United States
Department of
Agriculture

Forest Service

Fire and Aviation Management
Washington, DC

Aerial Application of Fire Retardant

Environmental Assessment

October 2007

Cover photo by Kreig Rasmussen, Fishlake National Forest, 2005.

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Proposed Action: The Forest Service proposes to continue the aerial application of fire retardant to fight fires on National Forest System lands and to permanently adopt the Guidelines for Aerial Delivery of Retardant or Foam near Waterways, which were established in 2000.

For More Information:

Forest Service
Fire and Aviation Management
1400 Independence Ave.
Mail Stop 1107
Washington, DC 20250
(202) 205-1332

ERRATA

October 31, 2007

Page 21
The citation in the last paragraph has been corrected. The original citation incorrectly read:
(National Interagency Fire Center 2007a; National Wildlife Coordinating Group 2004)

Page 23
The citation in the last paragraph has been corrected. The original citation incorrectly read:
(Interagency Standards for Fire and Fire Aviation Operations, 2007 NFES 2724)

Page 24
The quote in the second paragraph has been corrected. The original quote, which read, “Be sure the line is clear of personnel prior to dropping retardant” was from a 2003 edition of the Interagency Standards for Fire and Fire Aviation Operations.

Page 30
The following reference was added:
National Interagency Fire Center, 2007c, Safety. In: Interagency standards for fire and fire aviation operations. Chapter 7. 17 p.

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Chapter 1 Purpose and Need for Action

Introduction

The Forest Service, U.S. Department of Agriculture, conducted a programmatic environmental analysis and prepared this Environmental Assessment (EA) to determine whether allowing future nationwide aerial application of fire retardant using *Guidelines for Aerial Delivery of Fire Retardant or Foam Near Waterways* (U.S. Forest Service and others 2000) to suppress wildland fires on National Forest System (NFS) lands would result in significant environmental impacts as defined by the National Environmental Policy Act of 1969, and to comply with the Endangered Species Act. Based on this EA, the Forest Service Responsible Official will determine whether the Proposed Action warrants documentation in an Environmental Impact Statement (EIS).

Scope

Environmental effects have been analyzed on a nationwide, programmatic scale. The information, averages, and estimates contained in this analysis are derived from the most accurate, readily available data. Quantifications are limited and vary because this analysis is national in scope.

The potentially affected area is limited to NFS lands, which comprise approximately 193 million acres (fig. 1). This small portion may include lands near aquatic environments containing threatened, endangered, candidate, or sensitive species. The provisions contained in this EA neither alter nor diminish Forest Service responsibilities under the Endangered Species Act of 1973 (ESA) (U.S. Congress 1973).

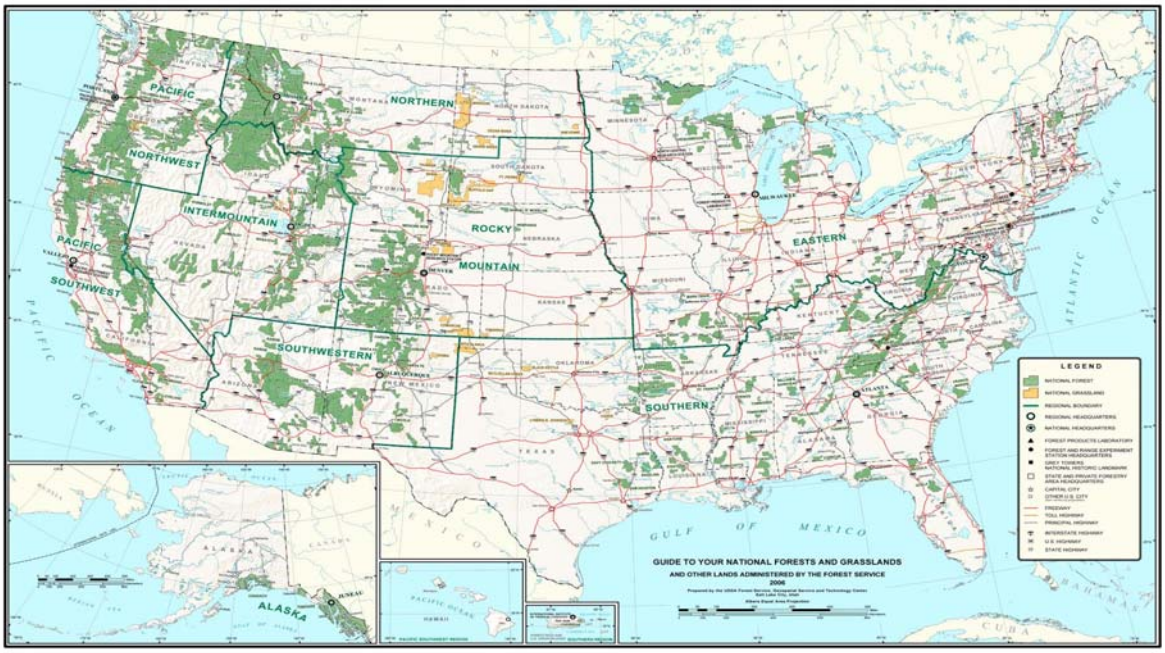

Figure1. Map of National Forest System lands.

Project Record

This analysis incorporates by reference its Project Record, which contains specialist reports and other technical documentation used in disclosing the effects discussed in the analysis. Regulations require that EAs shall be analytical rather than encyclopedic and that EAs shall provide enough supporting information to demonstrate a reasoned consideration of the environmental impacts of the alternatives, without repeating detailed analysis and information available elsewhere (40 CFR 1500.4). The Project Record is available for review at the National Interagency Fire Center (NIFC), located in Boise, ID. This environmental assessment and cited references are available on the web at http://www.fs.fed.us/fire/retardant/index.html.

Purpose and Need for Action

Because a limited number of effective firefighting tools exist, it is essential that firefighters are able to utilize every available means—including retardant—to fight wildland fires[1]. All firefighting tools help contain and control fires, as well as prevent damage to human life, property, and valuable natural resources.

The purpose and need for the Proposed Action is to allow the Forest Service to maintain the ability to rapidly reduce wildfire intensities and rates of spread until ground forces can safely take suppression action and throughout the duration of an incident without harming fish and aquatic habitat. High fire intensities and rates of spread greatly reduce the ability of ground-based firefighters to fight wildland fires directly and safely. In addition, the remote nature of many wildland fires can delay the deployment of ground forces for suppression. Firefighters need the ability to quickly reduce rates of spread and intensities of wildland fires, often in remote locations, and to do so until ground forces can safely take suppression action or until a wildfire is contained or controlled.

Background

Fire retardant, which is approximately 85 percent water, slows the rate of fire spread by cooling and coating the fuels, robbing the fire of oxygen, and slowing the rate of fuel combustion with inorganic salts that change how the fire burns. Retardant is typically applied to fuels in front of an advancing fire, not directly to the fire. When determined to be an appropriate suppression tactic, retardant may be applied to any type of landscape experiencing wildfire: from the low-lying desert ecosystems through the oak woodlands and into the high alpine forests. Most retardant is applied in the Western United States; it is rarely used in the Northeast, and only occasionally in the Midwest. Retardant is periodically used in the Southeast depending on the severity of the fire season.

