



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

**National Marine Fisheries Service
Endangered Species Act Section 7 Consultation**

Biological and Conference Opinion

Agencies: United States Department of Agriculture, Forest Service

Activities Considered: The aerial application of long-term fire retardants on all Forest Service lands

Consultation Conducted by: Endangered Species Act Interagency Cooperation Division of the Office of Protected Resources, National Marine Fisheries Service

Approved by: Heidi Hilde for J. H. Jackson

Date: November 7, 2011

Section 7(a)(2) of the Endangered Species Act (ESA), as amended requires each Federal agency to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species (16 U.S.C. 1531 *et seq.*). When the action of a Federal agency “may affect” a threatened or endangered species or critical habitat that has been designated for them, that agency is required to consult with either the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS) (together, “the Services”), depending upon the species that may be affected by the action.

This document represents NMFS’ biological and conference opinion (Opinion) on the U.S. Forest Service’s (USFS) proposal to aerially apply long-term fire retardants to all USFS lands. Long-term fire retardants are required to be composed of ammonium phosphate or diammonium phosphate along with “inert” ingredients, which range from guar gums, thickeners, clay, ash, or other substances added to the fertilizer/water mixture for various reasons. The purpose of this consultation is to evaluate the effectiveness of the proposed aerial retardant application guidelines, the results of increased monitoring between 2008 and present, and to analyze any risks associated with accidental input. This is both a programmatic and a national consultation, assessing the effects of aerially applied fire retardants generally on the environment and the statistical probabilities that listed resources are affected on a national scale. Other actions taken in response to a fire including the application of foams or other fire fighting chemicals were not proposed as part of the Federal action. Subsequent consultations that “tier” off of this programmatic consultation, specifically emergency consultations, when warranted, would



analyze the site specific effects of fire retardants, as well as foams and other fire fighting activities authorized, funded, or carried out by the USFS.

This Opinion has been prepared in accordance with section 7(a)(2) of the ESA of 1973, as amended (16 U.S.C. 1531 et seq.) and implementing regulations at 50 CFR 402. However, consistent with a decision rendered by the Ninth Circuit Court of Appeals on August 6, 2004, we did not apply the regulatory definition of “destruction or adverse modification of critical habitat” at 50 CFR 402.02. Instead, we relied on the statutory provisions of the ESA to complete our analysis of the effects of the action on designated critical habitat. Essential Fish Habitat (EFH) consultations, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1801, et seq.) and implementing regulations at 50 CFR 600, are conducted at a regional level. The MSA section at the end of this document explains the process of the EFH consultation.

This Opinion is based on our review of the Aquatics Report, previous environmental assessments (EAs), and supporting documentation; the draft recovery plan for Sacramento winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Southern California steelhead, California Central Valley steelhead, ; the U.S. recovery plan for Pacific salmonids, Puget Sound Chinook salmon, Upper Columbia River (UCR) spring Chinook salmon, UCR steelhead, Middle Columbia River steelhead, Hood Canal chum salmon, shortnose sturgeon, smalltooth sawfish; white papers; primary literature; past and current research, both published and unpublished; the documents that were used to list green sturgeon and smalltooth sawfish as threatened and endangered species (respectively); and monitoring reports from prior fires and misapplications of fire retardants.

Consultation History

On September 30, 2005, the United States District Court for the District of Montana issued a decision on the use of fire retardants on National Forest lands. Prior to this decision, the federal agencies had considered misapplications of fire retardants emergencies and initiated emergency consultation when misapplications occurred. The court determined that the use of fire retardant predictably occurred annually and therefore the USFS was required to initiate formal consultation with NMFS and USFWS.

On October 9, 2007, NMFS issued an Opinion to the USFS, concluding the USFS was unable to insure its actions would not jeopardize or adversely modify critical habitat of 27 listed species and their 24 critical habitats.

On February 11, 2008, Oregon Coast coho salmon were listed as threatened under the ESA and NMFS began reinitiating consultation to include this species in the Opinion.

On April 2, 2008, the Forest Service Employees for Environmental Ethics filed suit against the USFS, NMFS, and USFWS alleging violations of both the National Environmental Policy Act (NEPA) and the ESA.

On April 14, 2008, the USFS requested clarification on several typographical errors in the

October 9, 2007, Opinion, and NMFS agreed to amend the original Opinion and make the appropriate corrections prior to completing new Opinion required by reinitiation of consultation.

On June 5, 2008, NMFS issued an amended Opinion, identifying 28 listed species that were likely to be jeopardized and 22 critical habitats that were likely to be adversely modified.

On July 25, 2008, NMFS issued an Opinion to complete the reinitiation of consultation for the Oregon Coast coho salmon.

On July 27, 2010, the United States District Court for the District of Montana again ruled against USFS, USFWS, and NMFS, requiring a new NEPA process and completed Opinions to be finalized by December 31, 2011.

BIOLOGICAL OPINION

Description of the Proposed Action

The USFS has requested programmatic consultation on its long-term fire retardant specifications as well as its continued aerial application of approved long-term fire retardants on USFS lands. The USFS approves long-term fire retardants for use under its fire management program after the fire retardant products and their ingredients have been evaluated by the Wildland Fire Chemical Systems (WFCS) provided they meet USFS requirements. Once approved, the WFCS maintains the long-term fire retardant Qualified Products List (QPL), which is one of three QPLs. Several fire fighting products are approved for use and listed on the QPL. This Opinion analyzes the chemical constituents identified in by the published specifications for fire retardants as well as the effects of the currently approved aerially applied long-term fire retardants. Other fire fighting chemicals, such as foams, and activities authorized, funded, or carried out in response to wildland fires were not proposed as part of the Federal action and are not analyzed herein. Since 2007, the USFS's published specifications have transitioned from long-term fire retardants with ammonia sulfate salt bases to long-term fire retardants with inorganic phosphate salt bases, which reduce the level of ammonia from 3.1% to 2.2%.

This proposed action is similar to the proposed action identified in 2007, however the USFS has implemented the Reasonable and Prudent Alternatives identified by NMFS in the 2008 Opinion. That Opinion had one RPA with five different sub-sections that needed to be completed. The first, identify toxicity of two already authorized long-term fire retardants has been completed and the toxicity is discussed in the effects analysis below. The second portion, conduct research on acute and sub-lethal toxicity of fire retardants, was completed identifying smolts as the most acutely susceptible life stage, reduced growth rates of juveniles, and increased mortality upon entering sea water of juveniles who survived the acute fire retardant dose. The third portion, guidance for conducting site assessments, has been completed and when retardants are suspected of entering water, an assessment is made and a report filed with an estimate of the amount of intrusion and likely effects. The fourth portion, policy and guidance for follow up consultations, was tied to the incidental take statement in that Opinion, which was struck down by the court.

And the fifth portion, monitoring and biennial reporting, has been completed and the results of those reports have been used by both agencies during this consultation.

The decision where and when to use a particular fire retardant is left to the discretion of the Incident Commander, Forest Supervisors, District Rangers and other USFS field personnel (FSM 5100), and is informed by policy and guidance set by the Washington Office as well as the Regional Office (see the subsequent section in this Opinion on the *Legal and Policy Framework for Fire Retardant Use by the USFS*). The decision to approve particular retardants as a Qualified Product, however, is made at the Washington Office of the USFS. As a result of monitoring and research that began in 1980, the *Guidelines for Aerial Delivery of Retardant or Foam near Waterways* (2000 Guidelines) were established as interim guidelines in April 2000. These guidelines have been further adjusted based on monitoring data from 2008-2010 to minimize the amount of fire retardant entering visible bodies of water.

Decision Making and Use of Retardants

Depending on the topography, fuels amounts, fire behavior, flame lengths, and weather conditions, aerially applied fire retardants may be used in conjunction with ground support resources. Aviation use must be prioritized based on management objectives and the probability of success (2010 Interagency Guide Chapter 16). Interagency guidance (2009, Interagency Aerial Supervision Guide) recommends direct or indirect attacks in front of or parallel to fires, respectively, depending on the fire's characteristics and speed. Indirect attack pre-treats fuels which are far removed from the main fire. Examples include safety zones, ridgelines, roads, or areas of light/sparse fuels. Flame lengths from 4 to 8 feet require increasingly higher coverage levels. Retardant, unless applied in heavy coverage levels and greater widths, is not generally effective when flame lengths are greater than 8 feet. Long term retardant is most effective when applied to available fuels outside of the fire perimeter using parallel or indirect attack strategies.

Firefighters integrate fuel models and fuel descriptions to determine the appropriate retardant coverage level. Fuel models are classified into four fuel complex groups that include grasses, brush, timber litter, and slash (Anderson 1982). The fire behavior relates to the fuel loading expressed in tons/acre and the fuel bed depth which relates to the fuels distribution among the fuel size classes. Anderson (1982) identified fuel load and depth as significant fuel properties for determining a fire's ignition, rate of spread, and its intensity. Scott and Bergan (2005) further refined fuel models by including non-burnable fuel types (urban, ice, water, rock), and sub-grouping the fuel complexes by adding moisture climatic condition classes along with the fuel loading and distributions.

In the event that fire suppression decisions are deemed necessary, a Wildland Fire Decision Support System (WFDSS) is prepared. WFDSS is a decision support process that provides an analytical method for evaluating alternative suppression strategies that are defined by different goals and objectives, suppression costs, and impacts on the land management base. A WFDSS alternative describes a suppression strategy consistent with the "delegation of authority," (a set of instructions) communicated from a land unit administrator to an incoming incident commander. The "delegation" identifies what is important to protect, and may also establish cost targets. The FS 5100 Manual requires that the Agency Administrator ensures that a WFDSS is prepared when the conditions exist and that all decisions are documented.

When the USFS determines that a WFDSS is necessary, the Agency Administrator or designated staff prepare a preliminary WFDSS document. This document is reviewed and refined as necessary throughout the fire and includes concerns and constraints, such as the presence and locations of threatened or endangered species, designated critical habitat, or other important resources. It may also specify particular fire suppression tactics that can or cannot be used. A Resource Advisor (RA) is assigned to the fire and assists in the development of the WFDSS document. The RA also works with the Incident Commander (IC) and the Incident Management Team daily to provide information on all important resources that may be affected by the fire.

In order to inform firefighting efforts, the National Forests and Grasslands are mapping avoidance areas for ESA listed species. These avoidance areas are broken into two categories: critical avoidance areas and key avoidance areas. Critical avoidance areas are locations with ESA listed species or critical habitat. Key avoidance areas are determined by USFS sensitive species where aerial application of fire retardant is not likely to affect listed species or species that currently may be trending toward listing under the Endangered Species Act; including proposed and candidate species. When defining these areas, the USFS worked with NMFS and FWS to identify listed species and designated critical habitat, population information in occupied sites, occupied locations of USFS sensitive species, with an annual plan to update the maps of these areas annually in cooperation with NMFS and FWS.

Guidelines for Aerial Delivery of Retardant or Foam near Waterways¹

The interim 2000 Guidelines were useful and likely limited misapplications of fire retardant and harmful impacts to aquatic species; however, there were numerous exceptions to the guidelines and no guidance for terrestrial areas with listed species. Through adaptive management and interagency review, a new set of guidelines has been developed for the 2012 fire season and beyond.

The 2012 modified guidelines have been reduced to reflect the newly devised avoidance areas and to limit the number of exceptions available to ICs. The 2012 modified guidelines are:

Pilots and ICs are required to avoid aerial application of retardant on mapped avoidance areas for threatened, endangered, or certain sensitive species or within 300 feet of waterways. These guidelines do not require the helicopter or air tanker pilots-in-command to fly in such a manner as to endanger their aircraft, other aircraft or structures or compromise ground personnel safety or the public. The only exception to these guidelines is when human life or safety is threatened and the use of retardant can be reasonably expected to alleviate the threat.

Whenever practical, the Forest Service will use water in areas occupied by or designated critical habitat for threatened, endangered and sensitive species. However, prior to aerial application of

¹ The 2000 guidelines apply to the aerial application of foams and retardants. The USFS uses, foams, retardants, and gels while fighting fires; however, this consultation is specific to the aerial application of long-term fire retardants.

fire retardant, the pilot will make a “dry run” over the intended application area to identify avoidance areas if mapped in the vicinity of the wildland fire. When approaching mapped avoidance areas for TES species or waterways that are visible to the pilot, the pilot will terminate the application of retardant approximately 300 feet before reaching the mapped avoidance area or waterway. When flying over a mapped avoidance area or waterway, pilots will wait one second after crossing the far border of a mapped avoidance area or bank of a waterway before applying retardant. Pilots will make adjustments for airspeed and ambient conditions such as wind to avoid the application of retardant within the 300-foot buffer zone around the mapped avoidance area.

Retardants and Methods Proposed for Aerial Delivery of Retardants on USFS Lands

The USFS is proposing to authorize the production of long-term fire retardants in accordance with Forest Service Specification 5100-304c as well as the continued use of long-term fire retardants currently on the QPL. In accordance with section 3.5.1 of the specifications, all long-term fire retardants considered for use under the fire retardant program must be composed of ammonium polyphosphate, monoammonium phosphate, or diammonium phosphate. Additionally, section 3.4.2 requires all approved fire retardants to have an LC50 (the point at which there is 50% survival) above 100 mg/L total ammonia. In addition to these active ingredients, the compounds are combined with gum thickeners, such as guar gum, and suspending agents, such as clay, dyes, and corrosion inhibitors (Johnson and Sanders 1977, Pattle Delamore Partners 1996). The QPL is available on the USFS webpage. Each chemical is listed at a specific mix ratio and for use through qualified applications. Additional information on these chemicals can be found at <http://www.fs.fed.us/rm/fire/wfcs/index.htm>. Although retardant is approximately 85 percent water, the ammonia compounds constitute about 60 to 90 percent of the remainder of the product. 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 *et al.* 1995); however, the USFS stopped using the corrosion inhibitors with sodium ferrocyanide to reduce harmful effects on the environment.

The USFS uses three primary kinds of firefighting aircraft to dispense the eight long-term fire retardants: multi-engine air tankers, single engine air tankers, and helicopters. The air tankers are classified in to four types based on size. The multi-engine air tankers comprise tanks capable of carrying more than 3,000 gallons, between 1,800 and 2,999 gallons, and between 800 and 1,799 gallons, which are types I, II, and III, respectively. The USFS only has 18 multi-engine air tankers at their disposal for fighting fires (USFS EIS). Type IV is the single engine air tanker that holds less than 800 gallons. Type IV craft are predominately modified agricultural aircraft that can operate from remote airstrips and open fields or closed roads, reloading at portable retardant bases. There are two types of helicopters, those capable of carrying large loads of up to 2,000 gallons or smaller loads of fewer than 1,000 gallons. The speed, range, and retardant delivery capacity of the large (Type I and II) air tankers make them very effective in both initial attack and support to large fires. These air tankers typically make retardant drops from a height of 150 to 200 feet above vegetation and terrain. They move at airspeeds of 125 to 150 knots. Large fixed-wing air tankers have complex, computer controlled retardant dispersal systems capable of both precise incremental drops and long-trailing drops one-fourth of a mile or more in

length. Retardant flow rates are controlled to vary the retardant coverage level. Retardant is dispersed as needed after consideration of a fire's intensity/behavior and the vegetative fuel type(s) involved.

Approach to the Assessment

NMFS approaches its program specific section 7 analyses through a series of steps. The first step identifies those aspects of proposed actions that are likely to have direct and indirect effects on the physical, chemical, and biotic environment of an action area. As part of this step, we identify the spatial extent of these direct and indirect effects, including changes in the spatial extent over time. The results of this step represent the action area for the consultation. The second step of our analyses identifies the listed species and designated critical habitat that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our exposure analyses). In this step of our analyses, we try to identify the primary constituent elements (PCEs), number, age, life stage, and gender of the listed resources that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. Once we identify the listed resources that are likely to be exposed to an action's effects and the nature of that exposure, we examine whether and how those listed resources are likely to respond given their exposure (these represent our response analyses).

The final steps of our analyses—establishing the risks those responses pose to listed resources—are different for listed species and designated critical habitat (these represent our risk analyses). Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" were listed, which may encompass the biological species, subspecies, or distinct population segments of vertebrate species. Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability (probability of extinction or probability of persistence) of listed species depends on the viability of the populations that comprise the species. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so). Our destruction or adverse modification determinations must be based on an action's effects on the conservation values of the essential features of critical habitat.

A programmatic review, however, typically analyses the general environmental consequences of a broad scope of actions or policy alternatives under consideration by an agency program. Similarly, interagency (and intra-agency) consultations on programmatic actions (that is, programmatic consultations) focus on the general patterns associated with an agency's program and the broad scope of actions proposed under the Federal agency's preferred alternative. Subsequent consultations that "tier" off of these programmatic consultations, when warranted, would analyze the project and site specific effects typical of most consultations. Any subsequent section 7 consultations conducted by NMFS personnel would be designed to determine whether and to what degree the specific action under review fits within the general pattern identified in the "parent" or national programmatic consultation, and would determine whether the specific action, is or is not likely to jeopardize the continued existence of endangered and threatened species or result in the destruction or adverse modification of designated critical habitat.

The conceptual model NMFS uses for programmatic consultations focuses on four main

elements of an action agency's program: (1) the decision-making process an action agency proposes to use for specific actions the program will authorize, fund, or carry out; (2) the classes of actions or activities the program would authorize, fund or carry out; (3) the types of intended and unintended consequences that are likely to result from authorized activities; and (4) the mechanisms that improve the program's implementation over time. We begin our programmatic consultations by recognizing that an agency's program normally represents the agency's decision to authorize, fund, or carry out a suite or class of activities that may require specific actions undergo subsequent review and decision-making (or they may not require subsequent review).

An agency's decision-making process will normally identify certain standards that an action must satisfy before an agency would authorize, fund or carry them out. Generally decision-making involves hard or formal procedures (such as public noticing requirements), soft or flexible information standards (the information an applicant might submit or the information agency personnel would gather and review to evaluate a submittal), and outlines how the agency would decide whether or not to authorize, fund or carry out specific actions. Typically an agency's decision-making process is shaped to respond to:

- a. the statutory and regulatory standards an action must satisfy before the agency would authorize, fund, or carry them out;
- b. any data and other information the agency must gather and evaluate to satisfy their statutory and regulatory requirements, as well as requirements of the Administrative Procedure Act, National Environmental Policy Act, Information Quality Act, and related administrative statutes (e.g., the Paperwork Reduction Act, Regulatory Flexibility Act, etc.);
- c. the agency's obligation to review and analyze the relevant information within the context of applicable standards to ensure that specific actions satisfy all applicable statutory and regulatory requirements;
- d. the results of the agency's efforts to monitor specific actions the agency has authorized, funded, or carried out, and the consequences of those decisions;
- e. and any other feedback mechanisms an agency has created to ensure that a program satisfies its statutory mandates, regulatory requirements, and applicable goals and objectives.

Specifically, in consultation we would ask whether and to what degree the decision-making process can ensure that actions taken under the program are not likely to, individually or cumulatively, jeopardize the continued existence of endangered or threatened species or are not likely to result in the destruction or adverse modification of designated critical habitat. An agency can satisfy this requirement when the program contains features that: (1) prevent listed resources from being exposed to actions or their direct or indirect effects; (2) mitigate how listed resources respond to that exposure, when listed resources are exposed to the program's actions and their effects; or (3) mitigate the risks any responses pose to listed individuals, populations, species, or designated critical habitat, when listed resources are likely to be exposed and respond

to that exposure. Our programmatic consultation would focus on the evidence available to determine whether and to what degree the agency's decision-making process is likely to prevent exposure, or mitigate responses or the risks any responses would pose to listed species or their designated critical habitat.

In examining an agency's decision process, we examine the classes of actions or activities the program would authorize, fund or carry out. During this step of our assessment, we identify the geographic distribution, timing, and constraints of the different classes of activities that would be authorized, funded or carried out by a program. The area directly and indirectly affected by the class of actions that would be authorized, funded or carried-out by a program represents the *action area* of a programmatic consultation.

The next step of our analyses identifies the listed resources that are likely to co-occur in this geographic area, and the nature of their co-occurrence with the classes of activities authorized, funded or carried out by the program. We use the best scientific and commercial data available to identify the intended and unintended consequences that are likely to result from those activities. This step of our assessment is designed to determine whether and to what degree listed resources under our jurisdiction are likely to be exposed to these different classes of activities that would be authorized, funded or carried out under a program. As part of this step we try to identify the populations and subpopulations, ages (or life stages), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. Once we conclude that listed resources are likely to be exposed to the effects of a program's action, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure.

Similar to a project specific consultation, the next step of our analysis in a programmatic consultation establishes the risks that the responses pose to listed species and their designated critical habitat. A programmatic consultation, however, is necessarily focused on whether and to what degree a program can ensure that actions taken under the program are not likely to, individually or cumulatively, jeopardize the continued existence of endangered or threatened species and are not likely to result in the destruction or adverse modification of designated critical habitat. Our description of the probable responses and the risks the program poses to listed resources is at the core of our evaluation, and is informed by the program's decision structure and by the general patterns we observed through prior experience with a program or a class of activities.

When individual listed plants or animals are expected to experience reductions in fitness, we would expect those reductions to also reduce the abundance, reproduction rates, or growth rates (or increase variance in one or more of those rates) of the populations those individuals represent (see Stearns 1992). Reductions in one or more of these variables (or one of the variables we derive from them) is a *necessary* condition for reductions in a population's viability, which is itself a *necessary* condition for reductions in a species viability. On the other hand, when listed plants or animals exposed to an action's effects are *not* expected to experience reductions in fitness, we would *not* expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (for example,

see Anderson 2000, Mills and Beatty 1979, and Stearns 1992). If we conclude that listed species are not likely to experience reductions in their fitness, we would conclude our assessment.

If, however, we conclude that listed animals are likely to experience reductions in their fitness, we examine whether the program included sufficient safeguards to ensure that the actions they authorize, fund, or otherwise carry out would not reduce the viability of the populations those individuals represent (typically measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). For those species likely to be adversely affected by the activities conducted under a program, we would examine their status and the environment in which the species exists (in this Opinion, the *Environmental Baseline and Status of the Species* are examined in the section titled Listed Resources in the Action Area), in detail, as a point of reference for determining if changes in population viability are likely, and if, in turn, any changes in population viability would be sufficient to reduce the viability of the species.

Evidence Available for this Consultation

To conduct our analyses we considered the information contained in the 2007 Aquatics Report, *Ecological Risk Assessment: Wildland Fire-Fighting Chemicals* (Labat 2007), *the Interagency Standards for Fire and Aviation Operations - Redbook 2010* (Redbook 2010), *Interagency Strategy for the Implementation of Federal Wildland Fire Management Policy*, the Forest Service Manual (FSM), and monitoring data acquired between 2008 and 2010 in response to the previous Opinion. Emergency consultation data between 2001 and 2008 coupled with increased monitoring data from 2008-2010 allowed us to evaluate some of the past problems observed when fire retardants were unintentionally introduced in rivers, and the adaptation of the program's (agency's) use of fire retardants on USFS lands in response to these actions that were authorized, funded or carried out by the USFS.

We supplemented this information using electronic searches of literature published in English or with English abstracts using research platforms in the *Online Computer Library Center's First Search*, *CSA Illumina*, and *ISI Web of Science*. These platforms allow us to cross-search multiple databases for journals, open access resources, books, proceedings, Web sites, doctoral dissertations and master's theses for literature on the biological, ecological, and medical sciences. Particular databases we searched for this consultation included *BasicBiosis*, *Dissertations*, *ArticleFirst*, *Proceedings*, *Aquatic Sciences and Fisheries Abstracts*. Some of the databases provide access to documents published from the 1960s through present, although references for many scientific journals contained in these databases only date back to the 1970s or later. Through these databases we accessed the major journals dealing with the biology, ecology, distribution, status, and trends of the threatened and endangered species considered in this Opinion, and the impacts of fire retardants on freshwater ecosystems.

For our literature searches, we used paired combinations of the keywords: fire retardant, fire fighting, Chinook salmon, and many others. We acquired references that, based on a reading of their titles and abstracts, appeared to comply with our keywords. If a reference's title did not allow us to eliminate it as irrelevant to this inquiry, we acquired and reviewed the reference. We supplemented our electronic searches by searching the literature cited sections and bibliographies

of references we retrieved electronically to identify additional papers that had not been captured in our electronic searches.

Collectively, this information provided the basis for our determination as to whether and to what degree listed resources under our jurisdiction are likely to be exposed to the USFS' use and application of fire retardants, and whether and to what degree the USFS can ensure that their use of fire retardants are not likely to, individually or cumulatively, jeopardize the continued existence of endangered or threatened species or are not likely to result in the destruction or adverse modification of designated critical habitat.

Application of this Approach in this Consultation

In this consultation, we evaluated USFS' 2011 modified guidelines, which aerially apply long-term fire retardants meeting USFS specifications, during fire management activities, and whether the USFS can ensure that any action authorized, funded, or carried out under this fire retardant program is not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of critical habitat. We began our analysis of the fire retardant program by exploring where, why, and how the USFS would use long-term fire retardants. Specifically, we asked whether there are geographic, political, or other substantive decision criteria that would influence the USFS' decision to use one retardant over another when fighting a fire. We asked whether there are substantive decision criteria they follow as to when it is appropriate to aerially apply a retardant versus other means of fire control and suppression (e.g., fire line construction, ground crews, ground retardant application, *etc.*) prior to engaging and while engaged in fire fighting activities

Through the course of this consultation we learned that the decision where, when, and how to apply a particular fire retardant formulation is largely left to the discretion of the Incidental Commander, Forest Supervisor, and other USFS field personnel (FSM 5100). The decision is informed by policy and guidance set by the USFS' Washington Office and various statutes (see below), and the risk analyses conducted by the WFCS, a part of the Missoula Technology and Development Center, for determining what chemicals should be approved for use in fire suppression activities.

This consultation will evaluate the long-term fire retardant program. The USFS routinely receives new applications from companies with less toxic and more effective long-term fire retardants. As those new retardants are reviewed and accepted for use, their impact to listed species and their critical habitats will be analyzed in new consultations, tiered to this programmatic. Additionally, because the program overseeing the application of foams and gels is the same as the long-term fire retardant program, future consultations for those fire retardant chemicals could be tiered to this consultation.

Legal and Policy Framework for Fire Retardant Use by the USFS

Various authorities define the fire management responsibilities of the USFS. The following acts authorize and guide fire management activities for the protection of USFS lands and resources (FSM 5100 – Fire Management):

1. Organic Administration Act, June 4, 1897 (16 U.S.C. 551). This act authorizes the Secretary of Agriculture to make provisions for the protection of National forests against destruction by fire.

2. Bankhead-Jones Farm Tenant Act, July 22, 1937 (7 U.S.C. 1010, 1011). This act authorizes and directs the Secretary of Agriculture to develop a program of land conservation and land utilization to "assist in controlling soil erosion, reforestation, preserving natural resources, protecting fish and wildlife,...mitigating floods,...protecting the watersheds of navigable streams, and protecting the public lands..."

3. National Forest Management Act, October 22, 1976 (16 U.S.C. 1600 *et seq.*). This act directs the Secretary of Agriculture to specify guidelines for land management plans to ensure protection of forest resources. Regulations at Title 36, Part 19 of the Code of Federal Regulations (36 CFR 219.27) specify that, consistent with the relative resource values involved, management prescriptions in forest plans must minimize serious or long-lasting hazards from wildfire.

4. Granger-Thye Act, April 24, 1950 (16 U.S.C. 572). This act authorizes expenditure of United State Department of Agriculture and USFS funds to erect buildings, lookout towers, and other Federal structures on land owned by states. It provides for the procurement and operation of aerial facilities and services for the protection and management of the National Forests and other lands administered by the Forest Service.

The USFS also has a variety of authorities that provide for cooperation with other Federal land managers on all aspects of wildland fire management and some non-fire emergencies, and to engage in suppression actions on state, local and private lands. Pursuant to Title 41, United States Code, section 1856b and agency regulations (36 CFR 211.5) the USFS, in the absence of a written reciprocal agreement with a fire organization, is permitted to render emergency assistance in suppressing wildland fires and in preserving life and property from the threat of fire within the vicinity of the agencies fire protection facilities. Assistance may be offered without reimbursement if an USFS-initiated prescribed fire escapes onto non-USFS lands; and assistance may be offered on a reimbursable basis when requested, without regard to the threat of the NFS lands or resources (FSM 5132).

These policies as well as several guidance documents on fire management that govern the USFS use of fire retardants recognize that fires do not respect jurisdictional boundaries and that cooperative operations are necessary to respond to a wide range of emergency situations. According to the wildland fire management decision process outlined in the Interagency Strategy for the Implementation of Federal Wildland Fire Management Policy, Federal wildland decisions are affected by three influences: planning direction that guides decisions, actions that are planned to occur given an ignition, and actions that are based upon the situation that exists at the time (DOA & DOI 2003). The Interagency Policy emphasizes developing quality plans to facilitate effective decision making in operational activities. In particular, the Policy emphasizes the role of the Land/Resource Management Plans and Fire Management Plans to articulate strategies and objectives for implementation of prescribed burns, Appropriate Management Responses for wildland fires, including conducting situation analyses and after action reviews (DOA & DOI

2003). The implementation strategy requires that “wildland fire management plans and procedures be tied to approved Land/Resource Management Plans and that on-going evaluation is part of an iterative, improved policy.” For all areas subject to wildland fires, a Fire Management Plan must be developed in compliance with the Guidance for Implementation of Federal Wildland Fire Management Policy (2008). The purpose of the Fire Management Plan is to formally document operational parameters for the fire manager but it does not prescribe decisions (DOA & DOI 2003).

Among other things, Fire Management Plans incorporate firefighter and public safety, and environmental considerations. Among the many legal and regulatory statutes, the USFS must also ensure that any action authorized, funded, or carried out under their fire management program or using the long-term fire retardants on the QPL is not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of critical habitat. This is done under section 7 consultation with the Services.

USFS Decision Structure -Use of Fire Retardants

The use of the fire retardants by the USFS personnel is a multifaceted action (a complex program of actions that may require consultation). Under the fire program, one of the early and arguably most important actions taken by the USFS is the review and approval of fire retardants, as well as foams and water enhancers (fire fighting chemicals) for use on USFS lands and elsewhere. Once a fire fighting chemical is approved for the QPL, the USFS purchases, warehouses, and distributes the chemical to individual bases across the nation. Since all agencies, state and Federal, obtain their fire fighting chemicals from the same bases, a particular chemical will continue to be used until it is exhausted, even when the chemical is no longer approved for use under the QPL. At the same time, if the USFS is no longer purchasing a product and its stockpile has been used up, no other agencies, state or Federal, will be able to use that chemical either.

Figure 1 depicts a simplified model of the USFS fire management program, as NMFS understands it. The use of the eight long-term fire retardants and the accompanying 2012 Guidelines, while an action that merits consultation, represents only a small part of the overall program and decision making process in fighting fires. During this consultation, we evaluated the currently approved retardants and the USFS’ decision-making process for where, when, and how to apply those retardants. We reviewed the data and other information that the USFS gathers, analyzes, and considers when applying those retardants and the information the USFS gathers to reach conclusions as to whether listed species were affected during the application of fire retardants (i.e., monitoring and conducting emergency consultations). We also reviewed the information that the USFS gathers to evaluate the validity of its conclusions (e.g., that threatened and endangered species are likely to be adversely affected when retardant is applied within 300 feet of waterway). We evaluated this information to determine whether and to what degree the USFS’ decision-making process ensures that any activities it authorizes, funds, or carries out are not likely to, individually or cumulatively, jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat that has been designated for them.

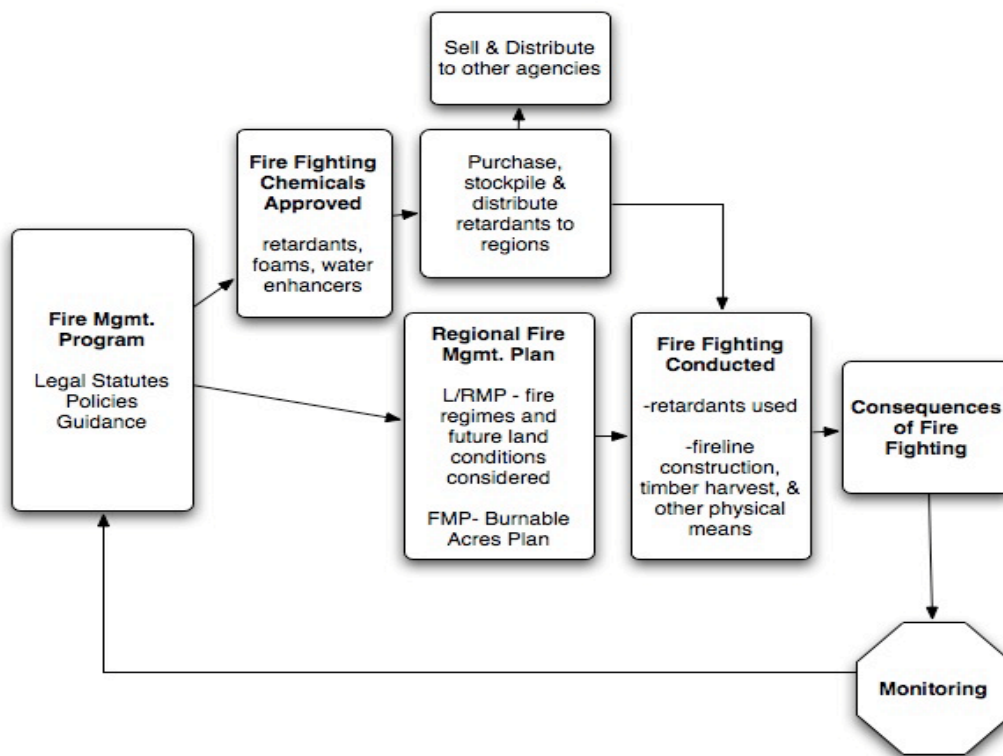


Figure 1. USFS' Fire Management Program Decision Making Process

We examined the USFS use of fire retardants and the accompanying 2012 Guidelines to see if it contains features that would necessarily prevent the exposure of endangered or threatened species, or their designated critical habitat (listed resources). We then broadly characterized the use of fire retardants on each forest over the past decade and fire recurrence intervals to describe the risk of listed resources being exposed to fire retardants used on USFS lands. If, based on this information, we expected that listed resources are not likely to be exposed to fire retardants used by the USFS, then we concluded that the action would have “no effect” on those listed resources. If, based on this information, we determined that listed individuals may be exposed to activities authorized by the research program, but (a) the probability of exposure to those stressors is so small that it would not be reasonable to expect exposure to occur, (b) there is no possibility or only a very small possibility that the individual would respond when exposed to the stressor, (c) there is no possibility or only a small probability of a negative response even if an individual does exhibit a response to their exposure, or (d) there is no possibility or only a small probability that the individual would experience a reduction in individual performance (or fitness), then we concluded that the USFS’ action is “not likely to adversely affect” those listed resources.

If listed resources are harmed or killed by actions the USFS authorizes, funds, or otherwise carries out, NMFS examines if the program includes sufficient safeguards to ensure that the incidental take of individuals does not occur in a manner that reduces the viability of the populations those individuals represent (typically measured using changes in the populations’ abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population’s extinction risks). Given their status and the

environment in which the species exist, are those species likely to be adversely affected by the activities conducted under the proposed action likely to suffer changes in population viability that would be sufficient to reduce the viability of the species those populations comprise?

LISTED RESOURCES IN THE ACTION AREA

The section 7 implementing regulations define the “Action Area” of a Federal action as all areas to be affected, directly or indirectly, and not merely the immediate area involved in the action (50 CFR 402.02). This Opinion assesses the consequences of the USFS’ use of eight long-term fire retardants on any USFS lands and immediately adjacent lands across the United States and its territories. According to the USFS, there are 192 million acres of National Forests and National Grasslands across 42 states and one territory. In all, this amounts to 155 National Forest, 22 National Grasslands, 6 National Monuments, 20 National Recreational Areas, 9 National Scenic Areas, and 1 National Preserve, of which 403 are designated wilderness units and river reaches that are designated Wild and Scenic Rivers.

At a minimum the extent of the action area is defined by USFS lands. Based on our assessment we have determined that the direct and indirect effects of the USFS’ use of the fire retardants may extend beyond these lands for reasons that are interrelated and interdependent actions, or indirect effects of fire retardant application. We expect that the USFS would typically conduct fire suppression activities primarily on USFS lands, which are scattered across the United States. We are aware that in some instances the USFS may fight fires along the interface between Federal lands and other landholders where the application and effect of fire retardants extend beyond USFS jurisdiction (e.g., the indirect effects of fire suppression activities extend to downstream areas or areas downslope of the USFS lands), and in certain instances the USFS may provide assistance to other Federal, state and local entities (fight fires and drop retardants on areas outside of the USFS [private lands or other Federal lands] see the section *Legal and Policy Framework for Fire Retardant Use by the USFS* in this Opinion). Because there may be times and areas where the application and the effects of long-term fire retardants extend beyond the geographical boundaries of USFS lands and because the nearly 200 distinct areas designated as part of the USFS are widely distributed across the United States, we have defined the action area for this consultation broadly to encompass all USFS lands and waters of the United States as well as land and water within 10 miles of USFS lands.

Status of the Species

Over 90 ESA-listed or proposed listed species² are under NMFS jurisdiction, but not all of these species will be affected by long-term fire retardants. For this consultation, any listed or proposed species or their critical habitat that may be affected by long-term fire retardants will be analyzed in the biological opinion. The species proposed for listing will be analyzed in this document as a

² In this section of the Opinion, we use the word “species” as it has been defined in section 3 of the Endangered Species Act of 1973, which include “species, subspecies, and any distinction population segment of any species of vertebrate fish or wildlife which interbreeds when mature” (16 U.S.C. 1533). Pacific salmon that have been listed as endangered or threatened were listed as “evolutionarily significant units” which NMFS uses to identify distinct population segments of Pacific salmon. Nevertheless, any ESU or DPS is a “species” for the purposes of the ESA.

conference opinion, which could then be adopted as a biological opinion following the final listing decision.

The downstream effects of long-term fire retardants are brief but intense, with lethal consequences extending downstream for a mile or more. While no research has been conducted to determine the worst case scenario for downstream effects, which would be a large load entering a stream with small volume and high gradient, NMFS believes the range of adverse effects is very likely limited to 10 miles downstream of the initial location of long-term fire retardant misapplication. As a result, species living on or downstream of USFS lands could be affected by this action.

