, Nevada, Hawaii, and parts of Arizona and Montana

National Park Service
U.S. Department of the Interior

Using Fire Safely to Maintain and Restore Ecosystems

Message from the Regional Director

As a former prescribed burn boss, I know first hand the work that is involved before, during, and after the application of prescribed fire. In the 1970's, we were so concerned about negative visitor reactions, we scraped charcoal off the bark on trees that park visitors might see. Today, most visitors know that fire is an integral part of how ecosystems and healthy forests are maintained.

The use of fire to restore ecosystem health, perhaps more than any other professional program within the National Park Service, demands that we consult, communicate, and collaborate in the service of conservation with every single partner, landowner, and concerned citizen.

Determining when, where, and how much fire is currently safe for our ecosystems is one of our biggest challenges. But, we have over 60 years of experience since we began using prescribed fire in the 1940's at Everglades National Park. Today, in cooperation with states and other land management agencies, our professionally trained and experienced personnel are applying prescribed fire and other fuel reduction techniques to thousands of acres of park lands.

Developing public understanding of how and why we use fire is one of our highest priorities. Your comments and concerns are important, and you may reach me at PWR_PIO@nps.gov.

Jon Jarvis
Regional Director

BURN BOSS -
the person who directs operations during a prescribed burn

PRESCRIBED FIRE -
fire used in a landscape to accomplish resource management objectives

WILDFIRE -
an unwanted fire which is suppressed

WILDLAND-URBAN INTERFACE-
developed areas near wildlands which may be at risk from wildfire

EXPERIENCE YOUR AMERICA

Prescribed Fire in Pacific West Parks

Fire Recycles!

FLAMES THE COLOR OF SUNSETS, SWIRLS OF BILLOWING smoke. Like volcanic eruptions, or showering geyers, wildland fire is a powerful force which demands respect and caution. As an ecological process, fire affects almost all of the earth's vegetation. By shaping habitat, it significanlty affects wildlife as well. Prescribed fire is the decision to allow this process to occur under specific conditions. In national parks, prescribed fire is used to preserve natural and cultural resources, and is part of a strategy to protect park and community structures from wildfire. Today, every park manager must consider if and where fire will be allowed. Fire that is wanted to meet resource management objectives is prescribed. Unwanted fire is wildfire and is suppressed.

A fire regime is the pattern of fire in a landscape over time. A park's prescribed fire program considers the fire history of the area and how ecosystems are different today to determine how much fire is appropriate and safe. The amount of fuel present, invasive non-native species, and increased development in the wildland-urban interface are critical factors in any plan to use prescribed fire. These plans divide areas where fire is appropriate into burn units which are typically burned periodically, every several years.

In many parts of the Pacific West, fire has occurred often enough that species depend on it. Fire promotes biodiversity by recycling parts of the landscape back to earlier stages, creating variation in vegetation and its structure. Each stage in an ecosystem's development has different plants and animals associated with it.

Fire regimes differ based on the climate, vegetation, and the number of ignitions in each place. Ignitions are mainly caused by lightning, volcanic ash, lava, and a variety of human sources, both planned and accidental. Without humans, almost all fire is caused by lightning. There is increasing evidence that many ecosystems in the Pacific West have also had human-caused, prescribed fire as an integral process for thousands of years.

A **Fire Regime** is defined by the **Fire Return Interval or "Fire Cycle"** - average number of years between fires; **Size** - average number of acres burned; **Spatial Complexity -** variation in effects on vegetation; **Seasonality** - time of year when fires occur; **Intensity** - energy or heat released, related to the amount of fuel; **Severity** - ecological effects, both physical and biological; and **Fire Type,** whether fire mainly occurs in the ground, surface, understory or tree crowns.

THE NATIONAL FIRE PLAN

Fire regimes in National Parks and other wildland areas have been radically changed in modern times. To protect human communities and the enviroment, the National Fire Plan is concerned with returning these regimes to a more historic condition. Wildland ecosystems across the United States are placed into 5 fire regime groups and 3 condition classes for the purpose of managing this far reaching restoration effort. Prescribed fire in combination with other treatments is being used to achieve this goal. The National Fire Plan is still in draft form.
Please visit www.fireplan.gov for more details.

FIRE REGIMES

Group	Fire Frequency	Ecological Severity
I	0-35 years	low severity
II	0-35 years	stand replacement
III	35-100+ years	mixed severity
IV	35-100+ years	stand replacement
V	> 200 years	stand replacement

CONDITION CLASSES

1 Fire regimes are within their historical range.
The vegetation is intact and functioning ecologically.

2 Fire regimes have been moderately altered from their historical range.
Some fire cycles have been missed or added.

3 Fire regimes have been significantly altered from their historical range.
Many fire cycles have been missed or added. Vegetation composition, structure and diversity have been significantly altered.

Ecosystems

Periodic Fire

Benefits

WHAT'S INSIDE

Fire Regimes and Condition Classes..... 1
Small Burns Prevent Big Fires..... 2
Smoke and Ecosystem Management..... 3
Fire Adapted Species..... 3
Each Place is Unique..... 4-5
Writing the Prescription..... 6
Risk Management..... 6
Wildland Fire Use..... 7
Culture and Fire..... 7
Fire Effects Monitoring & Research..... 8

Ecosystem Networks in the Pacific West

The idea of using ecological boundaries rather than political boundaries has had an increasing influence on land management. It is becoming commonly shared wisdom that wildland fire, watersheds, and species, are all best managed when viewed holistically as part of ecosystems.

PUBLICATION TEAM

NATIONAL PARK SERVICE STAFF CONTRIBUTORS

Regional Office
Jon Jarvis, *Regional Director*
Holly Bundock, *Public Affairs Specialist*
Deanne Adams, *Interpretation and Education Program Lead*

Fire Education, Prevention & Information
Marty O'Toole . Jody Lyle . Carol Jandrall
Scott Isaacson . Jennifer Chapman

Interpretation
Tim Manns . James Wheeler . Marea Ortiz
Joe Zarki . Dominic Cardea . John Fiedor
Janis Burger . Roger Brandt . Corky Hays
Marsha McCabe . Eric Weisman

Fire and Fuels Management
Dan Buckley . Mike Lewelling . Marti Witter . Tim Duck (BLM) . Kara Paintner
Kendall Derby . Mary Beth Keifer . Todd Rankin

Resource Management
Rhonda Loh . Steve Acker . Leigh Smith
Ken Hyde . Arnie Peterson

DESIGNER / EDITOR
Jennifer Chapman

PHOTO CREDITS
Page 1
Acorn woodpecker image provided courtesy of Point Reyes Bird Observatory.
Page 3
Chia sage, manzanita, and live oak images provided courtesy of California Academy of Sciences (CAS).
Page 7
Lightning image provided courtesy of National Oceanic and Atmospheric Administration, NOAA Photo Library, NSSL collection.

All other photos provided by the National Park Service (NPS).

Small Burns Prevent Big Fires

Prescribed Fire in Stehekin at North Cascades National Park

ON SUMMER NIGHTS IN 1994, BOTH curiosity and concern drew Stehekin residents to Buckner Orchard. From there they could watch the Boulder Creek Fire lighting the slopes and ridges high above and slowly backing down towards their homes on the valley floor. Before fire suppression began 80 or more years earlier, each acre of the valley burned every 25 to 100 years, more often on the dry alluvial fans. A century of logging, building, and fire suppression had set the stage for potential catastrophe. That summer, among the sights greeting passengers bound for Stehekin on the Lady II was a barge loaded with fire trucks. Measures taken to protect the people and property in the Stehekin Valley, including a plan for evacuation by boat, were not needed as intensive water drops and changing weather kept the fire on the slopes and out of the valley bottom.

