Chapter 10 Study Guide and Case Studies: Wildfires

Key Concepts

- Fire is the rapid combination of oxygen with organic material in a reaction that produces flames, heat and light.
- Fire and respiration can be understood as the reverse process of photosynthesis where cellulose and oxygen are used to produce water and carbon dioxide.
- The most important natural cause of wildfires is a lightning strike. Spontaneous combustion (e.g. in a heating pile of composting organic material) can also cause a fire.
- Only 15% of wildfires have a natural cause, while the other 85% are caused by humans.
- Human causes include arson but also unintended ignition through a car's failing catalytic converter, improperly discarded cigarette butts, unattended camp fires, sparks from mechanical equipment and target shooting. Fires started for waste removal and fire suppression cause get out of control and grow into major wildfire.
- The four stages of fire are preheating phase, pyrolysis, flaming combustion and glowing combustion.
- Dry weather with very low relative humidity (e.g. less than 20%) removes water from living and dead plant material, thereby shortening stage 1 of a fire. Removal of water also accelerates the heating.
- Chemically, combustion is a type of oxidation (oxygen is used to produce a new compound)
- Since hot air rises, fires typically spread uphill faster than downhill, unless pushed by winds.
- The fire triangle consists of fuel, oxygen and heat. Firefighters try to remove at least one leg of the triangle. For example water sprayed on a fire takes up its heat. A fire extinguisher cuts off the oxygen supply.
- The intensity and spread of a wildfire depends on fuel and prevailing weather conditions. Grass fuel typically moved slowly, with smaller flames that shrub or tree fires.
- Ladder fuel, a vegetation where all types and sizes of fuel are available to 'climb up the ladder'. Wildfires involving ladder fuel are typically more severe than fires in a managed forest where one story of fuel was removed (e.g. tall shrub).
- Fuel in southern California are typically highly flammable because they contain aromatic oils. This includes chaparral, non-native eucalyptus trees, pine trees and palm trees. The latter burn like sparklers, emitting large amounts of ember that can easily transported by wind to start new fires.

- In some natural situations, wildfire is beneficial, e.g. for germination, pest control, recycling of organic material but also to influence insect behavior.
- Some climates do not require wildfires to promote plant growth: deserts, polar and tropical regions.
- Some plants adapt to wildfires, e.g. pine cones do not open until heat or smoke is present. Some trees have thick, spongy bark to protect against fire (e.g. Giant Sequoia) or wood is intrinsically fire-resistant (Redwood).
- Large wildfires cause their own 'weather', including large cumulus clouds and fire tornadoes
- Weather situations with strong winds can push a wildfire out of control. These includes winds associated with cold fronts and weather conditions with Foehn winds.
- Santa Ana weather conditions tremendously raise the risk of large and multiple wildfires in Southern California. Santa Ana weather is associated with strong winds from the high desert, low relative humidity (sometimes into the single digits) and high temperatures as a result of adiabatic heating.
- Santa Anas are caused by high atmospheric pressure parked in the U.S. Great Basin. They typically occur from September through April.
- Similar weather conditions occur elsewhere, e.g. Diablo (Northern California) and Chinook (along Rocky Mountains).
- Firefighters from different departments are often allocate where the current needs is greatest. But this also means that local resources may not be available when needed.
- Wildfires do not know boundaries. Communication and allocation issues arise when wildfires move from state forests to federal forests, or when fires involve military bases.

Key Terms

- Flames
- Combustion
- Lightning
- Arson
- Preheating
- Pyrolysis
- Oxidation
- Fire triangle
- Fuel
- Ladder fuel
- Recycling
- Germination
- Aromatic oils
- Fire tornado
- Cold front winds
- Foehn winds
- Santa Ana weather
- Relative humidity
- Cluster fires

Questions for Review

1. Provide four example how humans use fire to their advantage.

2. Provide and discuss four examples how humans cause wildfires.

3. Name and describe the four stages of fire.

4. In a terrain with topography, how do wildfires usually spread? In which cases would the spread the other way?

5. Name the three legs of the fire triangle and provide examples how to fight a fire for each of them.

6. What is ladder fuel? What would you do to prevent large fires in a forest with ladder fuel?

7. Name and describe four ways how nature needs wildfires.

8. Provide two examples of each, climates that need wildfires and climates that do not.

9. Describe strong-wind weather situations in which wildfires could spread out of control.

10. From a meteorological point of view, what is a Santa Ana?

11. What are the three weather factors that make a Santa Ana a great fire hazard? Explain how each of the three increases the risk of large and uncontrollable wildfires.

12. Give some examples of vegetation fuel in Southern California.

13. Discuss why prescribed fires to reduce the risk of large wildfires do not always work.

14. Provide four examples how buildings in rural Southern California can be protected from the risk to being a victim of wildfires.

15. Research on global climate change predicts that spring in Southern California will arrive earlier and winter will arrive later. Given that winter is the rainy season, discuss the changing risk of wildfires.