Because no fires would be fought by the USFS internationally, in estuaries, or the ocean NMFS would not expect the effects of long-term fire retardants to reach ocean waters or foreign species. Blue whale (*Balaenoptera musculus*), bowhead whale (*Balaena mysticetus*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), southern resident killer whale (*Orcinus orca*), Insular Hawaiian DPS false killer whale (*Pseudorca crassidens*), Cook Inlet DPS beluga whale (*Delphinapterus leucas*), North Atlantic right whale (*Eubalaena glacialis*), North Pacific right whale (*Eubalaena japonica*), sei whale (*Balaenoptera borealis*), Southern right whale (*Eubalaena australis*), sperm whale (*Physeter macrocephalus*), Chinese River dolphin (*Lipotes vexillifer*), Western North Pacific grey whale (*Eschrichtius robustus*), Gulf of California harbor porpoise (*Phocoena sinus*), Indus River dolphin (*Platanista minor*), Guadalupe fur seal (*Arctocephalus townsendi*), Mediterranean monk seal (*Monachus monachus*), Hawaiian monk seal (*Monachus schauinslandi*), Eastern DPS Steller sea lion (*Eumetopias jubatus*), Western DPS Stellar sea lion (*E. Jubatus*), Saimaa seal (*Phoca hispida saimensis*), Southern DPS spotted seal (*Phoca largha*), ringed seal (*Phoca hispida*), Beringia DPS bearded seal (*Erignathus barbatus*), Okhotsk DPS bearded seal (*E. barbatus*), all populations of green sea turtle (*Chelonia mydas*) including Florida and Mexico, hawksbill sea turtle (*Eretmochelys imbricata*), Kemp's ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), Mediterranean Sea DPS loggerhead sea turtle (*Caretta caretta*), North Indian Ocean DPS loggerhead sea turtle (*C. caretta*), North Pacific Ocean DPS loggerhead sea turtle (*C. caretta*), Northeast Atlantic Ocean DPS loggerhead sea turtle (*C. caretta*), Northwest Atlantic Ocean DPS loggerhead sea turtle (*C. caretta*), South Atlantic Ocean DPS loggerhead sea turtle (*C. caretta*), South Pacific Ocean DPS loggerhead sea turtle (*C. caretta*), Southeast Indo-Pacific Ocean DPS loggerhead sea turtle (*C. caretta*), Southwest Indian Ocean DPS loggerhead sea turtle (*C. caretta*), all populations of olive ridley sea turtle (*Lepidochelys olivacea*) including Mexico, smalltooth sawfish (*Pristis pectinata*), largetooth sawfish (*Pristis perotteti*), Puget Sound/Georgia Basin DPS bocaccio (*Sebastes paucispinis*), Puget Sound/Georgia Basin DPS canary rockfish (*Sebastes pinniger*), Puget Sound/Georgia Basin DPS yelloweye rockfish (*Sebastes ruberrimus*), totoaba (*Totoaba macdonaldi*), black abalone (*Haliotis cracherodii*), white abalone (*Haliotis sorenseni*), elkhorn coral (*Acropora palmata*), staghorn coral (*Acropora cervicornis*), and Johnson's seagrass (*Halophila johnsonii*) will not be affected by long-term fire retardants and therefore are not considered in this consultation. In the case of Gulf of Mexico sturgeon (*Acipenser oxyrinchus desotoi*), NMFS consults on this species when an action with a federal nexus may affect them in the ocean or estuarine habitat. Because this species will not be affected by USFS fire retardant misapplications in the ocean or estuaries, Gulf of Mexico sturgeon and their critical habitat under NMFS jurisdiction will also not be affected by the

proposed action.

There are no USFS lands in areas occupied by listed Atlantic salmon (*Salmo salar*), Ozette Lake ESU sockeye salmon (*Oncorhynchus nerka*), Sacramento winter-run Chinook salmon (*O. tshawytscha*), central California coast coho salmon (*O. kisutch*), or central California coast steelhead (*O. mykiss*). While the USFS is allowed to drop fire retardants adjacent to its land, it is unlikely that it would venture so far from NFS lands as to drop retardant near any watersheds containing these listed species. These species are also not in areas with frequent fire return intervals so NMFS believes it is extremely unlikely that the USFS' use of fire retardants would overlap with the distribution of these species.

On the USFS lands with listed species present, we used a screening process to determine the likelihood of exposure. NMFS determined that if there was a 99.99% probability that an application would be made successfully adjacent to a body of water containing a listed species, then we could reach the determination that they may be affected, but not adversely affected. Table BA-12 in the USFS BA identified approximately 10,000 fire retardant drops between 2009 and 2010, with a resulting intrusion rate into water of 0.0032477 and an intrusion rate within the buffer zone including water of 0.004263. Because the national rate of intrusion events for the recent three years of monitoring exceeded our screening criteria, NMFS and USFS decided to address the risks to all species inhabiting National Forests where one or more applications had been documented since 2000, when intensive monitoring began.

While the species above will not be directly affected by fire retardants, some species may be indirectly affected by the use of long-term fire retardants. Southern resident killer whales, Eastern DPS Steller sea lions, and Western DPS Steller sea lions rely on both listed and non-listed species of salmonids as a food source. While we recognize Puget Sound Chinook salmon are a food source for the southern resident killer whale as specified in its critical habitat designation, these species, as explained below, have a very low probability of being affected by long-term fire retardants. The probabilities are not discountable, and therefore the risk is analyzed in this Opinion. In the event there is an effect, the extent of the impacts are not likely to result in any indirect effects to southern resident killer whales because there are alternative food sources available to them and the impacts to Puget Sound Chinook salmon juveniles are not expected to have a significant effect on the number of returning adults because of the naturally high mortality rate for juveniles and smolts. Additionally, because of the short-term duration of water quality impairments and potential long-term benefits of increased nitrogen and phosphorous in oligotrophic systems, any water quality impairments far upstream of Puget Sound would not be detectable within the sound itself. Likewise, both DPSs of Steller sea lions depend on salmonids as part of their diet, however not all of those salmonids come from impaired stocks or even from US waters. Additionally, Steller sea lions feed on a variety of other prey so any reduction in salmonids caused by an intrusion event would not likely be detectable to either DPS of Steller sea lions.

NMFS has determined that the following species and critical habitat designations (Table 1) may be affected by the USFS use of fire retardants:

Table 1. Species and critical habitat designations considered in this consultation

Common Name	Scientific Name	Listed As	Critical Habitat
Chinook salmon (California coastal) (CC)	<i>O. tshawytscha</i>	Threatened	Yes
Chinook salmon (Central Valley spring-run) (CV)		Threatened	Yes
Chinook salmon (Lower Columbia River) (LCR)		Threatened	Yes
Chinook salmon (Snake River fall-run)		Threatened	Yes
Chinook salmon (Snake River spring/summer-run)		Threatened	Yes
Chinook salmon (Upper Columbia River spring-run) (UCR)		Endangered	Yes
Chinook salmon (Upper Willamette River)		Threatened	Yes
Chinook salmon (Puget Sound)		Threatened	Yes
Chum salmon (Columbia River)		Threatened	Yes
Chum salmon (Hood Canal summer-run)		Threatened	Yes
Coho salmon (Lower Columbia River) (LCR)	<i>O. kisutch</i>	Threatened	No
Coho salmon (Southern Oregon Northern Coast California) (SONCC)		Threatened	Yes
Coho salmon (Oregon Coast)		Threatened	Yes
Sockeye salmon (Snake River)	<i>O. nerka</i>	Endangered	Yes
Steelhead (California Central Valley) (CCV)	<i>O. mykiss</i>	Threatened	Yes
Steelhead (Lower Columbia River) (LCR)		Threatened	Yes
Steelhead (Middle Columbia River) (MCR)		Threatened	Yes
Steelhead (Northern California)		Threatened	Yes
Steelhead (Snake River Basin)		Threatened	Yes
Steelhead (South Central California Coast) (SCCC)		Threatened	Yes
Steelhead (Southern California)		Endangered	Yes
Steelhead (Upper Columbia River) (UCR)		Threatened	Yes
Steelhead (Upper Willamette River)		Threatened	Yes
Steelhead (Puget Sound)		Threatened	No
Shortnose sturgeon	<i>A. brevirostrum</i>	Endangered	No
Southern DPS Atlantic sturgeon*	<i>A.o. oxyrinchus</i>	Endangered	No
Carolina DPS Atlantic sturgeon*		Endangered	No
Chesapeake DPS Atlantic sturgeon*		Endangered	No
New York Bight DPS Atlantic sturgeon*		Endangered	No
Gulf of Maine DPS Atlantic sturgeon*		Threatened	No
Green sturgeon	<i>A. medirostris</i>	Threatened	Yes
Pacific eulachon smelt	<i>T. pacificus</i>	Threatened	Yes*

*proposed

By regulation, NMFS must consider the status of these threatened species, endangered species, and designated critical habitat when making its ‘jeopardy’ or ‘destruction or adverse modification’ determinations (50 CFR 402.02). We determine a species’ status by estimating its probability of extinction in particular time intervals (or its probability of persistence in a time interval, which is [1 – probability of extinction] in the time interval). We use this estimate to determine whether the effects of an action are likely to reduce a species’ likelihood of both

surviving and recovering in the wild.

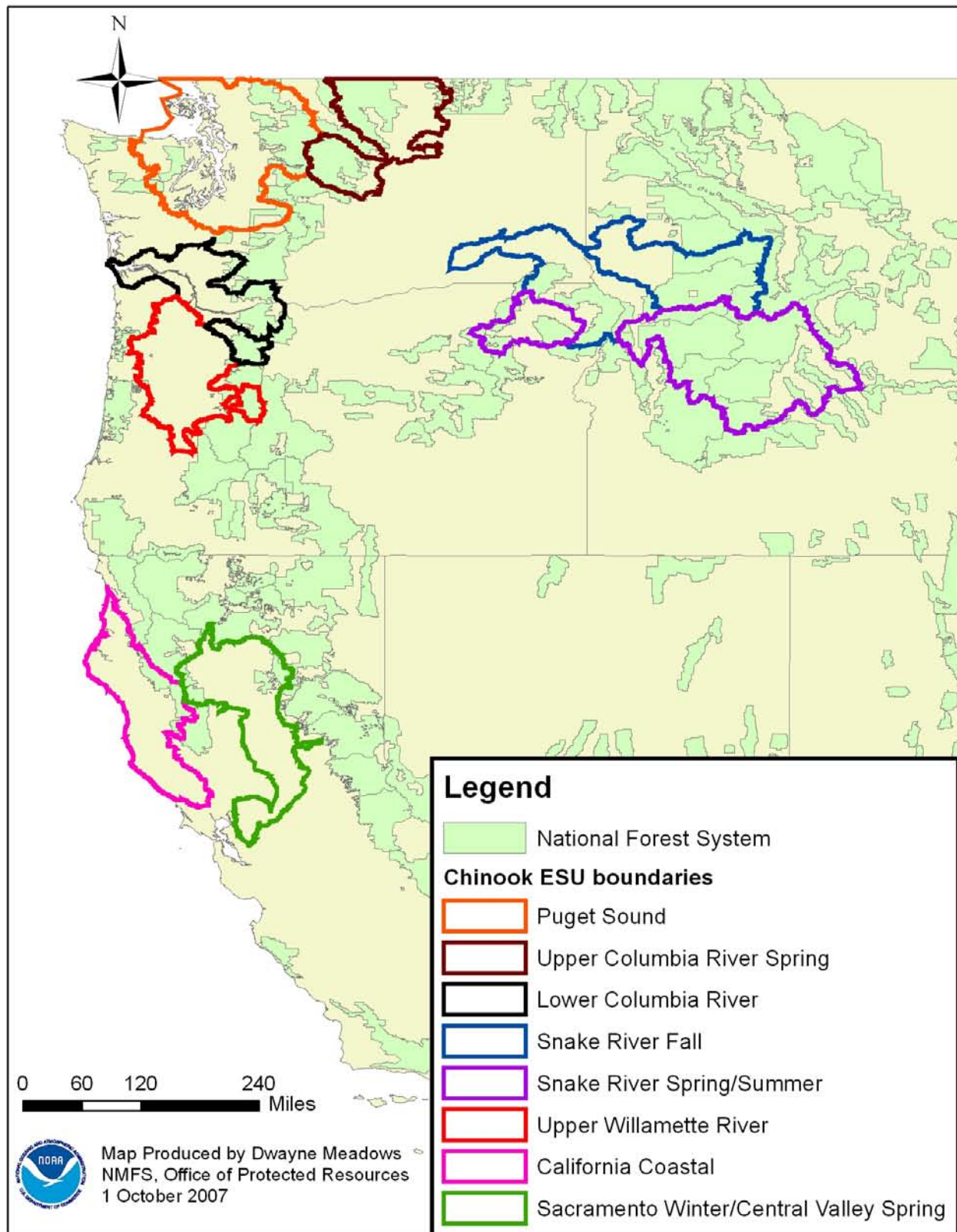
The species' narratives that follow this introduction focus on the status of the threatened and endangered species and designated critical habitats that are likely to occur in the action area and may be adversely affected by the misapplication of fire retardants. The information presented in this section summarizes a larger body of information and is intended to establish the status of the listed species and critical habitat designations that we consider in this Opinion. These summaries are the foundation for the analyses we present in the *Effects of the Action* section of this Opinion. Because this is a programmatic consultation that does not consider site-specific data or other information, we only summarize information on the geographic distribution of the species, their ecological relationship with waters of the United States, status, and principal threats to their survival and recovery.

More detailed information on the status and trends of these listed resources, their biology and ecology can be found in a number of published documents including assessments of the status and trends of Pacific salmon (Good *et al.* 2005); recovery plan for shortnose sturgeon (NMFS 1998); the status review of Atlantic sturgeon (ASSRT 2007); the status review of green sturgeon (NMFS 2005); the final rule to list the southern DPS of Pacific eulachon as threatened under the ESA (75 FR 13012); and listing regulations and critical habitat designations that have been published in the *Federal Register*.

Chinook Salmon

Figure 2 is a depiction of the distribution of the nine threatened and endangered Chinook salmon. Chinook salmon are the largest of the Pacific salmon and historically ranged from the Ventura River in California to Point Hope, Alaska in North America, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991). In addition, Chinook salmon have been reported in the Canadian Beaufort Sea (McPhail and Lindsey 1970). We discuss the distribution, status, and critical habitats of the nine species of endangered and threatened Chinook salmon separately, and summarize their common dependence on waters of the United States.

Figure 2. US Forest Service Boundaries and Listed Chinook Salmon Distributions



Of the Pacific salmon species, Chinook salmon exhibit arguably one of the most diverse and complex life history strategies. Chinook salmon are generally described as one of two races, within which there is substantial variation. One form, the “stream-type” resides in freshwater for a year or more following emergence, and the “ocean-type” migrates to the ocean within their first year. The ocean-type typifies populations north of 56°N (Healy 1991). Within each race, there is often variation in age at seaward migration, age of maturity, timing of spawning migrations, male precocity, and female fecundity.

Over the past few decades, the size and distribution of Chinook salmon populations have declined because of natural phenomena and human activity, including the operation of hydropower systems, over-harvest, hatcheries, and habitat degradation. Natural variations in freshwater and marine environments have substantial effects on the abundance of salmon populations. Of the various natural phenomena that affect most populations of Pacific salmon, changes in ocean productivity are generally considered most important.

Chinook salmon are exposed to high rates of natural predation, during freshwater rearing and migration stages, as well as during ocean migration. In general, Chinook salmon are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the increasing size of tern, seal, and sea lion populations in the Pacific Northwest may have reduced the survival of some salmon ESUs.

Dependence on Waters of the United States

Chinook salmon survive only in aquatic ecosystems and, therefore, depend on the quantity and quality of those aquatic systems. Chinook salmon, like the other salmon NMFS has listed, have declined under the combined effects of overharvests in fisheries; competition from fish raised in hatcheries and native and non-native exotic species; dams that block their migrations and alter river hydrology; gravel mining that impedes their migration and alters the dynamics (hydrogeomorphology) of the rivers and streams that support juveniles; water diversions that deplete water levels in rivers and streams; destruction or degradation of riparian habitat that increase water temperatures in rivers and streams sufficient to reduce the survival of juvenile Chinook salmon; and land use practices (logging, agriculture, urbanization) that destroy wetland and riparian ecosystems while introducing sediment, nutrients, biocides, metals, and other pollutants into surface and ground water and degrade water quality in the freshwater, estuarine, and coastal ecosystems throughout the Pacific Northwest.

Puget Sound Chinook salmon

Distribution. The boundaries of the Puget Sound ESU correspond generally with the boundaries of the Puget Lowland Ecoregion, and include all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound, and the Strait of Georgia in Washington (70 FR 37160). The Puget Sound ESU comprises 38 historic populations, of which 22 are believed to be extant. Chinook salmon in this area generally have an “ocean-type” life history. Twenty-six hatchery populations were determined to be no more genetically divergent relative to local populations than what would normally be expected between closely related populations within the ESU.

Status. Puget Sound Chinook salmon were listed as threatened in 1999 (64 FR 14308); that status was re-affirmed on June 28, 2005 (70 FR 37160). Five geographic recovery regions are identified for this ESU and two to four reproducing populations within each region must have a low risk of extinction for the ESU to be viable. Long term trends in abundance and median population growth rates for naturally spawning populations of Puget Sound Chinook salmon indicate that 12 of the populations are declining and 10 are increasing in abundance over the length of available time series. Eight of 22 populations are declining over the short-term, compared to 12 populations that have long-term declines (Ford *et al.* 2010). Widespread declines and extirpations of spring- and summer-run Puget Sound Chinook populations represent a significant reduction in the life history diversity of this ESU (Myers *et al.* 1998).

The estimated peak run size of Chinook salmon in Puget Sound since 1990 was 152,000 fish, representing a loss of nearly 540,000 fish from historic numbers. During a recent five-year period, the geometric mean of natural spawners in populations of Puget Sound Chinook salmon ranged from 81 to just over 10,345 fish. Most populations had natural spawners numbering in the hundreds between 2005 and 2009 (median recent natural escapement is 909); however, 2009 natural spawners were the lowest since 1997. Estimates of the historical equilibrium abundance, based on pre-European settlement habitat conditions, range from 1,700 to 51,000 potential Puget Sound Chinook salmon spawners per population. The historical estimates of spawner capacity are several orders of magnitude higher than spawner abundances currently observed throughout the ESU (Good *et al.* 2005). The most recent 5-year estimate (2002-2006) of 0.65 spawners produced per spawner are the lowest observed since monitoring began in 1982.

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). The critical habitat designation for this ESU identifies PCEs that include sites necessary to support one or more Chinook salmon life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Of 49 sub-basins (5th field Hydrological Units) reviewed in NMFS' assessment of critical habitat for the Puget Sound ESUs, nine sub-basins were rated as having a medium conservation value, 12 were rated as low, and the remaining sub-basins (40), where the bulk of Federal lands occur in this ESU, were rated as having a high conservation value to Puget Sound Chinook salmon. Factors contributing to the downward trends in this ESU are hydromorphological changes (such as diking, revetments, loss of secondary channels in floodplains, widespread blockages of streams, and changes in peak flows), degraded freshwater and marine habitat affected by agricultural activities, urbanization, and poor forest practices. Changes in habitat quantity, availability, diversity, flow, temperature, sediment load, and channel stability are common limiting factors in areas of critical habitat.

Lower Columbia River Chinook salmon

Distribution. Lower Columbia River (LCR) Chinook salmon includes all naturally-spawned populations of Chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon, east of the Hood River and the White Salmon River, and includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River. Seventeen artificial propagation programs are also listed. The predominant life history type for this species is the

fall-run, which consists of an early component that returns to the Columbia River in mid-August and spawns within a few weeks (Kostow 1995).

Status. LCR Chinook salmon were originally listed as threatened on March 24, 1999, and reaffirmed as threatened on June 28, 2005. Historical records of Chinook salmon abundance are sparse, but cannery records suggest a peak run of 4.6 million fish (43 million pounds [see Lichatowich 1999]) in 1883. This ESU is composed of three runs: fall (“tules”), late fall (“brights”), and spring. Although fall-run Chinook salmon are still present throughout much of their historical range, they are still subject to large-scale hatchery production, relatively high harvest, and extensive habitat degradation. The Lower Columbia Fish Recovery Board and Oregon Department of Fish and Wildlife finished recovery plans for the LCR Chinook salmon in 2010 (LCFRB 2010, ODFW 2010), finding 20 of 21 populations of fall run Chinook salmon are at “very high risk” of extinction with the Clatskanie population being either “high risk” or “very high risk.” Eight of the nine spring Chinook salmon populations in this ESU are at “very high risk” of extinction, while the Sandy population was at “moderate” or “high” risk of extinction. The two populations of late fall Chinook salmon, Lewis and Sandy Rivers, were determined to be at “very low risk” and “low risk” of extinction, respectively. Abundances largely declined during 1998 to 2000, increased slightly in the early 2000s, and then declined to near 2000 levels in 2009. Trend indicators for most populations are negative, especially if hatchery fish are assumed to have a reproductive success equivalent to that of natural-origin fish.

New data acquired for the Good *et al.* (2005) report, and updated in the Ford *et al.* (2010) report includes spawner abundance estimates through 2001, new estimates of the fraction of hatchery spawners, and harvest estimates. There are 32 historical spawning populations in this ESU and 28 of them are extirpated or at “very high risk” of being extirpated. Near loss of both fall runs and spring runs remains an important concern. High hatchery production continues to pose genetic and ecological risks to natural populations and to mask their performance. Generally, LCR Chinook salmon populations in 2009 are not significantly changed from levels seen in 2000.

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). The critical habitat designation for this ESU identifies PCEs that include sites necessary to support one or more Chinook salmon life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Of 48 sub-basins reviewed in NMFS' assessment of critical habitat for the LCR Chinook salmon ESU, 13 sub-basins were rated as having a medium conservation value, 4 were rated as low, and the remaining sub-basins (31), were rated as having a high conservation value to LCR Chinook salmon. Federal lands were generally rated as having high conservation value to the species.

Factors contributing to the downward trends in this ESU are hydromorphological changes resulting from hydropower development, loss of tidal marsh and swamp habitat, and degraded freshwater and marine habitat from industrial harbor and port development, urbanization, logging, and agricultural development (Ford *et al.* 2010). Limiting factors identified for this

species include: (1) Reduced access to spawning/rearing habitat in tributaries, (2) hatchery impacts, (3) loss of habitat diversity and channel stability in tributaries, (4) excessive fine sediment in spawning gravels, (5) elevated water temperature in tributaries, and (6) harvest impacts.

Upper Columbia River spring-run Chinook salmon

Distribution. The Upper Columbia River (UCR) spring-run Chinook salmon ESU includes naturally spawning spring-run Chinook salmon in the major tributaries entering the Columbia River upstream of Rock Island Dam and the associated hatchery programs (70 FR 37160). They currently spawn in only three river basins above Rock Island Dam: the Wenatchee, Entiat, and Methow Rivers. Several hatchery populations are also listed including those from the Chiwawa, Methow, Twisp, Chewuch, and White rivers, and Nason Creek.

Status. UCR spring-run Chinook salmon were listed as endangered on March 24, 1999, and reaffirmed as endangered on June 28, 2005, because they had been reduced to small populations in three watersheds. Based on redd count data series, carcasses, and passage over Tumwater Dam on the Wenatchee River, populations of UCR spring-run Chinook salmon reached a critically low point in 1994 and the population has been gradually increasing through 2008. In the most recent 5-year geometric mean (2003 to 2008), spawning escapements were 489 for the Wenatchee population, 111 for the Entiat population, and 402 for the Methow population. Population viability assessments conducted in 2008 suggest UCR spring-run Chinook salmon in the remaining three rivers supporting their populations are at high risk due to low abundance, lack of productivity, lack of diversity, and lack of spatial structure (Ford *et al.* 2010). Overall, the ESU has likely improved since 2001 monitoring, but remains at a moderate to high risk of extinction in the next 100 years.

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). The critical habitat designation for this ESU identifies PCEs that include sites necessary to support one or more Chinook salmon life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. The UCR Spring-run Chinook salmon ESU has 31 watersheds within its range. Five watersheds received a medium rating and 26 received a high rating of conservation value to the ESU. The Columbia River rearing/migration corridor downstream of the spawning range was rated as a high conservation value. Factors contributing to the downward trends in this ESU include: (1) mainstem Columbia River hydropower system mortality, (2) tributary riparian degradation and loss of in-river wood, (3) altered tributary floodplain and channel morphology, (4) reduced tributary stream flow and impaired passage, and (5) harvest impacts.

Upper Willamette River Chinook salmon

Distribution. The ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River, and its tributaries, above Willamette Falls, Oregon, as well as seven artificial propagation programs: the McKenzie River Hatchery (Oregon Department of Fish and Wildlife (ODFW) stock #24), Marion Forks/North Fork Santiam River (ODFW stock #21), South Santiam Hatchery (ODFW stock #23) in the South Fork Santiam

River, South Santiam Hatchery in the Calapooia River, South Santiam Hatchery in the Mollala River, Willamette Hatchery (ODFW stock #22), and Clackamas hatchery (ODFW stock #19) spring-run Chinook hatchery programs. The Upper Willamette spring-run Chinook salmon are one of the most genetically distinct Chinook salmon groups in the Columbia River Basin. Fall-run Chinook salmon spawn in the Upper Willamette but are not considered part of the species because they are not native.

Status. Upper Willamette River Chinook salmon were listed as threatened on March 24, 1999, and reaffirmed as threatened on June 28, 2005. The total abundance of adult spring-run Chinook salmon (hatchery-origin + natural-origin fish) passing Willamette Falls has remained relatively steady over the past 50 years (ranging from approximately 20,000 to 70,000 fish), but it is an order of magnitude below the peak abundance levels observed in the 1920s (approximately 300,000 adults). Between 2005 and 2010, all but one year (2010) produced fewer than 40,000 fish returning to the Upper Willamette River ESU, a distinct downtrend from 2000-2004, which had all five years at or above 2005-2009 return levels.

Most natural spring Chinook salmon populations are likely extirpated or nearly so (McElhany *et al.* 2007), with only seven rivers supporting reproduction and two remaining low and moderate risk populations, the Clackamas and McKenzie Rivers, respectively, identified in this ESU. The Willamette Lower Columbia Technical Review Team (WLC TRT) determined this ESU was not viable based on a viability scale of 0-4, where a viable population scored above a 2.25. The Upper Willamette spring-run Chinook salmon ESU scored 0.71. This is supported by other publications that have determined this ESU is supported by hatchery spawning and likely not self-sustaining (Schroeder *et al.* 2005, McElhany *et al.* 2007, Schroeder *et al.* 2007, ODFW 2010). The primary concerns for this ESU are low abundance, high fraction of hatchery-origin spawners, and loss of quality spawning habitat (Ford *et al.* 2010). Natural spawner abundance in this population up to 2004 had been relatively low, but between 2005 and 2009, the geometric mean of natural return spawners has fallen below 2,000. Despite reduced natural spawners, hatchery returns have increased. Although the number of adult spring-run Chinook salmon crossing Willamette Falls is in the same range (about 40,000 adults) it has been for the last 50 years, a large fraction of these are hatchery produced. Of concern is that a majority of the spawning habitat and approximately 30 to 40% of total historical habitat are no longer accessible because of dams (Good *et al.* 2005).

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). The critical habitat designation for this ESU identifies PCEs that include sites necessary to support one or more Chinook salmon life stages. Specific sites include freshwater spawning and rearing sites, freshwater migration corridors. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Of 60 sub-basins reviewed in NMFS' assessment of critical habitat for the Upper Willamette River Chinook salmon ESU, 18 sub-basins were rated as having a medium conservation value, 19 were rated as low, and the remaining sub-basins (23), were rated as having a high conservation value to Upper Willamette River Chinook salmon. Federal lands were generally rated as having high conservation value to the species' spawning and rearing. Factors contributing to the downward trends in this ESU include: (1) Reduced access to spawning/rearing habitat in tributaries, (2) hatchery impacts, (3)

altered water quality and temperature in tributaries, (4) altered stream flow in tributaries, and (5) lost/degraded floodplain connectivity and lowland stream habitat.

Snake River spring/summer-run Chinook salmon

Distribution. This species occupies the Snake River basin, which drains portions of southeastern Washington, northeastern Oregon, and north/central Idaho. Environmental conditions are generally drier and warmer in these areas than in areas occupied by other Chinook species. The Snake River Spring-Summer Chinook salmon ESU includes all naturally spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River sub-basins, as well as fifteen artificial propagation programs. Juvenile fish mature in fresh water for one year before they migrate to the ocean in the spring of their second year.

Status. Snake River spring/summer-run Chinook salmon were originally listed as threatened on April 22, 1992, and were reaffirmed as threatened on June 28, 2005. Although direct estimates of historical annual Snake River spring/summer Chinook returns are not available, returns may have declined by over 90% between the late 1800s and 2010. According to Matthews and Waples (1991), total annual Snake River spring/summer Chinook production may have exceeded 1.5 million adult fish in the late 1800s. Total (natural plus hatchery origin) returns fell to roughly 100,000 spawners by the late 1960s (Fulton 1968) and were below 10,000 by 1980. Between 1981 and 2000, total returns fluctuated between extremes of 1,800 and 44,000 fish. The most recent five year geometric mean (2005-2009) suggests approximately 7,640 total Snake River spring/summer Chinook salmon spawners. The 1997 to 2001 geometric mean total return for the summer run component was slightly more than 6,000 fish, compared to the geometric mean of 3,076 fish for the years 1987 to 1996. Good *et al.* (2005) reported that risks to individual populations within the ESU may be greater than the extinction risk for the entire ESU due to low levels of annual abundance and the extensive production areas within the Snake River basin.

The Interior Columbia Basin Technical Recovery Team (ICBTRT) has identified 27 extant populations and 4 extirpated populations in 5 major population groups (Upper Salmon River, South Fork Salmon River, Middle Fork Salmon River, Grande Ronde/Imnaha, Lower Snake Mainstem Tributaries) for this species. Historic populations above Hells Canyon Dam are considered extinct (ICBTRT 2003). Thus, despite the recent increases in total spring/summer-run Chinook salmon returns to the basin, natural origin abundance and productivity are still below their targets. Snake River spring/summer Chinook salmon remains likely to become endangered (Good *et al.* 2005).

Critical habitat. Critical habitat for these salmon was designated on October 25, 1999. This critical habitat encompasses the waters, waterway bottoms, and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to listed Snake River salmon (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams). Adjacent riparian zones are defined as those areas within a horizontal distance of 300 feet from the normal line of high water of a stream channel or from the shoreline of a standing body of water. Designated critical habitat includes the Columbia River from a straight line connecting the west end of the Clatsop jetty (Oregon side) and the west end of the Peacock

jetty (Washington side) and including all river reaches from the estuary upstream to the confluence of the Snake River, and all Snake River reaches upstream to Hells Canyon Dam; the Palouse River from its confluence with the Snake River upstream to Palouse Falls, the Clearwater River from its confluence with the Snake River upstream to its confluence with Lolo Creek; the North Fork Clearwater River from its confluence with the Clearwater river upstream to Dworshak Dam. Critical habitat also includes several river reaches presently or historically accessible to Snake River spring/summer Chinook salmon. Limiting factors identified for this species include: (1) hydrosystem mortality, (2) reduced stream flow, (3) altered channel morphology and floodplain, (4) excessive fine sediment, (5) degraded water quality (NMFS 2006).

Snake River fall-run Chinook salmon

Distribution. The Snake River fall Chinook salmon ESU includes fish spawning in the lower mainstem of the Snake River and the lower reaches of several of the associated major tributaries including the Tucannon, the Grande Ronde, Clearwater, Salmon and Imnaha Rivers (70 FR 37160). Historically, this ESU included two large additional populations spawning in the mainstem of the Snake River upstream of the Hells Canyon Dam complex. The spawning and rearing habitat associated with the current extant population represents approximately 20% of the total historical habitat available to the ESU (Double 2000). Adult Snake River fall-run Chinook salmon enter the Columbia River in July and August. Spawning occurs from October through November. Juveniles emerge from the gravels in March and April of the following year, moving downstream from natal spawning and early rearing areas from June through early fall.

Status. Snake River fall-run Chinook salmon were originally listed as endangered in 1992 but were reclassified as threatened on June 28, 2005. The ICBTRT has defined only one extant population for the Snake River fall-run Chinook salmon, the lower Snake River mainstem population. Estimated annual returns for the period 1938 to 1949 was 72,000 fish, and by the 1950s, numbers had declined to an annual average of 29,000 fish (Bjornn and Horner 1980). Numbers of Snake River fall-run Chinook salmon continued to decline during the 1960s and 1970s as approximately 80% of their historic habitat was eliminated or severely degraded by the construction of the Hells Canyon complex (1958 to 1967) and the lower Snake River dams (1961 to 1975). Counts of natural-origin adult Snake River fall-run Chinook salmon at Lower Granite Dam were 1000 fish in 1975, ranged from 78 to 905 fish (with an average of 489 fish) over the ensuing 25-year period (Good *et al.* 2005), and increased to an average of 2880 between 2000-2003. The most recent five year geometric mean for the Snake River fall Chinook salmon ESU is 11,321.

Snake River fall-run Chinook salmon have exhibited an upward trend in returns over Lower Granite Dam since the mid 1990s. Both the long (6%) and short-term (16%) growth trends in natural returns are positive. Harvest impacts on Snake River fall Chinook salmon declined after listing and have remained relatively constant in recent years. There have been major reductions in fisheries impacting this stock. Mainstem conditions for sub-yearling Chinook migrants from the Snake River have generally improved since the early 1990s. Snake River fall Chinook salmon are considered at moderate risk (6 to 25%) of extinction in the next 100 years (Ford *et al.* 2010).

Critical habitat. Critical habitat for these salmon was designated on December 28, 1993. This critical habitat encompasses the waters, waterway bottoms, and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to listed Snake River salmon (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams). Adjacent riparian zones are defined as those areas within a horizontal distance of 300 feet from the normal line of high water of a stream channel or from the shoreline of a standing body of water. Designated critical habitat includes the Columbia River from a straight line connecting the west end of the Clatsop jetty (Oregon side) and the west end of the Peacock jetty (Washington side) and including all river reaches from the estuary upstream to the confluence of the Snake River, and all Snake River reaches upstream to Hells Canyon Dam. Critical habitat also includes several river reaches presently or historically accessible to Snake River fall-run Chinook salmon. Limiting factors identified for Snake River fall-run Chinook salmon include: (1) Mainstem lower Snake and Columbia hydrosystem mortality, (2) degraded water quality, (3) reduced spawning and rearing habitat due to mainstem lower Snake River hydropower system, and (4) harvest impacts.

Central Valley spring-run Chinook salmon

Distribution. The Central Valley Spring-run Chinook salmon includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California, including the Feather River, as well as the Feather River Hatchery spring-run Chinook program. This species includes Chinook salmon entering the Sacramento River from March to July and spawning from late August through early October, with a peak in September. Spring-run fish in the Sacramento River exhibit an ocean-type life history, emigrating as fry, sub-yearlings, and yearlings.

Status. Central Valley spring-run Chinook salmon were listed as threatened on September 16, 1999, a classification this species retained when the original listing was reviewed on June 28, 2005. This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. This species was listed because dams isolate them from most of their historic spawning habitat and the habitat remaining to them is degraded. Within this ESU, 18 or 19 independent populations and a small number of dependent populations have been identified within four diversity groups (Williams *et al.* 2011). However, only three independent populations are extant and all are within the Northern Sierra Nevada diversity group.

Historically, spring-run Chinook salmon were predominant throughout the Central Valley occupying the upper and middle reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit Rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and the 1940s (DFG 1998). Before construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry 1961). Following the completion of Friant Dam, the native population from the San Joaquin River and its tributaries (*i.e.*, the Stanislaus and Mokelumne Rivers) was extirpated. Spring-run Chinook salmon no longer exist in the American River due to the operation of Folsom Dam. Naturally spawning populations of Central Valley spring-run Chinook salmon

currently are restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (DFG 1998). Since 1969, the Central Valley spring-run Chinook salmon ESU (excluding Feather River fish) has displayed broad fluctuations in abundance ranging from 25,890 in 1982 to 1,403 in 1993 (DFG unpublished data).

The average abundance for the ESU was 12,499 for the period of 1969 to 1979, 12,981 for the period of 1980 to 1990, and 6,542 for the period of 1991 to 2001. In 2003 and 2004, total run size for the ESU was 8,775 and 9,872 adults respectively, well above the 1991 to 2001 average. However, declines since 2006 have led to an increased risk of extinction (Williams *et al.* 2011).

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). The critical habitat designation for this ESU identifies PCEs that include sites necessary to support one or more Chinook salmon life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Factors contributing to the downward trends in this ESU include: reduced access to spawning/rearing habitat behind impassable dams, climatic variation, water management activities, hybridization with fall-run Chinook salmon, predation, and harvest have all impacted spring-run Chinook salmon critical habitat and population numbers (DFG 1998). Several actions have been taken to improve and increase the PCEs of critical habitat for spring-run Chinook salmon, including improved management of Central Valley water (*e.g.*, through use of CALFED EWA and CVPIA (b)(2) water accounts), implementing new and improved screen and ladder designs at major water diversions along the mainstem Sacramento River and tributaries, removal of several small dams on important spring-run Chinook salmon spawning streams, and changes in ocean and inland fishing regulations to minimize harvest. Although protective measures and critical habitat restoration likely have contributed to recent increases in spring-run Chinook salmon abundance, the ESU is still below levels observed from the 1960s through 1990. Threats from hatchery production (*i.e.*, competition for food between naturally spawned and hatchery fish, and run hybridization and homogenization), climatic variation, reduced stream flows, high water temperatures, predation, and large scale water diversions persist.

California Coastal Chinook salmon

Distribution. CC Chinook salmon includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River to the Russian River, California, as well as seven artificial propagation programs: the Humboldt Fish Action Council (Freshwater Creek), Yager Creek, Redwood Creek, Hollow Tree, Van Arsdale Fish Station, Mattole Salmon Group, and Mad River Hatchery fall-run Chinook hatchery programs. CC Chinook salmon are a fall-run, ocean-type fish. A spring-run (river-type) component existed historically, but is now considered extinct (Bjorkstedt *et al.* 2005).

Status. CC Chinook salmon were listed as threatened on September 16, 1999, and retained that listing upon review on June 28, 2005, because of the combined effect of dams that prevent them from reaching spawning habitat, logging, agricultural activities, urbanization, and water withdrawals in the river drainages that support them. The ESU contained 10 independent and 5

dependent runs of fall Chinook salmon along with 6 independent runs of spring Chinook salmon. Of those, all spring Chinook salmon are believed to be extinct, 6 of the 10 independent populations of fall Chinook salmon are either at high risk of extirpation or are extirpated, one independent population is at moderate or high risk of extinction, and the remaining 3 independent fall Chinook populations are data deficient (Williams *et al.* 2011).

Historical estimates of escapement, based on professional opinion and evaluation of habitat conditions, suggest abundance was roughly 73,000 in the early 1960s with the majority of fish spawning in the Eel River (see California Fish and Game 1965 in Good *et al.* 2005). The species exists as small populations with highly variable cohort sizes. The Russian River probably contains some natural production, but the origin of those fish is not clear because of a number of introductions of hatchery fish over the last century. The Eel River contains a substantial fraction of the remaining Chinook salmon spawning habitat for this species. Since its original listing and status review, little new data are available or suitable for analyzing trends or estimating changes in this population's growth rate (Good *et al.* 2005, Williams *et al.* 2011); however, NMFS is concerned by several factors: 1) all Chinook salmon have been lost from one diversity stratum, 2) the only extant population in the southernmost diversity stratum is at the southern end of this ESU in the Russian River, 3) the resulting loss of connectivity between populations in the ESU because of the distance between the Mattole and Russian Rivers, and 4) all spring-run Chinook salmon in this ESU have been extirpated.

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). The critical habitat designation for this ESU identifies PCEs that include sites necessary to support one or more Chinook salmon life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Critical habitat in this ESU consists of limited quantity and quality summer and winter rearing habitat, as well as marginal spawning habitat. Compared to historical conditions, there are fewer pools, limited cover, and reduced habitat complexity. The limited instream cover that does exist is provided mainly by large cobble and overhanging vegetation. Instream large woody debris, needed for foraging sites, cover, and velocity refuges is especially lacking in most of the streams throughout the basin. NMFS has determined that these degraded habitat conditions are, in part, the result of many human-induced factors affecting critical habitat including: dam construction, agricultural and mining activities, urbanization, stream channelization, water diversion and logging among others.