1 Any fire occurring on the wildlands, regardless of ignition source, damages, or benefits.

Most retardant delivery occurs on ridge tops and adjacent to human-caused or natural fire breaks, such as roads, meadows, and rock outcrops. Occasionally, retardant is applied adjacent to aquatic environments that are being used as a natural fire break. Applying retardant adjacent to these human-caused or natural fire breaks enhances the effectiveness of fire breaks by widening the fire break, such as may be the case, in applying adjacent to aquatic environments. Retardant delivery to aquatic systems is limited because aquatic habitats are relatively small linear or polygon shapes in a larger terrestrial landscape. Retardant delivery to aquatic habitats is also limited because pilots have been instructed to avoid known bodies of water and maintain communication with Resource Advisors, scouts, and others through the Incident Commander on a fire event. Retardant may also be applied if firefighters, public safety, or structures are threatened and the use of retardant is reasonably expected to alleviate the threat.

Retardant is normally stored and mixed at the airtanker base, or in some instances, on site near a fire incident. Containment and treatment systems are required for retardant loading pits, mixing and pump areas, storage tanks, areas where retardant deliveries are received, aircraft maintenance areas, and where loaded airtankers are staged for dispatch (National Interagency Aviation Council 2007). When retardant is mixed at the incident site, precautions include establishing reload sites to manage retardant in portable tanks (National Interagency Fire Center 2007b).

In 1930, the Forest Service began aerial application of water to suppress fires. These early efforts were not as successful as hoped because the air turbulence created by the aircraft caused most of the water to drift off course and evaporate before reaching the fire on the ground. Firefighting agencies conducted studies to determine how to increase the effectiveness of aerial application of liquid to fight fires.

By 1955, land management agencies were using chemical retardants to fight fires, and they found that adding sodium calcium borate to the mixture held the retardant together so that loss due to air turbulence was significantly reduced and more retardant reached the fire on the ground. However, sodium calcium borate is corrosive to airplane tanks and to retardant-mixing equipment; also, it forms lumps, separates, and is a soil-sterilizing agent.

In 1963, manufacturers introduced fertilizer-based retardants containing diammonium phosphate, ammonium phosphate, and ammonium sulfate, and agencies began using these retardant solutions to fight fires. The industry continues to manufacture retardant from ingredients used in agricultural fertilizers today.

Current retardant formulations are primarily inorganic fertilizers, the active compound being ammonia sulfate, or ammonia polyphosphates, most commonly the latter (Dennis 1969). Although retardant is approximately 85 percent water, the ammonia compounds constitute about 60 to 90 percent of the remainder of the product. The other ingredients include thickeners, such as guar gum and attupulgite clay, dyes, and corrosion inhibitors (Johnson and Sanders 1977; Pattle Delamore Partners 1996). The ammonia salt causes the solution to adhere to vegetation and other surfaces; this stickiness makes the solution effective in retarding the advance of fire (Johansen and Dieterich 1971). Corrosion inhibitors are needed to minimize the deterioration of retardant tank structures and aircraft, which contributes to flight safety (Raybould and others 1995). Previous retardant formulas contained sodium ferrocyanide[2] as a corrosion inhibitor. It was found that under certain conditions, sodium ferrocyanide poses greater toxicity to aquatic species and aquatic environments than retardant solutions without this agent (Little and Calfee 2000).

A full understanding about how retardant chemical components interacted with various elements of the environment was generally lacking during early use of the materials. Over the past several years, the wildland firefighting agencies have conducted more monitoring and review of the environmental and safety aspects of retardant use (Labat-Anderson 1994a; Carmichael 1992; Finger 1997; Krehbiel 1992; Van Meter and Hardy 1975). Due to fish kills that occurred when retardant containing sodium ferrocyanide accidentally entered streams and lakes during fire incidents (Carmichael 1992; Krehbiel 1992; Norris and others 1991), the Forest Service contracted with the Columbia Environmental Research Center (CERC) of the U.S. Geological Survey (USGS) to perform additional research on the chemical reaction of sodium ferrocyanide in water solutions exposed to ultraviolet radiation as it pertained to retardant use.

The CERC report (Little and Calfee 2000) spurred a review of procedures used by the Forest Service, Bureau of Land Management (BLM), National Park Service (NPS), and Fish and Wildlife Service (FWS) during aerial firefighting. As a result of these studies, the *Guidelines for Aerial Delivery of Retardant or Foam near Waterways* (U.S. Forest Service and others 2000) were established as interim guidelines in April 2000. Due to the potential increased toxicity, the Forest Service has not accepted for contract or purchased retardants that contain sodium ferrocyanide since 2005 (U.S. Forest Service 2000a; 2002). The Forest Service intends to discontinue the use of retardants containing sodium ferrocyanide after the 2007 fire season.

The Forest Service administers national long-term retardant contracts that are used by other Federal land management agencies. It is not possible to determine how much retardant is applied only to NFS lands because information on the use of retardant is tracked by individual fire incidents, each of which may include public lands involving various Federal and State land management agencies. The amount of retardant referenced in this section represents the total retardant usage in the United States for all Federal and State agencies using retardant purchased through the national contracts managed by the Forest Service at NIFC.

[2] Sodium ferrocyanide is a complex cyanide in which cyanide ions are bound to metal ions, such a ferrous iron. The odorless, yellow powder has a slightly toxic hazard rating in Dangerous Properties of Industrial Materials (ERM-New England, Inc. 1987). It has low toxicity to humans, and the Food and Drug Administration has approved it for use as an anti-caking agent in table salt (Food and Drug Administration 2000).

Some of the most destructive fire seasons in the United States in 50 years have occurred beginning with the 2000 fire season. In the 2006 fire season alone, wildfires burned more than 9.87 million acres throughout the nation, which includes Federal, State, and private lands that were reported. During the 2006 fire season, approximately 31.3 million gallons of retardant were applied covering roughly 26,600 acres, or less than 0.3 percent of the 9.87 million acres affected by wildland fires (U.S. Forest Service 2006). As of August 20, 2007, 6,470,000 acres have burned during this current fire season.

From 2000 to 2006, wildland fires burned a total of 10.7 million acres of NFS lands (fig. 2). Although no records are kept or maintained for retardant use on NFS lands only, it is reasonable to assume that the same percentage on average would apply. Therefore, it is expected that during a fire season, retardant would be applied to less than 0.3 percent of the lands affected by wildfire. For example, in 2006, 2.04 million acres of NFS lands were burned as a result of wildland fires. It is, therefore, assumed that retardant was applied to approximately 6,000 acres on NFS lands.