Case Studies

Case Study 1: Devastating 2010 Peat and Wildland Fires in Russia

Figure 10.C1 A street in Yasenevo District in Moscow. Left: at 20:20 on 17 June 2010 before the wildfires; right: at 17:00 on 7 August. The smog from the wildfires is evident as visibility is greatly reduced. (source: Wikipedia)

Figure 10.C2 Smoke at Moscow's Sheremetyevo International airport on 7 August 2010. The smoke was so thick that visibility dropped to 325 m (1,050 ft) and 7 flights had to be diverted to other airports. (source: Wikipedia)

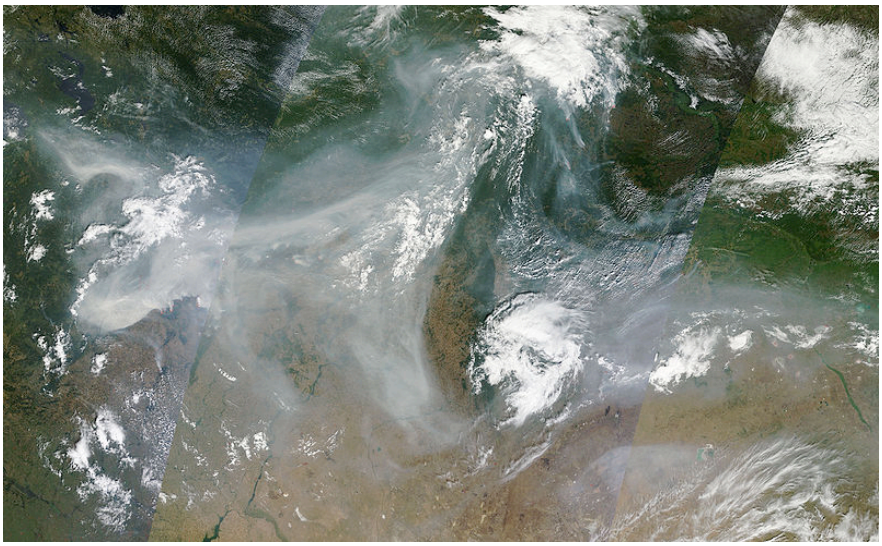

Figure 10.C3 Smoke over western Russia on 4 August 2010. (source: Jeff Schmaltz, NASA/Wikipedia)

The devastation of peat fires of recent years, with a significant human-impact component in both effect but also cause, is dramatically illustrated by the **2010 wildfires in Russia**. After record-high temperatures during an oppressive heat wave and drought-conditions in early summer, several hundred wildfires, including many peat fires, broke out in late July. Smoke from the fires produced heavy smog (a mix of smoke and fog) that blanketed large urban regions (Figs. 10.C1, 10.C2). Within a few days, the smog in Moscow was so thick that flights had to be diverted to other airports. By noon on 7 August, the carbon monoxide level there reached 6.6 times the normal level, and particulate matter 2.2 times the normal level. An estimated 56,000 people perished from the effects of the smog and heat wave. The bogs surrounding Moscow had been drained in the 1960s for agricultural use and peat mining to generate energy. In 2002 already, a series of hard-to-extinguish peat fires led the government to recognize that some peat fields should be re-waters to prevent wildfires. And the areas not re-watered by 2010 were exactly those that burned. In the aftermath, there also had been extensive debate about who was responsible to extinguish the fires, the central government or local authorities, after the Russian State Fire Service was abolished in 2007. Some criticize that current fire fighting companies chose not to fight forest fires in order to stay profitable.

Case Study 2: Prescribed Fires Gone Bad – The 2000 Cerro Grande Fire

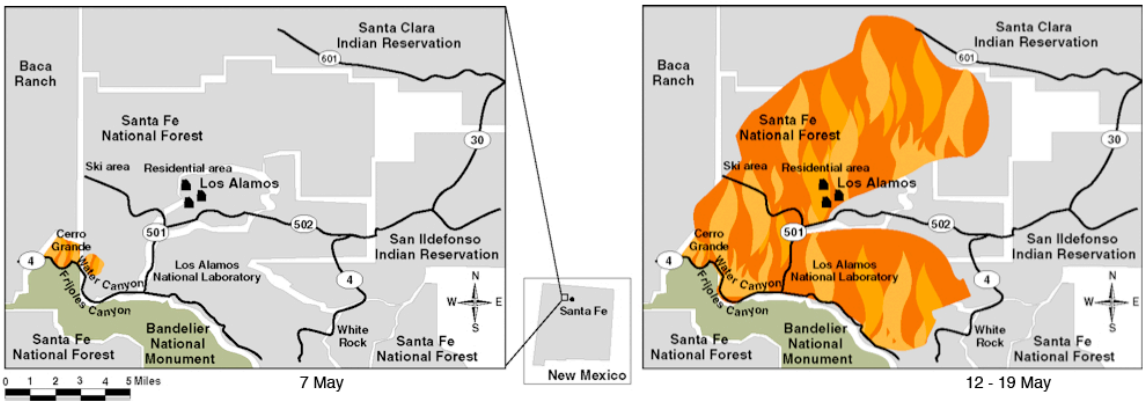

Figure 10.C4 Progression of the 4 May 2000 Cerro Grande Fire, NM that destroyed 400 homes in Los Alamos. Left: The prescribed fire on 7 May, when 100 firefighters tended to a 550-acre fire. Right: its extent from 12 to 19 May when over 1,000 firefighters fought the fire. (modified from Wikipedia/Government Accountability Office)