Chum Salmon

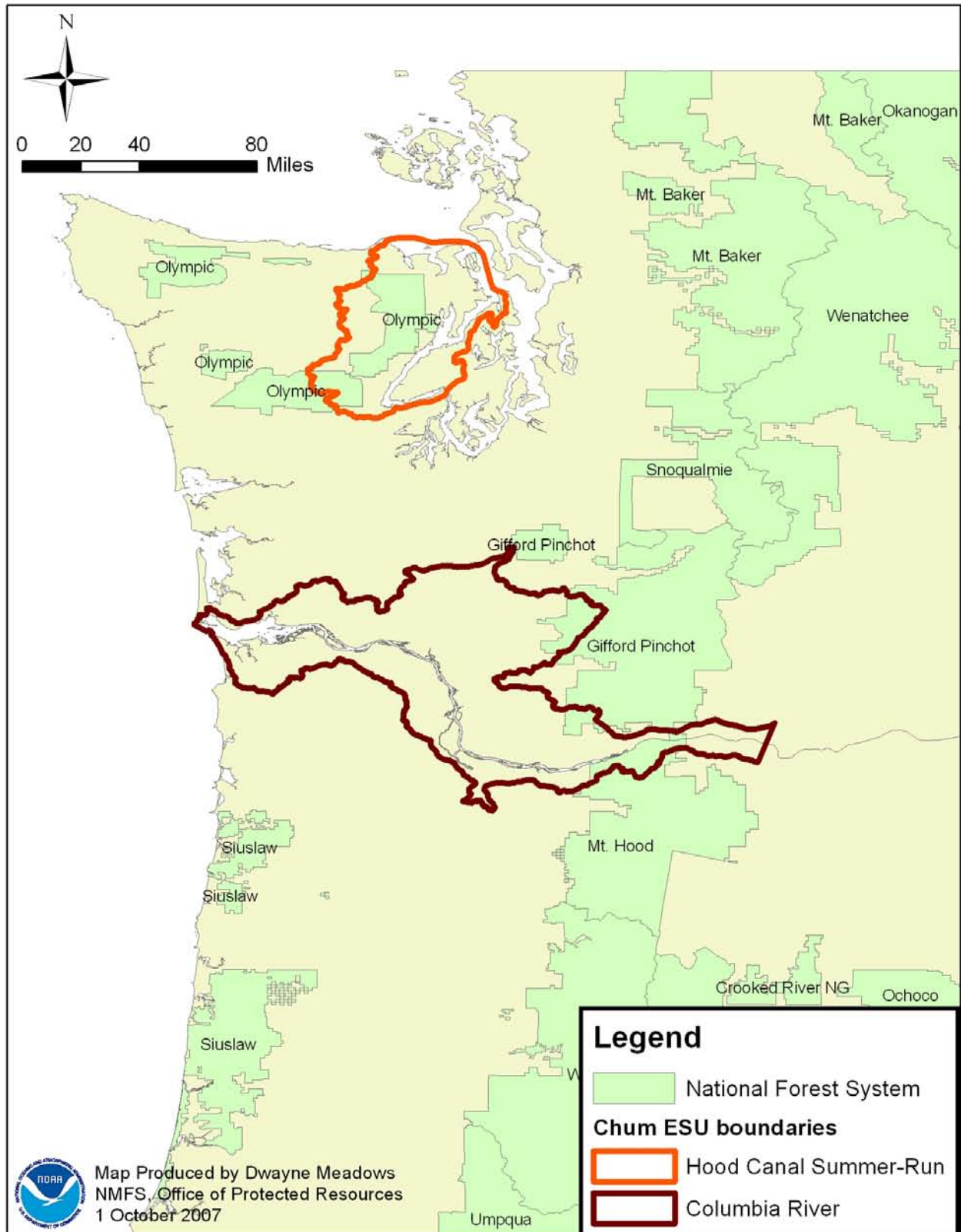
Historically, chum salmon were distributed throughout the coastal regions of western Canada and the United States, as far south as Monterey Bay, California. Presently, major spawning populations are found only as far south as Tillamook Bay on the northern Oregon coast. Figure 3 is a depiction of the distribution of the two threatened chum salmon ESUs relative to Forest Service boundaries.

Chum salmon are semelparous, spawn primarily in freshwater and, apparently, exhibit obligatory anadromy (there are no recorded landlocked or naturalized freshwater populations). Chum salmon spend two to five years in feeding areas in the northeast Pacific Ocean, which is a greater proportion of their life history than other Pacific salmonids. Chum salmon distribute throughout the North Pacific Ocean and Bering Sea, although North American chum salmon (as opposed to chum salmon originating in Asia), rarely occur west of 175°E longitude.

North American chum salmon migrate north along the coast in a narrow coastal band that broadens in southeastern Alaska, although some data suggest that Puget Sound chum, including Hood Canal summer run chum, may not make extended migrations into northern British Columbian and Alaskan waters, but instead may travel directly offshore into the north Pacific Ocean.

Chum salmon, like pink salmon, usually spawn in the lower reaches of rivers, with redds usually dug in the mainstem or in side channels of rivers from just above tidal influence to nearly 100 kilometers from the sea. Juveniles out-migrate to seawater almost immediately after emerging from the gravel that covers their redds (Salo 1991). This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus *Oncorhynchus* (e.g., coastal cutthroat trout, steelhead, coho salmon, and most types of Chinook and sockeye salmon), which usually migrate to sea at a larger size, after months or years of freshwater rearing. This means that survival and growth in juvenile chum salmon depend less on freshwater conditions (unlike stream-type salmonids which depend heavily on freshwater habitats) than on favorable estuarine conditions. Another behavioral difference between chum salmon and species that rear extensively in freshwater is that chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

Figure 3. US Forest Service Boundaries and Listed Chum Salmon Distributions



Chum salmon have been threatened by over harvests in commercial and recreational fisheries, adult and juvenile mortalities associated with hydropower systems, habitat degradation from forestry and urban expansion, and shifts in climatic conditions that changed patterns and intensity of precipitation.

Dependence on Waters of the United States

Chum salmon survive only in aquatic ecosystems and depend on the quantity and quality of those aquatic systems. Chum salmon, like the other salmon NMFS has listed, have declined under the combined effects of overharvests in fisheries; competition from fish raised in hatcheries and native and non-native exotic species; dams that block their migrations and alter river hydrology; gravel mining that impedes their migration and alters the dynamics (hydrogeomorphology) of the rivers and streams that support juveniles; water diversions that deplete water levels in rivers and streams, destruction or degradation of riparian habitat that increase water temperatures in rivers and streams sufficient to reduce the survival of juvenile chum salmon; and land use practices (logging, agriculture, urbanization) that destroy wetland and riparian ecosystems while introducing sediment, nutrients, biocides, metals, and other pollutants into surface and ground water and degrade water quality in the freshwater, estuarine, and coastal ecosystems throughout the Pacific Northwest.

Columbia River chum salmon

Distribution. The ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon, as well as three artificial propagation programs: the Chinook River (Sea Resources Hatchery), Grays River, and Washougal River/Duncan Creek chum salmon hatchery programs. The species consists of three populations: Grays River, Hardy, and Hamilton Creek in Washington State.

Status. Columbia River chum salmon were listed as threatened on March 25, 1999, and their threatened status was reaffirmed on June 28, 2005. Chum salmon in the Columbia River once numbered in the hundreds of thousands of adults and were reported in almost every river in the Lower Columbia River basin, but by the 1950s most runs disappeared (Rich 1942, Marr 1943, Fulton 1970). The total number of chum salmon returning to the Columbia River in the last 50 years has averaged a few thousand per year, with returns limited to a very restricted portion of the historical range. Significant spawning occurs in only three of the 17 historical populations, meaning that 88% of the historical populations are extirpated, or nearly so (Ford *et al.* 2010). The three remaining populations are the Washougal, Grays River, and the Lower Gorge (Ford *et al.* 2010). Chum salmon appear to be extirpated from the Oregon portion of this ESU. In 2000, ODFW conducted surveys to determine the abundance and distribution of chum salmon in the Columbia River, and out of 30 sites surveyed only one chum salmon was observed.

Historically, the Columbia River chum salmon supported a large commercial fishery in the first half of this century which landed more than 500,000 fish per year as recently as 1942. Commercial catches declined beginning in the mid-1950s, and in later years rarely exceeded 2,000 per year. During the 1980s and 1990s, the combined abundance of natural spawners for the Lower Gorge, Washougal, and Grays River populations was below 4,000 adults. In 2002, however, the abundance of natural spawners exhibited a substantial increase at several locations

(estimate of natural spawners is approximately 20,000 adults). Since 2002, abundances have declined back to the range observed over the previous several decades (Ford *et al.* 2010). Overall, the populations that remain have low abundance, limited distribution, and poor connectivity (Good *et al.* 2005).

Critical habitat. Critical habitat was originally designated for this on February 16, 2000 (65 FR 7764) and was re-designated on September 2, 2005 (70 FR 52630). The critical habitat designation for this ESU identifies PCEs that include sites necessary to support one or more chum salmon life stages. Columbia River chum salmon have PCEs of 1) freshwater spawning, 2) freshwater rearing, 3) freshwater migration, 4) estuarine areas free of obstruction, 5) nearshore marine areas free of obstructions, and 6) offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Of 20 sub-basins reviewed in NMFS' assessment of critical habitat for the Columbia River chum salmon ESU, three sub-basins were rated as having a medium conservation value, no sub-basins were rated as low, and the majority of sub-basins (17), were rated as having a high conservation value to Columbia River chum salmon. The downstream rearing/migration corridor is also considered to have high conservation value. Washington's Federal lands were rated as having high conservation value to the species. The major factors limiting recovery for Columbia River chum salmon are altered channel form and stability in tributaries, excessive sediment in tributary spawning gravels, altered stream flow in tributaries and the mainstem Columbia River, loss of some tributary habitat types, and harassment of spawners in the tributaries and mainstem.

Hood Canal summer-run Chum salmon

Distribution. The ESU includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington, as well as eight artificial propagation programs: the Quilcene NFH, Hamma Hamma Fish Hatchery, Lilliwaup Creek Fish Hatchery, Union River/Tahuya, Big Beef Creek Fish Hatchery, Salmon Creek Fish Hatchery, Chimacum Creek Fish Hatchery, and the Jimmycomelately Creek Fish Hatchery summer-run chum hatchery programs. NMFS determined that these artificially propagated stocks are no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the species.

Status. Hood Canal summer-run chum salmon were listed as threatened on March 25, 1999, and reaffirmed as threatened on June 28, 2005. The recent five-year mean abundance is 5,433 and 13,903 total spawners for Strait of Juan de Fuca and Hood Canal populations, respectively. Hood Canal summer-run chum are the focus of an extensive rebuilding program developed and implemented since 1992 by the state and tribal co-managers. The recent abundances show an increasing population since listing occurred, but the most recent five year geometric mean population is lower than the population during the previous five year period. Productivity has also declined, with the productivity of brood years 2002-2006 the lowest since measurements began in 1971 (Ford *et al.* 2010).

Of an estimated 18 historical populations in the ESU, seven populations are believed to have been extirpated or nearly extirpated. Most of these extirpations have occurred in populations on

the eastern side of Hood Canal, generating additional concern for ESU spatial structure. The widespread loss of estuary and lower floodplain habitat was noted by the biological review team (BRT) as a continuing threat to ESU spatial structure and connectivity. There is some concern that the Quilcene hatchery stock is exhibiting high rates of straying, and may represent a risk to historical population structure and diversity. However, with the extirpation of many local populations, much of this historical structure has been lost, and the use of Quilcene hatchery fish may represent one of a few remaining options for Hood Canal summer-run chum conservation.

Of the eight programs releasing summer chum salmon that are considered to be part of the Hood Canal summer chum ESU, six of the programs are supplementation programs implemented to preserve and increase the abundance of native populations in their natal watersheds. NMFS' assessment of the effects of artificial propagation on ESU extinction risk concluded that these hatchery programs collectively do not substantially reduce the extinction risk of the ESU. The hatchery programs are reducing risks to ESU abundance by increasing total ESU abundance as well as the number of naturally spawning summer-run chum salmon. Several of the programs have likely prevented further population extirpations in the ESU. The contribution of ESU hatchery programs to the productivity of the ESU in-total is uncertain. The hatchery programs are benefiting ESU spatial structure by increasing the spawning area utilized in several watersheds and by increasing the geographic range of the ESU through reintroductions. These programs also provide benefits to ESU diversity. By bolstering total population sizes, the hatchery programs have likely stemmed adverse genetic effects for populations at critically low levels. Additionally, measures have been implemented to maintain current genetic diversity, including the use of native broodstock and the termination of the programs after 12 years of operation to guard against long-term domestication effects. Hatchery releases of chum salmon have declined since 2005, coinciding with the highest genetic robustness measured since monitoring began in the 1970s. Collectively, artificial propagation programs in the ESU presently provide a slight beneficial effect to ESU abundance, spatial structure, and diversity, but uncertain effects to ESU productivity.

Critical habitat. Critical habitat for this species was designated on September 2, 2005. Hood Canal summer-run chum salmon have PCEs of 1) freshwater spawning, 2) freshwater rearing, 3) freshwater migration, 4) estuarine areas free of obstruction, 5) nearshore marine areas free of obstructions, and 6) offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Of 12 sub-basins reviewed in NMFS' assessment of critical habitat for the Hood Canal chum salmon ESU, nine sub-basins were rated as having a high conservation value, while only three were rated as having a medium value to the conservation. In addition to these 12 sub-basins, five nearshore marine areas were also considered to have a high conservation value. Limiting factors identified for this species include: (1) Degraded floodplain and mainstem river channel structure, (2) Degraded estuarine conditions and loss of estuarine habitat, (3) Riparian area degradation and loss of in-river wood in mainstem, (4) Excessive sediment in spawning gravels, (5) reduced stream flow in migration areas.

Coho Salmon

Coho salmon occur naturally in most major river basins around the North Pacific Ocean from central California to northern Japan (Laufle *et al.* 1986). Figure 4 is a depiction of the distribution of the three threatened and endangered coho salmon ESUs relative to Forest Service boundaries. After entering the ocean, immature coho salmon initially remain in near-shore waters close to the parent stream. Most coho salmon adults are 3-year-olds, having spent approximately 18 months rearing in freshwater and 18 months in salt water. Most coho salmon enter rivers between September and February, but entry is influenced by discharge and other factors. In many systems, coho salmon and other Pacific salmon are unable to enter the rivers until sufficiently strong flows open passages and provide sufficient depth. Wild female coho return to spawn almost exclusively at age three. Coho salmon spawn from November to January, and occasionally into February and March. Spawning occurs in a few third-order streams must spawning activity occurs in fourth- and fifth-order streams. Spawning generally occurs in tributaries with gradients of 3% or less.

Eggs incubate for about 35 to 50 days, and start emerging from the gravel two to three weeks after hatching. Following emergence, fry move to shallow areas near the stream banks. As fry grow, they disperse upstream and downstream to establish and defend territories. Juvenile rearing usually occurs in tributaries with gradients of three percent or less, although they may move to streams with gradients of four to five percent. Juvenile coho salmon are often found in small streams less than five feet wide, and may migrate considerable distances to rear in lakes and off-channel ponds. During the summer, fry prefer pools featuring adequate cover such as large woody debris, undercut banks, and overhanging vegetation. Overwintering tends to occur in larger pools and backwater areas.

North American coho salmon will migrate north along the coast in a narrow coastal band that broadens in southeastern Alaska. During this migration, juvenile coho salmon tend to occur in both coastal and offshore waters. During spring and summer, coho salmon will forage in waters between 46° N, the Gulf of Alaska, and along Alaska's Aleutian Islands.

Dependence on Waters of the United States

Coho salmon survive only in aquatic ecosystems and depend on the quantity and quality of those aquatic systems. Coho salmon, like the other salmon NMFS has listed, have declined under the combined effects of overharvests in fisheries; competition from fish raised in hatcheries and native and non-native exotic species; dams that block their migrations and alter river hydrology; gravel mining that impedes their migration and alters the dynamics (hydrogeo-morphology) of the rivers and streams that support juveniles; water diversions that deplete water levels in rivers and streams, destruction or degradation of riparian habitat that increase water temperatures in rivers and streams sufficient to reduce the survival of juvenile chum salmon; and land use practices (logging, agriculture, urbanization) that destroy wetland and riparian ecosystems while introducing sediment, nutrients, biocides, metals, and other pollutants into surface and ground water and degrade water quality in the freshwater, estuarine, and coastal ecosystems throughout the Pacific Northwest.

Figure 4. US Forest Service Boundaries and Listed Coho Salmon Distributions



Lower Columbia River Coho Salmon

Distribution. The LCR ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia River up to and including the Big White Salmon and Hood Rivers, and includes the Willamette River to Willamette Falls, Oregon. The ESU also comprises twenty-five artificial propagation programs: the Grays River, Sea Resources Hatchery, Peterson Coho Project, Big Creek Hatchery, Astoria High School (STEP) Coho Program, Warrenton High School (STEP) Coho Program, Elochoman Type-S Coho Program, Elochoman Type-N Coho Program, Cathlamet High School FFA Type-N Coho Program, Cowlitz Type-N Coho Program in the Upper and Lower Cowlitz Rivers, Cowlitz Game and Anglers Coho Program, Friends of the Cowlitz Coho Program, North Fork Toutle River Hatchery, Kalama River Type-N Coho Program, Kalama River Type-S Coho Program, Washougal Hatchery Type-N Coho Program, Lewis River Type-N Coho Program, Lewis River Type-S Coho Program, Fish First Wild Coho Program, Fish First Type-N Coho Program, Syverson Project Type-N Coho Program, Eagle Creek National Fish Hatchery, Sandy Hatchery, and the Bonneville/Cascade/Oxbow complex coho hatchery programs.

Status. LCR coho salmon were listed as endangered on June 28, 2005 (70 FR 37160). The vast majority (over 90%) of the historic population in the LCR coho salmon ESU appear to be either extirpated or nearly so. The two populations with any significant natural production (Sandy and Clackamas Rivers) are at appreciable risk because of low abundance, declining trends and failure to respond after a dramatic reduction in harvest. Most of the other populations are believed to have very little, if any, natural production. The Sandy and Clackamas populations remain below the combined long-term “minimum abundance threshold” of 3,000 natural origin individuals (Ford *et al.* 2010).

The Sandy population had a mean abundance of 870 spawners and a very low fraction of hatchery-origin spawners between 2006 and 2008. The Clackamas population is larger with a recent (2006-2008) estimated at 3,799 natural origin spawners but nearly 35% of the total population is composed of hatchery fish, well above the viability standard of 10% (Ford *et al.* 2010). The long-term geometric mean of natural origin spawners for both the Sandy and Clackamas populations is approximately 2,049 since 1995. Other populations in this ESU are dominated by hatchery production. There is very little, if any, natural production in Oregon outside of the Clackamas and Sandy rivers. The Washington side of the ESU is also dominated by hatchery production and there are no populations with appreciable natural production. The most serious threat facing this ESU is the scarcity of naturally-produced spawners, with additional risks associated with small population, loss of diversity, and fragmentation and isolation of the remaining naturally-produced fish. In the Sandy and Clackamas populations, short and long-term trends are negative and productivity (as gauged by pre-harvest recruits) is down sharply from 1980s levels.

Critical habitat. Critical habitat has not been designated for this species.

Southern Oregon/Northern California Coast Coho Salmon

Distribution. Southern Oregon/Northern California coast coho salmon consists of all naturally spawned populations of coho salmon in coastal streams between Cape Blanco, Oregon, and Punta Gorda, California, as well three artificial propagation programs: the Cole Rivers Hatchery (ODFW stock #52), Trinity River Hatchery, and Iron Gate Hatchery coho hatchery programs. The three major river systems supporting Southern Oregon – Northern Coastal California coast coho are the Rogue, Klamath (including the Trinity), and Eel rivers.

Status. Southern Oregon/Northern California coast coho salmon were listed as threatened on May 7, 1997; they retained that classification when their status was reviewed on June 28, 2005 (70 FR 37160). The status of coho salmon coastwide, including the Southern Oregon/Northern California Coast coho salmon ESU, was formally assessed in 1995 (Weitkamp *et al.* 1995). Two subsequent status review updates were published by NMFS prior to 2000, one addressing all West Coast coho salmon ESUs (NMFS 1996) and a second specifically addressing the Oregon Coast and Southern Oregon/Northern California Coast coho salmon ESUs (NMFS 1997). In the 1997 status update, estimates of natural population abundance were based on very limited information. New data on presence/absence in northern California streams that historically supported coho salmon were even more disturbing than earlier results, indicating that a smaller percentage of streams contained coho salmon compared to the percentage presence in an earlier study. However, it was unclear whether these new data represented actual trends in local extinctions, or were biased by sampling effort.

Data on population abundance and trends are limited for the California portion of this ESU. No regular estimates of natural spawner escapement are available. Historical point estimates of coho salmon abundance for the early 1960s and mid-1980s suggest that statewide coho spawning escapement in the 1940s ranged between 200,000 and 500,000 fish. Numbers declined to about 100,000 fish by the mid-1960s with about 43% originating from this ESU. Brown *et al.* (1994) estimated that the California portion of this ESU was represented by about 7,000 wild and naturalized coho salmon (see Good *et al.* 2005). In the Klamath River, the estimated escapement has dropped from approximately 15,400 in the mid-1960s to about 3,000 in the mid 1980s, to about 2,000 in the early 2000s (see Good *et al.* 2005), and as low as several hundred by 2008, with an average generational (3 years) decline over the past nine years of almost 50% (Williams *et al.* 2011). Abundances in Prairie Creek, a tributary to Redwood Creek, have declined over the past 12 years, but not significantly. Freshwater Creek, a tributary to Humboldt Bay, SONCC coho salmon populations have significantly declined between 2001 and 2009. Based on counts in the Rogue River and its tributaries, there is a significantly positive trend over the past 30 years, but a non-significant negative trend over the past 12 years. Approximately 7,000 wild fish have returned past the Gold Ray Dam to the upper Rogue River in recent years.

Critical habitat. Critical habitat was designated for this species on November 25, 1997 and re-designated on May 5, 1999. Critical habitat for this species encompasses all accessible river reaches between Cape Blanco, Oregon, and Punta Gorda, California. Critical habitat consists of the water, substrate, and river reaches (including off-channel habitats) in specified areas. Accessible reaches are those within the historical range of the ESU that can still be occupied by any life stage of coho salmon. Of 155 historical streams for which data are available, 63% likely still support coho salmon. Limiting factors identified for this species include: (1) loss of channel complexity, connectivity and sinuosity, (2) loss of floodplain and estuarine habitats, (3) loss of riparian habitats and large in-river wood, (4) reduced stream flow, (5) poor water quality, temperature and excessive sedimentation, and (6) unscreened diversions and fish passage structures.

Oregon Coast coho salmon

Distribution. The Oregon Coast coho ESU includes all naturally spawned populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco (63 FR 42587; August 10, 1998). One hatchery stock, the Cow Creek (ODFW stock # 37) hatchery coho, is considered part of the ESU.

Status. The Oregon coast coho salmon ESU was listed as a threatened species on February 11, 2008 (73 FR 7816). The abundance and productivity of Oregon Coast coho since the previous status review (NMFS 1997) represent some of the best and worst years on record. Yearly adult returns for the Oregon Coast coho ESU were in excess of 160,000 natural spawners in 2001 and 2002, far exceeding the abundance observed for the past several decades. These encouraging increases in spawner abundance in 2000–2002 were preceded by three consecutive brood years (the 1994–1996 brood years returning in 1997–1999, respectively) with fewer recruits than had returned in the previous year class. The encouraging 2000–2002 increases in natural spawner abundance occurred in many populations in the northern portion of the ESU, which were the most depressed at the time of the last review (NMFS 1997). Although encouraged by the increase in spawner abundance in 2000–2002, the BRT noted that the long-term trends in ESU productivity were still negative due to the low abundances observed during the 1990s (73 FR 7816).

Since 2002, the total abundance of natural spawners in the Oregon Coast coho ESU has declined each year. The abundance of total natural spawners in 2006 (111,025 spawners) was approximately 43% of the recent peak abundance in 2002 (255,372 spawners). In 2003, ESU-level productivity (evaluated in terms of the number of spawning recruits resulting from spawners three years earlier) was above replacement, and in 2004, productivity was approximately at replacement level. However, productivity was below replacement in 2005 and 2006, and dropped to the lowest level since 1991 in 2006. Preliminary spawner survey data for 2007 suggest that the 2007-2008 return of Oregon Coast coho is either: (1) much reduced from abundance levels in 2006, or (2) exhibiting delayed run timing from previous years.

The recent 5-year geometric mean abundance (2002-2006) of approximately 152,960 total natural spawners remains well above that of a decade ago (approximately 52,845 from 1992-1996). However, the decline in productivity from 2003 to 2006, despite generally favorable marine survival conditions and low harvest rates, is of concern (73 FR 7816). The long-term trends in productivity in this ESU remain strongly negative.

Critical habitat. Critical habitat was proposed for Oregon Coast coho on December 14, 2004 (69 FR 74578). The final designation of critical habitat is included in the final rule published on February 11, 2008 (73 FR 7816). Approximately 6,568 stream miles (10,570 km) and 15 square miles (38.8 sq km) of lake habitat are designated critical habitat.

Sockeye Salmon

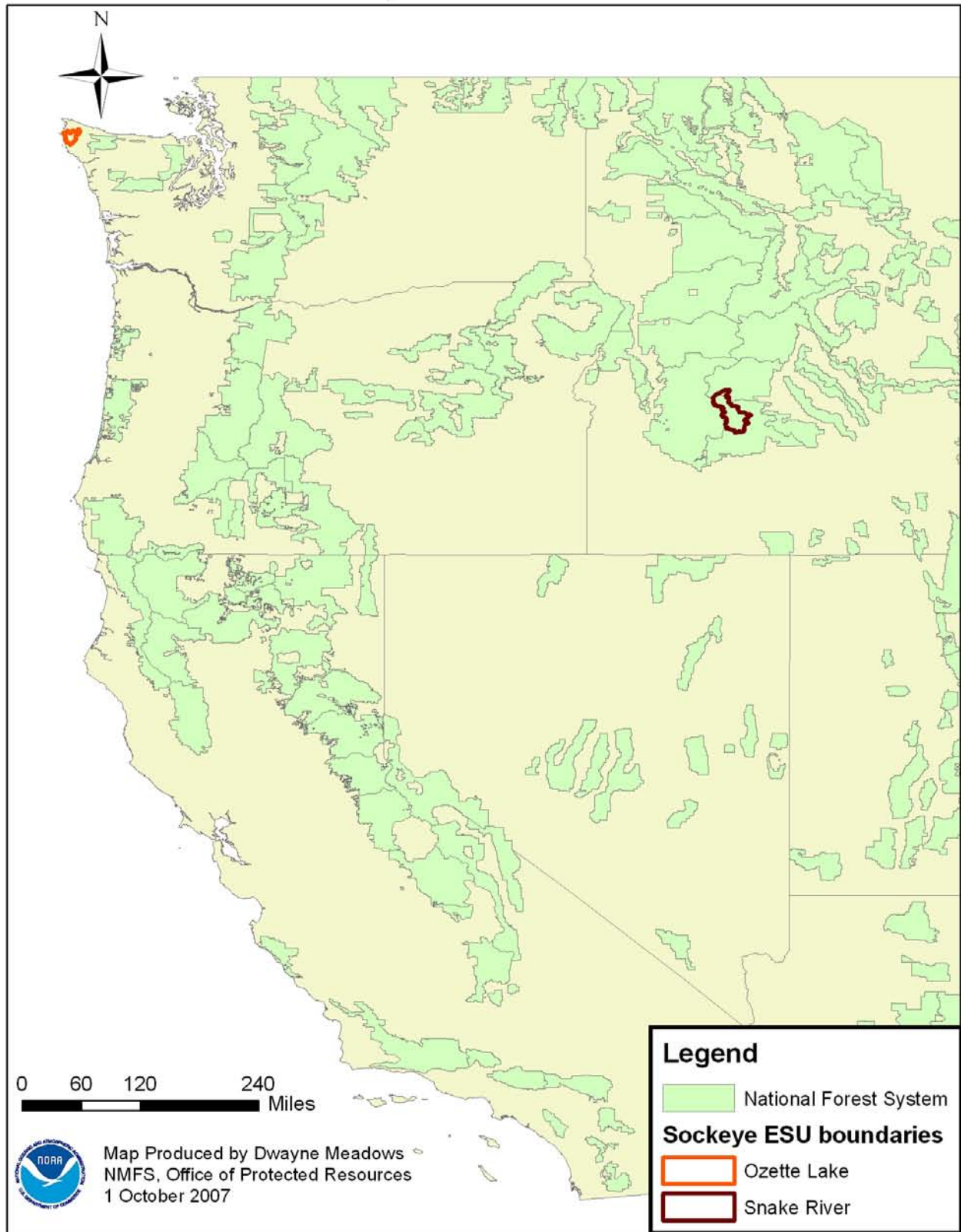
Sockeye salmon occur in the North Pacific and Arctic oceans and associated freshwater systems. This species ranges south as far as the Klamath River in California and northern Hokkaido in Japan, to as far north as Bathurst Inlet in the Canadian Arctic and the Anadyr River in Siberia. Figure 5 is a depiction of the distribution of the two threatened and endangered sockeye salmon ESUs relative to Forest Service boundaries.

The species exhibits riverine and lake life history strategies, the latter of which may be either freshwater resident forms or anadromous forms. The vast majority of sockeye salmon spawn in outlet streams of lakes or in the lakes themselves. These “lake-type” sockeye use the lake environment for rearing for up to 3 years and then migrate to sea, returning to their natal lake to spawn after 1-4 years at sea. Some sockeye spawn in rivers, however, when lake habitat for juvenile rearing is unavailable. Offspring of these riverine spawners tend to use the lower velocity sections of rivers as the juvenile rearing environment for 1 to 2 years, or may migrate to sea in their first year.

Certain populations of *O. nerka* become resident in the lake environment over long periods of time and are called kokanee or little redbfish (Burgner 1991). Kokanee and sockeye often co-occur in many interior lakes, where access to the sea is possible but energetically costly. On the other hand, coastal lakes where the migration to sea is relatively short and energetic costs are minimal rarely support kokanee populations.

Spawning generally occurs in late summer and autumn, but the precise time can vary greatly among populations. Males often arrive earlier than females on the spawning grounds, and will persist longer during the spawning period. Average fecundity ranges from about 2,000 to 2,400 eggs per female to 5,000 eggs, depending upon the population and average age of the female. Fecundity in kokanee is much lower and may range from about 300 to less than 2,000 eggs.

Figure 5. US Forest Service Boundaries and Listed Sockeye Salmon Distributions



Incubation is a function of water temperatures, but generally lasts between 100 and roughly 200 days (Burgner 1991). After emergence, fry move rapidly downstream or upstream along the banks to the lake rearing area. Fry emerging from lakeshore or island spawning grounds may simply move along the shoreline of the lake (Burgner 1991).

Dependence on Waters of the United States

Sockeye salmon survive only in aquatic ecosystems and depend on the quantity and quality of those aquatic systems. Sockeye salmon, like the other salmon NMFS has listed, have declined under the combined effects of overharvests in fisheries; competition from fish raised in hatcheries and native and non-native exotic species; dams that block their migrations and alter river hydrology; gravel mining that impedes their migration and alters the dynamics (hydrogeomorphology) of the rivers and streams that support juveniles; water diversions that deplete water levels in rivers and streams, destruction or degradation of riparian habitat that increase water temperatures in rivers and streams sufficient to reduce the survival of juvenile chum salmon; and land use practices (logging, agriculture, urbanization) that destroy wetland and riparian ecosystems while introducing sediment, nutrients, biocides, metals, and other pollutants into surface and ground water and degrade water quality in the freshwater, estuarine, and coastal ecosystems throughout the Pacific Northwest.

Snake River Sockeye Salmon

Distribution. The ESU includes all anadromous and residual sockeye salmon from the Snake River Basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program. Snake River sockeye salmon are unique compared to other sockeye salmon populations. Sockeye salmon returning to Redfish Lake in Idaho's Stanley Basin travel a greater distance from the sea (approximately 900 miles) to a higher elevation (6,500 feet) than any other sockeye salmon population and are the southern-most population of sockeye salmon in the world (Bjornn *et al.* 1968; Foerster 1968). Stanley Basin sockeye salmon are separated by 700 or more river miles from two other extant upper Columbia River populations in the Wenatchee River and Okanogan River drainages. These latter populations return to lakes at substantially lower elevations (Wenatchee at 1870 feet, Okanagon at 912 feet) and occupy different ecoregions.

The only extant sockeye salmon population in the Snake River basin at the time of listing was that in Redfish Lake, in the Stanley Basin (upper Salmon River drainage) of Idaho. Other lakes in the Snake River basin historically supported sockeye salmon populations, including Wallowa Lake (Grande Ronde River drainage, Oregon), Payette Lake (Payette River drainage, Idaho) and Warm Lake (South Fork Salmon River drainage, Idaho) (Waples *et al.* 1997). These populations are now considered extinct. Although kokanee, a resident form of *O. nerka*, occur in numerous lakes in the Snake River basin, other lakes in the Stanley Basin and sympatrically with sockeye in Redfish Lake, resident *O. nerka* were not considered part of the species at the time of listing (1991). Subsequent to the 1991 listing, a residual form of sockeye residing in Redfish Lake was identified. The residuals are non-anadromous, completing their entire life cycle in freshwater, but spawn at the same time and in the same location as anadromous sockeye salmon. In 1993, NMFS determined that residual sockeye salmon in Redfish Lake were part of the Snake River sockeye salmon. Also, artificially propagated sockeye salmon from the Redfish Lake Captive Propagation program are considered part of this species (70 FR 37160; June 28, 2005). NMFS

has determined that this artificially propagated stock is genetically no more than moderately divergent from the natural population (NMFS 2005).

Five lakes in the Stanley Basin historically contained sockeye salmon: Alturas, Pettit, Redfish, Stanley and Yellowbelly (Bjornn *et al.* 1968). It is generally believed that adults were prevented from returning to the Sawtooth Valley from 1910 to 1934 by Sunbeam Dam. Sunbeam Dam was constructed on the Salmon River approximately 20 miles downstream of Redfish Lake. Whether or not Sunbeam Dam was a complete barrier to adult migration remains unknown. It has been hypothesized that some passage occurred while the dam was in place, allowing the Stanley Basin population or populations to persist (see Bjornn *et al.* 1968, Waples *et al.* 1991).

Status. Snake River sockeye salmon were originally listed as endangered in 1991 and retained that classification when their status was reviewed on June 28, 2005. Adult returns to Redfish Lake during the period 1954 through 1966 ranged from 11 to 4,361 fish (Bjornn *et al.* 1968). Sockeye salmon in Alturas Lake were extirpated in the early 1900s as a result of irrigation diversions, although residual sockeye may still exist in the lake (Chapman and Witty 1993). From 1955 to 1965, the Idaho Department of Fish and Game eradicated sockeye salmon from Pettit, Stanley, and Yellowbelly lakes, and built permanent structures on each of the lake outlets that prevented re-entry of anadromous sockeye salmon (Chapman and Witty 1993). In 1985, 1986, and 1987, 11, 29, and 16 sockeye, respectively, were counted at the Redfish Lake weir (Good *et al.* 2005). Only 18 natural origin sockeye salmon have returned to the Stanley Basin since 1987. The first adult returns from the captive brood stock program returned to the Stanley Basin in 1999. From 1999 through 2005, a total of 345 captive brood program adults that had migrated to the ocean returned to the Stanley Basin.

Recent annual abundances of natural origin sockeye salmon in the Stanley Basin have been extremely low. No natural origin anadromous adults have returned since 1998 and the abundance of residual sockeye salmon in Redfish Lake is unknown. This species is entirely supported by adults produced through the captive propagation program at the present time. However, returns of hatchery-origin sockeye salmon in 2008 and 2009 are the highest since the program began with 650 and 809 individuals, respectively. These returns likely correspond with a nearly six-fold increase in the number of hatchery-reared juvenile sockeye salmon planted in Redfish Lake and Redfish Lake Creek beginning in 2005.

Critical habitat. Critical habitat for these salmon was designated on December 28, 1993, and encompasses the waters, waterway bottoms, and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to listed Snake River salmon (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams). Adjacent riparian zones are defined as those areas within a horizontal distance of 300 feet from the normal line of high water of a stream channel or from the shoreline of a standing body of water. Designated critical habitat includes the Columbia River from a straight line connecting the west end of the Clatsop jetty (Oregon side) and the west end of the Peacock jetty (Washington side) and including all river reaches from the estuary upstream to the confluence of the Snake River, and all Snake River reaches upstream to the confluence of the Salmon River; all Salmon River reaches to Alturas Lake Creek; Stanley, Redfish, yellow Belly, Pettit, and Alturas Lakes (including their inlet and outlet creeks); Alturas Lake Creek and that portion of Valley

Creek between Stanley Lake Creek and the Salmon River. Critical habitat also includes all river lakes and reaches presently or historically accessible to Snake River sockeye salmon. Limiting factors identified for Snake River sockeye include: (1) Reduced tributary stream flow, (2) impaired tributary passage and blocks to migration, and (3) mainstem Columbia River hydropower system mortality (NMFS 2005a).

Steelhead

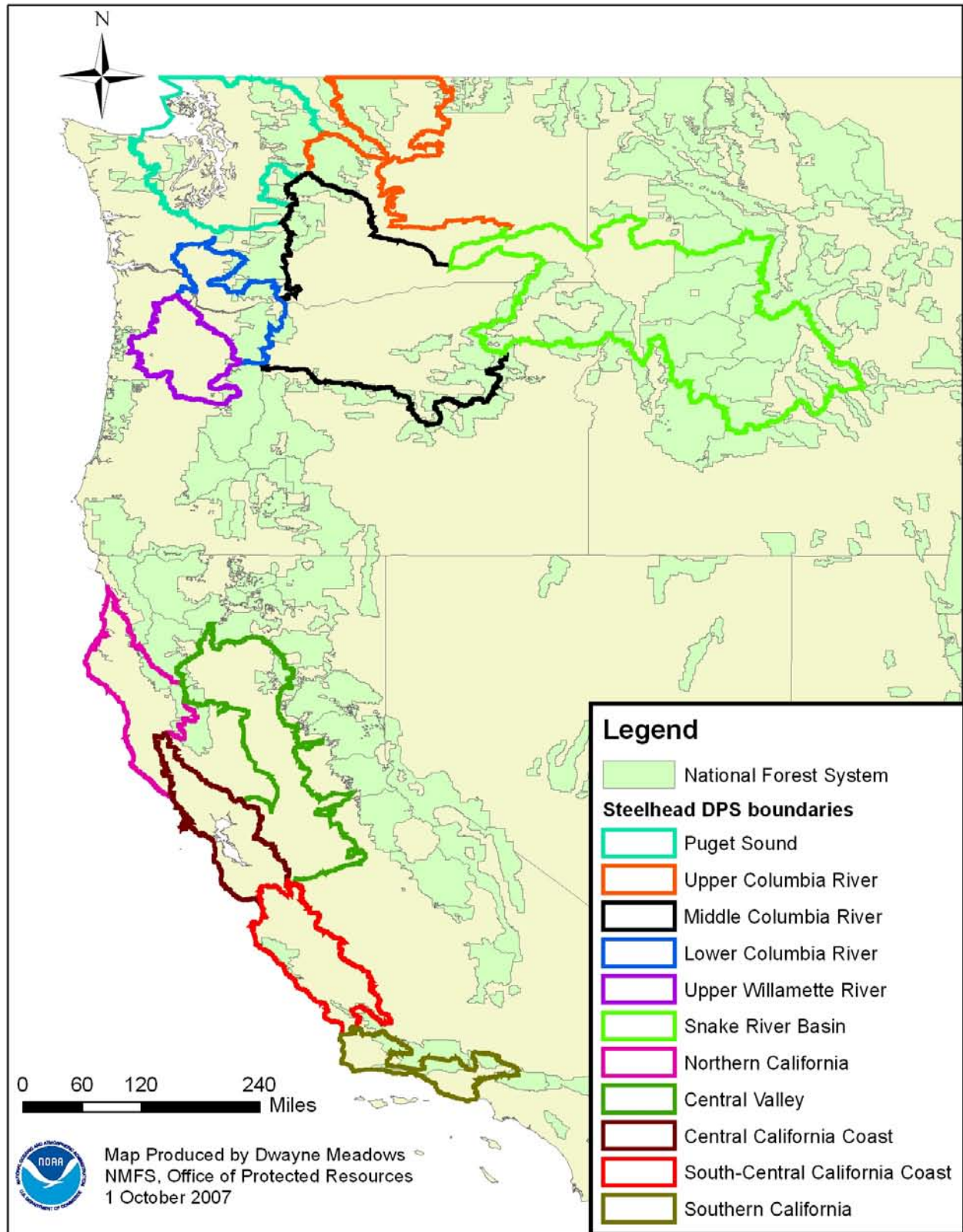
Steelhead are native to Pacific Coast streams extending from Alaska south to northwestern Mexico (Moyle 1976, NMFS 1997, Good *et al.* 2005). Figure 6 is a depiction of the distribution of the 11 threatened and endangered steelhead DPSs relative to Forest Service boundaries. They can be divided into two basic run-types: the stream-maturing type, or summer steelhead, enters fresh water in a sexually immature condition and requires several months in freshwater to mature and spawn and the ocean-maturing type, or winter steelhead, enters fresh water with well-developed gonads and spawns shortly after river entry. Variations in migration timing exist between populations. Some river basins have both summer and winter steelhead, while others only have one run-type.