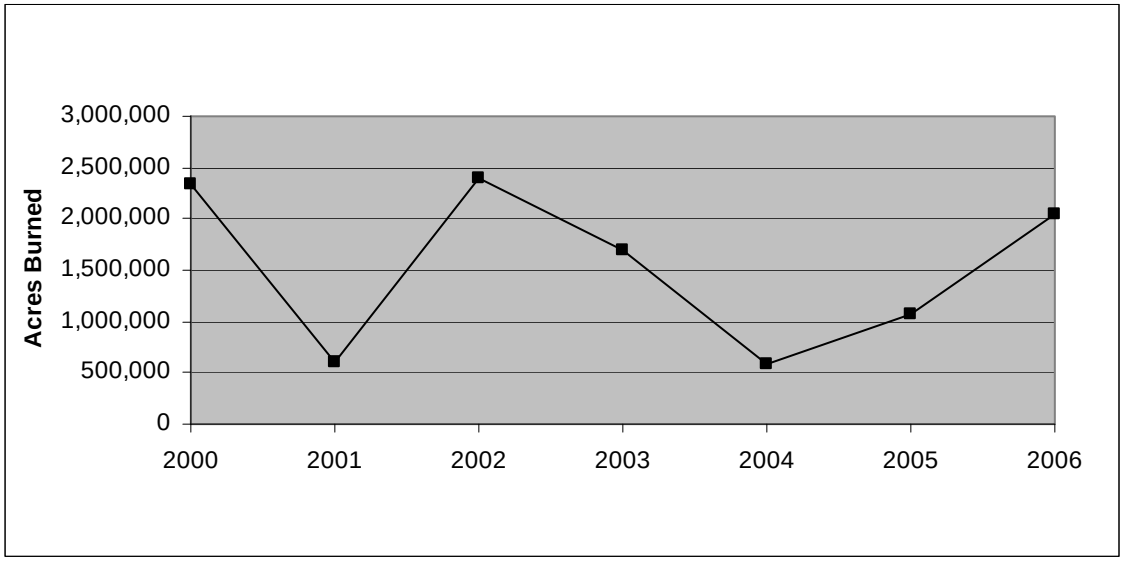

Figure 2. Wildland fires on National Forest System lands, 2000-2006 (compiled from National Interagency Fire Center 2006 data).

Proposed Action

The Forest Service proposes to continue the nationwide aerial application of fire retardant to fight fires on NFS lands. The Proposed Action would adopt the current interim *Guidelines for Aerial Delivery of Retardant or Foam near Waterways* (U.S. Forest Service and others 2000) (see page 8 of this document) as permanent. The guidelines, herein referred to as the 2000 Guidelines, define a waterway as any body of water including lakes, rivers, streams, and ponds whether or not they contain aquatic life. This is broadly interpreted to include swamps, marshes, and other wetlands. The 2000 Guidelines, established by the Forest Service, BLM, NPS, and FWS, were implemented to prevent the aerial application of fire retardant into waterways.

This Proposed Action will not result in a requirement to apply retardant, nor does it compel the use of retardant at a later time or place. The Proposed Action does allow the Incident Commanders and fire managers to use retardant according to the 2000 Guidelines.

Decision Framework

The deciding official for this proposal is the Chief of the Forest Service. Based on this EA and information contained in the Project Record, the Chief will decide whether to implement the action as proposed, or as modified in an alternative, including any mitigation measures. As part of that decision, the Chief will determine if a Finding of No Significant Impact will be prepared and the decision documented in a Decision Notice or if preparation of an EIS is required.

Public Involvement

Scoping is defined in 40 CFR 1501.7, as "…an early and open process for determining the scope of issues to be addressed…" As part of the formal scoping process, a July 25, 2006, letter requesting comments was sent to various Federal and State agencies, non-governmental organizations, and individuals. A public forum was established on the internet for the public to discuss and exchange ideas relating to the Proposed Action. The Forest Service also contacted other Federal and State fire organizations for input.

On July 28, 2006, a notice was published in the Federal Register indicating the intention of the Forest Service to prepare this EA and initiating the scoping comment period. As a result of this request for comment, 17 letters were received. Eight letters were from individuals or representatives of businesses; six were from special interest groups; two were from Native American tribal governments; and one letter was received from a federal agency's regional office. These letters were reviewed for issues and comments on the Proposed Action. All comments received during the formal comment period are part of the Project Record.

In addition to the formal scoping process, the Forest Service has been involved in identifying the issues associated with the aerial application of fire retardant for many years. An interagency group, consisting of the Forest Service, BLM, NPS, and FWS, worked with other involved Federal agencies such as the Environmental Protection Agency and the Council on Environmental Quality throughout April 2000 (U.S. Forest Service and others 2000).

Issues

An issue is a point of disagreement, debate, or dispute with a proposed action based on some anticipated effect. Significant issues must have a cause and corresponding effect relationship with the proposed action. Potential issues are collected and screened to ascertain which issues are significant to the proposed action within the context of NEPA (40 CFR 1501.7(a)(3)). Significant issues are used to develop alternatives to the proposed action. Significant issues are those that meet the following criteria:

- Within the scope of the analysis,
- Not decided by law, regulation, or previous decision,
- Related to the decision, and
- Amenable to scientific analysis rather than conjecture.

After screening the comments raised during scoping, none satisfied the criteria for a significant issue. The evaluation of issues is documented in the Project Record (Comment Analysis). Concerns identified during the scoping process that were evaluated but not used to develop alternatives are included in the comment analysis. Briefly, these concerns include:

- *Aquatic Environments:* In certain rare situations, when retardant comes in contact with water, the retardant chemicals can be toxic to aquatic wildlife and temporarily alter the water quality. Under the Proposed Action, contact of retardant with water from aerial delivery would be avoided, with the exception of those situations described in the 2000 Guidelines (see page 8). The exceptions were established so that Incident Commanders can balance a potential risk to the environment with potential public and firefighter safety.
- *Cultural Resources:* Cultural resources, such as petroglyphs, historic structures, traditional Native American gathering areas, may be affected by the aerial application of fire retardant. Based on the analysis, it has been determined that potential effects have been well documented and are best mitigated at the incident level.
- *Violations of Federal, State, and local laws*: No specific law was cited during public comment. Activities associated with the Proposed Action are subject to and would not violate Federal, State, or local laws.
- *Impacts to Upland Vegetation*: The use of retardant has no measurable impacts on upland vegetation. It is assumed the acres that may be treated with retardant during a wildland fire would otherwise be affected by the fire.
- *Decisions about Wildfire Suppression and Reductions in Hazardous Fuels*: Many wildland fires can be and are managed, rather than suppressed, to allow fire to perform its natural role in fire-adapted ecosystems. Decisions concerning whether to take suppression action on a specific wildland fire incident are made on a case-by-case basis at the local level, including whether to use retardant. Decisions on whether, where, and how to suppress specific fires are outside the scope of this analysis. Analysis and decisions on hazardous fuels and hazardous fuels reduction are also outside the scope of this analysis.
- *Emergency Retardant Drop*: An additional comment was received on September 11, 2007 concerning an emergency retardant drop on Feather Peak in the John Muir Wilderness Area on the Sierra National Forest. On July 8, 2007, Tanker 55 dropped a load of D-75R retardant on Feather Peak. The pilot made a decision to jettison the load of retardant based on aircraft and crew safety. This type of unforeseen incident is not an aspect of the proposed action.

Chapter 2 Alternatives

Two alternatives were analyzed in detail and are presented in this chapter: the No Action and the Proposed Action Alternatives. The Proposed Action Alternative was developed in response to the Purpose and Need and considered issues identified by the interdisciplinary team during the scoping process. Other possible alternatives were considered but eliminated because the alternatives were outside the scope of the analysis or did not meet the purpose and need for the Proposed Action. All alternatives are listed below.

Alternatives Considered in Detail

Alternative 1 (No Action Alternative): Discontinue the Aerial Application of Fire Retardants on National Forest Service Lands.