Figure 10.C5 Destroyed homes on Arizona St. in Los Alamos, NM after the Cerro Grande Fire. (source: DoE, wikipedia)

A controlled burn starting on 4 May 2000 was part of the 10-year Bandelier National Monument plan for reducing fire hazard within the monument (Fig. 10.C4). By the time of a prescribed fire high on Cerro Grande in the Jemez Mountains, the moisture content in some deadwood was less than that in well-cured firewood! It was felt that an unattended campfire or one of the frequent spring lightning strikes could ignite a perfect firestorm. But the Jemez Mountains are prone to high winds and low humidity in the spring time and critics insisted that the danger of a prescribed fire burning out of control would be extremely high. This is exactly what happened. On the third day after ignition, the fire became increasingly erratic, and on 10 May, strong winds pushed the fire into Los Alamos (Fig.10.C5). Over 1,000 firefighters were fighting the fire at this point. Residents were not allowed to return until 8 days later but the fire burned for a whole month before it was contained and another 1.5 months before it was declared extinguished on 20 July. The fire burned 48,000 acres (19,500 ha or 190 km^2) of land and caused an estimated total damages on the order of $1 billion. The inferno burned 400 homes in Los Alamos and structures in the Los Alamos National Laboratory though no radioactive material stored at LANL was allegedly affected.

Case Study 3: Duff, Diablo Winds and the 1991 Oakland Fires

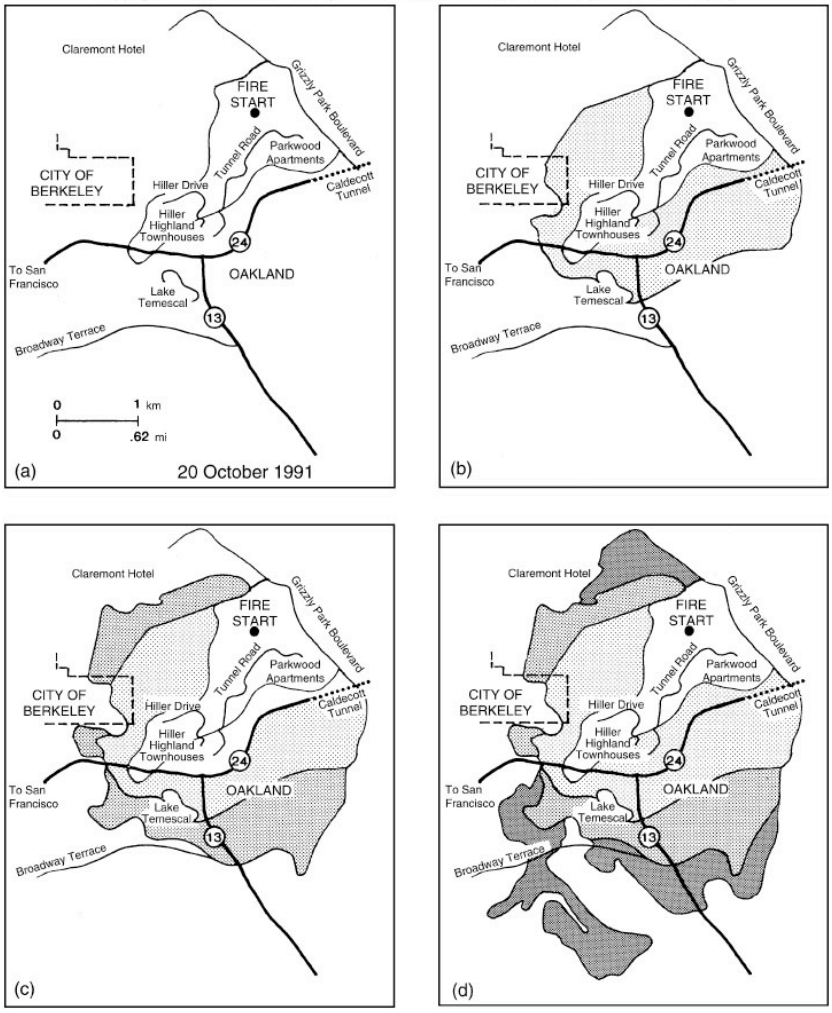

Figure 10.C6 The burn history of the Oakland/Berkeley Hills fire on 20 October 1991. Area burned by: (a) 11:30 a.m.; (b) 1 p.m.; (c) 3 p.m.; (d) 5 p.m. (source: AB)