HUMAN RESIDENTS IN THE FOREST

Fifty-mile long Lake Chelan, slicing between the Glacier Peak and Lake Chelan-Sawtooth Wildernesses and eventually reaching Lake Chelan National Recreation Area, is the travel way to the 100-resident community of Stehekin. No roads reach this mountain valley deep in the North Cascades. Year-round residents, joined by several hundred more in summer, come and go by boat, trail or float plane. Some homes line the lakeshore, but most are scattered through the forest in the narrow valley cut by glaciers and the Stehekin River.

When Congress created the North Cascades National Park Service Complex in northwestern Washington in 1968, Lake Chelan National Recreation Area was established along with North Cascades National Park and Ross Lake National Recreation Area. Most of the Stehekin Valley's residents live on the 439 private acres within the 4,900 acres of the lower valley. Almost all live in the forest.

ENCROACHING TREES

Mixed conifer, Douglas fir, and ponderosa pine stands cover about 1,700 acres. When non-Native Americans moved to the valley in the late 19th century, they began cutting trees, favoring the large, straight, and disease-free. They eventually logged an estimated 1,650 acres.

Fire suppression allowed Douglas fir and grand fir to invade open areas and form more dense forest stands. Today, ponderosa pine dominates less than 1% of the coniferous forest, leaving it less tolerant of fire and more prone to stand replacement. There are also greater accumulations of downed woody fuel.

STRATEGIC FUEL REDUCTION

The 1994 Boulder Creek Fire highlighted the need for a more effective program to reduce fire hazard in the valley. The next year the Forest Fuel Reduction / Firewood Management Plan set the needed new direction. It seeks to protect human life and property by restoring the coniferous forest to a healthier, late successional stage using a combination of management-ignited prescribed fire and thinning. The plan includes measures to protect natural and cultural resources. And it provides for long-term monitoring and evaluation.

This fire plan for the lower Stehekin Valley identifies 6 forest fuel reduction areas totaling 790 acres. These areas connect natural or human-made fire breaks and are one line of defense for wildfires moving up or down the valley. In each area, thinning followed by low intensity prescribed burns reduces stand density, canopy closure, ladder fuels, and fuels on the forest floor. Agency fire crews thin smaller diameter trees, and contractors using low-impact equipment over the snow remove certain overstory trees weakened by mistletoe, disease, or insects. Some snags remain for wildlife habitat.

Thinned trees not needed by the park may be purchased by local residents for firewood. Additional hazard fuel reduction around structures creates a more defensible space for firefighters during wildfire suppression.

The fire effects monitoring staff maintains 27 plots to track the program. Their 2002 report states, "By following the thinning treatments with prescribed fire, we can restore the role of fire in the dry Douglas-fir / Ponderosa pine forest, including reduced fine fuel, litter and duff, reduction of ladder fuels, and increased native shrub and herbaceous species."

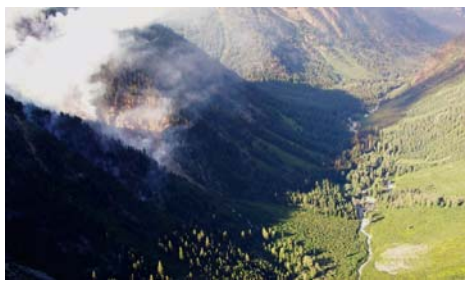
In May 2003, the fire staff burned 116 acres in 2 of the forest fuel reduction areas, moving the program another step ahead and meeting the goals for this year. Stehekin residents support the fire program as good for the forest and beneficial to them. Complete implementation of the program will take many years, but each year brings the Stehekin Valley closer to a condition both healthier for the forest and safer for the people who live in it.

RECENT FIRE EVENTS

PRESCRIBED FIRE
Stehekin Burn, 2003 - 116 acres

WILDFIRE
Glory Mountain Fire, 2001 - 1,495 acres
Flat Creek Fire, 2000 - 450 acres
Boulder Creek Fire, 1994 - 4,400 acres

Below: GLORY MOUNTAIN FIRE - *NPS, 2001*



Smoke and Ecosystem Management

LIKE FIRE, SMOKE IS AN INEVITABLE part of living in the wildland-urban interface, where human development blends with the natural environment. For years, interface residents have experienced smoky skies during large, unplanned wildfires. Now, more often than not, the smoke they are seeing is from prescribed fires.

Prescribed fire has proven to be very successful in creating healthy forest conditions and reducing wildfire risk for interface communities. This useful tool, however, challenges fire managers to balance protection of communities, resources, and air quality. Since smoke cannot be eliminated from the interface, fire managers use prescribed fire to control its timing, duration, and intensity.

From some people, there is a cry to stop prescribed burning because of smoke. "I don't mind the smoke if you are putting the fire out, but if you lit it, I don't want to breathe it," says a California resident.

Is smoke from a wildfire different than smoke from a prescribed burn? The same plants are burning; the same people are affected. The real difference is in perception. An escaped campfire that spreads to 200,000 acres may seem unavoidable and thus acceptable. But what about the management decisions that resulted in the unhealthy forest conditions that allowed a fire to get so big? Choosing to suppress fires over many decades, thereby permitting huge amounts of fuels to accumulate, was a conscious decision. Today the National Park Service (NPS) is making a conscious decision to correct that mistake. We now know that smoke is a reality in the wildland-urban interface. The surrounding landscape will burn; it's just a question of when and under what circumstances. Given that, it is preferable to utilize prescribed fire as a tool that offers some options to protect public health by incorporating smoke-management techniques. The ability to plan an ignition gives managers a chance to exert some control over smoke production. In an unplanned wildfire situation this is largely impossible.

While states enforce the Federal Clean Air Act, many delegate this authority to local Air Quality Districts. These local districts oversee geographic "airsheds." For wildland fire, the districts create smoke management programs that directly affect how prescribed fire operations are implemented on the ground.

Partnering with local Air Quality Districts, the NPS utilizes many different strategies when igniting or managing a fire:

- choosing ignition days with good weather conditions for dispersing smoke;
- controlling smoke output by limiting the number of acres ignited per day;
- using stationary and mobile equipment to monitor particulate levels near the burn;
- burning more frequently;
- cooperating with other burners in a single airshed or region to schedule burns; and
- providing information for local residents and visitors.

The NPS and local Air Quality Districts need public support for prescribed burning and smoke-management techniques. Successful completion of projects will prevent damaging fires in the future that can destroy personal property, natural resources, and harm regional air quality. It may not seem ideal, but some controlled fire and smoke now can protect our communities and wildlands from being overwhelmed by it in the future.

REDUCING EXPOSURE TO SMOKE

Extended smoke exposure is harmful to human health and should be avoided. Smoke contains water vapor, gases, and particles of minerals and soot. Smoke particles tend to be very small -- less than one micrometer in diameter. (Human hair is about 60 microm-eters in diameter.) When inhaled, such small particles can cause symptoms similar to a cold or allergies - scratchy throat, cough, headache, runny nose, and stinging eyes. Most symptoms subside after the smoke is gone. In general, the long-term risk from short-term smoke exposure is quite low.

If there is wildland fire smoke in your area (or any other particulate pollution), follow these simple guidelines to reduce your exposure:

Stop outdoor activity, especially physical exertion. Stay indoors as much as possible, especially seniors and children.

Close windows, doors, and outside vents when it is smoky. Set your air conditioner to re-circulate. Ventilate your home and work place when it is not smoky.

Drink lots of water, eat a balanced diet, and get adequate rest. A healthy immune system is the best protection against the effects of smoke.

Don't bother wearing paper masks. These masks generally will not protect your lungs from wildland fire smoke, and they may make it harder for you to breathe.

Consult the local Air Quality Index (AQI) for assistance in planning your daily activities. AQI values for local areas are usually reported on television news or in newspapers. The higher the AQI value, the greater the level of air pollution fand the greater the health danger. For a detailed description of the Air Quality Index, go to: www.epa.gov/airnow/aqi-broch.

If you have heart or lung disease, asthma or emphysema, be diligent about following your physician's instructions. People with pre-existing respitory respitory problems are at greater risk from smoke. Maintain at least a 5-day supply of any medications in case your travel is restricted.