Under this alternative, the Forest Service would discontinue the aerial application of fire retardant for those fires occurring on NFS lands. Ground-based application of foams, water enhancers (gels), and water (including aerial application of water only) would continue to be available for use by Incident Commanders as suppression tools. This alternative would not prohibit the aerial application of fire retardant on lands owned or administered by State, private, or other Federal entities.

Alternative 2 (Proposed Action): Continue the Nationwide Aerial Application of Fire Retardant on National Forest System Lands Using the 2000 Guidelines.

Under the Proposed Action, the Forest Service would continue aerial application of retardant and permanently adopt the 2000 Guidelines (U.S. Forest Service and others 2000). The *Guidelines for Aerial Delivery of Retardant or Foam near Waterways* follow:

Avoid aerial application of retardant or foam within 300 feet of waterways. These guidelines do not require the helicopter or airtanker pilot-in-command to fly in such a way as to endanger his or her aircraft, other aircraft, or structures or compromise ground personnel safety.

Guidance for pilots: To meet the 300-foot buffer zone guideline, implement the following:

- *Medium/Heavy Airtankers:* When approaching a waterway visible to the pilot, the pilot shall terminate the application of retardant approximately 300 feet before reaching the waterway. When flying over a waterway, pilots shall wait one second after crossing the far bank or shore of a waterway before applying retardant. Pilots shall make adjustments for airspeed and ambient conditions such as wind to avoid the application of retardant within the 300-foot buffer zone.

- *Single Engine Airtankers:* When approaching a waterway visible to the pilot, the pilot shall terminate application of retardant or foam approximately 300 feet before reaching the waterway. When flying over a waterway, the pilot shall not begin application of foam or retardant until 300 feet after crossing the far bank or shore. The pilot shall make adjustments for airspeed and ambient conditions such as wind to avoid the application of retardant within the 300-foot buffer zone.

- *Helicopters:* When approaching a waterway visible to the pilot, the pilot shall terminate the application of retardant or foams 300 feet before reaching the waterway. When flying over a waterway, pilots shall wait five seconds after crossing the far bank or shore before applying the retardant or foam. Pilots shall make adjustments for airspeed and ambient conditions such as wind to avoid the application of retardant or foam within the 300-foot buffer zone.

Exceptions:

- When alternative line construction tactics are not available due to terrain constraints, congested area, life and property concerns or lack of ground personnel, it is acceptable to anchor the foam or retardant application to the waterway. When anchoring a retardant or foam line to a waterway, use the most accurate method of delivery in order to minimize placement of retardant or foam in the waterway (e.g., a helicopter rather than a heavy airtanker).

- Deviations from these guidelines are acceptable when life or property is threatened and the use of retardant or foam can be reasonably expected to alleviate the threat.

- When potential damage to natural resources outweighs possible loss of aquatic life, the unit administrator may approve a deviation from these guidelines.

Threatened and Endangered (T&E) Species:

The following provisions are guidance for complying with the emergency section 7 consultation procedures of the ESA with respect to aquatic species. These provisions do not alter or diminish an action agency's responsibilities under the ESA.

Where aquatic T&E species or their habitats are potentially affected by aerial application of retardant or foam, the following additional procedures apply:

1. As soon as practicable after the aerial application of retardant or foam near waterways, determine whether the aerial application has caused any adverse effects to a T&E species or their habitat. This can be accomplished by the following:

    a. Aerial application of retardant or foam outside 300 feet of a waterway is presumed to avoid adverse effects to aquatic species and no further consultation for aquatic species is necessary.

    b. Aerial application of retardant or foam within 300 feet of a waterway requires that the unit administrator determine whether there have been any adverse effects to T&E species within the waterway.

    These procedures shall be documented in the initial or subsequent fire reports.

2. If there were no adverse effects to aquatic T&E species or their habitats, there is no additional requirement to consult on aquatic species with Fish and Wildlife Service (FWS) or National Marine Fisheries Service (NMFS).

3. If the action agency determines that there were adverse effects on T&E species or their habitats then the action agency must consult with FWS and NMFS, as required by 50 CFR 402.05 (Emergencies). Procedures for emergency consultation are described in the Interagency Consultation Handbook, Chapter 8 (March 1998) [U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998]. In the case of a long duration incident, emergency consultation should be initiated as soon as practical during the event. Otherwise, post-event consultation is appropriate. The initiation of the consultation is the responsibility of the unit administrator.

   Each agency will be responsible for insuring that the appropriate guides and training manuals reflect these guidelines.

Alternatives Considered But Not Evaluated in Detail

Several alternatives were suggested during the public scoping process and were examined by the Interdisciplinary Team. The alternatives examined but not evaluated in detail include the following:

Alternative A: Allow Use of Fire Retardant in an Unrestricted Manner.

While this alternative would maintain the ability to rapidly reduce wildfire intensities while slowing the spread of wildfire and protecting firefighters, it would not meet the need to protect aquatic environments. This alternative was not considered for detailed analysis because it would be contrary to Forest Service policy and the 2000 Guidelines established through interagency coordination and agreement.

Alternative B: Prohibit Aerial Application of Retardant in Areas Within One-Quarter Mile from Waterways, in Wilderness and Wilderness Study Areas, and in Other Withdrawn Land Allocation Areas.

This alternative was not considered for detailed analysis because it would unreasonably limit an Incident Commander's ability to be responsive to specific situations. An absolute restriction of aerial retardant could prohibit fire managers from responding quickly when a fire is inaccessible to ground-based suppression or other suppression forces are otherwise unavailable. This alternative would not allow Incident Commanders to protect private property adjacent to, or within one-quarter mile of waterways. Therefore, this alternative does not meet the purpose and need for the Proposed Action.

Alternative C: Use Water Only for Aerial Suppression of Fires.

This alternative was not considered for detailed analysis as a stand-alone alternative, because aerial application of water only is part of the No Action Alternative. As previously discussed, air turbulence caused by aircraft causes most of the water to drift and evaporate before reaching the ground. Therefore, this alternative does not meet the purpose and need to reduce wildfire intensities and rate of spread.

Alternative D: Restrict the Use of Retardant to Those Exceptional Situations Where the Benefits Far Outweigh the Risks.

This alternative was not considered for detailed analysis because the Incident Commanders already take into account the risk of using retardant. The 2000 Guidelines were established to address the risks of aerial applied retardant near water, and when the benefits of that use outweigh those risks. It would be speculative to determine when benefits would "far" outweigh the risks. As each wildland fire incident is different, it would be impossible to develop detailed site-specific guidance for evaluating and weighing various risks. A risk at one location may be of different importance than the same risk at a different location. This alternative can not be analyzed effectively due to its subjective nature.

Alternative E: Do Not Use Retardant until a New, Less Toxic Retardant is Developed.

In effect, this delay alternative is embodied in the No Action Alternative. The No Action Alternative considers the use of no retardants that are aerially applied. The Proposed Action considers the effects of allowing aerial application of retardants that do not contain sodium ferrocyanide. This analysis and subsequent decision would not prohibit a future decision on the use of new products. New products proposed for use in fire suppression are evaluated using a separate process for determining applicability. For this information on qualifying a product for use as a fire retardant, see the evaluation criteria described on the Forest Service Fire website (http://www.fs.fed.us/rm/fire/wfcs/index.htm#qpl).