Summer steelhead enter fresh water between May and October in the Pacific Northwest (Busby *et al.* 1996, Nickelson *et al.* 1992). They require cool, deep holding pools during summer and fall, prior to spawning (Nickelson *et al.* 1992). They migrate inland toward spawning areas, overwinter in the larger rivers, resume migration in early spring to natal streams, and then spawn (Meehan and Bjornn 1991, Nickelson *et al.* 1992) in January and February (Barnhart 1986). Winter steelhead enter fresh water between November and April in the Pacific Northwest (Busby *et al.* 1996, Nickelson *et al.* 1992), migrate to spawning areas, and then spawn, generally in April and May (Barnhart 1986). Some adults, however, do not enter some coastal streams until spring, just before spawning (Meehan and Bjornn 1991).

There is a high degree of overlap in spawn timing between populations regardless of run type (Busby *et al.* 1996). Difficult field conditions at that time of year and the remoteness of spawning grounds contribute to the relative lack of specific information on steelhead spawning. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996), although steelhead rarely spawn more than twice before dying; most that do so are females (Nickelson *et al.* 1992). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996).

After 2 to 3 weeks, in late spring, and following yolk sac absorption, alevins emerge from the gravel and begin actively feeding. After emerging from the gravel, fry usually inhabit shallow water along banks of perennial streams. Fry occupy stream margins (Nickelson *et al.* 1992). Summer rearing takes place primarily in the faster parts of pools, although young-of-the-year are abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson *et al.* 1992).

Figure 6. US Forest Service Boundaries and Listed Steelhead Salmon Distributions



Juvenile steelhead migrate little during their first summer and occupy a range of habitats featuring moderate to high water velocity and variable depths (Bisson *et al.* 1988). Juvenile steelhead feed on a wide variety of aquatic and terrestrial insects (Chapman and Bjornn 1969), and older juveniles sometimes prey on emerging fry. Steelhead hold territories close to the substratum where flows are lower and sometimes counter to the main stream; from these, they can make forays up into surface currents to take drifting food. Juveniles rear in freshwater from 1 to 4 years, then smolt and migrate to the ocean in March and April (Barnhart 1986). Winter steelhead juveniles generally smolt after two years in fresh water (Busby *et al.* 1996). Juvenile steelhead tend to migrate directly offshore during their first summer from whatever point they enter the ocean rather than migrating along the coastal belt as salmon do. During the fall and winter, juveniles move southward and eastward (Hartt and Dell 1986 *op. cit.* Nickelson *et al.* 1992). Steelhead typically reside in marine waters for 2 or 3 years prior to returning to their natal stream to spawn as 4- or 5-year olds.

General life history information

Summer steelhead enter freshwater between May and October in the Pacific Northwest (Busby *et al.* 1996). Winter steelhead enter freshwater between November and April in the Pacific Northwest (Busby *et al.* 1996). Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity. Intermittent streams may also be used for spawning (Barnhart 1986, Everest 1973). Depending on water temperature, steelhead eggs may incubate for 1.5 to 4 months (61 FR 41542) before hatching. Juveniles rear in fresh water from one to four years, then migrate to the ocean as smolts (61 FR 41542). Winter steelhead populations generally smolt after two years in fresh water (Busby *et al.* 1996).

Dependence on Waters of the United States

Steelhead survive only in aquatic ecosystems and, therefore, depend on the quantity and quality of those aquatic systems. Steelhead, like the other salmon NMFS has listed, have declined under the combined effects of overharvests in fisheries; competition from fish raised in hatcheries and native and non-native exotic species; dams that block their migrations and alter river hydrology; gravel mining that impedes their migration and alters the dynamics (hydrogeo-morphology) of the rivers and streams that support juveniles; water diversions that deplete water levels in rivers and streams, destruction or degradation of riparian habitat that increase water temperatures in rivers and streams sufficient to reduce the survival of juvenile chum salmon; and land use practices (logging, agriculture, urbanization) that destroy wetland and riparian ecosystems while introducing sediment, nutrients, biocides, metals, and other pollutants into surface and ground water and degrade water quality in the freshwater, estuarine, and coastal ecosystems throughout the Pacific Northwest.

Puget Sound Steelhead

Distribution. Puget Sound steelhead occupy river basins below natural migratory barriers of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington. Included are river basins as far west as the Elwha River and as far north as the Nooksack River. Puget Sound's fjord-like structure may affect steelhead migration patterns; for example, some populations of coho and Chinook salmon, at least historically, remained within Puget Sound and did not migrate to the Pacific Ocean itself. Even when Puget Sound steelhead migrate to the high seas, they may spend considerable time as juveniles or adults in the protected marine environment of Puget Sound, a

feature not readily accessible to steelhead from other areas of the Pacific Northwest. This species is primarily composed of winter steelhead but includes several stocks of summer steelhead, usually in sub-basins of large river systems and above seasonal hydrologic barriers.

Status. Listed as a threatened species on May 11, 2007 (72 FR 26722). Run size for this DPS, was calculated in the early 1980s at about 100,000 winter-run fish and 20,000 summer-run fish. It's not clear what portion were hatchery fish, but a combined estimate with coastal steelhead suggested that roughly 70% of steelhead in ocean runs were of hatchery origin. The percentage in escapement to spawning grounds would be substantially lower due to differential harvest and hatchery rack returns. By the 1990s, total run size for four major stocks exceeded 45,000, roughly half of which was natural escapement.

Nehlsen *et al.* (1991) identified nine Puget Sound steelhead stocks at some degree of risk or concern, while the Washington Department of Fish and Wildlife *et al.* (1993) estimated that 31 of 53 stocks were of native origin and predominantly natural production. Their assessment of the status of these 31 stocks was 11 healthy, 3 depressed, 1 critical, and 16 of unknown status. Their assessment of the status of the remaining (not native/natural) stocks was 3 healthy, 11 depressed, and 8 of unknown status.

Of the 21 populations in the Puget Sound ESU reviewed by Busby *et al.* (1996), 17 had declining and four increasing trends, with a range from 18% annual decline (Lake Washington winter-run steelhead) to 7% annual increase (Skokomish River winter-run steelhead). Since 1995, only three populations (Skokomish, East Hood Canal, West Hood Canal) are trending positive with only West Hood Canal significantly different from no increase (Ford *et al.* 2010). Ford *et al.* (2010) were not able to calculate trends for south Puget Sound populations. Of the 15 populations monitored between 2005 and 2009, seven of the populations have a geometric mean population below 250 individuals. Only the Green, Snohomish, Skagit, and Samish River populations have geometric mean populations over 500 individuals and only two of those have more than 1,000 individuals return to spawn (Ford *et al.* 2010). The Skagit and Snohomish River winter-run populations have been approximately three to five times larger than the other populations in the DPS, with average annual spawning of approximately 5,000 and 3,000 total adult spawners respectively.

Most populations within this DPS are declining by 3 to 10% annually. The DPS has a moderate to high likelihood of extinction in the next 100 years, but is not considered to be in imminent danger of extinction (Ford *et al.* 2010).

Critical habitat. Critical habitat is under development.

Upper Columbia River Steelhead

Distribution. The Upper Columbia Steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the US-Canada border, as well as six artificial propagation programs: the Wenatchee River, Wells Hatchery (in the Methow and Okanogan Rivers), Winthrop NFH, Omak Creek and the Ringold steelhead hatchery programs (70 FR 67130). All UCR steelhead are summer steelhead. Steelhead

primarily use streams of this region that drain the northern Cascade Mountains of Washington State. This species does not include the Skamania Hatchery stock because of its non-native genetic heritage.

Status. UCR steelhead were originally listed as endangered in 1997, after their status was reviewed, they were reclassified to threatened on January 5, 2006 and then reinstated to endangered status per the Eastern Washington U.S. District Court decision in June 2007. On August 24, 2009, following an appeal of the decision by the U.S. Court of Appeals for the Ninth Circuit, UCR steelhead were again listed as threatened (74 FR 42605). Abundance estimates of returning naturally produced UCR steelhead have been based on extrapolations from mainstem dam counts and associated sampling information (e.g., hatchery/wild fraction, age composition). The natural component of the annual steelhead run over Priest Rapids Dam increased from an average of 1,040 (1992-1996), representing about 10% of the total adult count, to 2,200 (1997-2001), representing about 17% of the adult count during this period of time (ICBTRT 2003), and increasing to 3,600 (2005-2009), representing 19% of the adult count (Ford *et al.* 2010).

In terms of natural production, recent population abundances for every population in the ESU remains well below the minimum abundance thresholds developed for these populations (Ford *et al.* 2010). A 5-year geometric mean (2005 to 2009) of approximately 935 naturally produced steelhead returned to the Wenatchee and Entiat rivers (combined). For the Methow population, the 5-year geometric mean of natural returns over Wells Dam was 505. The Okanogan has a 5-year geometric mean return of 152 UCR steelhead. This DPS is failing to meet viability criteria in all four categories; productivity, abundance, spatial structure, and genetic diversity, and is considered to be at high risk (Ford *et al.* 2010).

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52488). The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more life stages of steelhead. Specific sites include freshwater spawning and rearing sites, freshwater migration corridors, estuarine areas free of obstruction, and offshore marine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, and adequate passage conditions. The UCR steelhead DPS has 42 watersheds within its range. Three watersheds received a low rating, eight received a medium rating, and 31 rated a high conservation value to the DPS. In addition, the Columbia River rearing/migration corridor downstream of the spawning range was rated as a high conservation value. Limiting factors identified for the UCR steelhead include: (1) mainstem Columbia River hydropower system mortality, (2) reduced tributary stream flow, (3) tributary riparian degradation and loss of in-river wood, (4) altered tributary floodplain and channel morphology, and (5) excessive fine sediment and degraded tributary water quality.

Middle Columbia River Steelhead

Distribution. The Middle Columbia River steelhead distinct population segment (DPS) includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding *O. mykiss* from the Snake River Basin, as well seven artificial propagation programs: the Touchet River Endemic, Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek,

Naches River, and Upper Yakima River), Umatilla River, and the Deschutes River steelhead hatchery programs (61 FR 41541). This species includes the only populations of inland winter steelhead in the United States, in the Klickitat River and Fifteenmile Creek (Busby *et al.* 1996). MCR steelhead occupy the inter-montane region which includes some of the driest areas of the Pacific Northwest, generally receiving less than 15.7 inches of rainfall annually. Vegetation is of the shrub-steppe province, reflecting the dry climate and harsh temperature extremes. Because of this habitat, occupied by the species, factors contributing to the decline include agricultural practices, especially grazing, and water diversions and withdrawals. In addition, hydropower development has impacted the species by preventing these steelhead from migrating to habitat above dams, and by killing them in large numbers when they try to migrate through the Columbia River hydroelectric system.

Status. MCR steelhead were listed as threatened in 1999, and their status was reaffirmed on January 5, 2006 (71 FR 834). The ICBTRT (2003) identified 17 extant populations in four major population groups (Eastern Cascades Tributaries, John Day River, the Umatilla/Walla Walla, and the Yakima River). There are two extirpated populations in the Cascades Eastern Slope major population group, the White Salmon River and Deschutes Crooked River above the Pelton/Round Butte Dam complex; and another extirpated population in the Umatilla/Walla Walla drainage (Ford *et al.* 2010).

Seven hatchery steelhead programs are considered part of the MCR steelhead species. These programs propagate steelhead in three of 17 populations and improve kelt survival in one population. No artificial programs produce the winter-run life history in the Klickitat River and Fifteenmile Creek populations. All of the MCR steelhead hatchery programs are designed to produce fish for harvest, although two are also implemented to augment the naturally spawning populations in the basins where the fish are released.

The precise pre-1960 abundance of this species is unknown, but historic run estimates for the Yakima River imply that annual species abundance may have exceeded 300,000 returning adults (Busby *et al.* 1996). MCR steelhead run estimates between 1982 and 2009 were calculated by subtracting adult counts for Lower Granite and Priest Rapids Dams from those at Bonneville Dam as well as mark-recapture studies. The most recent (2005-2009) 5-year geometric mean for this DPS is approximately 14,364 total steelhead, however, there is no data for some rivers (Ford *et al.* 2010). Returns to the Yakima River, the Deschutes River and sections of the John Day and Umatilla River systems were substantially higher compared to 1992 to 1997 (Ford *et al.* 2010). Yakima River returns are still substantially below interim target levels of 8,900 (the current 5 year average is 2,319 fish) and estimated historical return levels, with the majority of spawning occurring in Satus Creek and Naches River (Ford *et al.* 2010). While the data is not comprehensive, 2006-2007 mark-recapture data in the Klickitat River suggests a spawning population of approximately 1,577 MCR steelhead (Ford *et al.* 2010).

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52488). The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more life stages of steelhead. MCR steelhead have PCEs of 1) freshwater spawning, 2) freshwater rearing, 3) freshwater migration, 4) estuarine areas free of obstruction, 5) nearshore marine areas free of obstructions, and 6) offshore marine areas with good water

quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, and adequate passage conditions. Although pristine habitat conditions are still present in some wilderness, roadless, and undeveloped areas, habitat complexity has been greatly reduced in many areas of designated critical habitat for MCR steelhead. Of 114 watersheds reviewed in NMFS' assessment of critical habitat for the MCR steelhead, 81 sub-basins were rated as having a high conservation value, while 24 were rated as having a medium value and nine were rated as having a low value to the conservation of the DPS. Limiting factors identified for MCR steelhead include: (1) hydropower system mortality; (2) reduced stream flow; (3) impaired passage; (4) excessive sediment; (5) degraded water quality; and (6) altered channel morphology and floodplain.

Lower Columbia River Steelhead

Distribution. LCR steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in streams and tributaries to the Columbia River between the Cowlitz and Wind Rivers, Washington (inclusive), and the Willamette and Hood Rivers, Oregon (inclusive), as well as ten artificial propagation programs: the Cowlitz Trout Hatchery (in the Cispus, Upper Cowlitz, Lower Cowlitz, and Tilton Rivers), Kalama River Wild (winter- and summer-run), Clackamas Hatchery, Sandy Hatchery, and Hood River (winter- and summer-run) steelhead hatchery programs. Excluded are *O. mykiss* populations in the upper Willamette River Basin above Willamette Falls, Oregon, and from the Little and Big White Salmon Rivers, Washington. This species includes both winter and summer steelhead.

Status. LCR steelhead were listed as threatened on March 19, 1998, and reaffirmed as threatened on January 5, 2006 (71 FR 834). All populations declined from 1980 to 2000, with sharp declines beginning in 1995. Historical counts in some of the larger tributaries (Cowlitz, Kalama, and Sandy Rivers) suggest the population probably exceeded 20,000 fish while in the 1990s fish abundance dropped to 1,000 to 2,000. Currently, only two of the 26 populations are considered viable, the Wind River summer-run and Clackamas River winter-run. Generally, all populations increased in abundance between 2000 and 2004, peaking in abundance in 2004, and by 2008 had returned to abundances near recent long-term means. Three recent evaluations all determined that the DPS is at high risk of extinction (McElhany *et al.* 2007, ODWF 2010, LCFRB 2010).

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52488). The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more life stages of steelhead. The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more steelhead life stages. Specific sites include: 1) freshwater spawning, 2) freshwater rearing, 3) freshwater migration, 4) estuarine areas free of obstruction, 5) nearshore marine areas free of obstructions, and 6) offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Of 42 sub-basins reviewed in NMFS' assessment of critical habitat for the LCR steelhead, 29 sub-basins were rated as having a high conservation value, while 11 were rated as having a medium value and two were rated as having a low value to the conservation of the DPS. In addition to these locations, the rearing/migratory habitat is also considered to have high conservation value.

Upper Willamette River steelhead

Distribution. Upper Willamette River DPS steelhead are all naturally spawned anadromous *O. mykiss* populations below natural and manmade impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River (inclusive). This is a late-migrating winter group that enters fresh water in March and April (Howell *et al.* 1985). Only the late run was included in the listing of this species, which is the largest remaining population in the Santiam River system.

Status. Upper Willamette River steelhead were listed as threatened in 1999, when their status was reviewed on January 5, 2006 they retained that classification (71 FR 834). Recent status reviews have determined this population of winter-run steelhead is being negatively impacted by a non-native, nearly completely hatchery-supported population of summer-run steelhead (Howell *et al.* 1985, Ford *et al.* 2010). Another major threat to Willamette River steelhead results from artificial production practices. In recent years, releases of winter steelhead are primarily of native stock from the Santiam River system.

The previous 5-year status review (Good *et al.* 2005) only contained population data through 2002, giving the appearance of an increasing trend in abundance. However, more recent data through 2009 show the population's abundance has returned to historic low levels seen in the early 1990s (Ford *et al.* 2010). The late-returning abundance estimate for the entire ESU in 2009 was 2,110 steelhead, down from 4,915 steelhead in 2008 (Ford *et al.* 2010).

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52488). The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more life stages of steelhead. The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more steelhead life stages. Specific sites include 1) freshwater spawning, 2) freshwater rearing, 3) freshwater migration, 4) estuarine areas free of obstruction, 5) nearshore marine areas free of obstructions, and 6) offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Of 38 sub-basins reviewed in NMFS' assessment of critical habitat for the Upper Willamette River steelhead, 15 sub-basins were rated as having a high conservation value, while 6 were rated as having a medium value and 17 were rated as having a low value to the conservation of the DPS. The Lower Willamette/Lower Columbia River rearing/migratory corridor was also determined to have high conservation value.

Snake River Steelhead

Distribution. Snake River basin DPS steelhead are all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho, as well six artificial propagation programs: the Tucannon River, Dworshak NFH, Lolo Creek, North Fork Clearwater, East Fork Salmon River, and the Little Sheep Creek/Imnaha River Hatchery steelhead hatchery programs. Snake River Basin steelhead do not include resident forms of *O. mykiss* (rainbow trout) co-occurring with these steelhead. The historic spawning range of this

species included the Salmon, Pahsimeroi, Lemhi, Selway, Clearwater, Wallowa, Grande Ronde, Imnaha, and Tucannon Rivers.

Status. Snake River steelhead were listed as threatened in 1997, when their status was reviewed on January 5, 2006 they retained that classification (71 FR 834). The ICBTRT (2003) identified 24 extant populations in the following six major population groups in this species: Clearwater River (5 extant, 1 extirpated), Grande Ronde River (4 populations), Imnaha River (1 population), Lower Snake River (2 populations), and Salmon River (12 populations). A number of tributaries above the Hells Canyon Dam were identified as capable of supporting steelhead populations, but the dam remains a complete barrier to anadromous fish passage. Snake River Basin steelhead remain spatially well distributed in each of the six major geographic areas in the Snake River basin (Good *et al.* 2005). Environmental conditions are generally drier and warmer in these areas than in areas occupied by other steelhead species in the Pacific Northwest. Snake River Basin steelhead were blocked from portions of the upper Snake River beginning in the late 1800s and culminating with the construction of Hells Canyon Dam in the 1960s. Snake River Basin DPS steelhead are all summer-run, but the run timing is broken into two groups of “A run” and “B run” fish. “A run” steelhead spend a year in the ocean and return to the Snake River as smaller adults than “B run” fish that spend two years at sea. The Snake River Basin steelhead “B run” population levels remain particularly depressed.

Annual return estimates are limited to counts of the aggregate A and B run return over Lower Granite Dam, and spawner estimates for the Grande Ronde. The Grande Ronde estimate, consisting of upper Grande Ronde River and Joseph Creek, has a 5-year (2003-2008) geometric mean of 3,367 steelhead (Ford *et al.* 2010). The two extant Grande Ronde populations are considered highly viable. The recent 5-year geometric mean abundance over Lower Granite Dam was 162,323 steelhead, but only 18,847 were natural returns (Ford *et al.* 2010).

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52488). The critical habitat designation for this ESU identifies PCEs that include sites necessary to support one or more life stages of steelhead. The critical habitat designation for this ESU identifies PCEs that include sites necessary to support one or more steelhead life stages. Specific sites include 1) freshwater spawning, 2) freshwater rearing, 3) freshwater migration, 4) estuarine areas free of obstruction, 5) nearshore marine areas free of obstructions, and 6) offshore marine areas with good water quality. Of the 289 watersheds in this DPS, 231 were rated as high, 44 were rated as medium, and 14 were rated as low conservation value. Additionally, the lower Snake River/Columbia River rearing/migratory habitat was considered to have high conservation value. The physical or biological features that characterize these sites include water quality and quantity, natural cover, and adequate forage. Limiting factors identified for Snake River Basin steelhead include: (1) hydrosystem mortality, (2) reduced stream flow, (3) altered channel morphology and floodplain, (4) excessive sediment, (5) degraded water quality, (6) harvest impacts, and (7) hatchery impacts (NMFS 2006).

Northern California Steelhead

Distribution. Northern California DPS steelhead includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in California coastal river basins from Redwood Creek southward to, but not including, the Russian River, as

well as two artificial propagation programs: the Yager Creek Hatchery, and North Fork Gualala River Hatchery (Gualala River Steelhead Project) steelhead hatchery programs.

Status. Northern California steelhead were listed as threatened on June 7, 2000, and when their status was reviewed on January 5, 2006 they retained that classification (71 FR 834). Long-term data sets are limited for the Northern California steelhead, with most data being collected in the past seven to nine years. Before 1960, estimates of abundance specific to this DPS were available from dam counts in the upper Eel River (Cape Horn Dam—annual average of 4,400 adult steelhead in the 1930s), the South Fork Eel River (Benbow Dam—annual average of 19,000 adult steelhead in the 1940s), and the Mad River (Sweasey Dam—annual average of 3,800 adult steelhead in the 1940s). Estimates of steelhead spawning populations for many rivers in this DPS totaled 198,000 by the mid-1960s. There is currently little information available on the actual contribution of hatchery fish to natural spawning, and little information on present total run sizes for the DPS (Busby *et al.* 1996). What information is available is usually from snorkel counts or adult counts from portions of rivers, potentially representing a fraction of the total run size.

Estimates of the Prairie Creek portion of the Redwood Creek population have averaged 64 adults over the past five years, though the last two years were only 4, 6, and 53 during 2008, 2009, and 2010, respectively (Wolff, Pers. comm., January 24, 2011). Freshwater Creek, a portion of the Humboldt Bay population has been declining over the past five years with a nine year average of approximately 212 adults. In Mad River, natural spawner counts do not exist; however, hatchery returns have averaged over 2,300 adults since 2001. Fish counts from the Van Arsdale Fish Station provide estimates for the upper portion of the Eel River and its tributaries, which average approximately 7,300 hatchery adults and only 250 natural adults despite only releasing steelhead once since 1997. Noyo River, Pudding Creek, Caspar Creek, and Hare Creek have all had short-term and slightly negative trends with an average of 302, 133, 64, and 90 spawners, respectively. Counts from the Wheatfield Fork, a portion of the Gualala River population, have averaged 1,915 adults over the past eight years with no discernable change in the abundance trend.

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52488). The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more life stages of steelhead. The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more steelhead life stages. Specific sites include 1) freshwater spawning, 2) freshwater rearing, 3) freshwater migration, 4) estuarine areas free of obstruction, 5) nearshore marine areas free of obstructions, and 6) offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, and adequate forage.

South-Central California Coast Steelhead

Distribution. The South-Central California steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in streams from the Pajaro River (inclusive) to, but not including the Santa Maria River, California.

Status. South-Central California Coast steelhead were listed as threatened in 1997, when their status was reviewed on January 5, 2006 they retained that classification (71 FR 834). Historical data on the South-Central California Coast steelhead DPS are limited. In the mid-1960s the California Department of Fish and Game estimated that the adult population at about 18,000. We know of no recent estimates of the total DPS. However, five river systems, the Pajaro, Salinas, Carmel, Little Sur, and Big Sur, indicate that runs are currently less than 500 adults. Past estimates for these basins were almost 5,000 fish. Carmel River time series data indicate that the population declined by about 22% per year between 1963 and 1993 (Good *et al.* 2005). Estimates are available since 1991 from counts at San Clemente Dam, while redd surveys are also made in the mainstem below the dam. Between 1991 and the early 2000s, the population increased from one adult, to 775 adults at San Clemente Dam; however, more recent surveys in 2007 and 2008 reveal total adult returns of fewer than 620 each year above and below the dam (Williams *et al.* 2011).

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52488). The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more life stages of steelhead. The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more steelhead life stages. Specific sites include 1) freshwater spawning, 2) freshwater rearing, 3) freshwater migration, 4) estuarine areas free of obstruction, 5) nearshore marine areas free of obstructions, and 6) offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, and adequate forage.

Southern California Steelhead

Distribution. Southern California DPS steelhead include all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in streams from the Santa Maria River, San Luis Obispo County, California, (inclusive) to the U.S.-Mexico Border.

Status. Southern California steelhead were listed as endangered in 1997, when their status was reviewed on January 5, 2006 they retained that classification (71 FR 834). In many watersheds throughout Southern California, dams isolate steelhead from historical spawning and rearing habitats and alter the hydrology of the basin (e.g., Twitchell Reservoir within the Santa Maria River watershed, Bradbury Dam within the Santa Ynez River watershed, Matilija and Casitas dams within the Ventura River watershed, Rindge Dam within the Malibu Creek watershed). Monitoring since 2000 on the Santa Ynez River has revealed between zero and four adult returns each year except for 16 in 2008 (Williams *et al.* 2011). Dam counts on the Paso Robles Diversion 14 miles up the Ventura River, which excludes potential adults in the mainstem and San Antonio Creek, revealed an average of 2.5 steelhead passing upstream between 2006 and 2009. Counts on the Santa Clara River between 1995 and 2009 ranged from zero to two adults, however a more accurate counting system was put in place in 2010. In Topanga Creek, just north of Los Angeles, observations between 2003 and 2009 have ranged between zero and four returning adults and even if only 1 in 10 returners was observed, then the population is still below 40 adults.

Critical habitat. Critical habitat was designated for this species on September 2, 2005. The designation identifies PCEs that include sites necessary to support one or more steelhead life stages and, in turn, these sites contain the physical or biological features essential for the species conservation. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine areas. The physical or biological features that characterize these sites include water quantity, depth, and velocity, shelter, cover, living space and passage conditions.

California Central Valley Steelhead

Distribution. CCV steelhead include all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in the Sacramento and San Joaquin Rivers and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries, as well as two artificial propagation programs: the Coleman NFH, and Feather River Hatchery steelhead hatchery programs.

Status. California Central valley steelhead were listed as threatened in 1998, when their status was reviewed on January 5, 2006 they retained that classification. This DPS consists of steelhead populations in the Sacramento and San Joaquin River (inclusive of and downstream of the Merced River) basins in California's Central Valley. Steelhead historically were well distributed throughout the Sacramento and San Joaquin Rivers (Busby *et al.* 1996). Historic Central Valley steelhead run size is difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead in the Sacramento River, upstream of the Feather River, through the 1960s. Steelhead counts at Red Bluff Diversion Dam declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on Red Bluff Diversion Dam counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at Red Bluff Diversion Dam ended in 1993 due to changes in dam operations.

The only consistent data available on steelhead numbers in the San Joaquin River basin come from DFG mid-water trawling samples collected on the lower San Joaquin River at Mossdale. These data indicate a decline in steelhead numbers in the early 1990s, which have remained low through 2002 (DFG 2003). In 2004, a total of 12 steelhead smolts were collected at Mossdale (DFG, unpublished data). Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other streams previously thought to be void of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995. It is possible that naturally spawning populations exist in many other streams but are undetected due to lack of monitoring programs.

The best data available for the Sacramento River system come from Battle Creek where a weir is operated for Coleman National Fish Hatchery. Approximately 2000 fish passed the weir in 2002

but annual counts since then have been only 330 to 650 adults, resulting in a 10 year trend of 17% reduction per year. Snorkel surveys conducted in American River and Clear Creek have identified 154 and 116 redds, respectively (Williams *et al.* 2011). USFWS midwater trawl data monitors the CCV DPS as a whole and reveals that hatchery fish proportions have increased in the population, rising to 90% in recent years and exceeding 95% in 2010. Because hatchery releases have remained constant, this data suggests wild juvenile populations are decreasing.

Critical habitat. Critical habitat was designated for this species on September 2, 2005 (70 FR 52488). The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more life stages of steelhead. The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more steelhead life stages. Specific sites include 1) freshwater spawning, 2) freshwater rearing, 3) freshwater migration, 4) estuarine areas free of obstruction, 5) nearshore marine areas free of obstructions, and 6) offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, and adequate forage.

Shortnose sturgeon

Shortnose sturgeon are anadromous fish that live primarily in slower moving rivers or nearshore estuaries near large river systems. They are benthic omnivores that feed on crustaceans, insect larvae, worms and molluscs (Moser and Ross 1995, NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell *et al.* 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks.

There is limited recruitment information available for shortnose sturgeon. Estimates of annual egg production for this species are difficult to calculate because females do not spawn every year (Dadswell *et al.* 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NMFS 1998). Thus, annual egg production is likely to vary greatly in this species. Fecundity estimates have been made and range from 27,000 to 208,000 eggs/female (Dadswell *et al.* 1984).

Shortnose sturgeon are believed to spawn at discrete sites within rivers (Kieffer and Kynard 1993). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1993). Squiers *et al.* (1982) found over three years in the Androscoggin River, adults returned to a 1-km reach; and Kieffer and Kynard (1993) found adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over gravel, rubble, or rock-cobble substrates (Dadswell *et al.* 1984, NMFS 1998). Additional environmental conditions linked to spawning activity include decreasing river discharge following the peak spring freshet, water temperatures between 8-12°C, and bottom water velocities of 0.4 to 0.7 m/sec (Dadswell *et al.* 1984, NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0°C (Kieffer and Kynard in press). The

eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell *et al.* 1984). Between 8° and 12°C, eggs generally hatch after approximately 13 days. In the south, shortnose sturgeon spawn between 10 and 13°C beginning in late February, extending to April, and eggs hatch within 7 to 8 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week-old larvae to be photonegative, forming aggregations with other larvae for concealment.

Juvenile shortnose sturgeon generally move upstream for the spring and summer seasons and downstream for fall and winter; however, these movements usually occur above the salt- and freshwater interface of the rivers they inhabit (Dadswell *et al.* 1984, Hall *et al.* 1991). Adult shortnose sturgeon prefer deep, downstream areas with soft substrate and vegetated bottoms, if present. While shortnose sturgeon are occasionally collected near the mouths of coastal rivers, they were not known to engage in coastal migrations until recently, as telemetry-tagged shortnose sturgeon from one river have been recorded on receivers in other rivers.

During the summer and winter, adult shortnose sturgeon occur in freshwater reaches of rivers or river reaches that are influenced by tides; as a result, they often occupy only a few short reaches of a river's entire length (Buckley and Kynard 1985). During the summer, at the southern end of their range, shortnose sturgeon congregate in cool, deep, areas of rivers where adult and juvenile sturgeon can take refuge from high temperatures (Flournoy *et al.* 1992, Rogers and Weber 1994, Rogers and Weber 1995, Weber 1996).

Dependence on Waters of the United States

Shortnose sturgeon are anadromous fish that live primarily in slower-moving rivers or nearshore waters; they prefer nearshore marine, estuarine, and riverine habitats near large river systems. They are benthic omnivores that feed on crustaceans, insect larvae, worms and mollusks (NMFS 1998) but they have also been observed feeding off plant surfaces and on fish bait (Dadswell *et al.* 1984).

Figures 7a-d are depictions of shortnose sturgeon (and in the case of 7b and 7d, Atlantic sturgeon) habitat along the Ocala, Francis Marion, Sumter, and Croatan National Forests. Shortnose sturgeon are present in the full length of each river within each National Forest.

Distribution. Shortnose sturgeon occur along the Atlantic Coast of North America, from the St. John River in Canada to the St. John's River in Florida. Nineteen, geographically-distinct populations of shortnose sturgeon in the wild are distributed from New Brunswick, Canada; Maine; Massachusetts; Connecticut; New York; New Jersey and Delaware; Chesapeake Bay and Potomac River; North Carolina; South Carolina; Georgia; and Florida. Two additional, geographically distinct populations represent shortnose sturgeon that were isolated by dams occur in the Connecticut River (above the Holyoke Dam) and in Lake Marion on the Santee-Cooper River system in South Carolina (above the Wilson and Pinopolis Dams).

Figure 7A. Ocala Forest Boundary and Shortnose Sturgeon Distribution

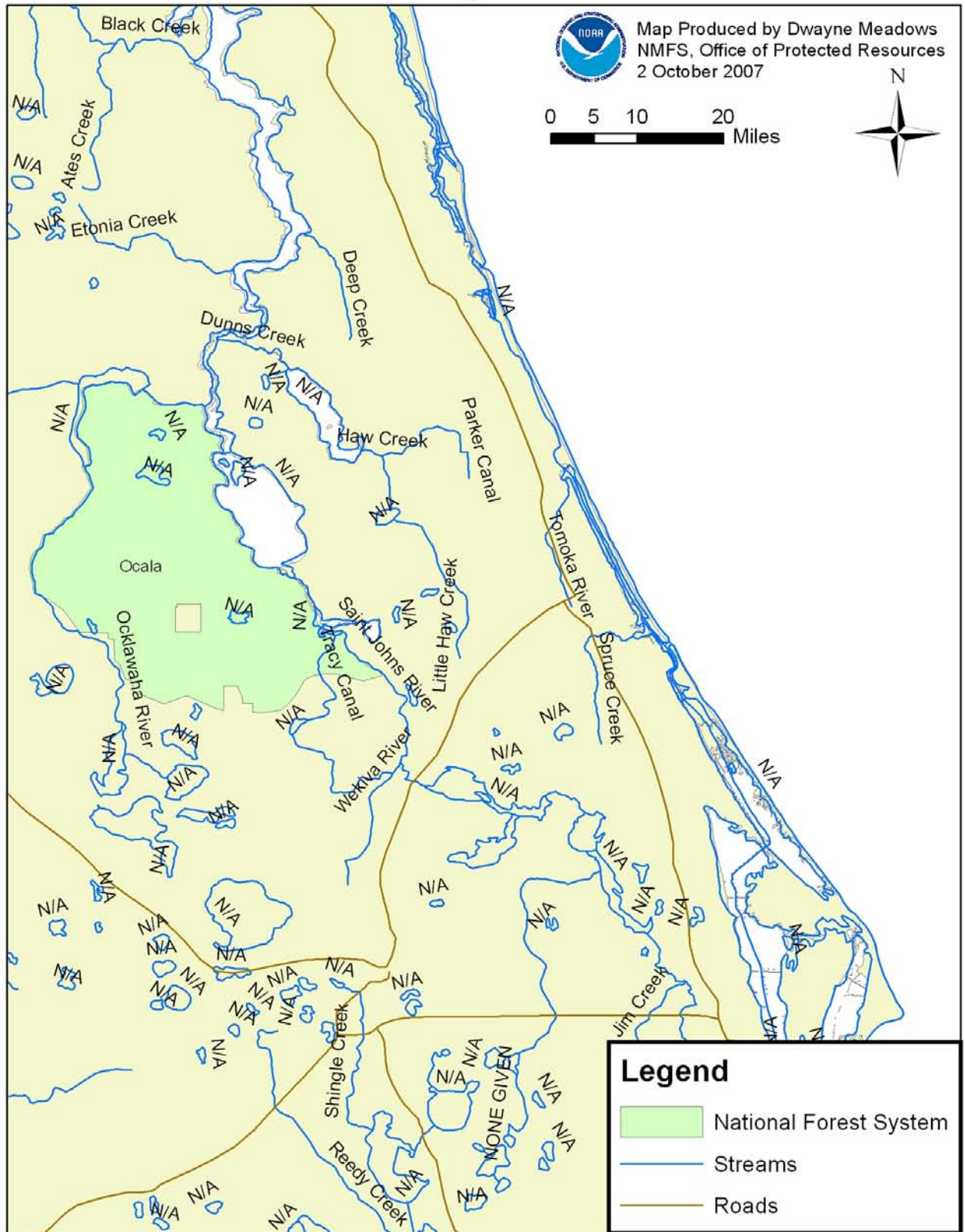


Figure 7B. Francis Marion Forest Boundary and Shortnose Sturgeon Distribution

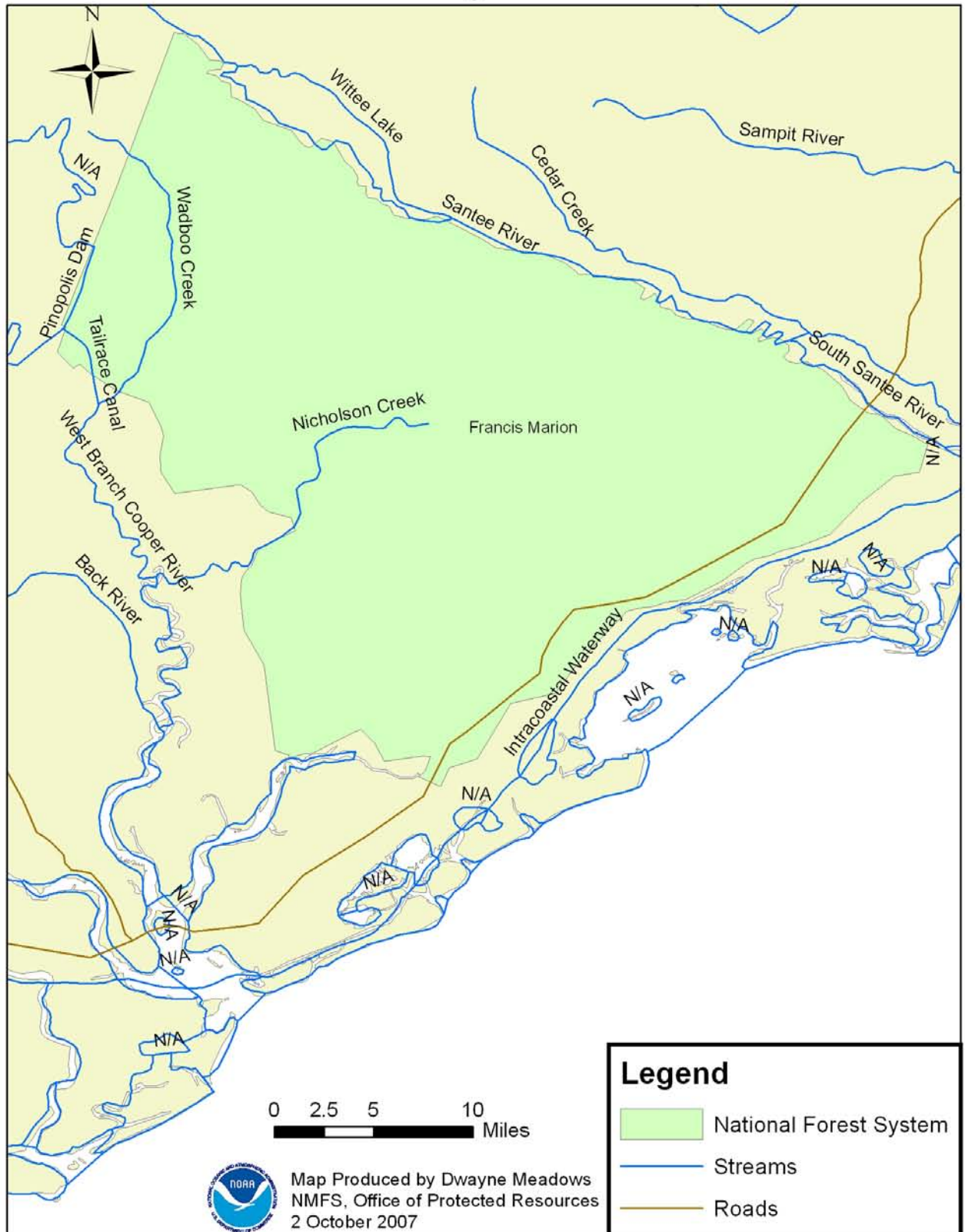


Figure 7C. Sumter National Forest Boundary and Shortnose Sturgeon Distribution

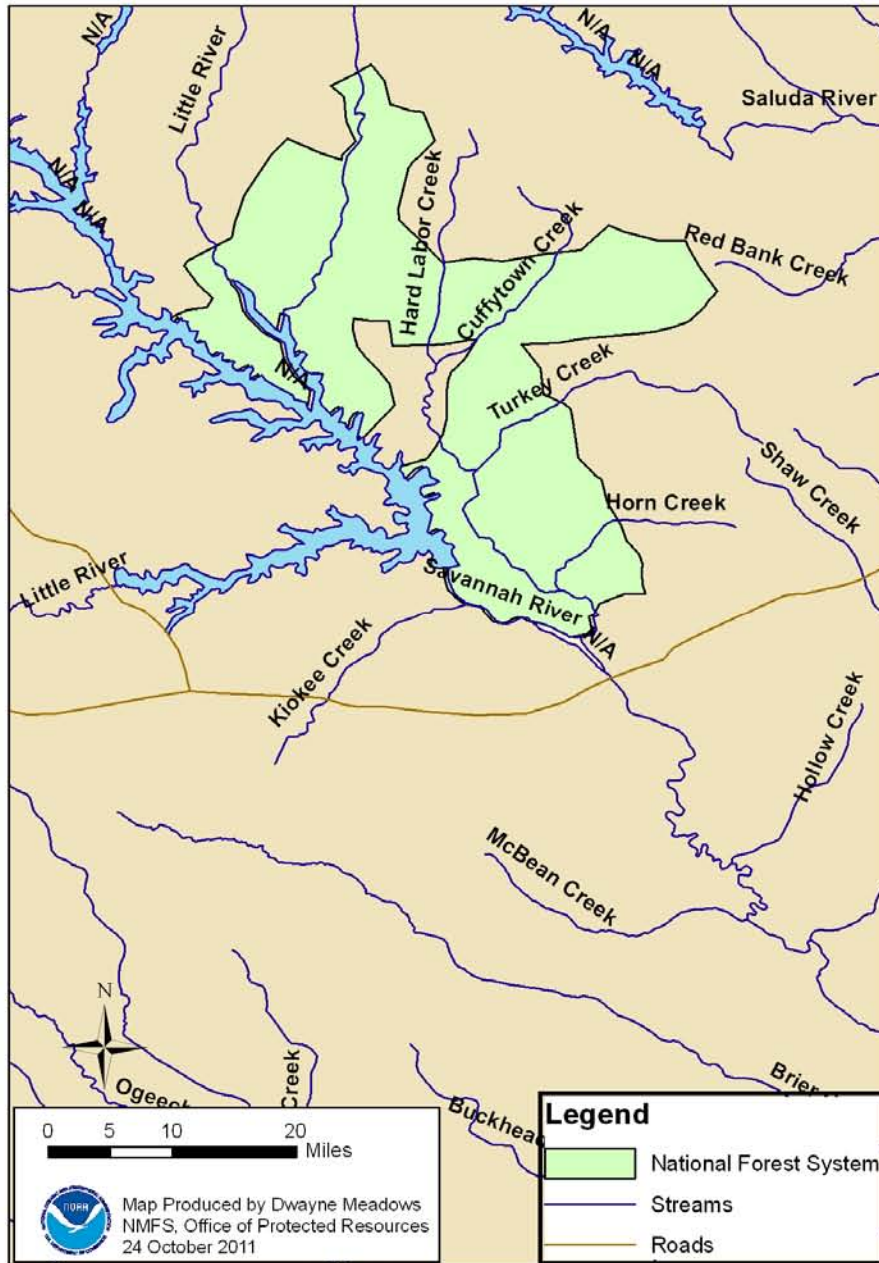


Figure 7D. Croatan National Forest Boundary and Shortnose Sturgeon Distribution



Status. Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001) and remained on the endangered species list with enactment of the Endangered Species Act of 1973, as amended. These sturgeon were listed as endangered because of population declines resulting

from the construction of dams in the large river systems of the northeastern United States during the late-1800s and early-1900s, dredging, the effects of water pollution, bridge construction, and incidental capture in commercial fisheries. More recently, alteration of freshwater flows into the estuaries of rivers had reduced the nursery habitat of juvenile shortnose sturgeon and larval and juvenile shortnose sturgeon have been killed after being impinged on the intake screens or entrained in the intake structures of power plants on the Delaware, Hudson, Connecticut, Savannah and Santee rivers.