Pay attention to your symptoms. Some people have undiagnosed respitory problems that can be triggered by exposure to smoke. Adhere to the guidelines above. Consult your healthcare provider if you experience the following symptoms: sudden fatigue, heart palpitations, dizziness, chest or arm pain, or difficulty breathing.

ECOSYSTEM BENEFITS FROM FIRE

Habitat
Standing dead trees (snags), provide perching and nesting sites. Cavities in fire scarred trunks also provide shelter. Charred wood is prime habitat for wood-boring insects to lay their eggs because of the food provided by decaying wood. Wood-peckers and other insectivores thrive on these insects.

Nutrient Cycling
Ash returns nutrients to the soil, especially potassium, calcium, and phosphorus. Nitrogen is replentished by the nitrogen-fixing plants that move into recently burned areas, such as species of ceanothus and lupine.

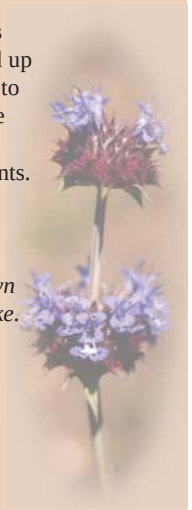
Germination
Heat, light, changes in soil chemistry, charcoal and smoke are important germination cues caused by fire which some species depend on in order to reproduce.

Natural Thinning
Fire removes young trees which reduces competition and ladder fuels and promotes stands of older, stronger, larger trees.

Removal of Surface Fuel
Leaf litter and small diameter woody debris which leads to heavy fuel build up is removed.

Less Pests and Pathogens
Excess litter may also be a breeding area for pests such as bark beetles and other pathogens which can lead to disease outbreaks. These forest health risks are removed by fire.

More Large Woody Debris
Larger downed logs that end up in streams provide nutrients to aquatic organisms and create pools and riffles which are important fish habitat elements.



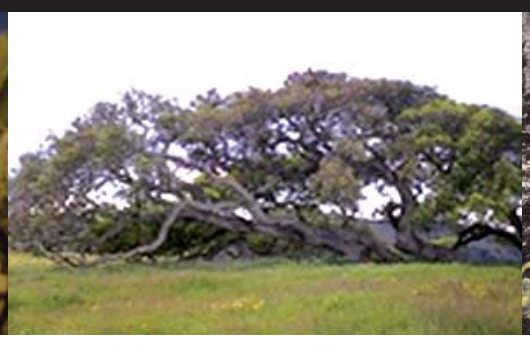
Germination in Salvia columbarie, commonly known as chia, is triggered by smoke. This characteristic has been found in 11 plant families.

CHIA SAGE - CAS, *Christopher L. Christie, 1997*

Fire Adapted Species in the Pacific West

BISHOP PINE - *NPS, Bruce Farnsworth, 1995*

EASTWOOD MANZANITA - *CAS, Beatrice F. Howitt, 1999*



LIVE OAK - *CAS, Beatrice F. Howitt , 1999*

COFFEEBERRY - *NPS,1995*

BARK THICKNESS IS ONE OF THE MOST IMPORTANT FACTORS DETERMINING fire resistance of trees. Ponderosa pine, giant sequoia, and coast redwood are examples of trees that have exceptionally thick bark. Thick bark insulates the inner, living tissue from heat damage. These trees thrive in low to moderate intensity fires that consume grasses, shrubs and small trees. With the competition gone, these trees can flourish to their grand sizes.

Some species are dependent on fire for reproduction. Many pines including lodgepole, bishop, Monterey and knobcone, have **serotinous cones** which are sealed with pitch. Heat is needed to melt the pitch and release the seeds. Once open, these cones release their seeds into the rich ash of recently burned soil and new trees take root.

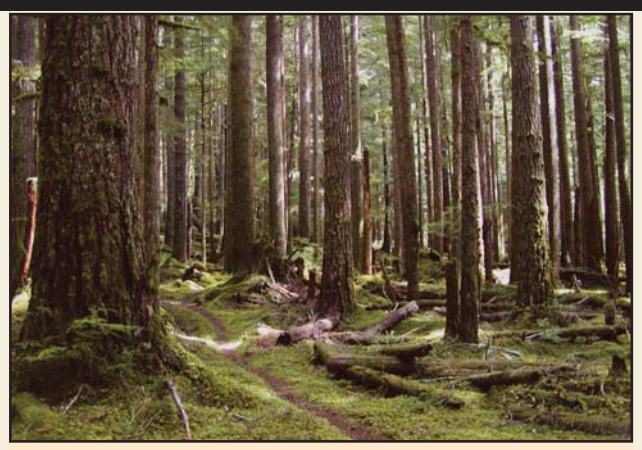
Basal sprouting, re-growth from special stem or root tissues at the bottom of the plant, allows many shrubs and trees to survive a fire. Oregon ash, oaks, mountain dogwood and many others can also undergo **upper crown sprouting**. This re-growth occurs from dormant buds on trunks beneath the bark, stimulated to grow in response to fire-induced mortality. Many shrub species such as manzanita and ceanothus have **dormant seeds** that can survive for hundreds of years until stimulated to germinate by the heat of a fire. Germination in some plants is also triggered by compounds in smoke and charcoal. Many herbaceous plants also lay dormant until a fire passes over, and then suddenly, they burst forth with wildflowers to reproduce in the open, nutrient filled ground.

Wildlife has also developed a relationship with fire. Deer, and other browsing and grazing animals return to a burned area to eat the new shoots that follow a fire. Bears ramble through a burned area to rip apart charred logs. These logs contain larvae of many kinds of insects. Many birds thrive in recently burned areas, eating the numerous insects that feed off the dead trees and new plant growth. Larger birds use snags for nesting and perching. Bats, too, have been known to roost in fire scarred tree cavities.

Each Place is Unique

SAN JUAN ISLANDS NATIONAL HISTORICAL PARK

The park's first-ever prescribed burn was conducted on July 1, 2003, in an effort to restore a declining oak woodland community. Evidence suggests approximately 100 acres of Garry oak woodlands in the Young Hill area were historically burned by Native Americans to create habitat for game animals and promote the growth of plants such as camas amd bracken fern for cultural use. Burning maintained the landscape found during the historic period commemorated by the park (1859-1872). Lack of fire has resulted in the encroachment of Douglas fir and shrub species, changing the character of the site and threatening the regeneration of Garry oaks. Prior to burning, 30 acres of Douglas fir were removed mechanically. Reintroduction of fire is intended to rejuvenate the oak stand and restore native grasses and forbs in the understory. *- Washington*



OLYMPIC NATIONAL PARK

Evidence of past wildland fire is found throughout the park in fire scars on trees and the mosaic of forest patterns. Fire history studies suggest most forest stands burned over intervals of 500 years or longer in the western part of the park, and over intervals of 100 to 200 years in the eastern part of the park. Olympic averages 10 lightning-caused fires per year, most of which are suppressed or go out naturally at less than 1 acre in size. The fire management plan being developed proposes that 57% of the park, comprising the rugged interior, will be managed as a Wildland Fire Use Unit. In this unit, all lightning-caused fires would be evaluated against criteria of safety and risk and when appropriate, these fires would be managed for the benefit of the ecosystem. Fires not meeting the criteria would be managed with a suppression strategy. *- Washington*

SEQUOIA AND KINGS CANYON NATIONAL PARKS

From foothill oak woodlands to mixed conifer forests, wildland fire shapes many different ecosystems in Sequoia and Kings Canyon by clearing dense trees, recycling nutrients, and stimulating new growth. Fire prepares the open, sunny seedbed needed for giant sequoias to germinate. Fire scars on old tree rings suggest that prior to Euro-American settlement, approximately 15,000 acres burned inside these parks each year. During the last century, fire suppression dramatically altered the landscape. Today, managers are reintroducing fire's natural role by igniting prescribed fires and managing lightning-caused fires that will preserve park resources for the future. *- Southern California*

LASSEN VOLCANIC NATIONAL PARK

Wildland fire has shaped various ecosystems in Lassen Volcanic National Park where 106,000 acres of mixed conifer, subalpine and alpine forest are protected. Fire history research indicates fire return intervals ranged from 12-16 years or 70-80 years depending on forest type, slope and aspect. Fire suppression interrupted these cycles to create high fuel loading and changes in forest structure. Fire managers hope to burn approximately 2,000 acres each year along the boundaries of the park. These fuel treatments will strengthen the boundaries, enabling fire to return to its natural role in the ecosystem in the interior of the park. *- Northern California*

PARASHANT NATIONAL MONUMENT

The monument contains a variety of ecosystems, each with a different fire regime. Fire was not a dominating force in the Mojave desert prior to the arrival of alien grasses such as red brome. An increase in fires has converted large areas of desert to Eurasian-like grasslands. Arizona chaparral, characterized by oak and manzanita, naturally burns every 50 to 100 years.