Chapter 3 Environmental Consequences

This chapter provides an overview of the affected environment, including specific resource components that would be affected by the alternatives, to establish a baseline for analysis. Additionally, this chapter presents the scientific and analytic basis for a comparison of the alternatives and describes the probable effects of each alternative on selected environmental resources. Resource specialist reports, contained in the Project Record, describe the affected environment in detail, and include the programmatic analyses of the environmental effects of both alternatives. The averages, estimates, and other information contained in this EA and the Project Record are derived from the most accurate, readily available data. Because this EA is national in scope, the predicted impacts may vary by site-specific factors.

Soils

There are numerous types of soils throughout the National Forest System, any of which may support vegetation that could burn during a wildfire. Most National Forest units have soils maps, which may be used to identify the location of soils that may be highly susceptible to the effects of a wildfire.

No Action Alternative:

Under the No Action Alternative, there would be no direct, indirect, or cumulative impacts to soils from the aerial application of fire retardant. Remaining fire suppression tactics, including firelines constructed by hand or with mechanical equipment, back burning, and the use of water (both ground-based and aerial application), would likely be increased to compensate for the loss of retardant use. However, it would be highly speculative to quantify the increase in the amount of acres disturbed by these activities associated with wildfire suppression, as each wildfire is a unique event based on vegetation, topography, terrain, weather conditions, geographic area, and so forth.

The effects of wildfire on soils would still occur and would likely increase as an indirect effect of discontinuing the use of aerial delivery of fire retardant. Absent the use of aerial delivery of retardant for suppression of wildfires, it is reasonable to assume that more acres are likely to be affected by wildfire than if retardant were aerially applied. The effects of wildfire, depending on its severity, intensity, and subsequent seasonal weather events, may lead to alteration of soil structure, reduction in productivity, and loss of top soil through erosion. (See Hydrology and Soils Specialist Report.)

Proposed Action Alternative:

A test of retardant effects on prairie and mountain soils resulted in an increase in biomass, mostly grasses, over the first growing season, but resulted in no measurable effect on woody species (Larson and Newton 1996). Tests on soil plots within a retardant drop zone in the Australian heathlands up to 12 months after application found a decrease in pH and a 5-fold increase in phosphorous. Increases in nitrogen, carbon, and sulfur were noted immediately after application, but all decreased to background rates within a few months. Application rates of retardant used for tests approximated rates used for fire control (Hopmans and Bickford 2003).

Cumulative Effects:

Cumulative effects are the impacts on the environment resulting from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of the entity or person performing the activity. Cumulative impacts can result from individually minor but collectively significant actions occurring over time (40 CFR 1508.7).

The increases in soil nutrients described above are temporary and localized to the retardant drop zone. There are no other actions identified at this programmatic level that contribute cumulatively to the effects of fire retardant on soils.

Air Quality

There would be no measurable effect of aerial delivery of retardant on air quality because retardant does not remain in the air long enough to be transported outside the immediate affected area. Assuming under the no-action alternative that more acres would burn, more potential exists for smoke in the air, but any attempt to quantify the increase in smoke would be speculative.

Aquatic Environments

The affected environment includes all waterways, as defined by the 2000 Guidelines (see page 8), within and flowing from NFS lands. These waterways include lakes, rivers, seeps, flowing streams, and ponds that are seasonal or perennial, whether or not they support aquatic life including, threatened, endangered, proposed, and Forest Service sensitive species. The affected environment is considered to be subject to a potential wildfire and, thus, has the potential to be affected by the No Action and Proposed Action Alternatives.

No Action Alternative:

Under the No Action Alternative, there would be no direct, indirect, or cumulative impacts to aquatic environments, species, or habitats from the aerial application of fire retardant. Remaining fire suppression tactics, including firelines constructed by hand or with mechanical equipment, back burning, and the use of water (both ground-based and aerial application), would likely be increased to compensate for the loss of retardant use. However, it would be highly speculative to quantify the increase in the amount of acres affected by these activities associated with wildfire suppression, as each wildfire is a unique event based on vegetation, topography, terrain, weather conditions, geographic area, and so forth. (See Aquatics Report and Biological Assessment.)

The effects of wildfire on aquatic environments would still occur and would likely increase as an indirect effect of discontinuing the use of aerial delivery of fire retardant. Without the use of aerially applied retardant to reduce wildfire intensity and slow the rate of spread, wildfires would likely increase in size, intensity, and severity. Such increases would likely extend to the effects on aquatic environments. The effects of wildfire, depending on its severity, intensity, and subsequent seasonal weather events, may lead to alteration of soil structure and reduction in productivity, loss of top soil, bank erosion of alluvial streams, and a reduction of habitat for aquatic life in streams. In extreme cases, indirect effects could include (1) flooding of valley bottoms, (2) transport of excessive sediment loads to downstream impoundments, diversions, and water-treatment facilities, and (3) exceeded water quality thresholds for beneficial uses on designated streams (Gallaher and Koch 2004; Neary and others 2005).

Proposed Action Alternative:

There are two facets to the *Guidelines for Aerial Delivery of Fire Retardant or Foam near Waterways* (U.S. Forest Service and others 2000) in the Proposed Action: First, the guidelines direct pilots to avoid waterways and maintain a minimum 300-foot buffer adjacent to waterways when applying fire retardants aerially. Second, the guidelines include provisions for deviating from the guidelines under certain circumstances (see Alternative 2 description in Chapter 2).

Avoidance and Buffer

Following the guidelines in the Proposed Action, aerial delivery of retardant to a waterway would normally not occur. The practice of avoidance in the guidelines includes a minimum 300-foot buffer to guard against wind drift and surface transport of retardant into a waterway. During wildland fire incidents in which fire retardants have been applied adjacent to a waterway or riparian area, researchers measured only minor amounts of retardant in the waterway. Research concluded that a buffer zone as small as 3 meters wide would virtually eliminate retardant from entering waterways from the riparian zone (Norris and others 1991). Accordingly, the practice of avoidance and buffering adjacent to waterways will have no effect on aquatic environments.

Deviation from Guidelines

The guidelines state that when alternative line construction tactics are not available due to terrain constraints, congested area, life and property concerns, or lack of ground personnel, it is acceptable to anchor the retardant application to the waterway. The unit administrator may also approve deviation from the guidelines when potential damage to natural resources outweighs possible loss of aquatic life. In either of these scenarios, deviation from the guidelines would normally involve anchoring a line of retardant to a waterway.

Anchoring a line of retardant is connecting the line to a landscape feature (in this case, a waterway) of sufficient size to ensure that the fire will not cross it. A waterway large enough to be suitable for anchoring would have a high probability of diluting initial concentrations of retardant as well as providing room for fish to avoid a contaminated area. Anchoring also means retardant would be dropped up to, but not necessarily in, a waterway. The 2000 Guidelines direct use of the most accurate delivery method possible (usually a helicopter) for anchoring to a waterway, which will minimize but not eliminate the possibility of retardant entering a waterway.

The effects of anchoring an aerial application of retardant adjacent to a waterway would be mostly confined to the immediate drop zone (Norris and others 1991). Effects on aquatic species would result from retardant dropped directly in the waterway and within 3 meters of the waters edge.