Critical habitat. Critical habitat has not been designated for shortnose sturgeon.

Green Sturgeon Southern DPS

Dependence on Waters of the United States. The status reviews, proposed and final regulations to list green sturgeon as threatened did not identify water quality as a problem. Further, the published literature on green sturgeon provides limited information on the ecological relationship between green sturgeon and water quality. However, studies from other sturgeon demonstrates that sturgeon populations are limited by low levels of dissolved oxygen levels and high temperatures in the rivers, streams, and estuaries they occupy; juvenile anadromous sturgeon also depend on the freshwater-brackish interface in the tidal portion of rivers for nursery areas.

Distribution. The southern population of green sturgeon occurs in the freshwater and estuarine waters of the Sacramento and Feather Rivers in central California (Figure 8), though there is uncertainty surrounding the extent of their distribution.

Status. The southern population of Green sturgeon was listed as threatened on April 7, 2006, primarily because of population declines caused by dams that prevented them from reaching upstream spawning areas (USFWS 1995). Population abundance information concerning the Southern DPS of North American green sturgeon is limited, and comes largely from incidental captures during the white sturgeon (*Acipenser transmontanus*) monitoring program by the California Department of Fish and Game. The California Department of Fish and Game uses a multiple-census or Peterson mark-recapture method to estimate the legal population of white sturgeon captures in trammel nets. By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult North American green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG does not consider these estimates reliable.

Fish monitoring efforts at Red Bluff Diversion Dam and Glen Colusa Irrigation District on the upper Sacramento River have captured between 0 and 2,068 juvenile North American green sturgeon per year, mostly between June and July. The only existing information regarding changes in the abundance of the Southern DPS of North American green sturgeon includes changes in abundance at the John Skinner Fish Protection Facility between 1968 and 2001 (State facility). The estimated average annual number of North American green sturgeon taken at the State Facility prior to 1986 was 732; from 1986 on, the average annual number was 47 (70 FR 17386). For the Tracy Fish Collection Facility (Federal facility), the average annual number prior to 1986 was 889; from 1986 to 2001 it was 32. In light of the increased exports,

particularly during the previous 10 years, it is clear that the abundance of the Southern DPS of North American green sturgeon is dropping. Catches of sub-adult and adult North American green sturgeon by the Interagency Ecological Program between 1996 and 2004 ranged from 1 to 212 green sturgeon per year (212 occurred in 2001), however, the portion of these catches that were made up of the Southern DPS of North American green sturgeon is unknown as these captures were primarily located in San Pablo Bay which is known to consist of a mixture of the Northern and Southern population segments. Additional analysis of North American green and white sturgeon taken at the State and Federal facilities indicates that take of both North American green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960's.

Larval and post larval North American green sturgeon are caught each year in rotary screw traps at the Red Bluff Diversion Dam. A total of 2,608 juvenile sturgeon were captured from 1994-2000. All were assumed to be North American green sturgeon since 124 of these fish were grown by the University of California, Davis' researchers to an identifiable size and all were North American green sturgeon. Young sturgeon appear in catches from early May through August. Most range in size from 1 to 3 inches. Catch rates were greatest in 1995 and 1996 and were lowest in 1999 and 2000.

Figure 8. US Forest Service Boundaries and Listed Green Sturgeon Distributions



No North American green sturgeon have been detected during intensive salmonid monitoring efforts in Clear, Battle, Butte, Deer and Mill Creeks, all of which are tributaries to the Sacramento River. Sampling on these tributaries includes monitoring adult passage at fish ladders (Battle Creek), snorkel surveys (Deer, Butte, Clear and Battle creeks), and rotary screw trapping (Deer, Mill, Clear, Battle and Butte creeks). Much of this monitoring has occurred during time periods when adult North American green sturgeon would be expected to be in the rivers spawning, and when juvenile North American green sturgeon would be expected to be hatching, rearing and migrating through the river systems.

Similar monitoring activities have likewise failed to detect North American green sturgeon in the American River. These sampling efforts included snorkeling, rotary screw trapping, and seining, and were conducted during periods when adult and juvenile North American green sturgeon would have been expected to be in the river.

Green and white sturgeon adults have been observed periodically in small numbers in the Feather River. There are at least two confirmed records of adult North American green sturgeon. There are no records of larval or juvenile sturgeon of either species, even prior to the 1960's when Oroville Dam was built. During high flow years, green sturgeon may reproduce in the Feather River.

Critical habitat. Critical habitat was designated for this species on November 9, 2009 (74 FR 52300). Critical habitat was identified as coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; the lower Columbia River estuary; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor). The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more life stages of steelhead. The critical habitat designation for this DPS identifies PCEs that include sites necessary to support one or more green sturgeon life stages in freshwater, estuaries, and saltwater. Specific freshwater elements include 1) food resources, 2) substrate type or size, 3) water flow, 4) water quality, 5) migratory corridor, 6) water depth, and 7) sediment quality. Specific estuarine elements include 1) food resources, 2) water flow, 3) water quality, 4) migratory corridor, 5) water depth, and 6) sediment quality. Specific saltwater elements include 1) migratory corridor, 2) water quality, and 3) food resources.

Atlantic Sturgeon

Dependence on Waters of the United States. The general life history pattern of Atlantic sturgeon is that of a long lived, late maturing, iteroparous, anadromous species. Atlantic sturgeon spawn in freshwater, but spend most of their sub-adult and adult life in the marine environment (See Figures 7b and 7d for Atlantic sturgeon occupied waters adjacent to USFS land). While few specific spawning locations have been identified in the United States, many rivers are known to

support reproducing populations. Early life stage Atlantic sturgeon coupled with upstream movements of adults suggest spawning adults generally migrate upriver in the spring/early summer; February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems (Smith 1985, Bain 1997, Smith and Clugston 1997, Kahnle *et al.* 1998). Some rivers may also support a fall spawning migration.

Sub-adult and adult Atlantic sturgeon undertake long marine migrations and utilize habitat up and down the East Coast for rearing, feeding, and migrating (Dovel and Berggren 1983, Bain 1997, Stevenson 1997). These migratory sub-adults, as well as adults, are normally located in shallow (10-50m) near shore areas dominated by gravel and sand substrate (Stein *et al.* 2004). Despite extensive mixing in coastal waters, Atlantic sturgeon display high site fidelity to their natal streams. Straying between rivers within a proposed DPS would sometimes exceed 5 migrants per generation, but between DPSs was usually less than one migrant per generation, with the exception of fish from the Delaware River straying more frequently to southern rivers (Grundwald *et al.* 2008).

Spawning intervals range from 1-5 years for male Atlantic sturgeon (Smith 1985, Collins *et al.* 2000, Scheuller and Peterson 2010) and 3-5 for females (Vladykov and Greely 1963, Stevenson and Secor 1999, Bain 2002, Schueller and Peterson 2010). Fecundity of Atlantic sturgeon has been correlated with age and body size (ranging from 400,000 – 8 million eggs) (Smith *et al.* 1982, Van Eenennaam and Doroshov 1998, Dadswell 2006).

Most Atlantic sturgeon managers and researchers consider water quality as a moderate risk to every DPS in the United States (ASSRT 2007). During all stages of development, Atlantic sturgeon are sensitive to temperatures above 28°C (Niklitschek and Secor 2005, Kahn and Mohead 2010, Niklitschek and Secor 2010) and dissolved oxygen levels below 4.3 to 4.7 parts per million (Secor and Niklitschek 2002, EPA 2003, Niklitschek and Secor 2009). Juvenile sturgeon are also stressed by high salinities until they mature and out migrate. Additionally, sturgeons generally and Atlantic sturgeon specifically are sensitive to pesticides, heavy metals, and other toxins in the aquatic environment.

Distribution. The Atlantic sturgeons' historic range included major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida (Smith and Clugston 1997, ASSRT 2007). Atlantic sturgeon have been documented as far south as Bermuda and Venezuela (Lee *et al.* 1980). Historically, Atlantic sturgeon were present in approximately 38 rivers in the United States from St. Croix, ME to the Saint Johns River, FL, of which 35 rivers have been confirmed to have had historic spawning populations. Atlantic sturgeon are currently present in 36 rivers, and spawning occurs in at least 20 of these. Other estuaries along the coast formed by rivers that do not support Atlantic sturgeon spawning populations may still be important rearing habitats.

Status. Prior to 1890, Atlantic sturgeon populations were at or near carrying capacity. Between 1890 and 1905, Atlantic sturgeon (and shortnose sturgeon) populations were drastically reduced for sale of meat and caviar. Between 1920 and 1998, the harvest level remained very low due to small remnant populations. Prompted by research on juvenile production between 1985 and 1995 (Peterson *et al.* 2000), the Atlantic sturgeon fishery was closed by the Atlantic States

Marine Fisheries Commission in 1998, when a coast-wide fishing moratorium was imposed for 20-40 years, or at least until 20 year classes of mature female Atlantic sturgeon were present (ASMFC 1998).

Since the closure of the Atlantic sturgeon fishery, the only assessments of adult spawning populations have been made in the Hudson and Altamaha Rivers. While Atlantic sturgeon have been captured, tagged, and tracked through estuaries and rivers along the East Coast, no other estimates of spawning run size or juvenile population sizes have been made. Making estimates of spawning adults relies on the assumptions that 1) all adults that migrate into the freshwater portion of a river are native to that river and 2) are making that upstream migration with the intention of spawning. Kahnle *et al.* (2007) reported that approximately 870 adults per year returned to the Hudson River between 1985 and 1995. Peterson *et al.* (2008) reported that approximately 324 and 386 adults per year returned to the Altamaha River in 2004 and 2005, respectively.

Juvenile Atlantic sturgeon abundance may be a more precise way to measure the status of Atlantic sturgeon populations because it is believed that all age-1 and age-2 juveniles are restricted to their natal rivers (Dovel and Berggren 1983, Bain *et al.* 1999), avoiding the assumptions noted above. Peterson *et al.* (2000) reported that there were approximately 4,300 age-1 and -2 Atlantic sturgeon in the Hudson River between 1985 and 1995. Schueller and Peterson (2010) reported that age-1 and -2 Atlantic sturgeon population densities ranged from 1,000 to 2,000 individuals over a 4 year period from 2004 to 2007.

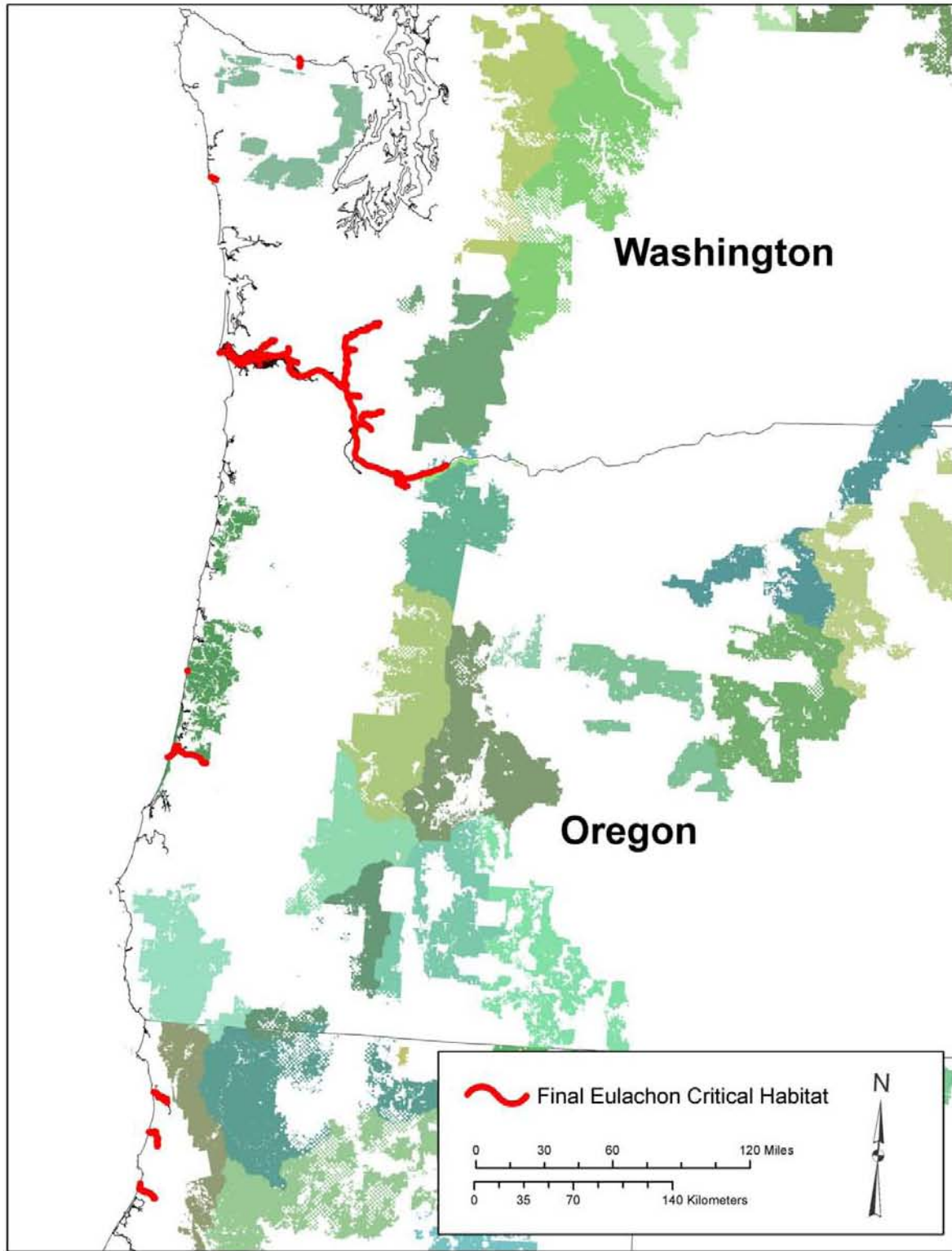
Listing status. Five DPSs of Atlantic sturgeon have been proposed for listing under the ESA. The Gulf of Maine DPS was proposed as threatened while the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were proposed as endangered (75 FR 61872 and 75 FR 904).

Critical habitat. Critical habitat for Atlantic sturgeon has not been proposed.

Pacific Eulachon Southern DPS

Dependence on Waters of the United States. Eulachon are semelparous and anadromous, spending most of their lives in marine environments before returning to freshwater to spawn once and die. Because larvae exit the freshwater systems almost immediately, they likely retain homing only to the estuarine system that their natal river drains to. Based upon this, the smallest stock unit is likely the estuary that natal streams drain (Hay and McCarter 2000, Beacham *et al.* 2005). Specific spawning rivers within the natal system are likely selected based upon environmental conditions at the time of return (Hay and Beacham 2005).

Figure 9. US Forest Service boundaries and the Southern DPS of Pacific Eulachon



The timing of eulachon entry into spawning rivers is likely tied to water temperature and tidal cycles (Ricker *et al.* 1954, WDFW and ODFW 2001, Lewis *et al.* 2002, Spangler 2002). Spawning normally occurs when water temperature is between 39° and 50° F. Spawn timing depends upon the river system involved (Willson *et al.* 2006). In the Columbia River and further south, spawning occurs from late January to May, although river entry occurs as early as December (Hay and McCarter 2000). The peak of eulachon runs in Washington State is from February through March. Fraser River spawning is significantly later, in April and May (Hay and McCarter 2000).

Males outnumber females by a roughly 2:1 margin. Eulachon sperm is viable for only minutes and a key factor of eulachon spawning may be male grouping *en mass* to broadcast their sperm. Once milt reaches downstream females, each female releases 7,000 to 31,000 eggs (in the Columbia River) at which time fertilization occurs (WDFW and ODFW 2001). This reproductive strategy requires high eulachon density to ensure fertilization. Eggs incubate for 30 to 40 days after which larvae drift to estuaries and coastal marine waters (Wydoski and Whitney 1979) and after three to five years, migrate back to natal basins to spawn.

Eulachon generally die following spawning (Scott and Crossman 1973, Clarke *et al.* 2007). Maximum known lifespan is 9 years of age, but 20 to 30% of individuals live to 4 years and most individuals survive to 3 years of age, although spawning has been noted as early as 2 years of age (Wydoski and Whitney 1979, Barrett *et al.* 1984, Hay and McCarter 2000, WDFW and ODFW 2001). However, the age distribution of spawners varies between river and from year-to-year (Willson *et al.* 2006).

Larval and post larval eulachon prey upon phytoplankton, copepods, copepod eggs, mysids, barnacle larvae, worm larvae, and other eulachon larvae until they reach adult size (WDFW and ODFW 2001). At this time, the primary prey of eulachon are copepods and euphausiids, including *Thysanoessa* spp., unidentified malacostracans, and cumaceans (Smith and Saalfeld 1955, Barraclough 1964, Wydoski and Whitney 1979, Drake and Wilson 1991, Sturdevant *et al.* 1999, Hay and McCarter 2000).

Distribution. Eulachon are smelt native to eastern North Pacific waters from the Bering Sea to Monterey Bay, California, or from 61° N to 31° N (Hart and McHugh 1944, Eschmeyer *et al.* 1983, Hay and McCarter 2000). Based upon run timing, genetic distinctions, size at maturity, and ecological features of both oceanic and freshwater environments, the eulachon that spawn in rivers south of the Nass River of British Columbia to the Mad River of California have been separated into the southern DPS eulachon. In addition, the southern DPS may have a different mean number of vertebrae from northern DPS (Hart and McHugh 1944, McLean *et al.* 1999, Hay and McCarter 2000, McLean and Taylor 2001, Beacham *et al.* 2005). However, the southern extent of their distribution has receded northward over the past several decades.

In the portion of the species' range that lies south of the U.S.–Canada border, most eulachon production originates in the Columbia River Basin. Within the Columbia River Basin, the major and most consistent spawning runs return to the mainstem of the Columbia River and the Cowlitz River. Spawning also occurs in the Grays, Elochoman, Kalama, Lewis, and Sandy Rivers. Adult eulachon have been recorded at several locations on the Washington and Oregon

coasts, and they were previously common in Oregon's Umpqua River and the Klamath River in northern California. Runs occasionally occur in many other rivers and streams, although these tend to be erratic, appearing in some years but not others, and appearing only rarely in some river systems (Hay and McCarter 2000, Willson *et al.* 2006, Gustafson *et al.* 2010).

Status. The southern DPS of eulachon was listed as threatened on March 18, 2010 (75 FR 13012). It is threatened by decreased abundance, natural predation, commercial and recreational fishing pressure (directed and bycatch), and loss of habitat. Population decline is anticipated to continue as a result of climate change and bycatch in commercial shrimp fisheries. However, as highly fecund fish, eulachon have the ability to rebound quickly if given the opportunity, a feature that is likely necessary to withstand significant predation pressure and high mortality likely experienced by pelagic larvae (Bailey and Houde 1989).

Eulachon formerly experienced widespread, abundant runs and have been a staple of Native American diets for centuries along the northwest coast. However, such runs that were formerly present in several California rivers as late as the 1960s and 1970s (i.e., Klamath River, Mad River, and Redwood Creek) no longer occur (Larson and Belchik 1998). This decline likely began in the 1970s and continued until the last Klamath River run was observed in 1999 (Larson and Belchik 1998, Moyle 2002). Eulachon have not been identified in the Mad River and Redwood Creek since the mid-1990s, although sampling effort here may be low or non-existent (Moyle 2002).

Historically, the Columbia River system likely supported half of all southern DPS spawning abundance, but has declined precipitously since the early and mid 1990s. Although regulations on commercial and recreational catches have been implemented throughout southern DPS freshwater range, commercial catch records suggest populations are a small fraction of their former abundance (an average of 998 metric tons from 1936 to 1992 compared to 91 metric tons annually from 1993 to present).

No population estimate is available for southern DPS eulachon. For the purposes of this consultation, a very rough and conservative estimate of the population is based on commercial bycatch from 2001 through 2009. Pacific Decadal Oscillation is thought to have contributed to larger than normal runs in the 2001 and 2002 seasons resulting from optimal rearing conditions in 1998-2000 (NMFS 2010). The conditions have switched and are currently sub-optimal for eulachon rearing, and as a result, the eulachon runs are smaller. Based on catches reported in the Columbia River in 2001, the eulachon population is estimated to be over 22 million fish (1,116,000 pounds). Also in 2001, commercial landings of eulachon brought to port in the Columbia River were measured to 313,100 pounds, which roughly equates to 6,224,652 eulachon or approximately 28% of the population (JCRMS 2007). In 2009, commercial landings were only 17,644 pounds, which roughly equates to 350,775 eulachon. Assuming a proportional ratio of commercial catch to overall population abundance, the Columbia River eulachon population may be approximately 1,250,000. This is a very conservative estimate for the Columbia River eulachon population because the proportion of the total population that can be captured as the size of the population decreases would likely decrease as well (as has been demonstrated by declines in CPUE from .253 kg/ha to .009 kg/ha), making it very unlikely that in 2009, 28% of the population was captured by the commercial fishery. Fishing restrictions

were implemented in 1995 and the steep decline recently is thought to be linked to a decline in the stock (Bargmann *et al.* 2005).

Critical habitat. Critical habitat was proposed for the southern DPS of eulachon on January 5, 2011 (76 FR 515).

Environmental Baseline

By regulation, the environmental baseline for biological opinions include the past and present impacts of all state, Federal or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this biological opinion also includes a general description of the natural factors influencing the current status of the listed species, their habitats, and the environment within the action area. The baseline analysis “is not the proportional share of responsibility the Federal agency bears for the decline in the species, but what jeopardy might result from the agency’s proposed actions in the present and future human and natural contexts.” (Pacific Coast Federation, 426 F3d at 1093).

Our summary of the environmental baseline complements the information provided in the status of the species section of this biological opinion, provides information on the past and present ecological conditions of the action area that is necessary to understand the species’ current risk of extinction, and provides the background necessary to understand information presented in the *Effects of the Action*, and *Cumulative Effects* sections of this biological opinion. When we “add” the effects of a new, continuing, or proposed action to the prior condition of endangered and threatened individuals and designated critical habitat, as our regulations require, our assessments are more likely to detect a proposed action’s “true” consequences on endangered species, threatened species, and designated critical habitat.

Because this is a programmatic consultation, however, on what is essentially a continuing action with a broad geographic scope that encompasses many waters of the United States this environmental baseline serves a slightly different purpose. The environmental baseline for this consultation focuses on the status and trends of the aquatic ecosystems in the United States and the consequences of that status for listed resources that occur in a general region. Since our action area and the environmental baseline encompass a very broad spatial scale with many distinct ecosystems, wherever possible we have focused on common indicators of the biological, chemical, and physical health of the nation’s aquatic environments. The environmental baseline for this consultation provides the backdrop for evaluating the effects of the action on listed resources under NMFS’ jurisdiction.

We divided the environmental baseline for this consultation into five broad geographic regions: the Northeast Atlantic Region, the Southeast Atlantic Region, the Gulf Coast Region, the Southwest Region, and the Pacific Northwest Region. In some instances regions were further subdivided according to ecoregions, importance to NMFS’ trust resources or other natural features. In each section we described the biological and ecological characteristics of the region

such as the climate, geology, and predominant vegetation to provide landscape context and highlight some of the dominant processes that influence the biological and ecological diversity of the region where threatened and endangered species reside. We then described the predominant land and water uses within a region to illustrate how the physical and chemical health of regional waters and the impact of human activities have contributed to current status of listed resources.

Baseline Conditions During a Fire

During this assessment, we evaluated several potential stressors associated with the proposed action including the general risk of fire and the frequency of fire retardant use, the regional distribution of species and the likelihood they would be exposed to retardants, the direct effects to exposed species, the indirect effects to exposed species, and the effects to their critical habitat. The narratives that follow describe the exposure, response, and risk to listed species, their forage resources, and their critical habitat in greater detail, based on the best scientific and commercial evidence available.

Fires are important ecological disturbances and provide a regular ecological service. Fires are most influenced by topography, climate, and vegetation at a local and regional scale (Rollins *et al.* 2002). Most fires are small in area and have limited adverse effects locally with negligible effects to whole populations of animals. In some cases topography, climate, and vegetation can come together to produce a large fire, but even then, the burn pattern at the regional scale provides a mosaic of variable-aged vegetative stands and new growth.

Millions of acres of land are burned by wildland fires each year in the United States (Figure 10). Since 1960 total acreage burned has ranged from 1.14 million acres in 1984 to as many as 9.87 million acres in 2006 and 9.32 million acres in 2007. The past three years have been three of the weakest fire years in the past decade. For three consecutive years, 2004 to 2006, total acreage burned by wildland fires set new record highs (NIFC 2007). According to the USFS, between 1950 and 1970 fire suppression activities resulted in relatively stable burned areas, whereas the 1980s marked an increase of wildfires, due in part to unprecedented success of fire suppression and its effects on forest conditions (USFS 2005). In 2010 USFS lands accounted for approximately 41.2% of the burned lands nationwide (1.41 million acres of 3.42 million acres).

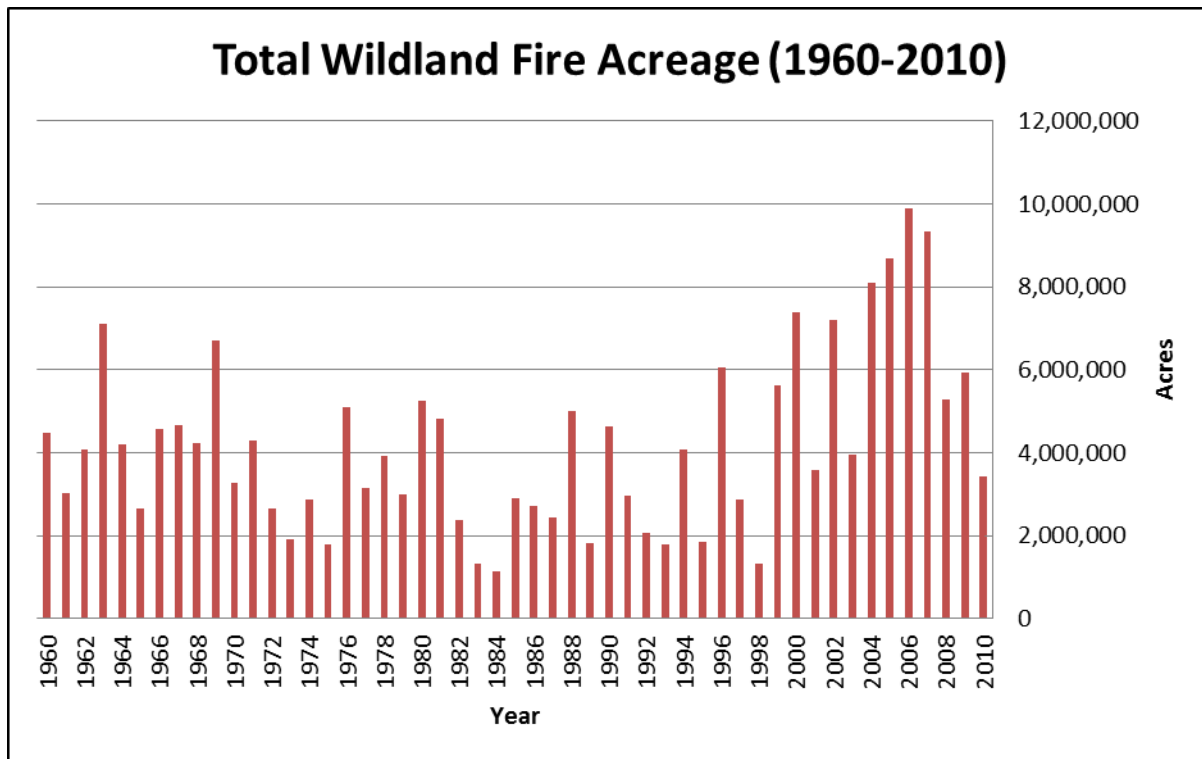


Figure 10. Total Wildland Fires in the United States between 1960 and 2010 (NFIC 2011. Note: Statistics were compiled by state and agency prior to 1983; 2004 data does not include fires in North Carolina).

Wildland fires that are allowed to burn naturally in riparian or upland areas have the potential to either benefit or harm aquatic species, depending on the severity and area coverage of the fire. As fire size increases, so do the chances of adverse effects, although, as mentioned above, most fires are small in size. Large fires that burn near the shores of streams and rivers can have biologically significant short term effects, such as increased water temperatures, ash, nutrients, pH, sediment, toxic chemicals, and large woody debris (Earl and Blinn 2003, Rinne 2004); however, fire is also one of the dominant habitat-forming processes in mountain streams (Bisson *et al.* 2003). As a result, many large fires burning near streams can result in fish kills with the survivors actively moving downstream to avoid the temporary poor water quality (Gresswell 1999, Rinne 2004). The patchy, mosaic pattern burned by fires provides a refuge for those fish and invertebrates that leave a burning area or simply spares some fish that were in a different location at the time of the fire (USFS 2000). Small fires or fires that burn entirely in upland areas also cause ash to enter rivers and increase smoke in the atmosphere, contributing to ammonia concentrations in rivers as the smoke adsorbs into the water (Gresswell 1999).

The presence of ash also has indirect effects on aquatic species depending on the amount of ash that enters the water. All ESA-listed fish rely on macroinvertebrates as a food source for at least a portion of their life histories. When small amounts of ash get into the water, there are usually no noticeable changes to the macroinvertebrate community or the water quality (Bowman and Minshall 2000). When significant amounts of ash are deposited into rivers, the macroinvertebrate community density and composition may be moderately to drastically reduced for a full year with long-term effects lasting 10 years or more (Minshall *et al.* 2001, Earl and

Blinn 2003). Larger fires can also indirectly affect fish by altering water quality because ash and smoke contribute to elevated ammonium, nitrate, phosphorous, potassium, and pH, which can remain elevated for up to four months after forest fires (Earl and Blinn 2003).

Many species have evolved in the presence of regular fires and have developed population-level mechanisms to withstand even the most intense fires (Gresswell 1999) and furthermore have come to rely on fire's disturbance to provide habitat heterogeneity. In the past century, humans have begun to move away from centralized towns and have increasingly developed land in remote locations, increasing the urban/wildland interface. As a result, the threat of fires to personal property and people has increased and so has the demand for protection of their safety and belongings. As a result, we expect listed fish species will be exposed to an increasing number of fires and fire fighting techniques over time.

The impacts of fire retardant must be considered in conjunction with the baseline conditions that exist during a fire. Low DO, high temperature, high ammonia, and ash in the water are all natural baseline conditions that may result in fish mortality without the use of fire retardant. Their presence in the system at the time of application makes fish all the more susceptible to lethal and sub-lethal effects. The risk assessment conducted below evaluates how the misapplication of fire retardants impacts listed species and their critical habitat as a separate stressor from natural wildfires.

Northeast Atlantic Region

This region encompasses Maine, New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Delaware, Pennsylvania, Maryland and Virginia. The region is ecologically diverse, encompassing several broad ecoregions—according to Bailey's (1995) *Description of the Ecoregions of the United States* this region encompasses the warm continental, the hot continental and the hot continental mountains divisions —these ecoregions can be further subdivided into provinces based on vegetation (Bailey 1995). This region encompasses the New England/Acadian mixed forests and the Northeastern Coastal Forests. The headwaters of the Connecticut River originate in New England/Acadian forests, and as the river descends, it transitions from boreal forest to temperate deciduous forest. As the river flows through the low gradient coastal region, the ecoregion transitions to Northeastern Coastal Forest. The headwaters of the Hudson River flow through Eastern Forest/Boreal Transition ecoregions. As the river descends, it transitions to Eastern Great Lakes Lowland Forest and then Northeastern Coastal Forest. The headwaters of the Delaware River originate in the Allegheny Highland Forest ecoregion, and then as the river descends, it transitions to Appalachian/Blue Ridge Forest and then Northeastern Coastal Forest ecoregions. The Chesapeake Bay watersheds originate in both Allegheny Highlands Forest and Eastern Forest/Boreal, through the Piedmont Province and empty into the Chesapeake in the Atlantic Coastal Plain.

There are no threatened or endangered species on or adjacent to National Forest Lands under NMFS jurisdiction in this region. Because no species will be affected by USFS activities in this region, it will not be analyzed further.

Southeast Atlantic Region

This region covers all the drainages that ultimately drain to the Atlantic Ocean between the states of North Carolina and Florida. This region includes all of South Carolina and parts of Georgia, North Carolina, Florida, and Virginia. NMFS trust resources occupy two ecoregions in the South Atlantic – the hot continental division and the subtropical division.

The hot continental division is characterized by its winter deciduous forest dominated by tall broadleaf trees, moderately leached soils rich in humus (Inceptisols, Ultisols, and Alfisols), and rainfall totals that decrease with distance from the ocean (Bailey 1995). Most of the Southeast Atlantic Coast Region is contained within the subtropical ecoregion and is characterized by a humid subtropical climate with particularly high humidity during summer months, and warm mild winters. Soils are strongly leached and rich in oxides of iron and aluminum (Bailey 1995). The subtropical ecoregion is forested, largely by second growth forests of longleaf, loblolly, and slash pines, with inland areas dominated by deciduous trees. Rainfall is moderate to heavy with annual averages of about 40 inches in the north, decreasing slightly in the central portion of the region, and increasing to 64 inches in southern Florida. The savanna ecoregion has a tropical wet-dry climate, controlled by moist warm tropical air masses and supports flora and fauna that is adapted to fluctuating water levels (Bailey 1995).

In the sections that follow we describe several basins and estuaries to characterize the general ecology and natural history of the area, and past and current human activities and their impacts on the area. The region contains more than 22 river systems that generally flow in a southeasterly direction to the Atlantic Coast. The diverse geology and climate ensures variability in biological productivity and hydrology. Major basins include the Albemarle-Pamlico Watershed and its tributaries, the Cape Fear River, Winyah Bay and the Santee-Cooper Systems, the Savannah, Ogeechee, and the St. Johns River, to name a few. The more northerly river, the Roanoke which is part of the Albemarle-Pamlico Watershed, is cooler and has a higher gradient and a streambed largely characterized by cobble, gravel and bedrock.

The southern rivers are characterized by larger portions of low gradient reaches, and streambeds that are composed of greater amounts of sand and fine sediments—are often high in suspended solids, and have neutral to slightly acidic waters with high concentrations of dissolved organic carbon. Rivers emanating entirely within the Coastal Plain are acidic, low alkalinity, blackwater systems with dissolved organic carbon concentrations often up to 50 mg/L (Smock *et al.* 2005). We described several river basins in detail to provide additional context for evaluating the influence of the environmental baseline on listed species under NMFS' jurisdiction and the health of the environment.

Albemarle-Pamlico Sound Complex

Natural History. The Albemarle-Pamlico Sound Estuarine Complex, the largest lagoonal estuarine system in the United States, includes seven sounds including Currituck Sound, Albemarle Sound, Pamlico Sound and others (EPA 2006). The Estuarine Complex is separated from the Atlantic Ocean by the Outer Banks, a long barrier peninsula, and is characterized by shallow waters, wind-driven tides that result in variable patterns of water circulation and salinity. Estuarine habitats include salt marshes, hardwood swamp forests, and bald cypress swamps.

The Albemarle-Pamlico watershed encompasses four physiographic regions—the Valley and Ridge, Blue Ridge, Piedmont and Coastal Plain Provinces. The geology of the basin strongly influences the water quality and quantity within the basin. The headwaters of the basin tributaries are generally steep and surface water flowing downstream has less opportunity to pick up dissolved minerals. However, as the surface water flows reaches the Piedmont and Coastal Plain, water velocity slows due to the low gradient and streams generally pick up two to three times the mineral content of surface waters in the mountains (Spruill *et al.* 1998). At the same time, much of the upper watershed is composed of fractured rock overlain by unconsolidated and partially consolidated sands. As a result, of the basin's geology, as a general matter more than half of the water flowing in streams discharging to the Albemarle-Pamlico Estuarine Complex comes from ground water.