Using mechanical fuel removal and prescribed fire, the monument is attempting to restore pre-settlement conditions to the ponderosa pine forests. These forests have changed from open, park-like stands with 50 trees per acre, to over-dense stands with 500 trees per acre. Presently, there is stand-replacing fire where historically, there was low-intensity fire every 5 to 10 years. Pre-treatment prior to burning includes raking duff and leaf litter away from the bases of large trees in order to protect them from the long, slow baking that can occur when 6-8 inches of duff burns.

Prescribed fire is also applied where pinyon-juniper and sagebrush have encroached upon grasslands due to grazing and fire suppression. Plans call for using fire in the future to restore decadent aspen stands which are being encroached upon by shade tolerant species. *- Arizona*

HAWAII VOLCANOES NATIONAL PARK

Let it burn? Not in the park's unique East Rift Zone rain forests. Since 1982, the park aggressively fights fires in the rainforest caused by ongoing volcanic eruptions. Resource managers are also investigating the dry woodlands damaged by wildfires carried by alien, fire-promoting grasses. These grasses have altered the natural, low frequency fire regime. Common Hawaiian species in these environments are not fire tolerant. The park is experimenting with prescribed fire to reduce the thick mat of non-native grasses and revitalize the native pili grasslands. The non-native grasses will come back after prescribed burning, but the fire tolerant natives will also spread. *- Hawaii*

JOSHUA TREE NATIONAL PARK

Prescribed fire has been used in the past to manage oases of native California fan palm, a species well adapted to fire. Evidence suggests desert people such as the Cahuilla and Serrano used fire in fan palm oases to stimulate palm growth and fruit production. However, the impact of fire on the fragile sites and artifacts left behind by the desert's inhabitants is also a concern of cultural resource managers. To truly understand fire and to better manage its role in the desert environment, additional research is needed. *- Southern California*

REDWOOD NAT'L AND STATE PARKS

Redwood uses prescribed fire to manage over 4,300 acres of naturally occurring prairies and oak woodlands that were maintained by four American Indian cultures prior to Euro-American settlement. *- Northern California*

Different Places, Different Strategies

WHISKEYTOWN NATIONAL RECREATION AREA

Mining, logging and fire suppression led to enormous fuel build up in Whiskeytown's manzanita thickets and pine stands. Prescribed fire is used to reduce fuel, protect nearby communities, and maintain ecosystems dependent on moderate to low intensity fires. An average of 1,200 acres are burned each year, with careful consideration for steep slopes and wildland-urban interface. Most burns take place after the first fall rains and during winter dry spells. Prior to burning, extensive fuel treatment is done to remove ladder fuels and protect large trees. Burn units are black-lined around the perimeter to secure the holding line, and aerial ignition is used to burn the interior.

- Northern California

POINT REYES NATIONAL SEASHORE

Prescribed fire is used at Point Reyes to maintain a mosaic of grasslands, scrub and chaparral, oak woodland, Bishop pine and Douglas fir. Evidence suggests fire was originally used in the grasslands by the Coast Miwok to enhance their food supply. Later, ranchers used these areas for cattle grazing, and changed the composition of the grasses. Today, the grasslands are burned to manage fuel loads in the wildland-urban interface and enhance biodiversity. High property values surrounding the park and strict air quality regulations have produced a strategy of burning small units within a single day. These burn units follow vegetation contours, adding complexity to prescribed fire operations. *- Northern California*

GOLDEN GATE NAT'L RECREATION AREA

Prescribed fire has been used at Golden Gate to reduce encroachment of coastal scrub into grasslands, and restore the natural role of fire, enhancing habitat for various plant and animal species. Fire is also used to restore landscapes associated with early Spanish explorers and coastal indians. Carefully controlled and monitored prescribed burns will be coducted in the Marin County areas of the park in the future to gain the healthful benefits that fire can provide.

- Northern California

Point Reyes and Golden Gate are contiguous parks, working cooperatively in fire and fuels management. Pictured above is Golden Gate in the foreground, and Point Reyes in the background.

OREGON CAVES NATIONAL MONUMENT

Fire helps control the quantity and quality of water that seeps from the forest floor into the cave environment. Lack of fire has resulted in stands of young trees that draw large amounts of water out of the ground as they vigorously compete with each other. As a result, less water gets into the cave, especially in late summer when temperatures are high and there is a lack of rainfall. Cave adapted life, dependent on a wet environment, is threatened by a drying cave. Lack of fire has also caused accumulation of debris on the forest floor. Decaying debris increases the acidity of water carried into the cave by rain and melting snow. The cave's formations will dissolve if the acidity gets high enough. Prescribed fire can restore the balance of natural processes, supporting the development of cave formations and the survival of cave adapted life. *- Oregon*

SANTA MONICA MOUNTAINS NRA

Santa Monica Mountains protects 155,000 acres within a rare Mediterranean ecosystem where extended drought and extreme hot, dry, wind events create one of the world's most severe fire environments. Although chaparral species are either fire-tolerant or fire-adapted, burning too often can lead to vegetation type-conversion if fire returns before shrubs reach reproductive maturity. The park is evaluating the use of prescribed fire as a restoration technique in degraded habitats. Prescribed fire was used in the past by the Chumash for resource management in both grasslands and shrublands. Currently, it is not needed for ecological health in the shrublands, due to increases in other human-caused ignitions associated with urbanization. With the abundance of non-native grasses present today, fire may even worsen the condition of the shrublands.

- Southern California

CRATER LAKE NATIONAL PARK

Crater Lake National Park protects a pristine environment that extends over 183,000 acres. Within the forests of the park, a rare beauty is accentuated. However, decades of fire suppression in these forests have led to unnatural fuel accumulations. Prescribed fire is currently being used to restore the ponderosa pine ecosystems that tower over the northeastern and southern regions of the park. The utilization of fire as a tool will reduce fuel loading and allow these protected trees to thrive under an open canopy. In the future, prescribed fire, in concert with other management strategies, will play a vital role in the reduction of dangerous fuel loads throughout the park. *- Oregon*

JOHN DAY FOSSIL BEDS NATIONAL MONUMENT

More than a century ago, the arrival of domestic livestock ranchers and the de-population of American Indian tribes changed the human influence on fire in the grassland and shrub steppe of Eastern Oregon. As we enter a new century, fire is being re-introduced, reducing juniper encroachment, and allowing the historic bunchgrass-sagebrush steppe to re-emerge as an ecological norm. The monument protects and studies a world-class fossil resource while re-creating and sustaining a resilient northern Great Basin and southern Columbia Basin ecological example. The return of fire as an ecosystem influence is made possible under the leadership of the National Park Service in cooperation with neighboring ranchers and local tribes. *- Oregon*

YOSEMITE NATIONAL PARK

The majority of prescribed burning is done in the low to mid-elevation Ponderosa Pine - mixed conifer forests on the west side of Yosemite National Park. These areas historically experienced low-intensity surface fires. Prior to fire suppression at the turn of the century, fire burned an average 16,000 of Yosemite's 747,000 acres each year. Since the 1970's, park managers have been using prescribed fire and managed lightning fires to reduce the fuels in overgrown forests and restore the ecosystems to a more natural state. Fire is also used to enhance cultural landscapes and provide defensible space for communities and developed areas within and surrounding the park.*- Northern California*

Weather, Topography, Fuels, *and Objectives*

Writing the Prescription

LOCATION, TEMPERATURE, RELATIVE HUMIDITY, WIND SPEED, wind direction, fuel moisture, atmospheric conditions, trained personnel, and proper equipment. Defining boundaries and the conditions under which fire can be managed safely is the essence of a prescription. The prescription is driven by safety first, and then by the objectives of the burn which may be to reduce fuels, create habitat, enhance biodiversity, eliminate non-native species, or preserve cultural landscapes.