Should retardant come in contact with an aquatic habitat, several factors determine whether an aquatic organism would be affected by levels of the ammonia compounds: (1) avoidance of the contaminated area, (2) time exposed to the toxin, (3) water quality, (4) quantity of retardant that comes in contact with freshwater, (5) type of water body, and (6) size of water body (Norris and others 1991; Van Meter and Hardy 1975). The toxicity or persistence of retardant compounds in water is somewhat dependent on water chemistry, flow velocity, and turbulence (Van Meter and Hardy 1975; U.S. Environmental Protection Agency 1999a, 1999b). However, within 24 hours after the initial application of retardant, nitrate and soluble organic nitrogen are the primary chemical components remaining in the stream. These chemicals are considered low in toxicity and are natural components of the aquatic ecosystem (Norris and others 1991).

According to Norris and others (1983), the magnitude of the mortality of aquatic organisms and the distance over which it occurs also varies with three elements:

1. The characteristics of the retardant application include orientation of the line of flight to the stream, size of load dropped, number of loads dropped, and the timing and placement of subsequent loads relative to the first load.

2. Several characteristics of the application zone determine the initial concentration of retardant in the stream and the length of the fish mortality zone. Narrow, deep streams have a much lower initial concentration (therefore a shorter mortality zone) than shallow, wide streams. The more dense the vegetation canopy, the less chemical that falls directly on the stream and the smaller the mortality zone. These site characteristics can be recognized and retardant applications adjusted accordingly to minimize the size of the mortality zone.

3. Streamflow characteristics influence the length of the mortality zone based on the degree and speed of mixing and dilution of retardant with downstream travel. Simulation studies indicate that streams with a smooth channel have a longer mortality zone than those with many pools and riffles; an equal streambed gradient is assumed. Pools and riffles cause the peak of retardant concentration to spread out, thus reducing the magnitude of exposure. Increased stream discharge with distance downstream, which occurs as a result of ground-water inflow and streamflow contribution, also is important because the retardant is increasingly diluted.

Resource information is taken into account by Incident Commanders, based upon advice and information from assigned Resource Advisors with local area knowledge, when considering the balance of risks, before making the decision to invoke an exception to the 2000 Guidelines. (National Interagency Fire Center 2007a). According to the 2000 Guidelines, the Incident Commander has the authority to employ the use of retardants near waterways if he or she deems that the risk to life, property, or other natural resources is greater than the risk to the known aquatic habitat or a specific species. If retardant does come in contact with an aquatic environment, intentionally or accidentally, an evaluation of the effects is made as soon as it can be completed safely. If retardant ever does reach a waterway, and there are adverse effects to a federally listed species, the Agency would enter into emergency Section 7 consultation, as required by ESA and as stated in the 2000 Guidelines.

Since the 2000 Guidelines were established, there have been no recorded incidents on NFS lands where an exception was invoked and adverse effects to federally listed species or their habitat resulted. Since the 2000 Guidelines were established, there have been 11 accidents on NFS lands where retardant accidentally came in contact with a waterway. During this same time, there were three documented accidents on other jurisdictions. Of these 14 accidents, only three resulted in fish mortality, including Federally listed fish species. The most serious of these three accidents did not involve aerial application of retardant, but rather a vehicle accident in which retardant concentrate was spilled directly into a creek.

Agency records indicate an average of approximately 16,000 aerial retardant drops per year since the 2000 Guidelines were established. Based on the low frequency of 14 accidents over 8 years and approximately 128,000 aerial drops, the likelihood of retardant entering a waterway is small.

The United States Environmental Protection Agency (EPA) has concluded that proper application of fire retardants, following the 2000 Guidelines and using only Forest Service approved products, should avoid or minimize any adverse effects on aquatic environments. The EPA has stated that the use of fire retardants in this manner does not require a National Pollutant Discharge Elimination System (NPDES) permit under the Clean Water Act (33 U.S.C. 1251 et seq.) and implementing regulations at 40 CFR 122.27 (U.S. Environmental Protection Agency 2003).

Under the proposed action, the probability of adverse effects of the aerial application of fire retardant use to aquatic and terrestrial species and their habitats is small. However, because there is a possibility that the continued aerial application of fire retardant may result in the contact of retardant to a waterway that contains a Threatened, Endangered or Proposed (TEP) species, affect other TEP species, or affect designated critical habitat, a Likely to Adversely Affect determination has been made at this programmatic level.

Cumulative Effects:

As described previously, direct and indirect adverse effects of the Proposed Action on aquatic species and their habitats are possible, but measurable effects at this programmatic scale would be highly speculative. Under the exceptions in the 2000 Guidelines, the effects to aquatic habitat, of an aerial retardant drop adjacent to a waterway would be limited to the immediate drop zone for a period of no more than 24 hours. Retardant transported from a drop zone by moving water would be diluted, rendering any potential for accumulation of effects from other actions off site unlikely. Further, retardant chemicals break down into low toxicity components within 24 hours, again, decreasing the potential accumulation of effects over time (Norris and others 1991). Because the 2000 Guidelines apply to the other Federal firefighting agencies, it can be expected that the effects of aerial application of fire retardant on non-NFS lands would likewise be localized and not contribute cumulatively to the effects of Forest Service aerial retardant applications.

Therefore, the effects of the Proposed Action Alternative are not cumulative to the effects of other past, present, or reasonably foreseeable actions.

Upland Ecosystems

The Forest Service is responsible for managing diverse landscapes—from grasslands and high deserts to coniferous and deciduous forests and alpine mountaintops. These landscapes provide scenery, wildlife habitats, grazing, timber products, recreation, and other benefits. All NFS lands within the United States are considered in the affected environment.

No Action Alternative:

Most of landscapes and respective vegetative, wildlife, and soil components have developed the ability to adapt to fire disturbances. However, changes in the vegetation and fuels, vital habitats for wildlife, the increasing number of developments in the wildland-urban interface, and other values are driving the need to protect resources from large destructive wildland fires (Hardy and Bunnell 2000; U.S. Forest Service 2000b).

Vegetation in upland ecosystems provides habitat for a variety of animal and bird species. Fire and fire suppression activities can change vegetation and habitat type, and different species may move into or out of an area. Fire does not kill significant numbers of animal populations (Labat-Anderson 1994a; Labat Environmental 2007). Animals escape destruction during a fire by avoidance: flying, running away, going underground, or hiding in rock crevasses. Although some individuals may die from a fire, the major effect on wildlife from fire is likely the habitat changes that occur across the landscape (Smith 2000).

Under the No Action Alternative, all suppression tactics would continue, with the exception of retardant applied through aerial delivery. As a result of the reduced ability to rapidly reduce wildfire intensities while slowing the spread of a wildfire through aerial application of fire retardant, there would likely be an overall increase in the size of wildfires that would otherwise receive retardant. As a result of these larger fires, ground-disturbing activities (e.g., fireline construction and mop-up) would increase accordingly.

Proposed Action Alternative:

The Proposed Action would allow Incident Commanders the option of using aerial retardant. Potential vegetation and habitat loss in the upland ecosystems, due to the effects of fire, could be reduced. The Proposed Action would not compel an Incident Commander to utilize the aerial application of retardant to suppress wildland fires.