The **20 October 1991 Oakland, CA Firestorm** developed to one of the most deadly and most destructive fires in terms of lost homes in recent in California history. A day earlier on Saturday, firefighters had fought a 5-acre (20,000 m^2) grass fire on a steep slope in the Berkeley Hills, in an area where Monterey pine trees grew and duff had accumulated (Fig. 10.C6). The firefighters had fought the fire for 3 hours and intended to return to "mop up" the smoldering duff the next morning. The fire re-ignited as a brushfire by 11 a.m. on Sunday, engulfing the Parkwoods Apartments 30 min later. Aided by flying embers, the fire had spread southwest to the Hiller Highlands, about 1.5 km (1 mi) away another 30 min later, at which point the fire had consumed 790

structures. Whipped by strong 65-mph (100-km) Diablo winds, the fire spread rapidly downhill, soon to overwhelm local and regional firefighting crews despite their 1,500 personnel and 400 fire engines. By 1 p.m., the fire had reached the city limits of Berkeley to the west and had crossed California State Routes 24 and 13 to the south. By 5 p.m., homes were destroyed in the Forest Park and in the upper Rockridge Neighborhoods and even reaching into Piedmont. Firefighters did not have a chance until the winds died down by 5 p.m.. The fire was declared under control on 23 October, 3 days later. The relatively small 1,500-acre (600 ha) fire consumed 437 apartment units and 3,354 single-family homes. Economic losses were estimated at $1.5 billion. 25 lost their lives. In the aftermath, it was found that some of the most intensely burning areas included housing surrounded by eucalyptus groves. This same area was burned in 1970 though during a smaller fire. The 1923 Berkeley fire was also thought to have been enhanced by the burning of non-native eucalyptus trees. Several initiatives arose after the fire to coordinate fuel-reduction strategies. City firefighters also were not prepared to deal with a wildland fire, exposing the consequences of perhaps aggressive urban sprawl into the surrounding hills. Firefighters are now equipped with more extensive wildland firefighting gear. Another problem in 1991 was that there were no standard for the size of fire hydrant outlets so that firefighters were unable to connect their hoses. A still persisting problem is that different firefighting agencies use different frequencies to communicate though Berkeley firefighters now carry extra radios to communicate with Oakland firefighters. This has also been a problem in San Diego with city and county firefighters.

Case Study 4: Arson and 26 October 2006 The Esperanza Fire

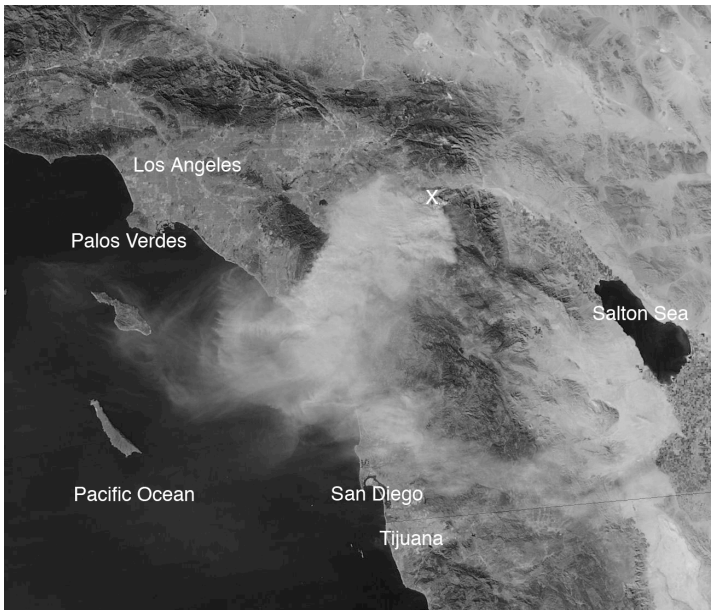

Figure 10.C7 MODIS satellite image of the 26 October 2006 Esperanza Fire in Southern California. The fire (white X) broke out during a Santa Ana. The smoke was pushed southwestward by strong northeasterly winds. (source: NASA)

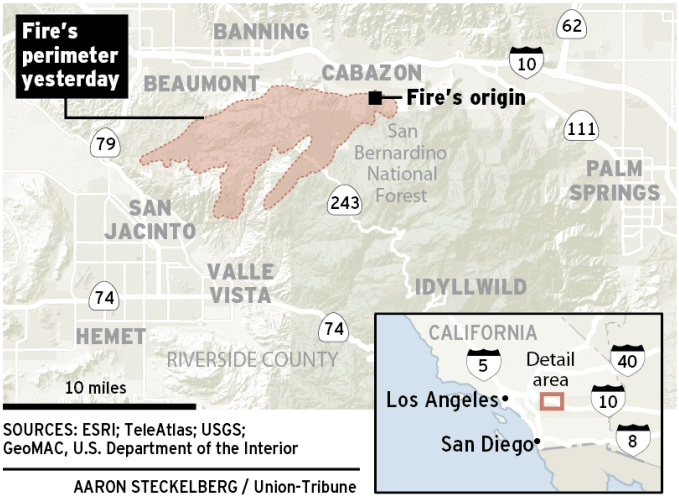

Figure 10.C8 Extent of the 26 October 2006 Esperanza Fire three days later. Pushed westward by moderate Santa Ana winds, the fire expanded extremely rapidly and burned an area of 163 km^2 (40,200 acres or 16,250 ha) before it was declared 85% contained on 30 October. (source: San Diego Union Tribune)

It burned 40,200 acres (16,250 ha or 163 km^2) before it was fully contained 4.5 days later. The fire destroyed 34 homes and 20 structure. Five firefighters died in the flames defending a vacant house that was ultimately destroyed. Raymond Lee Oyler was sentenced to death for starting the fire. Using cigarettes, matches and other incendiary devices that were thrown by a slingshot, he allegedly set 25 fires throughout the San Gorgonio Pass in summer 2006 that combined and were difficult to fight. Insured damages from the fire amount to $9 Mio while fire fighting costs may have exceeded $10 Mio.