A burn unit is defined for management ignited fires with control lines established around the perimeter. If a lightning ignition is managed for wildland fire use, a MMA (maximum manageable area), is defined. In either case, fire will be suppressed if it goes outside the boundaries. Many times these boundaries are defined by existing landscape features that will not burn such as bodies of water, rock formations, or roads.

Every burn plan and MMA must consider fuels, weather and topography. These three factors combine to influence fire behavior. The resulting fire behavior determines how well a fire can be controlled, and whether the objectives in a burn plan will be achieved. Fuels, weather and topography influence the ignition patterns (how a prescribed fire is lit), number of holding resources needed (fire management personnel along the edge of the burn), amount of preparation work required to get the unit ready, and how long the unit will have to be patrolled or mopped up after it has been fired.

A good example of how these three elements come into play is in the Studhorse 8 Prescribed Burn at Yosemite National Park. This unit has a midslope line at the top end, and concentrations of heavy fuels along both flanks. This unit has not burned in recent history, so the fuel loadings are uncharacteristically high for Ponderosa pine / bear clover and mixed conifer, the two fuel types in the burn unit. With unusual fuels and a difficult topographical position, the consideration of weather becomes even more important. This unit will be ignited in the late afternoon and early evening, to take advantage of higher humidity and downslope winds. Higher humidity will reduce the chance of spotting and lessen the intensity and rate of spread of the fire. Downslope winds will push the smoke column down into the unit, rather than upslope across the control lines. The firing will continue through the late evening to ignite heavier concentrations of fuels along the flanks so they have ample time during the late night and early morning hours to burn down. Nighttime cooler temperatures and higher humidity will help moderate flame intensities, which will aid in keeping the fire under control.

Risk Management, Go/No Go Decision

PUTTING FIRE ON THE GROUND INVOLVES RISK. BUT, FIRE EXCLUSION is also a risk. The Go/No Go decision process that determines whether or not a planned burn will proceed is an important part of how prescribed fire is managed. The burn boss and the agency administrator, typically the superintendent, are required to go through a risk management checklist before a burn is ignited. A typical Go/No Go checklist asks:

Are weather conditions within prescription?

Have the operational plans been distributed to all personnel?

Are all necessary equipment and supplies onsite?

Includes extra engines and water in case of emergency.

Are appropriate holding resources available? Considers the number of personnel that will surround the edge of the fire and keep it within its boundaries.

Has the burn unit been fully prepared?

Refers to control lines around the perimeter and any pre-treatment described in the burn plan.

Are all personnel properly certified?

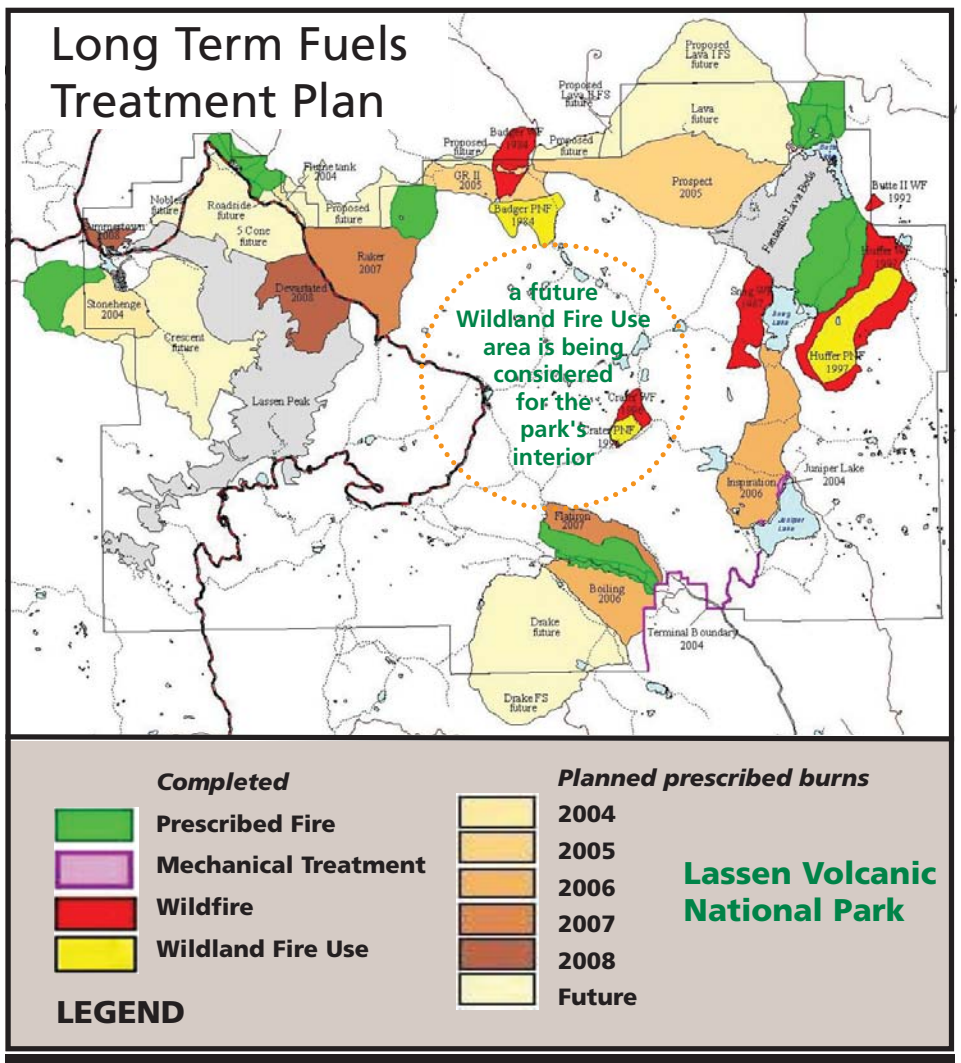
Refers to training required to perform functions during a burn.

Has there been public notification?

Ensures community is aware that a prescribed burn is in progress.

Does the regional preparedness level allow us to proceed? If high fire potential or existing wildfires could cause resources to be unavailable in an emergency, a burn may not take place.

Is a smoke management plan being implemented? Ensures particulate matter levels will not violate air quality standards, and traffic control measures are in place.



Why Some Parks Don't Use Fire

Exotic Plants Make Fires Too Big and Too Frequent in Desert Parks

❖A growing body of evidence shows that fire harms desert ecosystems by promoting the spread of exotic vegetation--mainly exotic annual grasses. This rapid spread of exotic grasses creates wholesale **type changes in habitats**, converting native desert shrubs and scrub woodlands to non-native grasslands. Several species of invasive exotic plants occur in sufficient densities to promote abnormally large fires by providing the fine fuel necessary to carry fire between native shrubs. After the resulting wildfire, exotics grow back more aggressively and may lead to still larger and more frequent fires.

❖Some scientists suspect a yet unproven link exists between **nitrogen deposition from air pollution and the spread of exotic grasses**. Long term eco-logical consequences of this vegetation type conversion and its effects on desert wildlife are poorly understood. To halt the cycle of exotic species proliferation through fire, desert parks have adopted fire suppression policies in areas particularly vulnerable to type conversions. Joshua Tree, Death Valley, Lake Mead and Mojave national park sites all share these concerns.