Primary freshwater inputs to the Estuary Complex include the Pasquotank, Chowan and Roanoke Rivers that flow into Albemarle Sound, and the Tar-Pamlico and Neuse Rivers that flow into Pamlico Sound. The Roanoke River is approximately 410 miles long and drains a watershed of 9,580 mi². The Roanoke River begins in the mountains of western Virginia and flows across the North Carolina border before entering the Albemarle Sound. The upper Roanoke River's geology is primarily a high gradient boulder-rubble bedrock system. The middle Roanoke River is primarily coarse sand and gravel. The lower section of the Roanoke is almost entirely organic-rich mud. The average precipitation is approximately 43 inches. At the mouth, the average discharge is 5.3 billion gallons each day, or 8,193 cubic feet per second (Smock *et al.* 2005). The Roanoke River is home to 119 fish species, and only seven of those are not native to the area (Smock *et al.* 2005). The Roanoke is also home to nine endangered fish species, two amphibians, and seven mussels, including several important anadromous fish species.

The Neuse River is 248 miles long and has a watershed of 6,235 mi² (Smock *et al.* 2005). The Neuse River watershed is also located entirely within the state of North Carolina, flowing through the same habitat as the Cape Fear River, but ultimately entering Pamlico Sound. The river originates in weathered crystalline rocks of the piedmont and crosses sandstone, shale, and limestone before entering Pamlico Sound (Turekian *et al.* 1967). The average precipitation is approximately 48 inches per year. At the mouth, the average discharge is 3.4 billion gallons each day, or 5,297 cubic feet per second (USGS 2005).

Land Use. Land use in the Roanoke River is dominated by forest (68%) and the basin contains some of the largest intact, least disturbed bottomland forest floodplains along the eastern coast. Only 3% of the basin qualifies as urban land uses, and 25% is used for agriculture (Smock *et al.* 2005). The only major town in the Roanoke watershed is Roanoke, Virginia. The population in the watershed is approximately 80 people per square mile (Smock *et al.* 2005). In contrast, the Neuse River watershed is described as 35% agriculture, 34% forested, 20% wetlands, and 5% urban, and 6% other, with a basin wide density of approximately 186 people per square mile (Smock *et al.* 2005). While the population increased in the Albemarle-Pamlico Complex more than 70% during the last 40 years, the rate of growth is relatively low for many coastal counties in the Southeast (EPA 2006). Much of the estuarine complex is protected by large amounts of state and federally protected lands, which may reduce development pressures.

Throughout the 20th century, mining, agriculture, paper and pulp mills, and municipalities contributed large quantities of pollutants to the Roanoke River and the Albemarle-Pamlico Estuarine Complex. Even so, today the Albemarle-Pamlico Estuarine Complex is rated in good to fair condition in the National Estuary Program Coastal Condition Report despite that over the past 40-year period data indicate some noticeable changes in the estuary, including decreased dissolved oxygen levels, increased pH, decreased levels of suspended solids, and increased chlorophyll *a* levels (EPA 2006).

Coal is mined from the mountainous headwaters of the Roanoke River in southwestern Virginia. Mining through the piedmont and coastal areas of North Carolina was conducted for limestone, lead, zinc, titanium, apatite, phosphate, crushed stone, sand, and fossils. Many active mines in these watersheds are still in operation today. These mines are blamed for increased erosion, reduced pH, and leached heavy metals.

Agricultural activities are major source of nutrients to the estuary and a contributor to the harmful algal blooms (HABs) in summer, although according to McMahon and Woodside 1997 (cited in EPA 2006) nearly one-third of the total nitrogen inputs and one-fourth of the total phosphorus input to the estuary are from atmospheric sources. Primary agricultural activities within the watershed include corn, soybean, cotton, peanut, tobacco, grain, potato, and the production of chicken, hog, turkey, and cattle.

In general, the Roanoke River is much cleaner since the passage of the CWA, although mercury, arsenic, cadmium, chromium, copper, lead, nickel, zinc, and PCBs are still considered high (NCDENR 2000). Fish tissues sampled within the estuary also showed elevated concentrations of total PAHs and total PCBs—10% of the sampled stations exceeded risk-based EPA Advisory Guidance values (EPA 2006). Water quality studies in the mid-1990s showed the Neuse Basin contained the highest nitrogen and phosphorus yields, while the Chowan Basin had the lowest yields (Spruill *et al.* 1998).

The Neuse River entered the national spotlight during the early 1990s due to massive and frequent fish kills within the basin. Over one billion American shad have died in the Neuse River since 1991. The problem is persistent but the cause of the kills differs among events; in 2004 more than 700,000 estuarine fish died and more than 5,000 freshwater fish died within the basin. Freshwater species most commonly identified during investigations included sunfishes, shad, and carp, while estuarine species most commonly reported included menhaden, perch, and croaker. Atlantic menhaden have historically been involved in a majority of estuarine kill events and have exhibited stress and disease in conjunction with fish kills. Fish kill events may often have different causative agents, and in many cases the precise cause is not clear, but high levels of nutrients, HABs, toxic spills, outbreaks of a marine organism, *Pfiesteria piscicida*, low DO concentrations and sudden wind changes that mix hypoxic waters, are some of contributing factors or causes to the basins persistent fish kills (NCDWQ 2004).

Both the Roanoke River and the Neuse Rivers are fragmented by dams. The reservoirs are used for flood control and recreation, but the amount of agricultural and urban runoff that collects behind the dams has caused sanitation problems in the recent past. Three dams were removed recently in an effort to improve environmental conditions and fish passage. Widespread stream

modification and bank erosion were rated high within the greater watershed relative to other sites in the Nation (Spruill *et al.* 1998).

Commercial and Recreational Fishing. The Albemarle and Pamlico Sounds and associated rivers support a dockside commercial fishery valued at over \$54 million annually. The commercial harvest includes blue crabs, southern flounder, striped bass, striped mullet, white perch, croaker, and spot, among others. Roughly 100 species are fished commercially or recreationally in the region. The Neuse River supports many of the same species as the Roanoke River.

Commercial and recreational fisheries exist for oyster, crab, clam, American shad, American eel, shrimp, and many other species. Shellfish can be collected by dredging, which has adverse effects to benthic organisms, including Atlantic and shortnose sturgeon that use estuarine areas for feeding. Commercial fisheries along the South Carolina coast use channel nets, fyke nets, gillnets, seines, and trawls. All of those methods must use some sort of turtle excluder device, but likely still have lethal and sub-lethal effects to Atlantic and shortnose sturgeon.

Major Southeast Coastal Plains Basins

Natural History. More than five major river basins flow through the Coastal Plains of the Southeast and directly enter the Atlantic Ocean including the Cape Fear, Great Pee-Dee, Altamaha, and the St. Johns Rivers (see Table 2 for a description of several basins within this region). Rainfall is abundant in the region and temperatures are generally warm throughout the year. Northern rivers originate in the Blue Ridge Mountains or the Piedmont Plateau, but all the rivers described in this section have sizeable reaches of slack water as they flow through the flat Coastal Plain. Two rivers, the Satilla River in Georgia and the St. Johns River in Florida, are located entirely within the Coastal Plain. The highest elevation of the St. Johns River is 26 feet above sea level, so the change in elevation is essentially one inch every mile, making it one of the most gradually flowing rivers in the country.

Smock *et al.* (2005) describe the mountains and plateau as areas of heavily dissected and primarily highly metamorphosed rock of Paleozoic age, with occasional areas of igneous and sedimentary rock. Underlying rock is varied with bands of limestone, dolomite, shale, sandstone, cherts, and marble, with a number of springs and caves scattered throughout the area. Where the Piedmont Plateau dips the sedimentary deposits of the coastal plain are termed the fall line. Here, steep changes in elevation result in rapids or falls before the rivers level off in their Coastal Plain reaches. In the Coastal Plain reaches of the area's rivers soils are acidic with a low cation exchange capacity and a sandy or loamy surface horizon, and a loamy or clay subsurface. The acidic characteristics, slow flowing water with poor flushing and high organic and mineral inputs gives these waters their characteristic "blackwater" (or "brownwater" for those that originate in the Piedmont Plateau) appearance. The Satilla River is a blackwater river that has a naturally low pH (between 4 and 6) and white sandbars--due to the low pH it also has naturally lower productivity than other rivers that originate within the mountains or the Plateau.

Table 2. Rivers of the Southeast United States (data from NCDENR 1999 and Smock et al. 2005).

Watershed	Length (mi.)	Basin Size (mi ²)	Physiographic Provinces*	Mean Annual Precipitation (in.)	Mean Discharge (cfs).	No. Fish Species	No. Endangered Species
Cape Fear River	320	9,324	PP, CP	47	7,663	95	8 fish, 1 mammal, 15 mussels
Great Pee Dee River	430	10,641	BR, PP, CP	44	13,102	>100	6 fish, 1 reptile
Santee-Cooper River	440	15,251	BR, PP, CP	50	15,327	>100	5 fish, 2 reptiles
Savannah River	300	10,585	BR, PP, CP	45	11,265	>100	7 fish, 4 amphibians, 2 reptiles, 8 mussels, 3 crayfish
Ogeechee River	250	5,212	PP, CP	44	4,061	>80	6 fish, 2 amphibians, 2 reptiles, 1 mussel
Altamaha River	140 (>400)	14,517	PP, CP	51	13,879	93	1 mammal, 12 fish, 2 amphibians, 2 reptiles, 7 mussels, 1 crayfish
Satilla River	200	3,530	CP	50	2,295	52	2 fish, 1 amphibian, 2 reptiles, 1 mussel
St. Johns River	311	8,702	CP	52	7,840	>150	1 mammal, 4 fish, 2 reptiles, 2 birds

* Physiographic Provinces: BR = Blue Ridge, PP = Piedmont Plateau, CP = Coastal Plain

Land Use. Across this region, land use is dominated by agriculture and industry, and to a lesser extent timber and paper production, although more than half of most basins remain forested. Basin population density is highly variable throughout the region with the greatest density in the St. Johns River watershed with about 200 people per square mile of catchment, most of whom are located near Jacksonville, Florida. In contrast, there are only 29 people per square mile in the Satilla River watershed in Georgia (Smock *et al.* 2005). See Table 3 for a summary of land uses and population densities in several area basins across the region (data from Smock *et al.* 2005).

The largest population centers in the region include Miami and Jacksonville, Florida, and Savannah, Georgia. Major towns include Greensboro, Chapel Hill, and Wilmington, North Carolina and Fayetteville, South Carolina in the Cape Fear River watershed; Winston-Salem, North Carolina and Georgetown, Florence, and Sumter, South Carolina in the Great Pee-Dee River Watershed; Charlotte, Hickory, and Gastonia, North Carolina and Greenville and Columbia, South Carolina in the Santee-Cooper River watershed; Savannah and Augusta, Georgia, in the Savannah River watershed; Louisville, Statesboro, and Savannah, Georgia, in the Ogeechee River watershed; Athens, and Atlanta, Georgia, in the Altamaha River watershed; and Jacksonville, Florida in the St. Johns River watershed.

Several of the rivers in the region have elevated levels of metals including mercury, fecal coliform, bacteria, ammonia, turbidity, and low DO. These impairments are caused by municipal sewage overflows, mining, and non-point source pollution, waterfowl, urban runoff, marinas, agriculture, and industries including textile manufacturing, power plant operations, paper mills and chemical plants (Harned and Meyer 1983; Berndt *et al.* 1998; NCDENR 1998; Smock *et al.* 2005).

Several watersheds exhibit high nitrogen loads including the Cape Fear River, Winyah Bay, Charleston Harbor, St. Helena Sound, Savannah River, Ossabaw Sound, Altamaha River, and St.

Mary's River and Cumberland Sound (Bricker *et al.* 2007). Nitrate concentrations (as nitrogen) tend to be higher in stream draining basins with agricultural and mixed land uses (Berndt *et al.* 1998). Based on studies in Georgia, however, nitrate loads did not vary with growing season of crops (periods of heaviest fertilizer application), but were influenced by high streamflow, which could be related to downstream transport by subsurface flows (Berndt *et al.* 1998).

Table 3. Land Uses and Population Density in Several Southeast Atlantic Basins (data from Smock et al. 2005)

Watershed	Land Use Categories (Percent)				Density (people/mi. ²)
	Agriculture	Forested	Urban	Other	
Cape Fear River	24	56	9	11	80
The Great Pee-Dee	28	58	8	6	127
Santee-Cooper River	26	64	6	4	168
Savannah River	22	65	4	9	91
Ogeechee River	18	54	1	17 (wetlands)	78
Altamaha River	--	64	3	7	73
Satilla River	26	72	1	1	29
St. Johns River	25	45	6	24 (wetlands & water)	202

Sediment is the most serious pollutant in the Yadkin (Pee-Dee) River and has historically been blamed on agricultural runoff. In the mid 1990s, farmers in the region began using soil conservation techniques that have reduced sediment inputs by 77%. Unfortunately, the reduction in sediment inputs from farms did not translate to a reduction in sediment in the river, as during this period there was a 25% reduction in agricultural land and a 38% increase in urban development.

Mining. Mining occurs throughout the region. South Carolina is ranked 25th in the states in terms of mineral value and 13th among the eastern 26 states, and produces 1% of the total nonfuel mineral production value in the United States. There are currently 13 minerals being extracted from 485 active mines in South Carolina alone. Portland and masonry cement and crushed stone were the State's leading nonfuel minerals in 2004 (NMA 2007). In contrast, Georgia accounts for 4%, Florida accounts for 5%, and North Carolina accounts for 1.76% of the total nonfuel mineral production value in the United States. North Carolina's leading nonfuel minerals in 2004 were crushed stone, phosphate rock, and construction sand and gravel. Georgia produces 24% of the clay in the nation; other leading nonfuel minerals include crushed stone and Portland cement. Florida is the top phosphate rock mining state in the United States and produces about six times more than any other state in the nation. Peat and zirconium concentrates are also produced in Florida.

The first gold mine discovered and operated in the United States is outside Charlotte, North Carolina in the Pee Dee watershed. Mines through Georgia are also major producers of barite and crude mica, iron oxide, and feldspar. There is a proposed titanium mine near the mouth of

the Satilla River. Unfortunately, mines release some toxic materials and negatively impact fish, as fish living around dredge tailings have elevated levels of mercury and selenium.

Hydromodification Projects. Several of the rivers within the area have been modified by dams and impoundments. In contrast to rivers along the Pacific Coast, we found considerable less information on other types of hydromodification projects in this area, such as levees and channelization projects. There are three locks and dams along the mainstem Cape Fear River and a large impoundment on the Haw River. The lower river and its tributaries are relatively undisturbed. The lower reach is naturally a blackwater river with naturally low dissolved oxygen, which is compounded by the reduced flow and stratification caused by upstream reservoirs and dams. The Yadkin (Pee Dee) River is heavily utilized for hydroelectric power. There are many dams on Santee-Cooper River system. The Santee River Dam forms Lake Marion and diverts the Santee River to the Cooper River, where another dam, St. Stephen Dam regulates the outflow of the Santee River. Lake Moultrie is formed by both St. Stephen Dam and Pinopolis Dam, which regulates the flow of the Cooper River to the ocean. NMFS, in a draft Opinion, recently determined the Federal Energy Regulatory Commission, the action agency responsible for insuring their dams are not likely to jeopardize listed species, was not able to adequately protect shortnose sturgeon. Below the fall line, the Savannah River is free-flowing with a meandering course, but above the fall line, there are three large dams that turn the piedmont section of the river into a 100-mile long stretch of reservoir. Although the Altamaha River is undammed, hydropower dams are located in its tributaries the Oconee and Ocmulgee Rivers above the fall lines. There are no dams, however, along the entire mainstem Satilla River. There are no major dams on the mainstem St. Johns River either, but one of the largest tributaries has a dam on it. The St. Johns River's flow is altered, however, by water diversions for drinking water and agriculture.

Commercial and Recreational Fishing. The region is home to many commercial fisheries targeting species like shrimp, blue crab, clams, American and hickory shad, oysters, whelks, scallops, channel catfish, flathead catfish, snapper, and grouper. Shortnose sturgeon can be caught in gillnets, but gillnets and purse seines account for less than 2% of the annual bycatch. Shrimpers are responsible for 50% of all bycatch in Georgia waters and often interact with sea turtles. There are approximately 1.15 million recreational anglers in the state.

The Risk of Fire in the Region

Peak fire season in the Southeast Atlantic Region occurs between October and June, depending on various vegetation types. Based on a review of more than 80,000 wildfires, Malamud *et al.* (2005) calculated the wildfire recurrence interval for large fires ($\geq 2,471$ acres (10 km^2)) in the subtropical ecoregion that encompasses most of this region, as ranging between every 19 years to 47. Of the total land area within this ecoregion (more than $4,000,000 \text{ mi}^2$ [which incidentally encompasses a sizeable portion of the Gulf Region—discussed next]) the USFS manages $16,571 \text{ mi}^2$ (less than 1%).

Gulf Coast Region

This region encompasses states of Alabama, Arkansas, Illinois, Iowa, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Oklahoma, South Dakota, Tennessee, the western portion of

Florida including the Florida Keys, and parts of, Georgia, Texas, Minnesota, Montana, North Dakota, Nebraska, Colorado, Indiana, Ohio, New Mexico, North Carolina, Pennsylvania, Virginia, West Virginia, Wisconsin, Wyoming, Mexico, and two Canadian provinces. Almost 2/3 of the continental United States drains to the Gulf of Mexico through the Mississippi River Basin. The Gulf is roughly 800 nautical miles wide, and is connected with the Atlantic Ocean through the Florida Straits and the Caribbean Sea through the Yucatan Channel between Cuba and Mexico.

While the Mississippi River is the most notable basin that drains to the Gulf of Mexico in terms of overall size (and the largest river in the United States) more than ten major river basins flow through to the Gulf including the Atchafalaya, Mobile, Red, Brazos, Colorado, and Rio Grande Rivers several. In the following sections, we describe several basins and estuaries that enter the Gulf of Mexico to characterize the general ecology and natural history of the area, and past and current human activities and their impacts on the area.

There are no threatened or endangered species under NMFS jurisdiction on or adjacent to USFS Lands in this region. Because no species will be affected by USFS activities in this region, it will not be analyzed further.

Southwest Coast Region

The basins described in this section are encompassed by the state of California and parts of Oregon. Select watersheds described herein characterize the general ecology and natural history of the area, and the past, present and future human activities and their impacts on the area. Essentially, this region encompasses all Pacific Coast Rivers south of Cape Blanco, California through southern California. The Cape Blanco area marks a major biogeographic boundary and has been identified by NMFS as a DPS/ESU boundary for Chinook and coho salmon, and steelhead on the basis of strong genetic, life history, ecological and habitat differences north and south of this landmark. Major rivers contained in this grouping of watersheds are the Sacramento, San Joaquin, Salinas, Klamath, Russian, Santa Ana and Santa Margarita Rivers (see Table 4).

California Coast

Natural History. The physiographic regions covered by the basins discussed herein, include: (a) the Cascade-Sierra Nevada Mountains province, which extends beyond this region as we have defined it and continue north into British Columbia, (b) the Pacific Border province, and (c) the Lower California province (Carter and Resh 2005). The broader ecoregions division, as defined by Bailey (1995) is the Mediterranean Division. Three major vegetation types are encompassed by this region: the temperate coniferous forest, the Mediterranean shrub and savannah, and the temperate grasslands/savannah/shrub. The area, once dominated by native grasses, is naturally prone to fires set by lightning during the dry season (Bailey 1995).

This region is the most geologically young and tectonically active region in North America. The Coast Range Mountains are folded and faulted formations, with a variety of soil types and nutrients that influence the hydrology and biology of the individual basins (Carter and Resh 2005). The region also covers the Klamath Mountains and the Sierra Nevada.

The climate is defined by hot dry summers and wet, mild winters, with precipitation generally decreasing in southern latitudes although precipitation is strongly influenced by topography and generally increases with elevation. Annual precipitation varies from less than 10 inches to more than 50 inches in the region. In the Sierra Nevada about 50% of the precipitation occurs as snow (Carter and Resh 2005), as a result snowmelt strongly influences hydrological patterns in the area. Severe seasonal patterns of flooding and drought, and high interannual variation in total precipitation makes the general hydrological pattern highly predictable within a basin, but the constancy is low across years (Carter and Resh 2005). According to Carter and Resh (2005) this likely increases the variability in the annual composition of the fish assemblages in the region.

Table 4. Select Rivers in the Southwest Coast Region (Carter and Resh 2005)

Watershed	Length (mi. [approx.])	Basin Size (mi ²)	Physiographic Provinces*	Mean Annual Precipitation (inches)	Mean Discharge (cfs).	No. Fish Species (native)	No. Endangered Species
Rogue River	211	5,154	CS, PB	38	10,065	23 (14)	11
Klamath River	287	15,679	PB, B/R, CS	33	17,693	48 (30)	41
Eel River	200	3651	PB	52	7416	25 (15)	12
Russian River	110	1439	PB	41	2331	41 (20)	43
Sacramento River	400	27,850	PB, CS, B/R	35	23,202	69 (29)	>50 T & E spp.
San Joaquin River	348	83,409	PB, CS	49	4,662	63	>50 T & E spp.
Salinas River	179	4241	PB	14	448	36 (16)	42 T & E spp.
Santa Ana River	110	2438	PB	13	60	45 (9)	54
Santa Margarita River	27	1896	LC, PB	49.5	42	17 (6)	52

* Physiographic Provinces: PB = Pacific Border, CS = Cascades-Sierra Nevada mountains, B/R=Basin & Range

The San Joaquin River, drains the largest basin in the region, originates within the Sierra Nevada near the middle of California and flows in a northwesterly direction through the southern portion of the Central Valley. The alluvial fan of the Kings River separates the San Joaquin from the Tulare River basin.

Land Use. Land use is dominated by forest (and vacant land) in northern basins, and grass, shrubland, and urban uses dominate in southern basins (see Table 5). Overall, the most developed watersheds are the Santa Ana, Russian, and Santa Margarita Rivers. The Santa Ana Watershed encompasses portions of San Bernardino, Los Angeles, Riverside, and Orange counties. About 50% of coastal sub-basin of the Santa Ana watershed is dominated by urban land uses and the population density is about 1,500 people per square mile. When steep and unbuildable lands are excluded from this area, then the population density in the watershed is 3,000 people per square mile. However, the most densely populated portion of the basin is near the city of Santa Ana where density reaches 20,000 people per square mile (Burton 1998, Belitz *et al.* 2004). The basin is home to nearly 5 million people and the population is projected to increase two-fold in the next 50 years (Burton 1998, Belitz *et al.* 2004).

Not only is the Santa Ana watershed the most heavily developed watersheds in the region, the Santa Ana is the most heavily populated study site out of more than 50 assessment sites studied across the nation by the United States Geological Survey (USGS) under the National Water-

Quality Assessment (NAWQA) Program. Water quality and quantity in the basin reflects the influence of the high level of urbanization. For instance, the primary source of baseflow to the river is the treated wastewater effluent; secondary sources--sources that influence peak flows—include stormwater runoff from urban, agricultural, and undeveloped lands (Belitz *et al.* 2004). Concentrations of nitrates and pesticides are elevated within the basin, and were more frequently detected than in other national NAWQA sites (Belitz *et al.* 2004). Belitz *et al.* (2004) found that total nitrogen concentrations commonly exceeded 3 mg/L in the Santa Ana basin. In other NAWQA basins with elevated total nitrogen concentrations across the country, the primary influencing factor was the level of agriculture and the application of manure and pesticides within the basin. In the Santa Ana basin the elevated nitrogen is attributed largely to the wastewater treatment plants, where downstream reaches consistently exceeding 3 mg/L total nitrogen. Samples of total nitrogen taken upstream of the wastewater treatment plants were commonly below 2 mg/L (Belitz *et al.* 2004). Other contaminants detected at high levels included volatile organic compounds (VOCs; including chlorform, which sometimes exceeded water quality standards), pesticides (including diuron, diazinon, carbaryl, chlopyrifos, lindane, malathion, and chlorothalonil), and trace elements (including lead, zinc, arsenic). As a result of the changes, the biological community in the basin is heavily altered (Belitz *et al.* 2004).

Table 5. Land Uses and Population Density in Several Southwest Coast Region (Carter and Resh (2005)).

Watershed	Land Use Categories (Percent)				Density (people/mi. ²)
	Agriculture	Forest	Urban	Other	
Rogue River	6	83	<1	9 grass & shrub	32
Klamath River	6	66	<1	24 grass, shrub, wetland	5
Eel River	2	65	<1	31 grass & shrub	9
Russian River	14	50	3	31 (23 grassland)	162
Sacramento River	15	49	2	30 grass & shrub	61
San Joaquin River	30	27	2	36 grass & shrub	76
Salinas River	13	17	1	65 (49 grassland)	26
Santa Ana River	11	57	32	---	865
Santa Margarita River	12	11	3	71 grass & shrub	135

In many basins, agriculture is the major water user and the major source of water pollution to surface waters. In 1990 nearly 95% of the water diverted from the San Joaquin River was diverted for agriculture, and 1.5% diverted for livestock (Carter and Resh 2005). During the same period, Fresno, Kern, Tulare, and Kings Counties ranked top in the nation for nitrogen fertilizer use. Nitrogen fertilizer use increased 500% and phosphorus use increased 285% in the San Joaquin River basin in a 40 year period (Knatzer and Sheton 1998 *in* Carter and Resh 2005). A study conducted by USGS in the mid-1990s on water quality within San Joaquin River basin detected 49 pesticides in the mainstem and three sub-basins--22 pesticides were detected in 20% of the samples and concentrations of seven exceeded water quality standards (Dubrovsky *et al.* 1998). Water chemistry in the Salinas River is strongly influence by intensive agriculture—water hardness, alkalinity, nutrients and conductivity are high in areas where agricultural uses predominate.

Mining. Famous for the gold rush of the mid 1800s, California has a long history of mining. In

2004, California ranked top in the nation for nonfuel mineral production with 8.23% of the total production (NMA 2007). Today, gold with silver and iron ore comprise only 1% of the production value. Primary minerals include construction sand and gravel, cement, boron and crushed stone. California is the only state to produce boron, rare-earth metals and asbestos (NMA 2007).

The State contains some 1,500 abandoned mines and roughly 1% are suspected of discharging metal-rich waters in the basins. The Iron Metal Mine in the Sacramento Basin releases more than 500 kg of copper and more than 350 kg of zinc to the Keswick Reservoir below Shasta Dam, as well as elevated levels of lead (Cain *et al.* 2000 in Carter and Resh 2005). Metal contamination seriously reduces the biological productivity within a basin, can result in fish kills at high levels and at low levels contributes to sub-lethal effects including reduced feeding, overall activity levels, and growth. The Sacramento Basin and the San Francisco Bay watershed is one of the most heavily impacted basins within the state from mining activities, largely because the basin drains some of the most productive mineral deposits in the region. Methylmercury contamination within San Francisco Bay, the result of 19th century mining practices using mercury to amalgamate gold in the Sierra Nevada Mountains, remains a persistent problem today. Based on sediment cores, we know that pre-mining concentrations were about 5 times lower than concentrations detected within the Bay today (Conaway *et al.* 2003 in EPA 2006).

Hydromodification Projects. Several of the rivers within the area have been modified by dams, water diversions and drainage systems for agriculture and drinking water, and some of the most drastic channelization projects within the nation. In all, there are about 1,400 dams within the State of California, more than 5,000 miles of levees, and more than 140 aqueducts (Mount 1995 in Carter and Resh 2005). While about 75% of the runoff occurs in basins in the northern half of the State, 80% of the water demand is in the southern half of the State. Two water diversion projects meet these demands—the Bureau of Reclamation's (BOR) Central Valley Project and the California State Water Project. The Central Valley Project, one of the world's largest water storage and transport systems, has more than 20 reservoirs and delivers about 7 million acre-feet each year to southern California. The State Water Project has 20 major reservoirs and holds nearly 6 million acre-feet of water, delivering about 3 million acre feet. Together these diversions irrigate about 4 million acres of farmland and deliver drinking water to about 22 million residents. NMFS recently determined the BOR was unable to insure this project was likely to avoid jeopardizing listed species or adversely modifying their critical habitat within the central valley of California and both parties have agreed to a set of Reasonable and Prudent Alternatives (RPAs) that will allow for the survival and recovery of listed species in this area.

Both the Sacramento River and the San Joaquin River are heavily modified, each with hundreds of dams. The Rogue, Russian, and Santa Ana Rivers each have more than 50 dams, and the Eel, Salinas, and the Klamath Rivers have between 14 and 24 dams. The Santa Margarita, considered one the last free flowing rivers in coastal southern California has 9 dams in its watershed. All major tributaries of the San Joaquin River are impounded at least once and most have multiple dams or diversions. The Stanislaus River, a tributary of the San Joaquin River has over 40 dams. As a result, the hydrograph of the San Joaquin River is seriously altered from its natural state, the temperature regime and sediment transport regime are altered, and such changes have had

profound influences on the biological community within the basin—while the modifications generally result in a reduction of suitable habitat for native species, these changes frequently result in a concomitant increase of suitable habitat for nonnative species. The Friant Dam on the San Joaquin River is attributed with the extirpation of spring-run Chinook salmon within the basin, a run once estimated as producing 300,000 to 500,000 fish (Carter and Resh 2005).

Commercial and Recreational Fishing. The region is home to many commercial fisheries. The largest in terms of total landings in 2006 were northern anchovy, Pacific sardine, Chinook salmon, sablefish, Dover sole, Pacific whiting, squid, red sea urchin, and Dungeness crab (CDFG 2007). Red abalone are also harvested off of the shores of California. Illegal poaching of abalone, including endangered white abalone continues to be of concern in the state, with the demand for abalone in local restaurants, seafood markets and international businesses (Daniels and Floren 1998). The first salmon cannery established along the west coast was located in the Sacramento River watershed in 1864 but it only operated for about two years because the sediment from hydraulic mining decimated the runs in the basin (Hittell 1882, and Goode and others, 1884-1887, cited in NRC 1996).

The Risk of Fire in the Region

Peak fire season in the Southwest Coast Region occurs between April and October. Based on a review of more than 80,000 wildfires, Malamud *et al.* (2005) calculated the wildfire recurrence interval for large fires ($\geq 2,471$ acres (10 km^2)) in the Mediterranean and Mediterranean Mountain ecoregions that encompasses most of this region, as every year to 3 years in the lowland or Mediterranean ecoregion, and less frequently in the Mediterranean Mountains – approximately every 9 to 17 years.

Pacific Northwest Region

This region encompasses Washington, Oregon, Idaho, and includes parts of Nevada, Montana, Wyoming, and British Columbia. The region is ecologically diverse, encompassing northern marine lowland forests, mountain forests, alpine meadows and Northern desert habitat. In this section we focus on three primary areas that characterize the region, the Columbia River Basin and its tributaries, the Puget Sound Region, and the Coastal Drainages north of the Columbia River. The broader ecoregion divisions, as defined by Bailey (1995), and encompassed within this region are the Marine and Marine Mountains Divisions, portions of the Temperate Desert, and Temperate Steppe and Temperate Steppe Mountains. Puget Sound and the coastal drainages are contained within the Marine Division, while the Columbia River watershed encompasses portions of all five ecoregions.

Columbia River Basin

Natural History. The most notable of all basins within the region is the Columbia River. The largest river in the Pacific Northwest and the fourth largest river in terms of average discharge the United States drains an area over 258,000 square miles (making it the sixth largest in terms of drainage area), the Columbia River Basin includes parts of Washington, Oregon, Nevada, Utah, Idaho, Wyoming, Montana and British Columbia and encompasses 13 terrestrial and three freshwater ecoregions, including arid shrub-steppes, high desert plateaus, temperate mountain forests, and deep gorges (Hinck *et al.* 2004, Kammerer 1990; Stanford *et al.* 2005).

Major tributaries include the Snake, Willamette, Salmon, Flathead, and Yakima Rivers; smaller rivers include the Owyhee, Grande Ronde, Clearwater, Spokane, Methow, Cowlitz and the John Day Rivers (see Table 6 for a description of select Columbia River Tributaries). The Snake River is the largest tributary at more than 1,000 miles long; its headwaters originating in Yellowstone National Park, Wyoming. The second largest tributary is the Willamette River in Oregon (Kammerer 1990; Hinck *et al.* 2004). The Willamette River is the 19th largest river in the nation in terms of average annual discharge (Kammerer 1990). The basins drain portions of the Rocky Mountains, the Bitterroot Range, and the Cascade Mountain Range.

The average annual runoff at the mouth of the Columbia River is 265,000 cubic feet per second (cfs; Kammerer 1990). A saltwater wedge extends 23 miles upstream of the mouth with tidal influences extending up to 146 miles upriver (Hinck *et al.* 2004). The climate within the basin is a mix of arid, dry summers, cold winters, and maritime air masses entering from the west. It is not uncommon for air temperatures in the Rocky Mountains to dip below zero in mid-winter, but summer air temperatures can reach more than 100 °F in the middle basin.

Table 6. Select Tributaries of the Columbia River (Carter and Resh 2005)

Watershed	Length (mi. [approx.])	Basin Size (mi ²)	Physiographic Provinces*	Mean Annual Precipitation (inches)	Mean Discharge (cfs).	No. Fish Species (native)	No. Endangered Species
Snake/Salmon River	870	108,495	CU, NR, MR, B/R	14	55,267	39 (19)	5 fish (4 T, 1 E), 6 (1 T, 5 E) snails, 1 plant (T)
Yakima River	214	6,139	CS, CU	7	3,602	50	2 (T)
Willamette River	143	11,478	CS, PB	60	32,384	61 (~31)	5 fish (4 T, 1 E),

* Physiographic Provinces: CU = Columbia-Snake River Plateaus, NR = Northern Rocky Mountains, MR = Middle Rocky Mountains, B/R=Basin & Range, CS = Cascade-Sierra Mountains, PB = Pacific Border

The river and estuary were once home to more than 200 distinct runs of Pacific salmon and steelhead, and represented adaptation to the local environment within a tributary or segment of a river (Stanford *et al.* 2005). Salmonids within the basin include Chinook, chum, coho, sockeye salmon, steelhead and redband trout, bull trout, and cutthroat trout. Other fish species within the basin include sturgeon, eulachon, lamprey, and sculpin (Wydoski and Whitney 1979). According to a review by Stanford *et al.* (2005), the basin contained 65 native fish species and at least 53 nonnative fishes. The most abundant non-native fish is the American shad, which was introduced to the basin in the late 1800s (Wydoski and Whitney 1979).

Land Use. More than 50% of the United State’s portion of the Columbia River Basin is in Federal ownership (most of which occurs in high desert and mountain areas), 39% is in private land ownership (most of which occurs in river valleys and plateaus), and the remainder is divided among tribes, state, and local governments (Hinck *et al.* 2004). See Table 7 for a summary of land uses and population densities in several sub-basins within the Columbia River watershed (data from Stanford *et al.* 2005).

Table 7. Land Uses and Population Density in Select Tributaries of the Columbia River (data from Stanford et al. 2005)

Watershed	Land Use Categories (Percent)				Density (people/mi. ²)
	Agriculture	Forest	Urban	Other	
Snake/Salmon River	30	10-15	1	54 scrub/rangeland/barren	39
Yakima River	16	36	1	47 shrub	80
Willamette River	19	68	5	--	171

The interior Columbia Basin has been altered substantially by humans causing dramatic changes and declines in many native fish populations. In general the basin supports a variety of mixed uses. Predominant human uses include logging, agriculture, ranching, hydroelectric power generation, mining, fishing and a variety of recreational activities, and urban uses.

The decline of salmon runs in the Columbia is attributed to loss of habitat, blocked migratory corridors, altered river flows and pollution, over harvest, and competition from hatchery fish. Critical ecological connectivity (mainstem to tributaries and riparian floodplains) has been disconnected by dams and associated activities such as floodplain deforestation and urbanization. The most productive floodplains of the watershed are either flooded by hydropower dams or dewatered by irrigation diversions. Portions of this basin are also subject to impacts from cattle grazing and irrigation withdrawals. In the Yakima River 72 stream and river segments are listed as impaired by the Washington Department of Ecology and 83% exceed temperature standards. In the Willamette River riparian vegetation was greatly reduced by land conversion. By 1990 only 37% of the riparian area within 120m was forested, 30% was agricultural fields and 16% was urban or suburban lands. In the Flathead River aquatic invasive plants such as pondweed, hornwort, water milfoil, waterweed, cattail and duckweed grow in the floodplain wetlands and shallow lakes and in the Yakima River non-native grasses and other plant are commonly found along the lower reaches of the river (Stanford *et al.* 2005).

Agriculture and Ranching. Roughly 6% of the annual flow from the Columbia River is diverted for the irrigation of 7.3 million acres of croplands within the basin. The vast majority of these agricultural lands are located along the lower Columbia River, the Willamette, Yakima, Hood, and Snake Rivers, and the Columbia Plateau (Hinck *et al.* 2004). The Yakima River Basin is one of the most agriculturally productive areas in the United States (Fuhrer *et al.* 2004). Croplands within the Yakima Basin account for about 16% of the total basin area of which 77% is irrigated.

Agriculture and ranching increased steadily but slowly within the Columbia River basin from the mid to late 1800. By the early 1900s, agricultural opportunities began increasing at a much more rapid pace with creation of more irrigation canals and the passage of the Reclamation Act of 1902 (NRC 2004). Today, agriculture represents the largest water use within the basin. More than 105,000 acre feet per day (more than 90 percent) is used for agricultural purposes. Agriculture, ranching, and the related services employ more than nine times the national average (19% of the households within the basin; NRC 2004).

Ranching practices have led to increased soil erosion and sediment loads within adjacent tributaries, the worst of these effects may have occurred in the late 1800s and early 1900s with deliberate burning to increase grass production (NRC 2004). Several measures are in use to reduce the impacts of grazing including restricting grazing in degraded areas, reduced grazing

allotments, and lower stocking rates. Today agricultural impacts to water quality within the basin are second to large scale influences of hydromodification projects for both power generation and irrigation. Water quality impacts from agricultural activities include alteration of the natural temperature regime, and insecticide and herbicide contamination, and increased suspended sediments.

The USGS has a number of fixed water quality sampling sites throughout various tributaries of the Columbia River, many of which have been in place for decades. Water volumes, crop rotation patterns, crop-type, and location of within the basin are some of the variables that influence the distribution and frequency of pesticides within a tributary. Detection frequencies for a particular pesticide can vary widely. One study conducted by the USGS between May 1999 and January 2000, detected 25 pesticide compounds (Ebbert and Embrey 2001). Another study detected at least two pesticides or their breakdown products in 91% of the samples collected, with the median number of chemicals being eight, and the maximum was 26. The herbicide 2,4-D occurred most often in the mixtures, along with azinphos-methyl, the most heavily applied pesticide, and atrazine, one of the most mobile pesticides in water (Fuhrer *et al.* 2004). However, the most frequently detected pesticides in the Yakima River Basin are total DDT, as well as its breakdown products DDE and DDD, and dieldrin (Johnson and Newman 1983, Joy 2002, Joy and Madrone 2002, Furher *et al.* 2004). In addition to current use-chemicals these legacy chemicals continue to pose a serious problem to water quality and fish communities despite their cancellation in the 1970s and 1980s (Hinck *et al.* 2004).

Fish and macroinvertebrate communities exhibit an almost linear decline in condition as the level of agriculture intensity increases within a basin (Cuffney *et al.* 1997, Fuhrer *et al.* 2004). A study conducted in the late 1990s examining 11 species of fish, including anadromous and resident fish collected throughout the basin for a suite of 132 contaminants, which included 26 pesticides revealed organochlorines, specifically hexachlorobenzene, chlordane and related compounds, and DDT and its metabolites, were the most frequently detected pesticides within fish tissues (Hinck *et al.* 2004).

Urban and Industrial Development. The largest urban area in the basin is the greater Portland metropolitan area, located at the mouth of the river. Portland's population exceeds 500,000 people, whereas the next largest cities, Spokane, Salem, Eugene, and Boise, have more than 100,000 people (Hinck *et al.* 2004). Overall, however the population within the basin is one-third the average, and while the basin covers about 8% of United States' land, only about 1.2% of the United States population lives within the basin (Hinck *et al.* 2004).