The 26 October 2006 Esperanza Fire. (Figs. 10.C7 and 10.C8) As most fires in Southern California, the fire was started by humans. In fact, this fire was intentionally set by an arsonist who was later captured and tried. In June 2009, Raymond Lee Oyler was sentenced to death for starting the fire at 1:12 PDT on 26 October 2006. Pushed by moderate Santa Ana winds but also encountering highly flammable brush, the Esperanza Fire spread extremely rapidly and burned 97 km^2 (24,000 acres) in the first 18 hours. The fire could be seen from higher elevations in San Diego, and there was also the smell of smoke. Four firefighters were overwhelmed by the shifting fire, while they tried to save a home, and were killed. One firefighter initially survived, with 90% of his skin burned but he lost his succumbed to the severe burns. It destroyed 34 homes and 20 outbuildings and damaged state route 243. The damage the fire caused was estimated at $6 million. According to the California Department of Forestry and Fire Protection (CDF) 1587 firefighters fought the fire in 54 fire crews, with 92 fire engines, 3 helicopters, 7 bulldozers and 10 water tender. Damages to insured structure are estimated at $9 Mio, while the firefighting costs are estimated at $9.9 Mio.

Case Study 5: Drought, A Tropical Storm and the 2011 Texas Wildfires

The 2011 fire season was one of its worst wildfire Texas has ever experienced. Between 15 November 2010 and 31 October 2011, nearly 28,000 fires burned nearly 4 million acres of wildland (1.62 million ha or 16,200 km^2) making up 47.3% of the acreage burned that season in the U.S.. The fires destroyed nearly 2,900 homes and over 2,700 other structures, with 1,900 homes burned on Labor Day weekend. To set this into perspective, prior to the 2011 fire season, the most destructive fire in Texas occurred in December 2005. It destroyed 116 home! A contributing factor to the particularly severe fires was an ongoing drought that followed a La Niña, with unusually high temperatures and low humidity but also an unusual convergence of strong winds. With the lowest single-year rainfall since 1895, and the hottest June – August period experienced by any U.S. state in recorded history, exceeding even the Dust Bowl years in the 1930s (see Chapter 13), the drought was the most severe drought since the 1950s.

Figure 10.C9 Aerial view of Possum Kingdom Lake, in the Hell's Gate area, after the devastating April 2011 wildfire. The lake is known for its clear blue waters. The fire destroyed 168 homes and buildings. 90% of the State Park was involved in the fire. (source: Wikipedia)

A group of four wildfires in April devastated the Possum Kingdom Lake area in Stephens, Young and Palo Pinto counties. The four fires consumed 148,000 acres of land (60,000 ha or 600 km^2) and destroyed 166 homes and 2 churches, setting a new record, at the time, as the most destructive fire in recorded Texas history. Possum Kingdom State Park was closed on 15 April and remained closed for 6 weeks. 450 firefighter, 3 helitankers and 3 helicopters fought the fire along a 270-mi (430-km) fire line. Another

fire broke out on 30 August that burned well into September, destroying another 39 homes.

Figure 10.C10 Smoke from the wildfire rising over Texas State Highway 71 near Bastrop on 9 September 2011. (source: Wikipedia)

The **Bastrop County Complex Fire** started on Sunday, 4 September on Labor Day weekend[20] (Fig. 10.C10). It engulfed Bastrop, just east of Austin, and destroyed 1,645 homes by 30 September. It burned 34,068 acres, and killed two people. It is considered the most destructive wildfire in Texas history. Apart from the ongoing drought, strong winds from Tropical Storm Lee contributed to the firestorm. Two small fires started near Bastrop State Park on Sunday afternoon. Tropical Storm Lee brought 30-mph (50-km/h) wind gusts and likely caused trees to topple into electric power lines, igniting dry grass and leave litter below. That weekend, 63 new fires ignited overall. A third fire broke out a few hours later on the south side of Texas State Highway 71 and quickly merged with the other two. Pushed by the winds, the Bastrop County Complex Fire quickly spread and engulfed 400 homes. By 7:30 p.m. the next day, the fire had consumed 25,000 acres (10,000 ha) of land and 500 homes. Winds started to die down but it took time to get the fire under control. The fire had jumped the Colorado River on at least two occasions.

On 8 September, the jumbo jet-sized Tanker 910 was supposed to aid in the firefighting loading facilities were not adequately equipped to load the plane, and no pilot was available (see Case Study 8). By the time the tanker was ready early on 9 September, it did not receive authorization to deploy. The DC-10 then deployed on 10 September retardant on a 20,000-acre fire that had destroyed 60 homes near Magnolia, north of Houston.

Air quality in nearby Austin reached a 14-year low. By 11 September, 1,554 homes had fallen victim to the fire. Tensions and frustration flared when residents evacuated a week earlier wanted to return to their homes, or what was left of them. The fire was finally contained 98% not until 1 October. Insured property losses are estimated at $325 million. According the Texas parks & Wildlife officials, only 50 – 100 acres of the 5,926 acres in Bastrop State Park remained undamaged. The endangered Houston toad was believed to have lost the vast majority of its habitat.