Fire Frequency Has Already Increased in Some Parks Due to Human Causes

❖Accidental ignitions from **electrical equipment, powerlines, vehicles, and a variety of other human sources** reduces the need for presribed fire in some parks such as Santa Monica Mountains NRA.

Fire Can Threaten Sensitive Soils, Rare Species, and Cultural Resources in Hawaiian Island Parks

❖Many **tropical soils** in West Hawaii are flamable, so not only native plants suffer in a fire, but the ability to re-seed is affected.
❖Fire can seriously impact **petroglyphs and other cultural deposits** in the non-native grasslands, so prescribed fire is out or at least in question.
❖Much of the traditional use of fire in Hawaii was a serious **detriment to native coastal forests** and played a large part in habitat loss and extinction of over a dozen species of bird unique to the islands.
❖**Weather, topography, and fuel are radically different** in island systems than continental systems so the set of norms for fire supression and ecosystem management requires rethinking.

Working With Nature's Prescription

Wildland Fire Use at Lassen Volcanic, Sequoia, and Kings Canyon National Parks

IN WILDLAND FIRE USE, UNPLANNED FIRES ARE MANAGED to benefit natural resources. Wildland fire use is one way parks can strive to reach their fire and fuels program goals of reintroducing the process of fire, restoring forest structure, reducing hazardous fuels, and protecting people, ecosystems and facilities from catastrophic fire. These fires are monitored and allowed to burn and move through the landscape if they stay within safe prescriptions and continue to reach resource management objectives.

Sequoia and Kings Canyon National Parks are located at the southern portion of the Sierra Nevada Range. Lassen Volcanic National Park lies at the northern end of the Sierra Nevada Range and the southern tip of the Cascade Range. Weather patterns associated with these mountains brings frequent lightning during summer and fall. These parks and their respective forest and plant communities have evolved over thousands of years with lightning ignited fire as a natural process shaping the landscape.

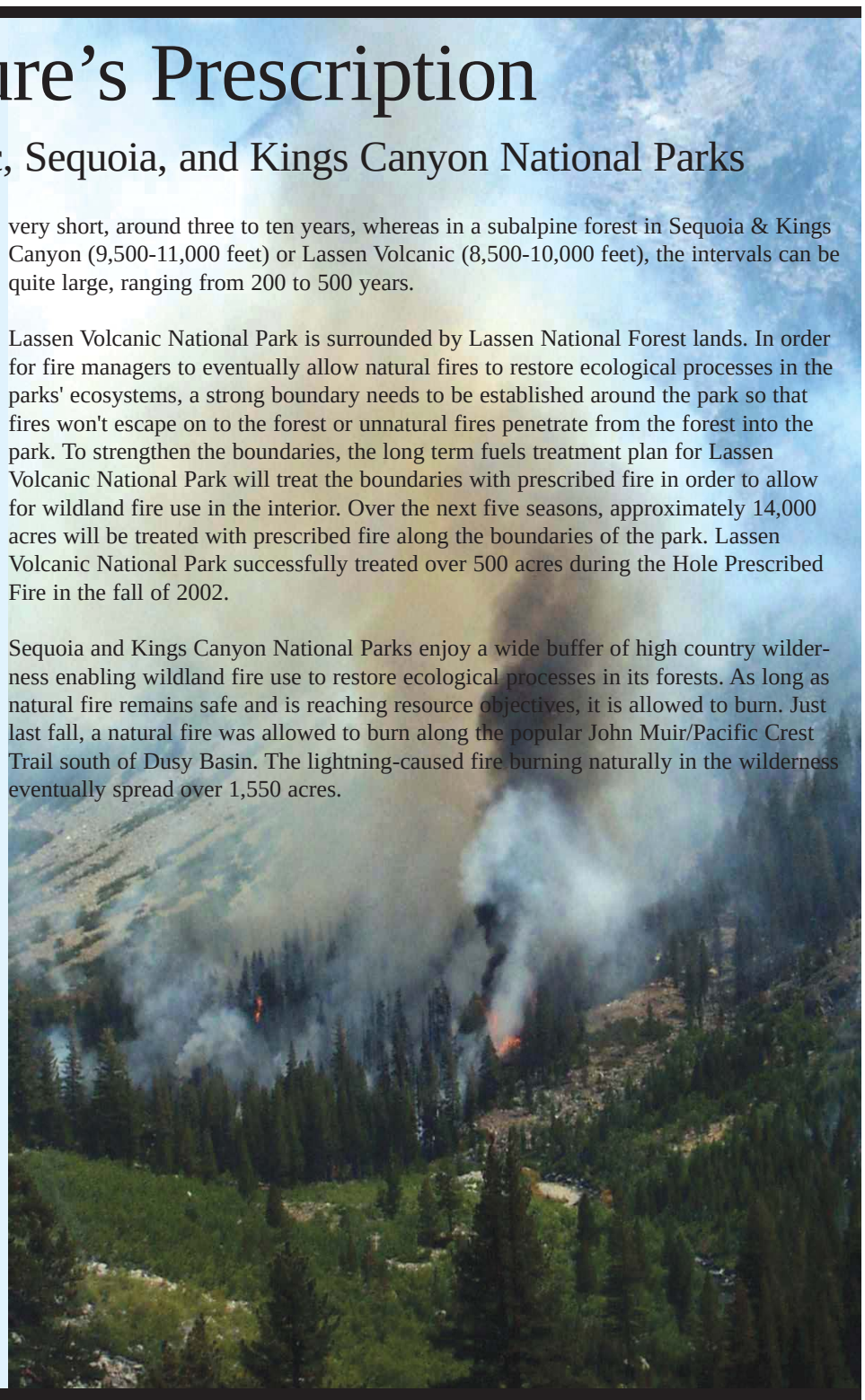
During the last century however, it was widely believed that fire was a destructive force and all wildland fires were suppressed. As a result, dramatic changes in the structure and composition in the fire-prone ecosystems within these parks have occurred. Stands are now denser because seedlings and saplings were not thinned by periodic low-intensity surface fires and there has been a compositional shift from fire-tolerant to fire-intolerant species. Trees are now found in areas once occupied by shrubs or grasses. In many areas where trees historically grew, there is an abnormal and dangerous accumulation of fuel -- dead trees, limbs, leaves, needles, dense thickets of small live trees, and undergrowth. Now when a fire starts, it can become extremely hot, fed by an overabundance of fuels. These fires can be difficult to control, threaten people, and cause long term damage to the ecosystem.

Lightning continues to start fires in quite a few national parks. The decision to manage a lightning ignited fire is called wildland fire use. These natural fires are wanted for their ecological work, but in many cases, they cannot be managed until the heavy fuel load that has built up in these forests is reduced. Fire managers are looking at ways to restore ecological conditions so that fire can safely return to the landscape. The three main tools parks can use to reduce heavy fuels are prescribed fire, mechanical fuel reduction, and wildland fire use.

Understanding fire history is important to determine how much fire is appropriate for a particular ecosystem. In Ponderosa pine stands at the 4,000-5000 feet elevation in Sequoia & Kings Canyon and at Lassen Volcanic (4,500-6,000 feet) fire intervals were very short, around three to ten years, whereas in a subalpine forest in Sequoia & Kings Canyon (9,500-11,000 feet) or Lassen Volcanic (8,500-10,000 feet), the intervals can be quite large, ranging from 200 to 500 years.

Lassen Volcanic National Park is surrounded by Lassen National Forest lands. In order for fire managers to eventually allow natural fires to restore ecological processes in the parks' ecosystems, a strong boundary needs to be established around the park so that fires won't escape on to the forest or unnatural fires penetrate from the forest into the park. To strengthen the boundaries, the long term fuels treatment plan for Lassen Volcanic National Park will treat the boundaries with prescribed fire in order to allow for wildland fire use in the interior. Over the next five seasons, approximately 14,000 acres will be treated with prescribed fire along the boundaries of the park. Lassen Volcanic National Park successfully treated over 500 acres during the Hole Prescribed Fire in the fall of 2002.