Discharges from sewage treatment plants, paper manufacturing, and chemical and metal production represent the top three permitted sources of contaminants within the lower basin according to discharge volumes and concentrations (Rosetta and Borys 1996). According to Rosetta and Borys (1996) based on their review of 1993 data, 52% of the point source waste water discharge volume is from sewage treatment plants, 39% from paper and allied products, 5% from chemical and allied products, and 3% from primary metals. However, suspended sediment loading is predominantly from point sources from the paper and allied products industry (71%), while 26% comes from sewage treatment plants and 1% is from the chemical and allied products industry. Non-point source discharges (urban stormwater runoff) account for

more of the total pollutant loading to the lower basin for most organics and over half of the metals. Although rural non-point sources contributions were not calculated, Rosetta and Borys (1996) surmised that in some areas and for some contaminants rural areas may contribute a large portion of the load; this is particularly the case for pesticide contamination in the upper river basin where agriculture is the predominant land use.

A study conducted in the late 1990s examining 11 species of fish, including anadromous and resident fish collected throughout the basin for a suite of 132 contaminants, which included 51 semi-volatile chemicals, 26 pesticides, 18 metals, seven PCBs, 20 dioxins, and 10 furans revealed PCBs, metals, chlorinated dioxins and furans (products of wood pulp bleaching operations) and other contaminants within fish tissues—white sturgeon tissues contained the greatest concentrations of chlorinated dioxins and furans (Hinck *et al.* 2004).

Hydromodification Projects. More than 400 dams exist in the basin ranging from mega dams that store large amounts of water to small diversion dams for irrigation. Every major tributary of the Columbia except the Salmon River is totally or partially regulated by dams and diversions. More than 150 dams are major hydroelectric projects of which 18 dams are located on mainstem Columbia River and its major tributary, the Snake River. The Federal Columbia River Power System encompasses the operations of 14 major dams and reservoirs on the Columbia and Snake Rivers, operated as a coordinated system. The Army Corps of Engineers operates nine of 10 major Federal projects on the Columbia and Snake Rivers, and Dworshak, Libby and Albeni Falls dams. The Bureau of Reclamation operates Grand Coulee and Hungry Horse dams. These Federal projects are a major source of power in the region, and provide flood control, navigation, recreation, fish and wildlife, municipal and industrial water supply, and irrigation benefits.

The Bureau of Reclamation has operated irrigation projects within the basin since the 1904. The irrigation system delivers water to about 2.9 million acres of agricultural lands; 1.1 million acres of land are irrigated using water delivered by two structures, the Columbia River Project (Grand Coulee Dam) and the Yakima Project. Grand Coulee Dam delivers water for the irrigation of over 670,000 acres of crop lands and the Yakima Project delivers water to nearly 500,000 acres of crop lands (BOR 2007).

The Bonneville Power Administration, an agency of the U.S. Department of Energy, wholesales electric power produced at 31 Federal dams (67% of its production) and non-hydropower facilities in the Columbia-Snake Basin, selling about half the electric power consumed in the Pacific Northwest. The Federal dams were developed over a 37-year period starting in 1938 with Bonneville Dam and Grand Coulee in 1941, and ending with construction of Libby Dam in 1973 and Lower Granite Dam in 1975.

Development of the Pacific Northwest regional hydroelectric power system, dating to the early twentieth century, has had profound effects on the ecosystems of the Columbia River Basin (ISG 1996). These effects have been especially adverse to the survival of anadromous salmonids. The construction of the Federal power system modified migratory habitat of adult and juvenile salmonids, and in many cases presented a complete barrier to habitat access. Both upstream and downstream migrating fish are impeded by the dams, and a substantial number of juvenile salmonids are killed and injured during downstream migrations. Physical injury and direct

mortality occurs as juveniles pass through turbines, bypasses, and spillways. Indirect effects of passage through all routes may include disorientation, stress, delays in passage, and exposure to high concentrations of dissolved gases, warm water, and increased predation. Dams have also flooded historical spawning and rearing habitat with the creation of massive water storage reservoirs. More than 55% of the Columbia River Basin that was accessible to salmon and steelhead before 1939 has been blocked by large dams (NWPPC 1986). Construction of Grand Coulee Dam blocked 1,000 miles of habitat from migrating salmon and steelhead (Wydoski and Whitney 1979). The mainstem habitats of the lower Columbia and Willamette Rivers have been reduced primarily to a single channel. As a result, floodplain area is reduced, off-channel habitat features have been eliminated or disconnected from the main channel, and the amount of large woody debris in the mainstem has been reduced. Remaining areas are affected by flow fluctuations associated with reservoir management for power generation, flood control and irrigation. Overbank flow events, important to habitat diversity, have become rare as a result of controlling peak flows and associated revetments. Consequently, the dynamics of estuary has changed substantially.

Artificial Propagation. There are several artificial propagation programs for salmon production within the Columbia River Basin, many of which were instituted under Federal law to ameliorate the effects of lost natural production of salmon within the basin from the dams on fishing. The hatcheries are operated by Federal, state, and tribal managers. For more than 100 years, hatcheries in the Pacific Northwest have been used to produce fish for harvest and replace natural production lost to dam construction, and have only minimally been used to protect and rebuild naturally produced salmonid population (e.g., Redfish Lake sockeye salmon). In 1987, 95% of the coho salmon, 70% of the spring Chinook salmon, 80% of the summer Chinook salmon, 50% of the fall Chinook salmon, and 70% of the steelhead returning to the Columbia River Basin originated in hatcheries (CBFWA 1990). More recent estimates suggest that almost half of the total number of smolts produced in the basin come from hatcheries (Mann *et al.* 2005).

The impact of artificial propagation on the total production of Pacific salmon and steelhead has been extensive (Hard *et al.* 1992). Hatchery practices, among other factors, are a contributing factor to the 90% reduction in natural coho salmon runs in the lower Columbia River of the past 30 years (Flagg *et al.* 1995). Past hatchery and stocking practices have resulted in the transplantation of salmon and steelhead from nonnative basins, and the impacts of these practices are largely unknown. Adverse effects of these practices likely included: the loss of genetic variability within and among populations (Busack 1990 and Riggs 1990 cited in Hard *et al.* 1992, Reisenbichler 1997), disease transfer; increased competition for food, habitat, or mates; increased predation; altered migration; and displacement of natural fish (Steward and Bjornn 1990 cited in Hard *et al.* 1992, Fresh 1997); and species with extended freshwater residence are likely to face higher risk of domestication, predation, or altered migration than are species that spend only a brief time in fresh water (Hard *et al.* 1992) to name a few. Nonetheless, artificial propagation also may contribute to the conservation of listed salmon and steelhead although it is unclear whether or how much artificial propagation during the recovery process will compromise the distinctiveness of natural population (Hard *et al.* 1992).

NMFS was mandated by congress in 2005 to institute hatchery reform within the Columbia

River Basin. This reform is a collaborative effort and review of how harvest and hatcheries, both federal and non-federal, are affecting the recovery of listed salmon and steelhead. This effort has resulted in some improvements in hatchery practices and in other cases, has yet to be implemented or the hatchery reform's success is yet to be determined. Eventually the goal is to have tribal, state, and federal managers effectively manage Columbia River Basin hatcheries in a way that will meet conservation and harvest goals consistent with their respective legal responsibilities.

Mining. Most of the mining in the basin is focused on minerals such as phosphate, limestone, dolomite, perlite, or metals such as gold, silver, copper, iron and zinc. Mining in the region is conducted in a variety of methods and places within the basin. Alluvial or glacial deposits are often mined for gold or aggregate, and ores are often excavated from the hard bedrocks of the Idaho batholiths. Eleven percent of the nation's output of gold has come from mining operations in Washington, Montana, and Idaho, and more than half of the nation's silver output has come from a few select silver deposits with 30% coming from two deposits located in the Columbia River Basin (the Clark Fork River and Coeur d'Alene deposits; Hinck *et al.* 2004, Butterman and Hilliard 2005). According to Wydoski and Whitney (1979) one of the largest mines in the region, located near Lake Chelan, once produced up to 2,000 tons of copper-zinc ore with gold and silver on a daily basis. Most of the phosphate mining within the basin occurs within the headwaters of the Snake River, but the overall output from these deposits accounts for 12% of the United States production of phosphate (Hinck *et al.* 2004).

Many of the streams and river reaches in the basin are impaired from mining and several abandoned and former mining sites are designated as superfund cleanup areas (Stanford *et al.* 2005, EPA 2007). According to the U.S. Bureau of Mines, there are about 14,000 inactive or abandoned mines within the Columbia River Basin of which nearly 200 pose a potential hazard to the environment (Quigley 1997 in Hinck *et al.* 2004). Contaminants that have been detected in the water include lead and other trace metals. Mining of copper, cadmium, lead, manganese, and zinc in the upper Clark Fork River have contributed wastes to this basin since 1880 (Woodward *et al.* 1994). Benthic macroinvertebrates and fish within the basin have bioaccumulated metals—the exposure and bioaccumulation of these metals in native fishes in the basin are suspected of reducing their survival and growth (Farag *et al.* 1994, Woodward *et al.* 1994). In the Clark River, several fish kills have occurred since 1984 and are attributed to contamination from trace metals such as cadmium, copper, lead and zinc (Hinck *et al.* 2004).

Commercial, Recreational, and Subsistence Fishing. Archeological records indicate that indigenous people caught salmon in the Columbia River more than 7,000 years ago. One of the most well known tribal fishing sites within the basin was located near Celilo Falls, an area in the lower river that has been occupied by Dalles Dam since 1957. Salmon fishing increased with better fishing methods and preservation techniques, such as drying and smoking, such that harvest substantially increased in the mid-1800s with canning techniques. Harvest techniques also changed over time, from early use of hand-held spears and dip nets, to river boats that used seines and gill-nets, eventually, transitioning to large ocean-going vessels with trolling gear and nets and the harvest of Columbia River salmon and steelhead off the waters of the entire west coast, from California to Alaska (Mann *et al.* 2005).

During the mid 1800s, an estimated 10 to 16 million adult salmon of all species entered the Columbia River each year. Large harvests of returning adult salmon during the late 1800s ranging from 20 million to 40 million pounds of salmon and steelhead annually significantly reduced population productivity (Mann *et al.* 2005). The largest harvest of Chinook salmon ever recorded occurred in 1883 when Columbia River canneries processed 43 million pounds of salmon (Lichatowich 1999). Commercial landings declined steadily from the 1920s to a low in 1993, when just over one million pounds were harvested (Mann *et al.* 2005).

Harvested and spawning adults reached 2.8 million in the early 2000s, of which almost half are hatchery produced (Mann *et al.* 2005). Most of the fish caught in the river are steelhead and spring/summer Chinook salmon, while ocean harvest consists largely of coho and fall Chinook salmon. Most ocean catches are made north of Cape Falcon, Oregon. Between 1999 and 2004, the number of spring and fall salmon commercially harvested in tribal fisheries has averaged between 25,000 and 110,000 fish (Mann 2004 in Mann *et al.* 2005). Recreational catch in both ocean and in-river fisheries varies around 140,000 to 150,000 fish (Mann *et al.* 2005).

Puget Sound Region

Natural History. The Puget Sound watershed defined by the crest lines of the Olympia Mountain Range (and the Olympic Peninsula) to the west and the Cascade Mountain Range to the east. The Olympic Mountains reach heights of about 8,000 feet above sea level, and are extremely rugged and steeply peaked with abrupt descents into the Puget Lowland. The Cascade Mountains on the east range in heights of 4-8,000 feet above sea level with the highest peak, Mount Rainer towering over the region at 14,410 feet above sea level. As the second largest estuary in the United States, Puget Sound has about 1330 miles of shoreline, extends from the mouth of the Strait of Juan de Fuca east, including the San Juan Islands and south to Olympia, and is fed by more than 10,000 rivers and streams.

Puget Sound is generally divided into four major geographic marine basins: Hood Canal, South Sound, Whidbey Basin, and the Main Basin. The Main Basin has been further subdivided into two sub-basins: Admiralty Inlet and Central Basin. Each of the above basins forms a depression on the sea floor in which a shallower ledge or sill separates the relatively deep water from the adjacent basin. The waters of Puget Sound function as a partially mixed, two-layer system, with relatively fresh water flowing seaward at the surface and salty oceanic water entering at depth.

The main ledge of Puget Sound is located at the north end of Admiralty Inlet where the water shoals to a depth of about 200 feet at its shallowest point (King County 2001). The deepest point in Puget Sound is found in the Central Basin and is over 920 feet. Approximately 43% of the Puget Sound's tideland is located in the Whidbey Island Basin. This reflects the large influence of the Skagit River, which is the largest river in the Puget Sound system and whose sediments are responsible for the extensive mudflats and tidelands of Skagit Bay.

Habitat types that occur within the nearshore environment include eelgrass meadows, kelp forest, mud flats, tidal marshes, sub-estuaries (tidally influenced portions of river and stream mouths), sand spits, beaches and backshore, banks and bluffs, and marine riparian vegetation. These habitats provide critical functions such as primary food production, support habitat for invertebrates and juvenile and adult fishes, and provide foraging and refuge opportunities for birds and other wildlife.

The Puget Sound ecoregion is a glaciated area consisting of glacial till, glacial outwash and lacustrine deposits with high quality limestone is found in the San Juan Islands (Wydoski and Whitney 1979). Relief in the valley is moderate with elevation ranging from sea level to about 1300 feet. Geology in the region consists of mostly Tertiary sedimentary bedrock formations.

The land and vegetation surrounding Puget Sound waters is classified as Puget Lowland Forest and occupies the depression or valley between the Olympic Peninsula on the west and the Cascade Mountains on the east (Franklin and Dyrness 1973). The alpine zone is expressly devoid of trees. Vegetation changes abruptly along the mountain slopes and across minimal horizontal distances as a result of steep topography, soil, and microclimate (sun exposure, temperature, and precipitation). Dominant vegetation types include from the Puget lowland region – the lowland forest, the mid-montane forest of Pacific silver fir (*Abies amabilis*) with Alaska yellow cedar (*Chamaecyparis nootkatensis*); the subalpine forest of mountain hemlock (*Tsuga mertensiana*) with subalpine fir (*Abies lasiocarpa*) and Alaska yellow cedar; and the alpine tundra or meadow above the tree line (Kruckeberg 1991).

The Puget Sound region has a Mediterranean-like climate, with warm, dry summers, and mild wet winters (Franklin and Dyrness 1973). Annual precipitation varies from 28-35 inches, and falls predominantly as rain in lowland areas. Annual snowpack in the mountain ranges is often high—although the elevation of the Olympia Mountains is not as high as that of the Cascade Mountain Range, abundant accumulation occurs, such that it will sometimes persist throughout much of the summer months. Average annual rainfall in the north Cascades at Mount Baker Lodge is about 110 inches, and at Paradise Station at Mount Rainer is about 105 inches, while average annual snowfall is 550 inches and 582 inches respectively--sometimes reaching more than 1,000 inches on Mount Rainer (Wydoski and Whitney 1979; Kruckeberg 1991).

Major rivers draining to Puget Sound from the Cascade Mountains include the Skagit River, the Snohomish River, the Nooksack River, the Puyallup/Green River, and the Lake Washington/Cedar River watershed. Major rivers from the Olympic Mountains include the Hamma Hamma, the Duckabush, the Quilcene, and the Skokomish Rivers. Numerous other smaller rivers drain to the Sound, many of which are significant producers of salmonids despite their small size.

The Puget Sound basin is home to more than 200 fish species, representing more than 50 families; and more than 140 mammals, of which less than a third are marine mammals. Salmonids within the region include coho salmon, Chinook salmon, sockeye salmon and kokanee, chum salmon, pink salmon, steelhead and rainbow trout, coastal cutthroat trout, bull trout, and Dolly Varden (Wydoski and Whitney 1979, Kruckeberg 1991). Important commercial fishes include the five Pacific salmon species and several rockfish species. A number of

introduced species occur within the region including brown trout, brook trout, Atlantic salmon, bass, tunicates (sea squirts), and a saltmarsh grass (*Spartina*). Estimates suggest that more than 90 species have been intentionally or accidentally introduced in the region (Ruckelshaus and McClure 2007). At present over 40 species in the region are listed as threatened and endangered under the ESA.

Land Use. Land use in the Puget Sound lowland is composed of agricultural areas (including forests for timber production), urban areas (industrial and residential use), and rural areas (low density residential with some agricultural activity). In the 1930s, all of Western Washington contained about 15.5 million acres of “harvestable” forest land and by 2004 the total acreage was nearly half that surveyed more than 70 years earlier (PSAT 2007). Forest cover in Puget Sound alone was about 5.4 million acres in the early 1990s and about a decade later the region had lost another 200,000 acres of forest cover with some watersheds losing more than half the total forested acreage. The most intensive loss of forest cover has occurred in the State’s Urban Growth Boundary, which encompasses specific parts of the Puget Lowland; in this area forest cover declined by 11.1% between 1991 and 1999 (Ruckelshaus and McClure 2007). Projected land cover changes (reviewed in Ruckelshaus and McClure 2007) indicate that trends are likely to continue over the next several decades with population changes—coniferous forests are projected to decline at an alarming rate as urban uses increase.

The Puget Sound Lowland contains the most densely populated area of Washington. The regional population in 2003 was an estimated 3.8 million people, with 86% residing in King, Pierce and Snohomish Counties (Snohomish, Cedar-Sammamish Basin, Green-Duwamish, and Puyallup River watersheds), and the area is expected to attract four to six million new human residents in the next 20 years (Ruckelshaus and McClure 2007).

According to the State of the Sound report (PSAT 2007) in 2001, impervious surfaces covered 3.3% of the region, with 7.3% of lowland areas (below 1,000 feet elevation) covered by impervious surfaces. In one decade, 1991 – 2001 impervious surfaces increased 10.4% region wide. The Snohomish River watershed, one of the fastest growing in the region, increased 15.7% in the same period.

Much of the region’s estuarine wetland losses have been heavily modified, primarily from agricultural land conversion and urban development (NRC 1996). Although most estuarine wetland losses result from conversions to agricultural land by ditching, draining, or diking, these wetlands are also experiencing increasing effects from industrial and urban causes.

The most extreme case of river delta conversion is observed in the Duwamish Waterway in Seattle. As early as the mid-1800s, settlers in the region began discussing the need for a ship canal that linked Lake Washington directly with Puget Sound. After several private and smaller attempts, by the early 1900s locks were built achieving this engineering feat. The resultant outcome was that the Black River, which formerly drained Lake Washington to the Green and White Rivers (at their confluence, these rivers formed the Duwamish River), dried up. The lower White River, which historically migrated sporadically between the Puyallup and the Green/Duwamish basins, was permanently diverted into the Puyallup River basin in 1914 with the construction of concrete diversion at river mile 8.5, resulting in a permanent increase of the

Puyallup River flows by about 50% and a doubling of the drainage area (Kerwin 1999). The Cedar River, on the other hand was permanently diverted to Lake Washington. The oxbow in the lower Duwamish River was lost with the lower river dredging in the early 1900s reducing the lower nine miles of the river to 5 miles in length. Overtime the waterway has been heavily armored and diked, result in the loss of all tidal swamps, 98% of the tidal forests, marshes, shallows and flats and 80% of the riparian shoreline (Blomberg *et al.* 1988 in Ruckelshaus and McClure 2007).

By 1980, an estimated 27,180 acres of intertidal or shore wetlands had been lost at eleven deltas in Puget Sound (Bortleson *et al.* 1980). Tidal wetlands in Puget Sound amount to about 17-19% of their historical extent (Collins and Sheikh 2005). Coastal marshes close to seaports and population centers have been especially vulnerable to conversion with losses of 50-90% common for individual estuaries.

More than 100 years of industrial pollution and urban development have affected water quality and sediments in Puget Sound. Many different kinds of activities and substances release contamination into Puget Sound and the contributing waters. Positive changes in water quality in the region, however, are also evident. One of the most notable improvements was the elimination of sewage effluent to Lake Washington in the mid 1960s, which significantly reduced problems within the lake from phosphorus pollution and triggered a concomitant reduction in the cyanobacteria (see Ruckelshaus and McClure 2007 for a review).

Even so, as the population and industry has risen in the region a number of new and legacy pollutants are of concern. According to the State of the Sound Report (PSAT 2007) in 2004, more than 1,400 fresh and marine waters in the region were listed as “impaired.” Almost two-thirds of these water bodies were listed as impaired due to contaminants, such as toxics, pathogens, and low dissolved oxygen or high temperatures, and less than one-third had established cleanup plans; more than 5,000 acres of submerged lands (primarily in urban areas; 1% of the study area) are contaminated with high levels of toxic substances, including polybrominated diphenyl ethers (PBDEs—flame retardants), and roughly one-third (180,000 acres) of the submerged lands within Puget Sound are considered moderately contaminated. PBDEs biomagnified in the food chain, and in the past 20 years the body burden in harbor seals has increased dramatically from 50 ppb to more than 1,000 ppb. Primary pollutants of concern in Puget Sound include heavy metals, organic compounds, PAHs, PCBs, dioxins, furans, DDT, phthalates, and PBDEs.

Areas of highest concern in Puget Sound are Southern Hood Canal, Budd Inlet, Penn Cove, Commencement Bay, Elliott Bay, Possession Sound, Saratoga Passage, and Sinclair Inlet (DOE 2002). Hypoxic dissolved oxygen concentration (<3 mg/L) were found at several (11 out of 54) stations. Dissolved oxygen concentrations less than 3 mg/L were measured in Hood Canal, Penn Cove, Saratoga Passage, Bellingham Bay, Discovery Bay, Elliott Bay, Strait of Georgia and West Point. Conditions in South Hood Canal were especially severe, with low DO concentration (<5 mg/L) evident year-round. Penn Cove also exhibited re-occurring hypoxia. Low DO was found at 18 other stations, including Saratoga Passage, Discovery Bay, Bellingham Bay, Elliott Bay, Budd Inlet, and Commencement Bay.

In 1989 the Washington State Department of Ecology (DOE) began a program to monitor marine sediment conditions called the Puget Sound Assessment and Monitoring Program (PSAMP). The PSAMP is a multi-agency partnership administered by the Puget Sound Action Team. From 1989-1995 the Marine Sediment Monitoring Program was implemented to characterize baseline sediment quality conditions and trends throughout the Greater Puget Sound area. This was the first large scale evaluation of Puget Sound sediment quality at ambient (i.e. away from point sources of contamination) stations through the Sound. Eighty-six stations were established throughout Puget Sound, Hood Canal, the Strait of Georgia, and the Strait of Juan de Fuca. Stations were grouped in two categories: core stations sampled annually, and rotating stations sampled once every three years alternating between North, Central, and South Puget Sound regions. At each station, replicate sediment samples were collected for the analysis of chemical contaminants, sediment variables, and benthic community structure.

Overall, contaminant concentrations at monitoring stations were generally low and below state sediment quality standards. Metals and semi-volatile organic compounds were most frequently detected. The highest metal and organic contamination was found in locations associated with urban and industrial centers. Low metal concentrations were also detected in some rural areas and in deep depositional environments. Contaminant concentrations occasionally exceeded state regulatory sediment quality standards. However, there was not a consistent pattern across years. An exception was mercury in Sinclair Inlet and Dyes Inlet, with concentrations above standards for each of the seven years monitored.

By 2000, annual monitoring of sediments at ten historical PSAMP stations showed mixed trends in recent years for some chemicals found in sediments (DOE 2005). Less than one third (32 percent) of almost 13,000 chemical measurements made were detected during testing. Those detected most often exceeded sediment quality guidelines in urban embayments: Sinclair Inlet (mercury), Thea Foss Waterway (PAHs).

In general, metals concentrations in 2000 were lower than in 1989 thru 1996 more often than they were higher, while the opposite was true of PAHs (DOE 2005). At the Port Gardner and Inner Budd Inlet station, concentrations of a number of priority pollutant and metals also decreased significantly. Individual PAH levels decreased at the Point Pully station, but increased significantly at the Bellingham Bay, Port Gardner, and East Anderson Island stations. Total HPAH and total PAH levels increased significantly at the Strait of Georgia, Bellingham Bay, East Anderson Island, and Budd Inlet stations. These changes may reflect changes in anthropogenic input of contaminants to the estuarine system over this 12-year study period. Also, changes in grain size and benthic infaunal community composition seen at the Strait of Georgia station were probably linked to increased precipitation and subsequent increased flow and sediment loading from the Fraser River in 1996 and 1997.

From 1997 to 1999, sediments were collected throughout Puget Sound as part of a joint monitoring program conducted by the DOE and NMFS (DOE 2003). Analyses were performed to quantify concentrations of potentially toxic chemicals, responses in laboratory toxicity tests, and the structure of benthic infauna communities in sediments.

Degraded conditions, as indicated by a combination of relative high chemical concentrations, statistically significant responses in one or more tests of toxicity, and adversely altered benthos, occurred in samples that represented about 1% of the total area (5,700 acres) (DOE 2003). These conditions occurred in samples collected within urbanized bays and industrial waterways, especially near the urban centers of Everett, Seattle, Tacoma, and Bremerton, where degraded conditions had been reported in previous studies. Sediments with high quality (as indicated by no elevated chemical concentrations, no significant responses in the toxicity tests, and the presence of abundant and diverse infauna and or pollution sensitive taxa) occurred in samples that represented a majority, 68% of the total study area (400,000 acres). Sediments in which results of the three kinds of analyses were not in agreement were classified as intermediate in quality and represented about 31% of the total area (179,000 acres).

Although the highly degraded sediments comprise a small percentage of Puget Sound's area these hot spots upload pollution into the food web, and the resulting damage to the ecological health and function of the Puget Sound ecosystem may be much greater than the small area suggest.

Researchers detected arsenic, copper, lead, and mercury throughout the Sound. They found cadmium at 59% of the stations and tributulin, an antifouling chemical found in ship hull paint, at 50% of the stations. PAHs were common while phthalate esters, PCBs, DDTs and dibenzofurans appeared at fewer stations (PSAT 2004). Degraded sediments were most prevalent in the Whidbey Basin and Central Sound regions (Everett Harbor, Elliott Bay, Commencement Bay). A higher degree of degradation in critical nearshore habitat may disproportionately affect important fish, shellfish and aquatic plant species (DOE 1997-2003 posters).

The USGS assessed water quality of streams, rivers and groundwater in the Puget Sound Basin as part of the National Water-Quality Assessment (NAWQA) Program between 1996 and 1998. This assessment focused on the quality of surface and ground waters and biological indicators such as fish, algal, and invertebrate status in relation to land use. A widespread detection of pesticide compounds was observed in surface waters of the Puget Sound Basin (Bortleson and Ebbert 2000). Slightly more than half of the pesticide compounds (26 of 47 analyzed) were detected. The study found that large rivers in the Puget Sound Basin were more likely to meet Federal and state guidelines than were small streams (Ebbert *et al.* 2000). A total of 74 manmade organic chemicals were detected in streams and rivers, with different mixtures of chemicals linked to agricultural and urban settings including atrazine, prometon, simazine and tebuthiuron, carbaryl, diazinon, and malathion (Bortleson and Ebbert 2000). Commonly detected volatile organic compound in the agricultural land-use study area was associated with the application of fumigants to soils prior to planting (Ebbert *et al.* 2000). The average concentration of total nitrogen in small streams draining agricultural lands was twice the concentration in streams draining urban areas and over 40 times the concentration in streams draining undeveloped areas (Ebbert *et al.* 2000). The study concluded that contaminants in runoff from urban and agricultural land surfaces were major influences on the water quality of streams and rivers (Ebbert *et al.* 2000), and according to the State of the Sound report water quality impacts from stormwater and wastewater runoff is a major limiting factor in the recovery of salmon and bull trout (PSAT 2007).

Hydromodification Projects. More than 20 dams occur within the region's rivers and overlap with the distribution of salmonids, and a number of basins contain water withdrawal projects or small impoundments that can impede migrating salmon. The resultant impact of these and land use changes (forest cover loss and impervious surface increases) has been a significant modification in the seasonal flow patterns of area rivers and streams, and the volume and quality of water delivered to Puget Sound waters. Several rivers have been hydromodified by other means including levees and revetments, and bank hardening for erosion control, and agriculture uses. The first dike built in the Skagit River delta was built in 1863 for agricultural development (Ruckelshaus and McClure 2007), other basins like the Snohomish River are diked and have active drainage systems to drain water after high flows that top the dikes. Dams were also built on the Cedar, Nisqually, White, Elwha, Skokomish, Skagit and several other rivers in the early 1900s to supply urban areas with water, prevent downstream flooding and allow for floodplain activities (like agriculture or development), and to power local timber mills (Ruckelshaus and McClure 2007).

In the past month, dam removal on the Elwha River commenced and soon the river will no longer have obstructions to additional spawning habitat. The Elwha River was formerly a very productive salmon river and this improvement is expected to open more than 70 miles of high quality salmon habitat (Wunderlich *et al.* 1994 in Ruckelshaus and McClure 2007). Estimates suggest that nearly 400,000 salmon could begin using the basin within 30 years after the dams are removed (PSAT 2007).

About 800 miles of Puget Sound's shorelines are hardened or dredged (PSAT 2004 in Ruckelshaus and McClure 2007). The area most intensely modified is the urban corridor (eastern shores of Puget Sound from Mukilteo to Tacoma); here nearly 80% has been altered, mostly from shoreline armoring associated with the Burlington Northern Railroad tracks (Ruckelshaus and McClure 2007). Levee development within the rivers and their deltas has isolated significant portions of former floodplain habitat that was historically used by salmon and trout during rising flood waters.

Mining. Mining has a long history in the State of Washington, and in 2004 the state was ranked 13th nationally in total nonfuel mineral production value and 17th in coal production (Palmisano *et al.* 1993, NMA 2007). Metal mining for all metals (e.g., zinc, copper, lead, silver, and gold) peaked in the State between 1940 and 1970 (Palmisano *et al.* 1993). Today, construction sand and gravel, Portland cement and crushed stone are the predominant materials mined. Where sand and gravel is mined from riverbeds (gravel bars and floodplains) it may result in changes in channel elevations and patterns, instream sediment loads, and seriously alter instream habitat. In some cases, instream or floodplain mining has resulted in large scale river avulsions. The effect of mining in a stream or reach depends upon the rate of harvest and the natural rate of replenishment, as well as flood and precipitation conditions during or after the mining operations.

Commercial and Recreational Fishing. Most of the commercial landings in the region are groundfish, Dungeness crab, shrimp, and salmon. Many of the same species are sought by Tribal fisheries, and by charter, and recreational anglers. Nets and trolling are used in commercial and

Tribal fisheries, whereas recreational anglers typically use hook and line, and may fish from boat, river bank, and docks. Entanglement of marine mammals in fishing gear is not uncommon and can lead to mortality or serious injury.

Oregon-Washington-Northern California Coastal Drainages

This region encompasses drainages originating in the Klamath Mountains, the Oregon Coast Mountains and the Olympic Mountains--the Coast Range ecoregion where elevations range from sea level to about 4,000 feet. More than 15 watersheds drain the region's steep slopes including the Umpqua, Alsea, Yaquina, Nehalem, Chehalis, Quillayute, Queets, and Hoh Rivers.

Numerous other small to moderately sized streams dot the coastline. Many of the basins in this region are relatively small—the Umpqua River drains a basin of 4,685 sq. miles and is a little over 110 miles long and the Nehalem River drains a basin of 855 sq. miles and is almost 120 miles long—yet represent some of the most biologically diverse basins in the Pacific Northwest (Johnson 1999, Kagan *et al.* 1999, Carter and Resh 2005).

The region is part of a coastal, temperate rainforest system, and is characterized by moderate maritime climate marked by long wet seasons with short dry seasons and mild to cool year-round temperatures. Average annual precipitation ranges from about 60 inches to more than 180 inches, much of which falls as rain, and supports a rich temperate forest. Vegetation is characterized by giant coniferous forests of Sitka spruce, western hemlock, Douglas fir, western red cedar, and red alder and black cottonwood

The Oregon Coast supports a unique coastal sand dune system. The sand dunes were largely created by the sand deposited from the coastal rivers, in particular the Umpqua and Columbia Rivers. North, steep headlands and cliffs are separated by stretches of flat coastal plain and large estuaries. Significant estuaries in the region (outside of the Columbia River estuary) include Coos Bay, Tillamook Bay and the Nehalem River Estuary in Oregon, and Grays Harbor, and Willapa Bay in Washington.

Land Use. The rugged topography of the western Olympic Peninsula and the Oregon Coastal Range has limited the development of dense population centers. For instance, the Nehalem River and the Umpqua River basins consist of less than 1% urban land uses. Most basins in this region have long been exploited for timber production, and are still dominated by forestlands. In Washington State, roughly 90% of the coastal region is forested (Palmisano *et al.* 1993). Approximately 92% of the Nehalem River basin is forested, with only 4% considered agricultural (Maser and Johnson 1999). Similarly, in the Umpqua River basin about 86% is forested land, 5% agriculture and 0.5% are considered urban lands—with about half the basin under Federal management (Carter and Resh 2005).

Tillamook County boasts about its dairy farming and cheese production—having a higher density of cows than people but even so, Tillamook County like many others in the region is dominated by forested lands (EPA 2006). Roughly 90% of Tillamook County is forestland, held by Federal and state governments and private entities. In the Nehalem Basin, state and private landowners own more than 90% of the forestlands, and about 80% of the private land holdings are large timber companies (Maser and Johnson 1999).

Hydromodification Projects. Compared to other areas in the greater Northwest Region, the coastal region has fewer dams and several rivers remain free flowing (e.g., Clearwater River). The Umpqua River is fragmented by 64 dams, the fewest number of dams on any large river basin in Oregon (Carter and Resh 2005). According to Palmisano *et al.* (1993) only about 30 miles of salmon habitat are permanently blocked by dams in the coastal streams of Washington.

In the past, temporary splash dams were constructed throughout the region to transport logs out of mountainous reaches. The general practice involved building a temporary dam in the creek adjacent to the area being logged, the pond was filled with logs and when the dam broke the floodwater would carry the logs to downstream reaches where they could be rafted and moved to market or downstream mills. Thousands of splash dams were constructed across the Northwest in the late 1800s and early 1900s. While the dams typically only temporarily blocked salmon habitat, in some cases they remained long enough to wipe out entire runs, the effects of the channel scouring and loss of channel complexity resulted in the long term loss of salmon habitat (NRC 1996).

Mining. Oregon is ranked 35th nationally in total nonfuel mineral production value in 2004, while Washington was ranked 13th nationally in total nonfuel mineral production value 2004 and 17th in coal production (Palmisano *et al.* 1993, NMA 2007). Metal mining for all metals (e.g., zinc, copper, lead, silver, and gold) peaked in Washington between 1940 and 1970 (Palmisano *et al.* 1993). Today, construction sand and gravel, Portland cement and crushed stone are the predominant materials mined in both Washington and Oregon. Where sand and gravel is mined from riverbeds (gravel bars and floodplains) it may result in changes in channel elevations and patterns, instream sediment loads, and seriously alter instream habitat. In some cases, instream or floodplain mining has resulted in large scale river avulsions. The effect of mining in a stream or reach depends upon the rate of harvest and the natural rate of replenishment, as well as flood and precipitation conditions during or after the mining operations.

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The Risk of Fire in the Region

Peak fire season in the Pacific Northwest Region occurs between April and October. Based on a review of more than 80,000 wildfires, Malamud *et al.* (2005) calculated the wildfire recurrence interval for large fires ($\geq 2,471$ acres (10 km^2)) in the marine mountain ecoregion that encompasses the Coastal Basins and Puget Sound, as ranging between every 63 to 137 years. Whereas, wildfire recurrence interval for large fires ($\geq 2,471$ acres (10 km^2)) in the Columbia River watershed, which also covers the more arid Temperate Desert, Temperate Steppe, and Temperate Steppe Mountain ecoregions, is more frequent—ranging from every 8 to 18 years in the Temperate Desert, every 14 to 30 years in the Temperate Steppe ecoregion, and every 26 to 46 years in the Temperate Steppe Mountain ecoregion (Malamud *et al.* 2005).

In the state of Oregon, between January 1 and September 21, 2007, there were more than 1,000 fires that burned more than 58,000 acres of forestlands protected by the Oregon Department of Forestry. The ten year average area of fires burned annually is slightly more than 20,000 acres (ODF 2007).

EFFECTS OF THE PROPOSED ACTION

Retardant Application

In 1930, the USFS 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 and heat from the fires caused most of the water to drift off course and evaporate before reaching the fire on the ground. By 1955, the agencies were using retardant to fight fires and they found that adding sodium calcium borate to the mixture held the retardant together. The sodium calcium borate significantly reduced loss due to air turbulence so that more retardant reached the fire on the ground. However, sodium calcium borate is corrosive to airplane tanks and retardant mixing equipment, forms lumps, separates, and is a soil-sterilizing agent. In 1963, fertilizer-based retardants containing diammonium phosphate, ammonium phosphate, and ammonium sulfate were first used and continue to be used today. Currently, fire retardant is about 85% water, 10% either ammonium phosphate or ammonium sulfate or a combination of the two, and five percent additives, such as gum thickeners, coloring agents, and corrosion inhibitors. Corrosion inhibitors, such as sodium ferrocyanide, are needed to minimize the deterioration of retardant tank structures and aircraft, which contributes to flight safety (Raybould *et al.* 1995), but none of the eight qualified chemicals considered in this consultation contain sodium ferrocyanide.

In 1956, 23,000 gallons of retardant were applied on or around fires nationwide. By 1977, the volume of retardant dropped on federal land increased to more than 14.55 million gallons. By 2000, the volume of retardant used had increased to 30.7 million gallons (Figure 11). Fire retardant application since 2000 has been highly variable (between 11.2 million and 33.6 million gallons per year) and the three fire years with the lowest retardant application occurred in 2008, 2009, and 2010. There does not appear to be a correlation between the number of acres in the US that is burned and the volume of fire retardant applied in the same year (Figure 12).

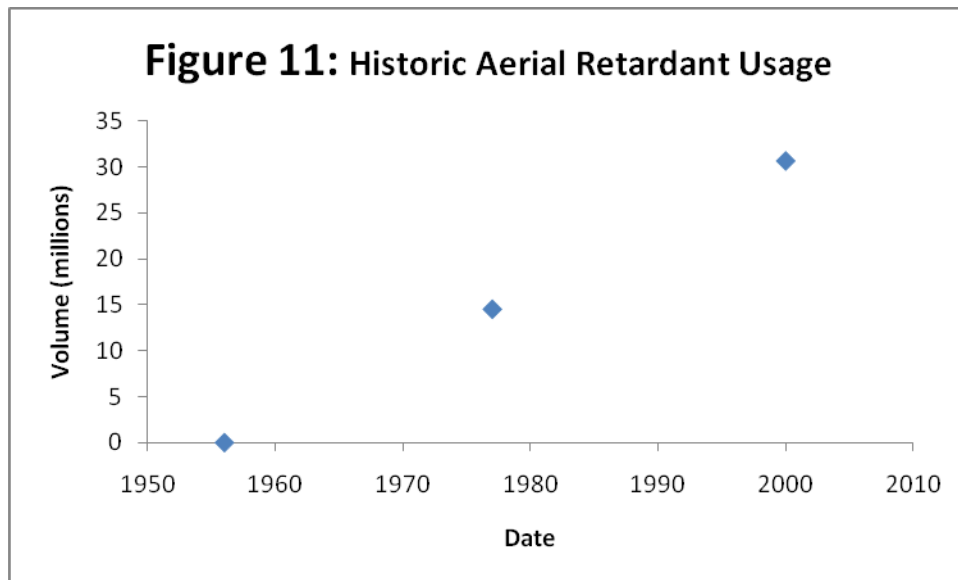


Figure 11: Example of historic trend in use of aerial fire retardant.