When retardant has been applied, studies show that fire avoidance behaviors minimize the risks of injury or retardant application to wildlife. Also, ingestion of retardant-coated food carries a low risk of toxicity (Labat-Anderson 1994a; Labat Environmental 2007). Any risks that exist are minor, small in scale, and unlikely to affect more than a few individuals at a time (Labat-Anderson 1994a; Labat Environmental 2007). Tests on soil plots within a retardant drop zone in the Australian heathlands up to 12 months after application found a decrease in pH and a 5-fold increase in phosphorous. Increases in nitrogen, carbon, and sulfur were noted immediately after application, but all decreased to background rates within a few months. Application rates of retardant used for tests approximated rates used for fire control (Hopmans and Bickford 2003). Samples of invertebrate numbers and diversity across the test plots before and after retardant application showed no significant difference. Likewise, vegetation numbers, diversity, and growth did not show a strong effect from retardant application.

The application of retardant may have a beneficial effect on vegetation because the main ingredient of retardant is agricultural fertilizer (Labat-Anderson 1994b; Labat Environmental 2007). However, because the area treated with retardant is small compared with the total area burned in a fire, it is assumed that retardant contributes less nitrogen to the system than the fire. Accumulations of nutrients are unlikely.

Cumulative Effects:

As described previously in this section, effects of the Proposed Action on upland ecosystems are isolated and of short duration and would not overlap with effects of a retardant drop from a different incident, in the same area, during the same fire year. Therefore, the effects of the Proposed Action Alternative on upland ecosystems are not cumulative to effects of other past, present, or reasonably foreseeable future actions.

Cultural Resources

The term, cultural resources, as used in this EA includes all resources referred to as cultural, historical, archaeological, ethnographic, and tribal or traditional. Cultural resources, which represent past human activities or uses, are considered irreplaceable and nonrenewable. Cultural resources represent important cultural values and are of special concern to the public and of great concern to specific ethnic or tribal groups.

As manager of almost 200 million acres of public land, the Forest Service is entrusted with the stewardship of a large share of the nation's historical and cultural heritage. National Forests contain many of the nation's best preserved heritage sites in some of the least disturbed natural settings with more than 320,000 sites currently inventoried on NFS lands. Conservative estimates of the number of archaeological and historic sites that may exist on Forest Service holdings range from 1.5 to 2.0 million sites. The Forest Service currently has 3,300 formal listings on the National Register of Historic Places, 19 National Historic Landmarks, and 1 World Heritage site. A comprehensive array of laws, executive orders, Federal regulations, and Forest Service policy and direction provides the basis for the protection of cultural resources.

As a rule, any activity that causes ground disturbance (disturbance to the soil matrix containing the cultural resource) has the potential to adversely affect cultural resources, both directly and indirectly. Ground disturbance may cause changes to the physical attributes of the resource that, in turn, compromise the integrity of the cultural resource and its context. Its context (the spatial relationship between the various artifacts, features and components of the cultural resource), is what is scientifically studied and interpreted and is the basis for determining the site significance. This effect of ground disturbance is irreparable and considered adverse under the National Historic Preservation Act (U.S. Congress 1966). Even a scientific archaeological excavation has an adverse effect because the integrity and context of the cultural resource are destroyed by removing the artifacts, features, and components.

No Action Alternative:

Under the No Action Alternative, there would be no aerial application of fire retardant, and therefore, no effects to cultural resources from aerial application of fire retardant.

There is potential for some wildfires to become larger if aerial fire retardant is no longer available. Without the ability to reduce wildfire intensities and rates of spread in support of fire suppression forces, the possibility of some cultural resource being burned over would likely increase. High-intensity fires can destroy historic wooden structures and can damage artifacts such as pottery, bone, glass, and mortared structures through exposure to intense heat. However, to say how many or what cultural resource sites might be lost without the availability of fire retardant would be highly speculative.

Proposed Action Alternative:

Under the Proposed Action Alternative, aerial application of fire retardant would be allowed under the 2000 Guidelines.

The aerial application of fire retardants may affect historic properties. The effects will vary according to the nature and age of the properties. Retardants, including the various chemicals contained in retardants, react in different ways to different materials or types of cultural resources. Cultural resources consist of many materials including, but are not limited to, wood, stone, bone, shell, ceramics, glass, and plants. A comprehensive discussion of how the retardant chemicals can react with each of the mentioned materials is contained in the Cultural Resource Specialist Report. What follows is a summary of potential effects to various cultural resources from retardant:

Deterioration

Long-term retardants contain fertilizer salts (ammonium phosphate or ammonium sulfate) that can leave a residue when dry. These salts can attract water and can cause the surface that they are in contact with, to swell and contract. Soluble salts crystallize as water evaporates, causing a great increase in volume. When crystallization occurs within a porous material like wood, bone, shell or some ceramics, it can cause physical damage, such as the spalling of the object's surface, losing any detail present (Society for Historic Archaeology n.d.). Additionally, rapid temperature changes caused by application of retardant to hot rocks may cause spalling of stone and degradation of mortar.

Staining

Retardants containing iron oxide have a high potential for staining raw wood, stone, bone, ceramics, shell and vegetation. Any applied decoration, pigment or other applications (scoring, etching) will be similarly affected. Retardant applications may have very different effects on painted surfaces. In some cases it easily washes off and in others it does not. Materials are a critical consideration—sandstone will absorb the retardant and the ferric oxide will bond to the stone making removal very difficult. Less porous materials, such as slate, may be more easily cleaned. In the case of rock art, especially pictographs, applied pigment designs may be irreversibly altered.

Protein Residues

Aerial retardant applications may present particular problems for the analysis of protein residues on bone and shell tools, ceramics, and ground stone surfaces. Of course it is likely that the retardant would be less detrimental to the residues than would exposure to open flame.

Discussion

As previously discussed, the physical attributes and spatial relationship between various artifacts constitute a site's context. The study of this context contributes to the determination of a site's significance. Aerially applied fire retardant does not disturb the ground, and therefore, does not affect the context of a heritage site. Scientific studies and site interpretations can account for a known site contaminant, such as fire retardant, and still form the basis for determining site significance.

Resource Advisors with local area knowledge are assigned to each large fire incident to ensure compliance with local Land and Resource Management Plans and Fire Management Plans and to provide Incident Commanders with information, analysis, and advice on various areas including archeological, historic, and paleontological resources, as well as other areas or resources that may be of local concern (National Interagency Fire Center 2007a). These resource advisors assist incident commanders in weighing potentially adverse effects of aerial application of fire retardant against potential damage from a wildfire without retardant.

Cumulative Effects:

Cultural resources on National Forest System lands are protected by an array of laws, regulations, and executive orders. The following list highlights relevant protections.

Laws

- Antiquities Act of 1906 (16 U.S.C. 431). Provides for misdemeanor-level penalties.
- Historic Sites Act of 1935 (16 U.S.C. 461). Declares national policy to "preserve for public use historic sites, buildings, and objects of national significance.
- National Historic Preservation Act of 1966 (NHPA) (16 U.S.C. 470). Directs all Federal agencies to take into account effects of their undertakings (actions, financial support, and authorizations) on properties included in or eligible for the National Register.
- The Archeological and Historic Preservation Act of 1974 (AHPA) (16 U.S.C. 469). Provides for the preservation of historical and archaeological data which might be lost or destroyed as the result of the construction of a Federally-authorized dam or other construction activity.
- Archaeological Resources Protection Act of 1979 (ARPA) (16 U.S.C. 47Oaa et seq.). Provides criminal penalties (felony and misdemeanor) and civil penalties for the unauthorized excavation, removal, damage, alteration, defacement, or the attempted unauthorized removal, damage, alteration, or defacement of any archaeological resource, more than 100 years of age, found on public lands or Indian lands.
- Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), (25 U.S.C. 3001). Provides a process for Federal agencies to return certain Native American cultural items to lineal descendants, and culturally affiliated Indian tribes and Native Hawaiian organizations and penalties for noncompliance and illegal trafficking.