Sequoia and Kings Canyon National Parks enjoy a wide buffer of high country wilderness enabling wildland fire use to restore ecological processes in its forests. As long as natural fire remains safe and is reaching resource objectives, it is allowed to burn. Just last fall, a natural fire was allowed to burn along the popular John Muir/Pacific Crest Trail south of Dusy Basin. The lightning-caused fire burning naturally in the wilderness eventually spread over 1,550 acres.



Culture and Fire - Restoring Balance Between Humans and Nature

THE USE OF PRESCRIBED FIRE AT REDWOODS NATIONAL AND STATE PARKS

"Burning is part of the Yurok culture. Yurok burn to maintain the land." Glenn Moore, Sr., Yurok Tribe Culture Committee

AMERICAN INDIANS USED FIRE as a land management tool throughout the Pacific West. Contrary to popular American myth, North America was not a wilderness when Europeans and Africans arrived, but home to many different cultures that developed a deep practical knowledged of local environments and strategies for survival and sustenance in lands they inhabited for thousands of years.

American Indian populations in the Pacific West were typically sedentary, occupying permanent villages, making seasonal forays to well known areas within their respective ancestral territories, and tending the natural resources. Historic population densities in the Pacific West range among the highest recorded in North America by early explorers. Yet, agriculture, as it is usually defined, was not adopted beyond the planting and harvesting of native tobacco for personal and ceremonial use. Recent research and American Indian testimony throughout the historic period, indicate that native populations of the Pacific West did practice husbandry - control and careful management of resources - which is usually tied to a ceremonial cycle. Frequent, low intensity burning accomplished the task in various plant communities.

Redwood National and State Parks (RNSP) contain portions of the ancestral territories of three extant Native Californian tribes, the Yurok, Tolowa, and Hupa/Chilula. The historic literature refers to these tribes as hunter/gatherers, implying a people who simply gathered what nature produced. The same literature, invariably describes aboriginal burning of grasslands, oak woodlands, and open understories in the forests, usually ascribing the practice to the hunting of rabbits, or some other reason better understood by Europeans. Instead, these writers were witnessing a system of planting, harvesting, and managing the environment, very different from that practiced in Europe.

"Prairies are burned by Yurok people. They should have always been burned, but when the whites came, they wanted to protect trees for timber and money..." Glenn Moore, Sr., Yurok Tribe Culture Committee

RNSP is returning fire to its historic role to manage cultural and historical landscapes, and native plant communities. Local tribes maintained over 4,300 acres of naturally occurring prairie balds and oak woodlands prior to Euro-American settlement. Central to the parks' management policies is the idea that natural and human-set fires, along with other natural events, led to the plant communities in the parks today. Fires along the coast and in the interior Bald Hills kept these areas open for thousands of years, ultimately drawing American settlers seeking open space for farming and ranching.

Regular burning in oak woodlands helped eliminate competing trees from the understory, keeping *tanoak* groves - a major food source and staple - healthy and productive. According to Yurok elders, burning accomplished many desirable objectives: 1) keeping prairies open and free of invading conifers; 2) improving growth and yields of basket materials like hazel sticks and bear grass, food plants and native grass seeds used for flour; 3) improving forage for deer and elk; 4) keeping travel corridors open; 5) clearing riparian areas of brush to keep streams flowing year-round; 6) fireproofing areas around villages and tanoak groves; 7) pest management to reduce certain insects like ticks; and 8) insect collection for food such as roasted grasshoppers.

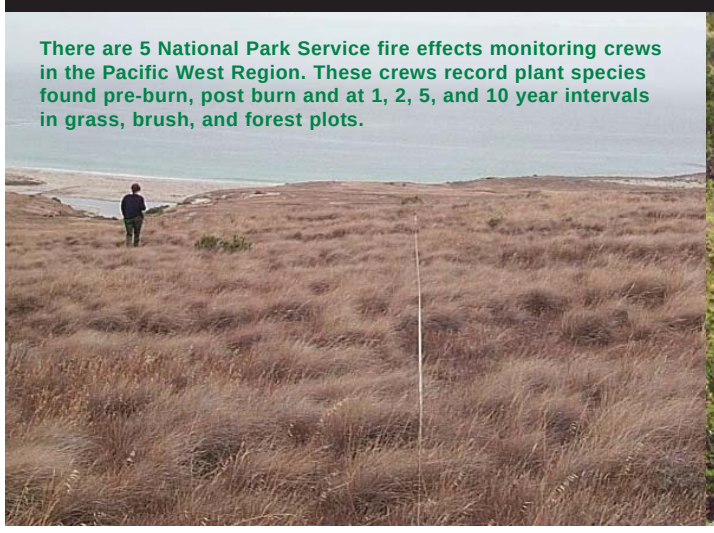
Early settlers continued "broadcast" burning to keep prairies open for their herds, until it was outlawed. Since the advent of fire supression in the early 1900s, prairies have been lost to encroaching Douglas fir in the hills and coastal scrub and Sitka spruce along the coast. These biologically and culturally rich landscapes are in danger of being lost.

"The Indian priority is about religion and balance, and following rules for keeping balance." Glenn Moore, Sr., Yurok Tribe Culture Committee

Since 1992, RNSP has successfully returned fire to the prairie and oak woodland landscape. Up to a thousand acres or more are burned, with all units burned on a three to five year rotation. This time frame approximates human-set fires by both American Indians and settlers in the region, and accomplishes several park management objectives. The long-term goal of the RNSP prescribed fire program is to, "use fire as a process to restore prairie, oak woodland, and coniferous forest to the state that existed just prior to Euro-American contact and influence." While achieving this may be difficult, restoring fire to the prairies and oak woodlands preserves cultural landscapes, historic viewsheds, diverse plant communities, and returns balance unseen in nearly 100 years.

What Did We Accomplish? FIRE EFFECTS MONITORING AND RESEARCH

There are 5 National Park Service fire effects monitoring crews in the Pacific West Region. These crews record plant species found pre-burn, post burn and at 1, 2, 5, and 10 year intervals in grass, brush, and forest plots.



Monitoring native purple needle grass in a burn unit at Channel Islands.

Recording vegetation in a brush plot dominated by chamise at Santa Monica Mountains.

A mechanical fuels treatment area which is being monitored at Yosemite.

PRESCRIBED FIRE HAS OBJECTIVES. TO FIND out if these objectives are being met, the vegetation in burn units is compared before and after the burn. By monitoring changes in vegetation, the prescription can be adjusted if necessary to achieve the desired results. For instance, the objectives may be to increase native species, reduce non-native species, reduce understory species, maintain overstory species, or reduce fuels. The monitoring program measures whether species or fuels increase, decrease, or stay the same which can indicate whether or not resource management objectives are being met.

CONTROL PLOTS

It may be important to also look at the same kind of vegetation in an area nearby area that hasn't burned to make sure the changes observed after the burn can be attributed to fire. This is a way of isolating a variable and establishing experimental controls. Control plots are compared to burn plots when fire research is being conducted. However, monitoring the burned areas alone may be sufficient to establish trends and determine whether or not objectives are being met.