Following the fire, Texas Governor Rick Perry and the Texas Legislature drew criticism for substantial budget cuts to the Texas Forest Service and volunteer fire departments. Perry in return criticized the Obama administration for delayed FEMA relief aid. The White House issued a formal statement on committing FEMA relief funds on 7 September. The cost of the removal of fire debris was estimated at $25 million ($19 million of which were expected to come from FEMA). FEMA also paid $30,000 to each family to cover expenses not covered by insurance policies, e.g. hotel bills, temporary housing and some construction costs.

Case Study 6: The 1910 Bitterroot Big Blowup

The two-day **Great Fire of 1910** (also termed the Big Blowup or the Big Burn) started on 20 August 1910 after a cold front brought hurricane-force winds to northeast Washington, northern Idaho and western Montana, after an unusually dry early summer. An estimated 1000 to 3000 small fires ignited by hot cinders from locomotives, sparks, backfiring crews but also lightning burned by mid August in Idaho, Montana, Washington and British Columbia. Hundreds of such small fires combined to a behemoth that was impossible to fight. The U.S. Forest Service (the called the National Forest Service) was only 5 years old and did not have the resources to fight such a fire but even the U.S. Army that was called in could stop the inferno. Believed to be the largest fire in recorded U.S. history, the fire burned 3 million acres (1.2 million ha or 12,000 km^2), and smoke from it could allegedly be seen as far east as Watertown, NY and as far south as Denver, CO. Ships 500 km (300 mi) out into the Pacific Ocean could not use the stars to navigate because the sky was too cloudy with smoke. 85 people perished in the fire, 78 of them being firefighters. Two towns in Idaho and five towns in Montana were destroyed. The fire was not extinguished until another cold front brought steady rain.

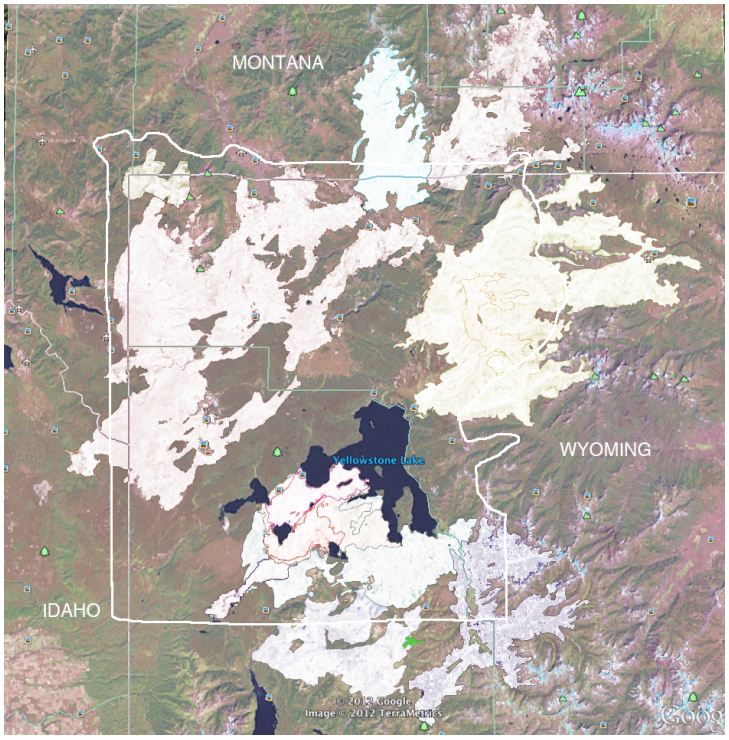

Figure 10.C11 Simplified Google Earth snapshot of a NASA animation of the 1988 Yellowstone Fires (white areas). The white line approximately marks the park boundary. (source: NASA/Goddard Space Flight Center[17])

Figure 10.C12 A crown fire approaches the Old Faithful complex on 7 September 1988. (source: wikipedia)

Case Study 7: Yellowstone Park - Fire Fighting or Suppression?

The Yellowstone fires of 1988 together formed the largest wildfire in the recorded history of the Yellowstone National Park (Figs. 10.C11, 10.C12). Yellowstone National Park was established in 1872 as the first National Park in the U.S. and is the most famous megafauna (large animals such as bison, bears, moose and elk) location in the contiguous U.S.. Before the fires, U.S. Forest Service policy dictated that small fires be suppressed, even in the park. As a consequence the acreage burned annually declined from 30 million acres (120,000 km^2) in the 1930s to 2 – 5 million acres (8,000 – 20,000 km^2) in the 1960s. But since the time when Forest Service policies were enforced, both foresters and ecologists voiced that fires are part of the natural cycle and beneficial to the ecosystem, as expressed in the Wilderness Act of 1964. By 1968, the National Park Service allowed natural-cause fires to burn if they were no threat to human life and property, i.e. only human-cause fires were extinguished. It is estimated that 6 to 10 fires in the park are caused by humans each year, and 35 by lightning. By 1972, it allowed natural fires in the park to burn under controlled conditions as so-called **prescribed natural fires**. Between 1972 and 1987, a total of 235 prescribed natural fires had burned only 34,000 acres (136 km^2) of land. Only 15 of these fires spread to more than 100 acres (40 ha) and only one reached 7,400 acres (3,000 ha). It seemed that the prescribed-natural-fires policies worked.