Executive Orders

- Executive Order 11593 – Protection and Enhancement of the Cultural Environment, issued May 13, 1971. Directs Federal agencies to inventory cultural resources under their jurisdiction and to nominate to the National Register all federally owned properties that meet the criteria.
- Executive Order 13007 – Indian Sacred Sites, issued May 24, 1996. Directs Federal land management agencies to avoid affecting the physical integrity of Indian sacred sites wherever possible.
- Executive Order 13175 – Consultation and Coordination with Indian Tribal Governments, issued November 6, 2000. Directs Federal agencies to establish regular and meaningful consultation and collaboration with Tribal officials in the development of Federal policies that have Tribal implications.
- Executive Order 13287 – Preserve America, issued March 3, 2003. Establishes Federal policy to provide leadership in preserving America's heritage by actively advancing the protection, enhancement, and contemporary use of the historic properties owned by the Federal government.

Regulations

- 36 CFR part 800 – Protection of Historic Properties. Implements NHPA Section 106 and defines how Federal agencies meet the statutory responsibility to take into account the effects of their undertakings on historic properties.

- 36 CFR part 60 – National Register of Historic Places. Establishes the National Register as a planning tool to help Federal agencies evaluate cultural resources.
- 36 CFR part 296 – Protection of Archaeological Resources Uniform Regulations. Establishes the uniform definitions, standards, and procedures for Federal land managers to follow in providing protection for archaeological resources located on public lands and Indian lands of the United States. Defines the prohibited acts, which include excavating, removing, damaging, or otherwise altering or defacing archaeological remains; and selling, purchasing, exchanging, transporting, or receiving any archaeological resource that was removed from Federal land in violation of ARPA or any other Federal law.
- 43 CFR part 10, Subpart B – Human Remains, Funerary Objects, Sacred Objects, or objects of Cultural Patrimony from Federal or Tribal Lands. Carries out provisions of the Native American Graves Protection and Repatriation Act and pertain to the identification and appropriate disposition of human remains, funerary objects, sacred objects, or objects of cultural patrimony that are in Federal possession or control or in the possession or control of any institution of State or local government receiving Federal funds. The regulations pertain to these objects whether they are inadvertently discovered or excavated intentionally under a permit issued under the authority of the Antiquities Act or ARPA.
- 36 CFR part 79 – Curation of Federally-owned and Administered Archaeological Collections. Establishes definitions, standards, procedures and guidelines for Federal agencies to preserve collections of prehistoric and historic material remains, and associated records recovered under the authority of the Antiquities Act, the Reservoir Salvage Act, NHPA, and ARPA.
- 36 CFR 219.24 – Cultural and Historic Resources. Directs the Forest Service to provide for the identification, protection, interpretation, and management of historic properties on National Forest System lands.

Given the protection afforded by Federal law, regulation, and executive order, there are no other past, present, or reasonably foreseeable future actions that would contribute cumulatively to the effects of fire retardant on cultural resources.

Public Health and Safety

Aerial fire retardant is used to reduce the wildfire intensity and rate of spread. For safety reasons the general public is excluded from the vicinity of wildfire suppression activities. Consequently, the public is not normally exposed to aerial application of fire retardant. Personnel engaged in fire suppression are required to have completed specialized training, which includes procedures for working with aerial fire retardant application. All personnel engaged in fire suppression activities and airtanker base operations must also wear appropriate personal protective equipment (National Interagency Fire Center 2007c).

No Action Alternative:

Under the No Action Alternative, there would be no aerial application of fire retardant on National Forest System lands. Therefore, there would not be any effects on public health or safety from aerial application of fire retardant on National Forest System lands.

Proposed Action Alternative:

Under the Proposed Action Alternative, fire suppression personnel could be exposed to aerially applied fire retardant. However, one airtanker operational principle states, "Persons downrange, but in the flight path of intended retardant drops, should move to a location that will decrease the possibility of being hit with a drop" (National Interagency Fire Center 2007b). Airtanker base personnel involved in mixing retardant from concentrate and those loading retardant into aircraft could also be exposed to retardant. Although excluded from areas where wildfire suppression activities are taking place, risks to members of the general public were also considered.

An assessment of the risks to human health from using fire-fighting chemicals found that fire retardant formulations pose negligible risks to firefighting personnel under typical conditions of exposure (Labat-Anderson 2003). The assessment employs the three principal analytical elements that the National Research Council described and the EPA affirmed as necessary for characterizing the potential adverse effects of human exposure to existing or introduced hazards in the environment: hazard assessment, exposure assessment, and risk characterization. The hazard assessment considered the toxicity of retardant formulations, while the exposure assessment estimated doses to persons from typical, maximum, and accidental exposures. The risk characterization compared hazard information with dose estimates to predict the potential for health effects to individuals under the conditions of exposure. The assessment noted a potential risk of adverse health effects from accidental drenching of a member of the public from the retardant formula Phos-Chek G75-W. This formula, however, is only approved for helicopter bucket drops and for use in ground engines (Long Term Retardant Qualified Products List, February 5, 2007). These two delivery methods are very accurate and all but eliminate the possibility of such accidental drenching.

Cumulative Effects:

The *Human Health Risk Assessment: Wildland Fire-Fighting Chemicals* considers lifetime doses to members of the public and to fire suppression and fire rehabilitation workers. Public exposure to retardant such as in cleaning a structure treated with retardant and exposure from accidental drenching are expected to be once in a lifetime events (Labat-Anderson 2003).

Exposure to workers from accidental drenching is expected to range from once per year for engine crews and type-2 (reinforcement) fire crews over a 7 to 8-year career, to three times per year for hotshot crews over a seven-year career.

Workers are also expected to be exposed to retardant from walking through treated vegetation. Type-2 firefighters are expected to be repeatedly exposed in this manner between 2 and 6 days per year over an 8-year career while hotshot crews are expected to be likewise exposed between 20 to 40 days per year over a 7-year career.

All of the above exposures are considered to pose negligible health risks with the exception of the aforementioned Phos-Chek G75-W formula in the scenario of an accidental drenching of a member of the public. Again, this particular scenario is extremely remote given the limitation on approved delivery systems.

During the many years of the evaluated chemicals' use in firefighting, reports of adverse health effects have been limited to skin and eye irritation and potential allergic reactions (Labat-Anderson 2003).

Chapter 4 Agencies and Persons Consulted

Jason Kahn	National Marine Fisheries Service
Nancy Golden	Fish and Wildlife Service
Patricia Cole	Fish and Wildlife Service
David Chevalier	Forest Service
Bill Biastoch	Forest Service - Retired
Marc Bosch	Forest Service
Merrill Saleen	Bureau of Land Management
Alice Forbes	Forest Service – Retired

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