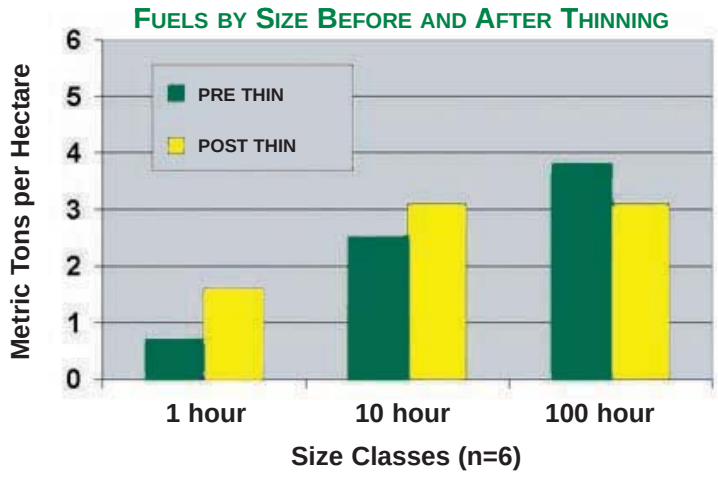
MONITORING EFFECTS OF MECHANICAL TREATMENTS

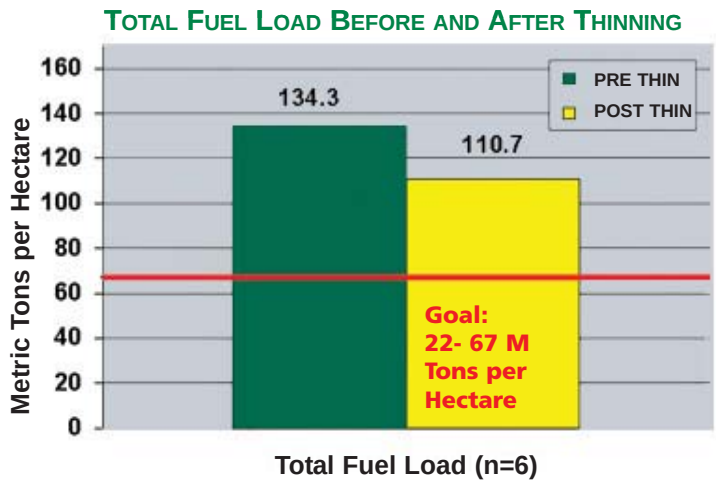
Fire effects crews have also been begun monitoring the effects of mechanical fuel treatments. This information will be useful in comparing the effects of fire with the effects of other kinds of treatments. At Yosemite National Park, it has been shown that thinning can increase small diameter surface fuels which are left on the ground during the thinning process. The park has learned that prescribed burning or extensive fuel removal by hand is needed after thinning in order to accomplish fuel reduction objectives.

The graph on the right shows how 1 hour and 10 hour fuels increased while 100 hour fuels decreased after treatment. ("Hours" relates to fuel size and how quickly the fuel dries out; 1 hour = 1/4 inch or less in diameter; 10 hour = 1/4 to 1 inch in diameter; 100 hour = 1 to 3 inches in diameter.) The lower graph shows that the target fuel load of 22 to 67 tons per hectare is still not achieved.

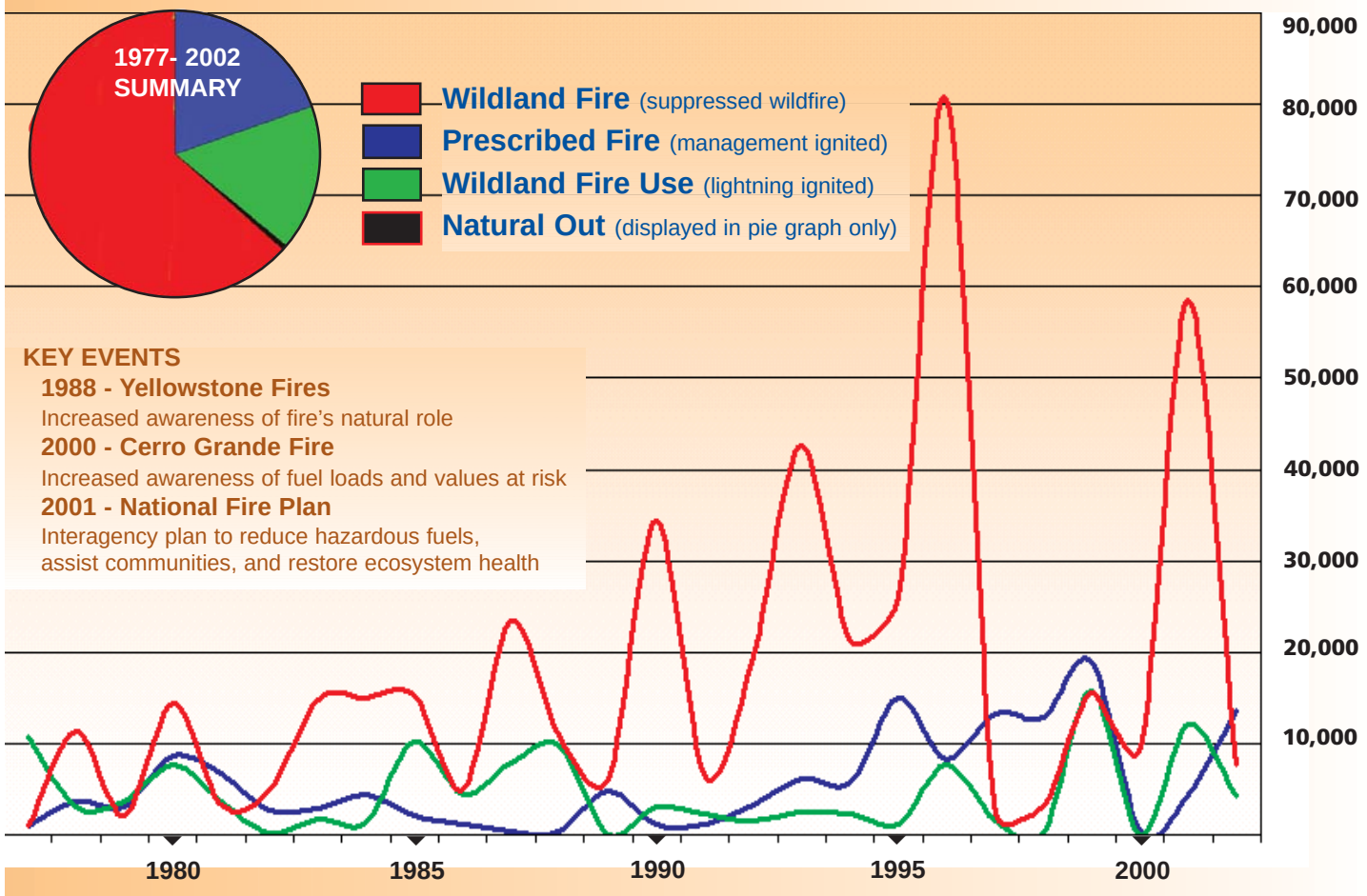
The thinning prescription at Yosemite was:
1) cut and pile all live and dead conifers less than 15.3 cm DBH (diameter at breast height); 2) do not cut sugar pine, Western white pine or any deciduous trees; 3) pile in open areas, not on downed logs or under heavily foliated trees; 4) limit piles to about the size of a small car.

Detecting an increase in small diameter fuels through monitoring is important because they allow fire to spread more quickly across a landscape. If these fuels are not further treated through burning or hand removal, there is still significant wildfire potential. Fire intensity may be less since ladder fuels were removed by thinning,which reduces the chance of crown fire. However, an increase in fine fuels also means the chance of ignition may be higher.





Recent Fire History in Pacific West Parks, 1977-2002



Acres per Year for Wildland Fire, Prescribed Fire, and Wildland Fire Use

Landmarks in Fire Management

1793 - Declaration to end Native American Burning in California

"With attention to the widespread damage which results to the public from the burning of fields, customary up to now among both Chrisitan and Gentile Indians in this country...I see myself required...to prohibit for the future...all kinds of burning..."

Governor Arrillaga

1963 - The Leopold Report

"...we would recommend that the biotic associations within each park be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by the white man. A national park should represent a vignette of primitive America.

...Of the various methods of manipulating vegetation, the controlled use of fire is the most "natural" and much the cheapest and easiest to apply. ...however, forest and chaparral areas that have been completely protected from fire for long periods may require careful advance treatment..."

Prepared for the Secretary of the Interior in response to elk management concerns at Yellowstone National Park.