Overlooked was the fact that a long-lasting infestation by the Mountain Pine beetle since the 1960s caused widespread tree kill. Overlooked was also that the last five years prior to the 1988 inferno were unusually wet years that allowed extensive growth in the understory vegetation. The vegetation dried out during an unusually dry 1987/1988 winter season and a U.S.-wide drought in 1988. Where deadwood typically has a water content of 10 – 25%, the water content now was only 2 – 7%. Lightning started fires in June 1988. Drought and heat-wave conditions continued and the decision was finally made on July 15 to fight the fire after it had consumed 8,500 acres (3,500 ha). However, despite the efforts, the fires spread to almost 100,000 acres (400 km^2) in only a week, in the park alone. Almost 250 fires had started in Yellowstone Park and the surrounding National Forests between June and August, with 7 of them being responsible for 95% of the acreage burned. On “Black Saturday” 20 August, the firestorm consumed 150,000 acres (610 km^2) within only 24 h, more than the total that burned in the preceding 116 years (146,000 acres). At the peak of the firefighting efforts 9,000 firefighters were assigned to the park, with another 4,000 U.S. military personnel aiding the effort. Two major visitor destinations were almost destroyed, and on 8 September, the park was closed to all non-emergency personnel, for the first time in the park’s history. Relief from the fires did not come until the first snowfalls in November.

A total of 25,000 personnel fought the fire, fire fighting costs amounted to $120 million, and losses amounted to $3 million. An estimated 790,000 acres (3,200 km^2), or 36% of the park was affected by the wildfire that almost destroyed two major visitor

destinations. Some news outfits had reported that most of the park was destroyed but that was actually not the case. Contrary to initial reports in the press, losses in the megafauna were surprisingly low: 345 elk (of 40,000 – 50,000), 36 deer, 12 moose, 9 bison and 6 black bears though the moose population has yet to rebound. About 100 fish died in two streams after a drop of fire retardant. No long-term impacts have been observed on aquatic life.

Case Study 8: Jumbo Jet-size Air Tankers

Large air tankers are essential to fight wildfires in inaccessible, mountainous terrain. And the larger the tanker is, the less time has to be spent on returning to the base and recharging it with water or fire retardant. In 2006, the CDF therefore introduced a modified jumbo jet-size airplane to fight such fires, Tanker 910 (Fig. 10.C13) that is operated by 10 Tanker Air Carrier. One drop from this modified DC-10 aircraft has as much firefighting potential as 12 drops from a more standard Grumman S-2 tracker tanker plane. The three holding tanks of Tanker 910 can be refilled in only 8 min, and the load can be dumped in 8 s. One drop of retardant can cover a line 300 ft (90 m) wide and 1 mi (1.6 km) long. The tanker was initially deployed in California but has been used elsewhere in the meantime, e.g., during both large fires in 2011 in Texas. In 2009, a Boeing 747 was converted to the Evergreen 747 Supertanker, the world's largest aerial firefighting aircraft, that can carry 20,500 gallons (78,000 l) of water. Expect for one incident in 2007 when the plane experienced severe turbulences, descended lower than expected and struck several trees (thereby damaging equipment on the leading edge of one wing), operators have been extremely please with the performance of Tanker 910. A second DC-10 was converted in 2008 and commissioned to fight fires in Australia in 2010.

However, using the DC-10s for firefighting is relatively expensive and a careful cost-benefit-analysis has to be made. In **2006**, Tanker 910 flew on a "call-when-needed" basis, with a $26,500/flight-hour charge (3-h minimum) and a 12 – 24-hour activation delay. In this year, the tanker flew on 6 fires in California and one in Washington. After its initial two drops on the Sawtooth Complex fire in July, firefighters reported that those two drops had a greater impact than what 12 helicopters dropped in the previous 10 days.

Pricing policies changed for the 2007-2009 fire seasons when California Governor Schwarzenegger authorized an exclusive-use contract of the plane at a cost of $5 million/year (or $41,000/day for the 15 June – 15 October fire season), with an additional $5,500/flight-hour charge. In **2007**, it flew two runs in the White Fire before the incident occurred. After repairs and investigation, Tanker 910 then flew in the Zaca Fire, the Moonlight Fire, the Slide and Grass Fires near Lake Arrowhead just days before the Witch Fire in San Diego, and then the Corral Fire near Malibu.

In **2008**, the tanker made 14 drops in response to the state of emergency in the Humboldt Fire in Butte County in June and in Big Sur a few weeks later.

In **2009**, the tanker was activated during the Station Fire in August.

In **2011**, the tanker left California for the first time to help firefighting efforts during the wildfires in Texas in April and in September. The tanker could not deploy in April because of delays in the fire-retardant mixing facility but then fought a prioritized fire north of Houston in September, after it was not authorize to deploy in the large Bastrop County Fire (see Case Study 6).

The Evergreen 747 Supertanker was first deployed in 2009 to fight a fire in Cuenca, Spain, and the in the Oak Glen Fire in California in August. In December 2010, it was deployed in the Mount Carmel forest fire in Israel. In June 2011, it helped fight the Wallow Fire in Arizona. The Wallow Fire burned more than 469,000 acres (190,000 ha) and was the largest in Arizona history.

Figure 10.C13 Tanker 910 dropping water over the Victorville Airport during a demonstration for Los Angeles County Fire officials on 15 December 2006. Tanker 910 is a converted McDonnel Douglas DC-10 that can carry up to 12,000 gallons (45,000 l) of water or fire retardant and release it in 8 s. (source: Wikipedia)

Case Study 9: San Diego's Worst Fires

The 26 October 2003 Cedar, Paradise and Otay Fires

Preceding the weekend of the tragic Cedar/Paradise and Otay fires, a number of factors had dramatically increased the fire risk in San Diego county in recent years:
1997/1998 strong El Nino; San Diego received 2-3 times normal rain fall
succeeding La Nina dried out countryside

warning that "next 10 years will be dry"
last 5 years below-average rainfall
threat of MAJOR wildfires; but did not happen
2002 Pines Fire east of Julian (helicopter downed power line) only major fire
explosive development of city into rural areas (Scripps Ranch faces several chaparral-loaded slopes)

extraordinary circumstances just before the weekend left San Diego practically defenseless
Red Flag Weather Warning on Oct 24! SANTA ANA!!
Fires had been burning in Camp Pendleton; Simi Valley; St. Bernardino (Santa Ana clusters fires!)
California sends fire fighters were they are needed, so S.D. had only few
a lost hunter is thought to have started the Cedar Fire
the Cedar fire started near Ramona and the San Diego County Estates and went quickly out of control
nature-induced spread: after burning for 6-7h, Santa Ana winds pushed fire out of control; fire spread west extremely fast (some estimates are > 15mi in less than 1h before it reached Scripps Ranch early Sunday morning)
human-induced spread: spread of fire might have been delayed if air support had been allowed to fly closer to sunset; miscommunication between county and city; too few fire fighters; Otay fire initially unattended because it didn't immediately threat homes.

By the end of Sunday, the winds died and shifted. By Monday the fires did no longer threat the city by which time new coverage diminished significantly. The Cedar Fire alone had burned 194,000 acres in the first 31h, 2/3 of the total area burned in this fire.
The fire had also burned toward the east and was spreading faster after the winds shifted. The fire became more intense because it now burned into the forest were fuel included trees. The fire had reached Cuyamaca by Wednesday, October 29 - despite a tremendous increase of fire fighting resources - and Sunrise Highway that leads to the the Mount Laguna area a day later. The historic part of Julian was spared but a large fraction of the houses in the area burned. The total area burned was 280,000 acres in the Cedar Fire alone (total of nearly 400,000 acres in all three fires). The worst preceding fire in terms of acreage burned was the 1971 (or 1970?) Mtn Laguna Fire that destroyed 108,000 acres. Though the loss of homes caused tremendous heart ache the city will recover sooner than later, perhaps just in a few years. The surrounding wildland will need significantly longer. While grass will start to grow this winter season, if it rains enough, estimate are that shrublands need in excess of a decade for full recovery. Wooded areas, such as the Silverwood Wildlife Sanctuary of the National Audubon Society, will need at least three decades and the forests in the Cuyamaca area probably longer... an awfully long time in a human lifespan.....but nothing really for Nature.
See also the summary on the Santa Ana page and links to the 2003 fires and 2007 fires.

How Can we Avoid this to Happen Again?

Good question! The problem is very complex and there is probably no perfect solution. If fact, some suggests are impossible to realize, and perhaps some shouldn't! They include:
ice plants everywhere! (not native to San Diego; does not support wildlife)
change air support flying rules (put fire fighters in harms way?)
better communication between City and County emergency crews
change California fire fighter exchange rule (though would we suggest the same if the Cedar Fire had started before the Grand Prix Fire in St. Bernardino?)
better house protection (no guarantee! Some house were lost despite all the right efforts)
buy more helicopters (who pays for this? The current sole San Diego fire fighting helicopter costs $200,000/month; the purchase of one would involve $1.5Mio)
stop urban sprawl?
more prescribed fires (who pays for this? Some burn out of control, e.g. Los Alamos 2000!)

NB: Update on October 2008: A week short of the 4th anniversary of the Cedar Fire, San Diego county was again struck by devastating wildfires in October 2007 (Witch Creek, Guejito, Rice, Harris Fires). The city then got a second helicopter (split-funded with SDG&E??) and communication and coordination with the military was promised to improve (the latter was poor in both fires). Proposition A on San Diego County's Nov 04, 2008 ballot calls for an addendum to the property tax (countywide parcel tax) to fund a new Regional Fire Protection Agency to coordinate fire fighting and prevention (50%) and to augment services at existing local fire agencies (50%).
Update 2010: the proposition was defeated with 63.25% of the vote.
check out at ballotpedia.org

The 26 October 2007 Witch (Creek)/Guejito, Pamoocha and Rice Fires