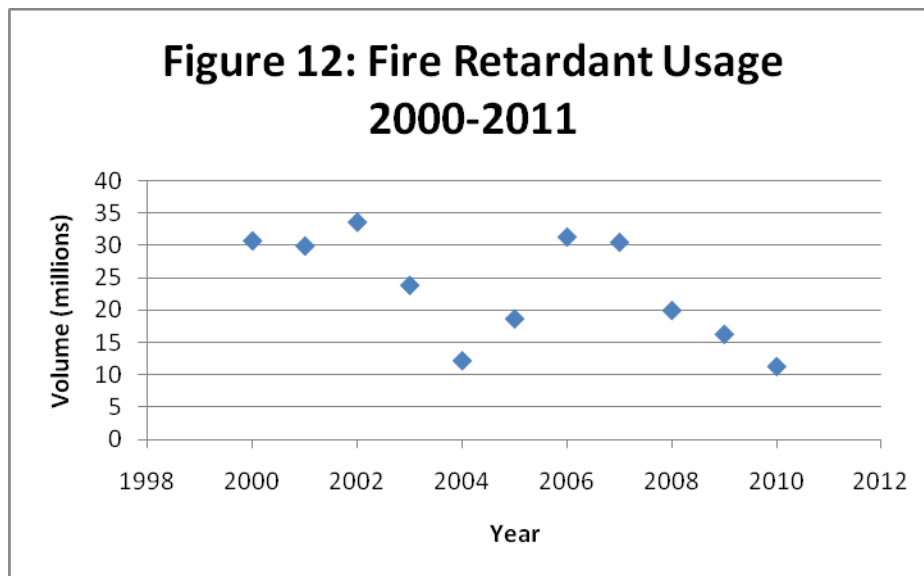


Figure 12: Amount of long-term fire retardant used compared to acres burned in the US (National Interagency Fire Center website 2011).

From 2000 through 2010 across only USFS lands, on average 8,215,437 gallons of retardant was applied to roughly 4,715 acres each year, when estimated at 4 gallons per 100 square feet (Labat 2007, USFS EIS 2011). This average volume translated to approximately 3,287 fire retardant drops per year over the past decade. Typically, 70% of all retardant dropped in a year is dropped in Washington, Oregon, and California (Norris *et al.* 1978), with much of the rest being applied to Idaho, Montana, and Alaska.

As the application of long-term fire retardants has increased since its inception, the USFS has developed means of evaluating which fires should be fought and which resources in particular areas are of the most importance and should be avoided or protected. For every fire, a Wildland

Fire Implementation Plan (WFIP) is initiated, which helps resource managers determine whether a fire can be managed for resource benefit or if it needs to be suppressed. When a fire exceeds its initial containment or anticipated prescription purpose, the USFS is required to conduct a Wildland Fire Situation Analysis (WFSA), which is a decision making structure that considers the objectives and constraints of fighting the fire, compares multiple strategic wildland fire management alternatives, evaluates the expected effects of the alternatives, selects the preferred alternative, and documents the decision. This process provides several alternative methods for fighting a fire and takes into consideration such resource considerations as archaeology, critical habitat, listed species, and socio-economic factors.

In 2010, only six of the eight qualified chemicals were used to fight fires (Table 8). Approximately 4.49 million gallons of Phos Chek LC 95-A and 4.32 million gallons of D75-F were used in 2010, accounting for nearly 80% of the long-term fire retardants used. In 2010, Fire Trol products LCA-R and LCG-R were used, but not on USFS lands. Foams and gels were applied in the United States as recently as 2009 and 2010, but those products are not included by the USFS as part of its action. In 2010, 7,936 loads of fire retardants were applied nationwide. The 10 USFS regions used approximately 98.9% of the total fire retardant in 2010, which amounted to 7,843 loads on USFS lands.

Table 8. 2008-2010 Average long-term fire retardants used Nationwide.

Fire Retardant	Volume	Loads	Average Load Size (gallons)
Phos Chek D75-F	8.02 million gallons	5,435	1,476
Phos Chek D75-R	2.72 million gallons	1,713	1,590
Phos Chek LC-95A-R	4.41 million gallons	3,000	1,469
Fire Trol LCA-R†	0.055 million gallons	41	1,344
Fire Trol LCG-R	0.112 million gallons	18	6,205
Phos Chek P100-F‡	1.28 million gallons	758	1,694

† Fire Trol LCA-R not used since 2008.

‡ Phos Chek P100-F first used in 2010.

The USFS determines which retardant is purchased for each base by the equipment at that base and the location of fire retardant distribution centers. In some cases, powder retardants are purchased and stored more easily at one location, whereas in other locations it may make sense to purchase liquid retardant formulations. And if one formulation of fire retardant is produced near a local air base, it is often less expensive to purchase that formulation and house it at that base than purchasing a different formulation from farther away.

Direct Application to Water

There are two primary ways that waterways containing listed fish species could be exposed to fire retardants. One is through the intentional application of retardants –a planned release across a waterbody or immediately adjacent—and the other is through the accidental drop or spill during aerial application or during on-the-ground activities. By following the 2011 Guidelines proposed in this action, the USFS could potentially drop fire retardants into bodies of water, both visible and out of sight. One of the USFS’s obligations is to protect resources of value that are found on USFS lands. The Incident Commander uses the WFSA as a tool to find multiple alternatives for fighting fires in a particular area, taking listed species and their critical habitat into account, along with other important USFS resources. The Incident Commander, after reviewing the WFSA alternatives, could determine aerial application of fire retardant adjacent to

a waterway is necessary to protect human lives, which may lead to fire retardant entering a waterway. Additionally, even when instructed to apply long-term fire retardants outside of the 300 foot buffer, misapplications occur on a regular, yet infrequent basis. While there could be multiple misapplications in one watershed while fighting a fire, the intents of the proposed action and the WFSA alternatives are to prevent this from happening. While the new guidelines for aerial application of long-term fire retardants are still flexible, and allow for the Incident Commander to make exceptions to conduct a drop that would expose a waterbody to retardants, these guidelines are much more restrictive than the 2000 Guidelines.

Much like the 2000 Guidelines, the proposed 2011 Guidelines only address visible water, so if water is not visible from the airplane at the time of the drop, no accidental introduction would be anticipated. The proposed USFS monitoring plan is expected to detect a proportion of these unanticipated, accidental intrusions to increase our knowledge of these events that had until now only been observed and reported during burned area emergency response (BAER) monitoring. We expect that in most instances the largest stream that may be accidentally hit with retardant and not seen through the trees would be a third order stream. This would be expected during smoky conditions, which could be often as most retardant would be applied downwind of the fire as a means of slowing its progression. Even during clear conditions, the pilots would be expected to watch where they are flying and not where the applications lands and would likely have difficulty detecting when a fire retardant entered a stream. When working aboard an aircraft, the crew has many duties, but no one is specifically assigned to monitor for intrusion events.

Fire retardant is designed to perform in several ways: to stay together during the drop from high up so that it all hits in the same general area, to cling to what it hits initially, and in some cases is thinned to drip through branches to the ground. The mix ratios of many formulations are variable so that the retardant can be more or less concentrated so that the appropriate application can be achieved in different environments. In forest lands for instance, to reach fires burning at ground level the retardant would be less concentrated so that it would seep through the leaves and branches and reach the ground (Johansen and Dieterich 1971). This application style would be expected when fighting ground fires in most West Coast forest land. Another aspect of attempting to apply retardant to fuels beneath the canopy is that it poses a much greater risk of contaminating streams that are not visible from aircraft.

Indirect Application to Water

Lethal and sub-lethal impacts of long-term fire retardant run-off are not monitored beyond reporting applications that entered the 300 foot buffer but did not enter the stream. While Labat (2007) analyzed the risk of runoff using mortality as the measurement endpoint, they did not evaluate persistent or sub-lethal effects, but stated that because retardant drops are likely to be intermittent one-time events a chronic analysis for the products was not conducted. Little and Calfee (2002) showed that when retardants are applied to riparian areas or even across a dry streambed, the retardants remain toxic for 21 days. Following fires, thunderstorms over ash and barren ground lead to increased runoff (de Dios Benavides-Solorio and McDonald 2005, Spigel and Robichaud 2007, Moody and Martin 2009). Post-fire water quality monitoring for streams near four wildfires showed that application of fire retardant near streams but not into the stream had minimal effects on surface water quality (Crouch *et al.* 2006).

Monitoring and Reporting Waterway Intrusion Events

Monitoring and reporting is proposed as part of the USFS fire retardant application program. Between 2008 and 2010, following the Reasonable and Prudent Alternatives (RPAs) adopted from the 2007 Opinions, all observed intrusion events into water as well as all applications into the 300 foot buffer around waterways were reported and provided annually to NMFS. Since 2007, all observed intrusions, regardless of amount, effects, or whether accidental or intentional, have been reported to the NIFC and to NMFS in annual reports. The USFS will continue to compile these monitoring reports and provide them to NMFS annually. Both agencies agree there is still the possibility that intrusion events could go unnoticed, however based on the reported rates of intrusions into water between 2000 and 2010, it is clear that many more incidents were reported, though likely the rate of incidents was unchanged because in all cases, pilots were following the 2000 Guidelines.

Likelihood of Observing Accidental Exposures

All fires larger than 300 acres are monitored by BAER teams while five percent of smaller fires suppressed with long-term fire retardants will also be monitored. Because of the increased monitoring proposed in 2011, the USFS is more likely to observe accidental intrusions in the future, particularly in lower order streams (first to third) that may be impacted during early response suppression activities. The intrusions may be found after the fact by observing the coloring agent of a fire retardant around a stream, at which point an evaluation for any impacts would be conducted, but this is often long after the fire is out and the impacts of fire retardants are still observable. Once an accident is observed, reports are made to the Resource Advisor. The reports are then transmitted up the chain of command to the District Ranger or Forest Supervisor and Incident Commander. The Incident Commander is responsible for reporting the accident to the National Interagency Fire Center (NIFC).

Exposure

Northwest and Southwest Regions

The Northwest and Southwest are home to most of the National Forests in this country and most of the USFS land with listed species in their watersheds. In the Northwest, there are 22 National Forests with listed species and critical habitat designations (Table 9). The Southwest is home to 10 National Forests with listed species and critical habitat designations (Table 10). The USFS fire fighting program has authority to fight fires an unspecified distance adjacent to their land (FSM 5132). Additionally, the proportion of a species range that is located on these National Forests is not a meaningful metric for determining risks to the DPSs or ESUs without information on the life stages present, the subpopulation and or genetic structure of the species present on USFS lands and its importance to the survival and recovery of the DPS or ESU, and the importance of that habitat compared to the habitat elsewhere in their range. Frequently, much of the most pristine salmonid habitat is located on USFS lands, while, as described in the baseline section, most severe and chronic watershed degradation is the result of private, developed lands. Based on habitat quality, the actual area of a species' habitat that is on USFS land is not really correlated with the value of that habitat to the species, as larger, impaired areas would have fewer listed fish than smaller, pristine areas. Therefore, NMFS did not rely on the percentage of the stream miles contained within USFS relative to the ESU or DPS as a metric for

evaluating exposure.

Table 9: Northwest National Forests and the NMFS trust resources that reside there.			
National Forest	Listed Species	Critical Habitat	Status
Columbia River Gorge	Columbia River chum salmon	Yes	Threatened
	LCR coho salmon	No	Threatened
	Snake River spring/summer Chinook salmon	Yes	Threatened
	Snake River fall-run Chinook salmon	Yes	Threatened
	LCR Chinook salmon	Yes	Threatened
	Snake River Basin steelhead	Yes	Threatened
	LCR steelhead	Yes	Threatened
	MCR steelhead	Yes	Threatened
	UCR steelhead	Yes	Endangered
	Pacific eulachon	Proposed	Threatened
Okanogan/Wenatchee	UCR spring-run Chinook salmon	Yes	Endangered
	MCR steelhead	Yes	Threatened
	UCR steelhead	Yes	Endangered
Wallowa-Whitman	Snake River sockeye salmon	Yes	Endangered
	Snake River spring/summer Chinook salmon	Yes	Threatened
	Snake River fall-run Chinook salmon	Yes	Threatened
	Snake River steelhead	Yes	Threatened
Gifford Pinchot	LCR coho salmon	No	Threatened
	LCR Chinook salmon	Yes	Threatened
	LCR steelhead	Yes	Threatened
	Pacific eulachon	Yes	Threatened
Malheur	MCR steelhead	Yes	Threatened
Olympic	Hood Canal summer-run chum salmon	Yes	Threatened
	Puget Sound Chinook salmon	Yes	Threatened
	Puget Sound steelhead	No	Threatened
	Pacific eulachon	Proposed	Threatened
Mount Baker	Hood Canal summer-run chum salmon	Yes	Threatened
	Puget Sound Chinook salmon	Yes	Threatened
	Puget Sound steelhead	No	Threatened
Mount Hood	LCR Coho salmon	No	Threatened
	Upper Willamette River Chinook salmon	Yes	Threatened
	LCR Chinook salmon	Yes	Threatened
	LCR steelhead	Yes	Threatened
	Pacific eulachon	Proposed	Threatened
Ochoco	MCR Steelhead	Yes	Threatened
Rogue River	Southern Oregon/Northern California Coast coho salmon	Yes	Threatened
	Green sturgeon	Yes	Threatened
Siskiyou	Southern Oregon/Northern California Coast coho salmon	Yes	Threatened
	Oregon Coast coho salmon	Yes	Threatened
	Pacific eulachon	Proposed	Threatened
	Green sturgeon	Yes	Threatened
Siuslaw	Oregon Coast coho salmon	Yes	Threatened
	Pacific eulachon	Proposed	Threatened
Umpqua	Oregon Coast coho salmon	Yes	Threatened
	Green sturgeon	Yes	Threatened
Umatilla	Snake River spring/summer Chinook salmon	Yes	Threatened
	Snake River fall-run Chinook salmon	Yes	Threatened
	Snake River Basin Steelhead	Yes	Threatened
	MCR Steelhead	Yes	Threatened

National Forest	Listed Species	Critical Habitat	Status
Willamette	Upper Willamette River Chinook salmon	Yes	Threatened
	Upper Willamette River Steelhead	Yes	Threatened
Clearwater	Snake River Basin steelhead	Yes	Threatened
	Snake River Spring/summer Chinook salmon	Yes	Threatened
	Snake River fall Chinook salmon	Yes	Threatened
Bitterroot	Snake River steelhead	Yes	Threatened
Nez Perce	Snake River steelhead	Yes	Threatened
	Snake River spring /summer Chinook salmon	Yes	Threatened
	Snake River fall Chinook salmon	Yes	Threatened
	Snake River sockeye salmon	Yes	Endangered
Sawtooth	Snake River sockeye salmon	Yes	Endangered
Salmon/Challis	Snake River sockeye salmon	Yes	Endangered
	Snake River spring/summer Chinook salmon	Yes	Threatened
	Snake River steelhead	Yes	Threatened
Payette	Snake River steelhead	Yes	Threatened
	Snake River spring/summer Chinook salmon	Yes	Threatened
Boise	Snake River steelhead	Yes	Threatened
	Snake River spring/summer Chinook salmon	Yes	Threatened

Table 10: Southwest National Forests and the NMFS trust resources that reside there.

National Forest	Listed Species	Critical Habitat	Status
Eldorado	California Central Valley steelhead	Yes	Threatened
Cleveland	Southern California steelhead	Yes	Endangered
Klamath	Southern Oregon/Northern California Coast coho salmon	Yes	Threatened
Lassen	Central Valley spring Chinook salmon	Yes	Threatened
	California Central Valley steelhead	Yes	Threatened
Los Padres	South-Central California Coast steelhead	Yes	Threatened
	Southern California steelhead	Yes	Endangered
Mendocino	Northern California steelhead	Yes	Threatened
	Central Valley spring Chinook salmon	Yes	Threatened
	California Coastal Chinook salmon	Yes	Threatened
	Southern Oregon/Northern California Coast coho salmon	Yes	Threatened
	California Central Valley steelhead	Yes	Threatened
Plumas	California Central Valley steelhead	Yes	Threatened
Shasta-Trinity	Southern Oregon/Northern California Coast coho salmon	Yes	Threatened
	California Central Valley steelhead	Yes	Threatened
	Central Valley spring run Chinook salmon	Yes	Threatened
	California Coastal Chinook salmon	Yes	Threatened
	Northern California steelhead	Yes	Threatened
	Green sturgeon	Yes	Threatened
Six Rivers	Southern Oregon/Northern California Coast coho salmon	Yes	Threatened
	Northern California steelhead	Yes	Threatened
	California Coastal Chinook salmon	Yes	Threatened
	Pacific eulachon	Proposed	Threatened
Tahoe	California Central Valley steelhead	Yes	Threatened

Fire seasons vary through the northwest and southwest regions. The Pacific Northwest from Puget Sound to the Willamette River Basin has peak fire seasons ranging from June to October. Further west along the Columbia and Snake Rivers to the base of the Rocky Mountains has a peak fire season from April to October. The northern Rocky Mountain fire season peaks from

June through September. Further south of the Willamette River Basin through Oregon and northern California the peak fire season lasts from July through October, while further south into southern California, the peak fire season is from August through October.

NMFS, as described in the Approach to the Assessment section and again in the Status of the Species section, evaluated the monitoring reports from 2008-2010 to determine the likelihood of an intrusion event. During the most recent Opinion on aerial application of long-term fire retardants, the available monitoring data and misapplication reports were insufficient to estimate a rate of intrusion (Appendix C of NMFS’ July 25, 2008 long-term fire retardant Opinion). The current data available (Table BA-12 in the BA) indicate an intrusion rate of 0.0032477 and fire retardants fell within the 300 foot buffer 0.4263% of the time. However, because fire retardant usage on a forest depends on the number of fires that can be successfully fought, which is highly variable from year to year, the 10 year mean fire retardant usage presented in the EIS has little utility for predicting future fire retardant use. To verify that the mean was a poor predictor, NMFS took the average fire retardant applications between 2000 and 2010 and determined the standard error around the mean to develop a confidence interval. For every forest with NMFS species, there was a single year in the data set where the amount of retardant used in the past decade exceeded the 99.99% confidence interval of predicted retardant use. For this reason, NMFS used the maximum single year observed application during the past 11 years to predict future potential peak usage (Table 11) but also relied on the median application rate over the past decade to estimate the probable annual usage.

Once NMFS determined the likely future peak application rate on each forest, it was possible to determine the expected rate of future intrusions by multiplying the 3 year rate of intrusions (0.0032477) by the maximum number of fire retardant applications administered over the past decade. The probability presented is actually a range of values from 0 to the maximum potential for an intrusion event, which is noted in the last column of Table 11.

National Forest	Calculated 11 year mean	11 year minimum application	11 year maximum application	Probability of an intrusion
Bitterroot NF	24	2	80	0.65 – 23%
Boise NF	75	3	213	0.97 – 50%
Clearwater NF	7	1	19	0.32 – 6%
Columbia River Gorge	12	9	14	2.92 – 5%
Gifford Pinchot NF	16	1	41	0.32 – 13%
Malheur NF	29	4	79	1.30 – 23%
Mount Baker-Snoqualmie NF	0	0	3*	0 – 1%
Mount Hood NF	21	3	60	0.97 – 18%
Nez Perce NF	22	3	78	0.97 – 22%
Ochoco NF	6	0	16	0 – 5%
Okanogan-Wenatchee NF	129	15	358	4.87 – 69%
Olympic NF	0	0	4*	0 – 1%
Payette NF	100	1	240	0.32 – 54%
Rogue River/Siskiyou	20	2	48	0.65 – 15%
Salmon-Challis NF	34	1	119	0.32 – 32%

National Forest	Calculated 11 year mean	11 year minimum application	11 year maximum application	Probability of an intrusion (min to max)
Sawtooth NF	42	1	111	0.32 – 30%
Siuslaw NF	N/A	0*	143*	0 – 37%
Umatilla NF	43	5	149	1.62 – 38%
Umpqua NF	24	1	64	0.32 – 19%
Wallowa-Whitman NF	73	4	203	1.30 – 48%
Willamette NF	41	8	130	2.60 – 35%
Cleveland NF	35	2	120	0.65 – 32%
Eldorado NF	7	1	15	0.32 – 5%
Klamath NF	27	2	85	0.65 – 24%
Lassen NF	22	1	60	0.32 – 18%
Los Padres NF	255	1	882	0.32 – 94%
Mendocino NF	50	2	143	0.65 – 37%
Plumas NF	48	8	214	2.60 – 50%
Shasta Trinity NF	133	6	318	1.94 – 65%
Sierra NF	30	1	72	0.32 – 21%
Six Rivers NF	23	1	111	0.32 – 30%
Tahoe NF	24	2	119	0.65 – 32%

*Better data were unavailable; therefore the 11 year total was used for the single year maximum.

In the table above (Table 11), the probability of an intrusion event doesn't consider the potential for multiple intrusion events. When working with probabilities, the goal is to determine the likelihood of a "success," which in this case, despite the negative ramifications to listed species, would be an intrusion event. Following the RPAs contained in the 2007 Opinion and maintained in the 2008 reinitiated Opinion, 10,000 applications were recorded during those three years and the "success" rate in this consultation was determined to be .0032477 (0.3248%). Therefore, if one fire retardant application is made to a National Forest, there is a 0.3248% chance that application errantly falls into water. If a second application is made on that forest, there is a 0.648% chance one of those applications reaches water and a 0.001% chance that both of those applications errantly land in water. The more applications made, the greater the likelihood of a misapplication or multiple misapplications.

As the number of long-term fire retardant applications increases, the probability of a misapplication increases (Table 11), and there is also an increase in the likelihood of having multiple misapplications during a single fire season. For instance, at the maximum rate of application over the past 11 years, the Los Padres has a 78.01% chance of multiple misapplications in a single year. There is a 32.4% chance the Okanogan National Forest could have multiple misapplications in one year. On the Shasta-Trinity National Forest, there is a 22.72% chance of multiple misapplications in one year. Those are the three forests with better than a one in five chance of having multiple misapplications. But there is still a 12% chance the Boise National Forest could have multiple misapplications in the same year. The Payette National Forest has an 18.37% chance, the Wallowa-Whitman has a 14.16% chance, the Plumas has a 15.39% chance, the Mendocino a 7.93% chance, the Willamette a 6.73% chance, and the Salmon-Challis National Forest has a 5.77% chance. The other forests also face a risk of multiple misapplications; however that risk is less than 1 in 20.

While multiple intrusion events could occur on a forest during any year, the USFS has included a mitigation measure in their proposed action to conduct a step-down consultation at the local level following an intrusion event to assess the risk of a second intrusion. Additionally, listed species are not present in every body of water on an entire National Forest. And listed species of a single DPS or ESU can be found on multiple National Forests, subjecting the listed entity to potential exposure across a broad geographic area. NMFS quantified the potential exposure to individual DPSs or ESUs caused by the maximum number of fire retardant applications over the past decade (Table 12). The probabilities reported are not expected every year; however they are the upper end of a range that could be expected in any given year.

ESU/DPS	National Forests	Cumulative Anticipated Applications	Probability of an Intrusion	Probability of Multiple Intrusions	Species Status
CC Chinook	Mendocino NF Shasta-Trinity NF Six Rivers NF	572	0.8444	0.5545	Threatened
CV spring-run Chinook	Lassen NF	60	0.1773	0.0165	Threatened
LCR Chinook	Mt. Hood NF Gifford Pinchot NF Columbia River Gorge NSA	115	0.3121	0.0543	Threatened
Snake River fall-run Chinook	Nez Perce NF Umatilla NF Clearwater NF Wallowa-Whitman NF Columbia River Gorge NSA	463	0.7782	0.4437	Threatened
Snake River spring/ summer-run Chinook	Boise NF Payette NF Salmon-Challis NF Nez Perce NF Clearwater NF Umatilla NF Wallowa-Whitman NF Columbia River Gorge NSA	1,035	0.9655	0.8492	Threatened
UCR spring-run Chinook	Okanogan-Wenatchee NF	358	0.6879	0.3239	Endangered
Upper Willamette River Chinook	Mt. Hood NF Willamette NF	190	0.4610	0.1273	Threatened
Columbia River Chum	Columbia River Gorge NSA	14	0.0445	0.0009	Threatened
Hood Canal summer-run chum	Olympic NF Mt. Baker-Snoqualmie	7	0.0225	0.0002	Threatened
LCR coho	Mt. Hood NF Gifford Pinchot NF Columbia River Gorge NSA	115	0.3121	0.0543	Threatened
Puget Sound Chinook	Olympic NF Mt. Baker-Snoqualmie	7	0.0225	0.0002	Threatened
Puget Sound steelhead	Olympic NF Mt. Baker-Snoqualmie	7	0.0225	0.0002	Threatened

ESU/DPS	National Forests	Cumulative Anticipated Applications	Probability of an Intrusion	Probability of Multiple Intrusions	Species Status
SONCC coho	Rogue NF Siskiyou NF Klamath NF Los Padres NF Shasta-Trinity NF Six Rivers NF Mendocino NF	1,587	0.9943	0.9647	Threatened
Oregon Coast coho	Umpqua NF Siskiyou NF Suislaw NF	231	0.5283	0.1733	Threatened
Snake River Sockeye	Wallowa-Whitman NF Salmon-Challis NF Sawtooth NF Nez Perce NF	511	0.8103	0.4944	Endangered
CCV steelhead	Eldorado NF Lassen NF Mendocino NF Tahoe NF Shasta-Trinity NF Plumas NF	869	0.9408	0.7732	Threatened
LCR steelhead	Mt. Hood NF Gifford Pinchot NF Columbia River Gorge NSA	115	0.3121	0.0543	Threatened
MCR steelhead	Umatilla NF Ochoco NF Malheur NF Okanogan-Wenatchee NF Columbia River Gorge NSA	616	0.8652	0.5946	Threatened
Northern California steelhead	Six Rivers NF Shasta-Trinity NF Mendocino NF	572	0.8444	0.5545	Threatened
Snake River steelhead	Boise NF Payette NF Salmon-Challis NF Sawtooth NF Nez Perce NF Clearwater NF Umatilla NF Bitterroot NF Wallowa-Whitman NF Columbia River Gorge NSA	1,226	0.9815	0.9074	Threatened
SCCC steelhead	Los Padres NF	882	0.9433	0.7802	Threatened
Southern California steelhead	Los Padres NF Cleveland NF	1,002	0.9616	0.8362	Endangered
UCR steelhead	Okanogan-Wenatchee NF Columbia River Gorge NSA	372	0.7018	0.3404	Threatened
Upper Willamette River steelhead	Willamette NF	130	0.3449	0.0673	Threatened
Green sturgeon	Shasta-Trinity NF Rogue NF Siskiyou NF	509	0.8091	0.4824	Threatened

ESU/DPS	National Forests	Cumulative Anticipated Applications	Probability of an Intrusion	Probability of Multiple Intrusions	Species Status
Pacific eulachon smelt	Six Rivers NF Columbia River Gorge NSA Mt. Hood NF Gifford Pinchot NF Siuslaw NF Siskiyou NF	393	0.7215	0.3649	Threatened

In the past decade, there are numerous examples of multiple fire retardant intrusions into rivers and streams affecting a single ESU or DPS of salmonids within the same years or consecutive years. During the 2004 and 2005 fire seasons, long-term retardant misapplications on the Nick Creek and Fly Creek Fires affected Snake River steelhead DPS and Snake River Spring/Summer Chinook salmon ESU. The Snake River steelhead population is estimated to be approximately 22,000 natural returning adult fish and there are on average approximately 7,600 spring/summer Chinook salmon adults. In addition to causing lethal and sub-lethal effects to the individually affected salmonids, these intrusions also affected designated critical habitat.

In 2002, the Southern Oregon/Northern California coast coho salmon were hit by fire retardant applications on the Biscuit and Forks Fires. The Southern Oregon/Northern California Coast coho salmon population is estimated to be approximately 7,000 returning adults (Good *et al.* 2005). The misapplications affected the PCEs for spawning, rearing, and migration. The SONCC coho salmon population was again hit with fire retardant applications on July 2, 2009, and July 19, 2010.

In 2001 and 2003, the same creek on the Colville Confederated Tribe's land received an accidental application of fire retardants, resulting in over 10,000 dead UCR steelhead, which has an estimated adult return of approximately 2,200 fish. The misapplications affected the PCEs for spawning, rearing, and migration. The chemical make-up of the long-term fire retardant that killed that many fish is no longer used by the USFS.

In two other misapplications of long-term fire retardants in 2002, the Deschutes National Forest had at least two misapplications that resulted in fish kills of over 21,000 fish, but NMFS does not have any listed fish on the Deschutes National Forest so only the USFWS needed to evaluate the effects to bull trout. Multiple misapplications have also occurred on Dixie National Forest and Cococino National Forest where there are also no NMFS species present.

On Mt. Hood National Forest on September 17 and 26, 2008, two intrusion events occurred. The first event landed in a tributary to East Hood River upstream of LCR steelhead critical habitat. The second intrusion event occurred in a tributary to Middle Hood River on a different fire, also upstream of LCR steelhead critical habitat. The peak fire retardant season on Mt. Hood National Forest had 60 fire retardant applications. That peak season occurred in 2008. That year, there was a 1.65% chance of multiple intrusions occurring on that forest.

Upper Willamette River Chinook salmon habitat was hit or nearly hit by errant fire retardant applications on July 24, 2008, and August 27, 2009. The 2008 event landed in a tributary to the South Fork McKenzie on an unnamed fire. The 2009 event occurred while fighting the Canal Creek Fire and landed in a tributary to Elk Creek about 5 miles upstream of critical habitat.

On the Mendocino National Forest, fighting the Lantz Fire on July 14, 2008 and the Mill Fire on July 25 and 27, 2008, fire retardant was applied to creeks in California Central Valley steelhead and northern California steelhead habitat, respectively. There were two other intrusion events on Mendocino National Forest in 2009, but the reports did not identify which species were in the area. On July 18, 2009, during the Elk Horn Creek Fire fought by CalFire's Mendocino Unit, there was an intrusion event. Then on August 12, 2009, while fighting the Summit Fire, another intrusion event occurred. It is possible that any of the 2009 intrusions affected one of the steelhead populations repeatedly, but without more information, it is difficult to tell.

Intrusion events upstream of Middle Columbia River steelhead populations occurred on Malheur National Forest on July 2, 2008 while fighting the Deardorff Fire and again on September 24, 2009 while fighting an unnamed fire. Another intrusion on August 16, 2010 also landed upstream of MCR steelhead habitat on the Deschutes National Forest.

While it is unknown which listed species if any were present, multiple misapplications were reported in the past three years on the Boise National Forest. On August 22, 2010, an intrusion occurred, followed 6 days later on the same fire by four additional intrusion events on August 26, 2010. Those four intrusions were four separate applications from a single airplane load. These five intrusions occurred on the Needles Fire, while also on the Boise National Forest on August 27, 2010, while fighting the Grimes Fire, another intrusion occurred. While all of these intrusion events occurred simultaneously, it reveals the difficulty of identifying an intrusion event while fighting a fire. Additionally, it illustrates that Incident Commanders may be able to take listed species habitat into account while fighting these fires, being more aggressive in watersheds without listed species, as these tributaries to Cascade Reservoir likely were.

When a stream is exposed to a fire retardant, the life stage of the fish present is an important factor in the severity of effects. Some researchers have found that swim up fry are most sensitive to fire retardants (Johnson and Sanders 1977, Gaikowski *et al.* 1996, Poulton *et al.* 1997, Kalambokidis 2000), and are clearly less capable of vacating an impacted area. Other researchers have found that swim up fry are just as susceptible as juveniles and adult fish (Rice and Stokes 1975), but eggs and alevins are clearly more resistant. In addition to this older information reported in the 2008 Opinion, in response to the second section of the RPA, NMFS learned that smolting salmonids are more vulnerable to long-term fire retardants than juvenile salmonids and also experience delayed mortality after surviving fire retardants when entering salt water (Dietrich *et al.* 2010).

The risk of various life stages being exposed to fires, and therefore long-term fire retardants, is variable, because of the vegetation type, wind direction and speed, fire season length, and many other factors. In the Northwest, adult salmonids will be present on every national Forest during some point between April and October. In the Southwest, salmonid movements depend much more on high flow events, as there is much less rain in California than in Oregon or Washington

systems. All species of California salmonids adults will be present during the fire season. Swim up fry in the southwest will be present during the fire season for all species of steelhead. Swim-up fry will be present on the Nez Perce, Clearwater, Umatilla, Columbia River Gorge, Wallowa-Whitman, Bitterroot, Salmon/Challis, Boise, Payette, Sawtooth, Mt. Hood, Gifford Pinchot, Lassen, Mendocino, Plumas, Shasta-Trinity, and Tahoe National Forests. Smolts will be present on every National Forest early in the year but they have usually out-migrated by June, limiting the amount of fire season to which they could be exposed. Juveniles will be present on every National Forest in the Northwest and Southwest Regions during the entire fire season.

Pacific eulachon adults enter freshwater systems between December and January. The spawning run typically peaks in spring months and all of the adults have spawned by May. As semelparous species, the adults die after spawning, so any remaining adults by June would be expected to die. Pacific eulachon use near coastal portions of rivers and the coastal fire season along the West Coast generally begins in June, though in California it begins in August. In all cases, the coastal fire season is over by the beginning of the winter spawning run. While it is not expected that Pacific eulachon will be present in freshwater systems when fire retardants may be applied, depending on any changes in the fire season in the future caused by global climate change, it is possible consultation may need to be reinitiated if fire season eventually overlaps with their spawning runs.

In some systems in North America (such as ponderosa pine and loblolly pine forests which historically had high frequency, low severity fires) reduced fire frequency beginning in the late 19th century has led to substantial fuel accumulation. These fuels increase fire hazard and burn severity, a condition that can be exacerbated by a longer fire season, as has been the case recently and is anticipated to continue (e.g. Westerling *et al.* 2006). A number of studies published over the past two decades suggest that fire hazard will increase, likely leading to increases in the annual area burned as well as in the severity of fires (Brown and Smith 2000, Flannigan *et al.* 1998, Fosberg *et al.* 1996, Lenihan *et al.* 1998, Stocks *et al.* 1998, Wotton and Flannigan 1993). The USFS, as reported to Congress, anticipates increased severity and frequency of wildland fires.

The Northwest is covered by western grasses, such as the Palouse dry steppe; shortneedle closed conifer systems, in both the Cascade and mountainous regions and Willamette lowlands; and sagebrush semi-desert. The primary region that burns in the southwest is the mixed chaparral located along the Southern California coastal range. Some upland areas in California have shortneedle conifer forests also. Virtually all fires in both the Northwest and Southwest occur between April and October. Many of the fires along the west coast are severe fires and the trees in this region have evolved to utilize fire for their reproduction. Most of these fires are mixed severity fires that burn in a mosaic pattern, with some stand replacement.

There are different fire retardant application rates for these various regions throughout the North and Southwest. Palouse grasses receive one gallon per 100 square feet, while shortneedle conifer systems receive between two and four gallons per 100 square feet with more being applied in the Rockies and Sierras and less near the coast, sagebrush receives three gallons per 100 square feet, and Chaparral receives at least six gallons and often more per 100 square feet (Labat 2007). The amount of retardant needed per 100 square feet is generally indicative of the intensity of the fires

in those regions. Each fire is attacked in a different fashion, dictated by the decisions made by the Incident Commander. The decision to use fire retardants is not made on every fire, therefore every fire will not expose listed fish to retardants, but this same variability could expose several rivers within one ESU or DPS to multiple fire retardant applications.

Southeast Region

In National Forest land along the East Coast, Atlantic and shortnose sturgeon are likely present on the Francis Marion (Santee-Cooper System), Sumter, Croatan, and Ocala (St. Johns River) National Forests. Shortnose sturgeon are expected to be found on all four of these forests, while Atlantic sturgeon would only be expected to occur on the Croatan and Francis Marion National Forest. Due to dams or extirpations, no Atlantic or shortnose sturgeon are expected to be on any other East Coast National Forests.

The southeastern woodlands experience a fire return frequency of less than 35 years, but the severity is low or mixed. This means that most often, under natural conditions, there are just surface fires and worst case scenario would replace fewer than 25% of the trees affected by the fire (Hann *et al.* 2003). Severe fires are rare along much of the East Coast and due to the climatic conditions, the use of fire retardant is expected to be extremely rare. If retardant had to be used in southern hardwood forests, the necessary coverage is only two gallons per 100 square feet (Labat 2007), but there are no assurances that more retardant would not be used during a large fire. The fire season in North Carolina and South Carolina is typically September to July. In Florida, the pine scrub forests will burn at greater intervals than other trees in the region, every 35 to 100+ years, but the fires usually result in over 75% of the trees in the area being destroyed (Hann *et al.* 2003). In the high intensity fire areas of Florida, the fire season is basically all year (September to July).

Since the fire season on the Croatan, Sumter, and Francis Marion National Forests is September to July, there is a good chance of sturgeon of all life stages being present during a fire. Any fires would be expected to be low to mixed severity and having a rate of return of at least every 35 years (Hann *et al.* 2003). On the Francis Marion and Sumter National Forests, fires have required aerial retardants 14 times during the past decade likely due to the risk to surrounding areas. The peak season during this time resulted in 7 applications of fire retardant. In North Carolina, fire retardants were used 205 times in the past decade with a peak season of 125 applications.

The Ocala National Forest has a very different fire regime from the Francis Marion and Sumter, as it is a fire dependent community of sandhills, pine flatwoods, scrub, and marsh. The primary locations on the East Coast that have major stand replacing fires are Florida scrub pine forests. Florida is heavily populated and any major fire in the region would likely receive aerial applications of fire retardant. Scrub pine forests typically burn every 35 to 100+ years, with the last major fire in the forest occurring in 1985. In the past decade, 469 fire retardant applications have been made in Florida, with a peak season of 246 applications in 2000 and another season with 101 applications in 2007. If retardant was dropped on a fire in the near future, there is not much likelihood for exposure of listed shortnose sturgeon to toxic ammonia concentrations, as there is uncertainty as to whether shortnose sturgeon in the St. Johns River, naturally the southern-most end of their range, have been extirpated. Atlantic sturgeon are occasionally

captured near the mouth of the St. Johns River, but they are not believed to migrate upriver. A shortnose sturgeon was captured there in 2002, but Rogers and Weber (1994) suggest the St. Johns River population has been extirpated. The Florida Fish and Wildlife Conservation Commission (2007) believes the captured sturgeon is most likely a transient from a river to the north and not originally from the St. Johns River. If transient sturgeon are making their way back to this system to repopulate it, any exposure could be dire.

Ecological Responses

When fire retardants initially enter a stream, there is an immediate spike in ammonia concentration in the receiving stream. For instance, when Phos Chek 259-F hits the surface of the water, it is 22.9% ammonia (Buhl and Hamilton 2000). The peak of the spike and area affected depends on many factors, such as volume of retardant to hit the water, volume of water to dilute the retardant, and turbulence of the stream. In simulations of only 267 gallons (a normal load being approximately 1,500 to 2,500 gallons) of fire retardants hitting the surface of a stream, peak ammonia concentrations reached 5,026 mg/l (Buhl and Hamilton 1998). When the volume of retardant hitting the stream is doubled, the zone of mortality is extended 10 times farther downstream (Norris *et al.* 1991). This is only the ammonia concentration caused directly by the fire retardant, but in a natural situation during a fire, ammonia levels will also be elevated due to smoke adsorption (Gresswell 1999). To further complicate what would actually occur during a wildfire, the application of fire retardants increases the amount of smoke produced by the fire (Kalabokidis 2000), which ultimately leads to more ammonia in the system.

When fire retardant enters a stream and causes the initial spike in ammonia, it immediately begins to form a chemical equilibrium between un-ionized ammonia, which is the more toxic form, and ionized ammonia. The chemical balance between these two forms of ammonia is determined by pH, hardness, temperature, and total ammonia concentration (Dietrich *et al.* 2010). Buhl (2000) reported ammonia-induced mortality is the result of the un-ionized component of the equilibrated mixture. In most streams, the pH is sufficiently low that ionized ammonia predominates. However, in highly alkaline waters, un-ionized ammonia concentrations increase and can reach toxic levels. Most research analyzes the lethal levels of ionized ammonia, the least toxic form that will be present in the river.

Norris *et al.* (1978) applied Phos Chek directly to a California stream but the maximum allowable application was 0.5 mg/l. In the natural environment, after 30 minutes, the concentration had been reduced by 90% at the point of entry, but there was no determination of whether there could be similar expectations in the speed of dilution of extremely large introductions of retardant or under actual fire conditions with heat, smoke, and ash. The highest concentrations of ammonia were detected 148 feet downstream of the point of contact and had dissipated to 1% of their peak concentration (in Buhl and Hamilton's [1998] research), 50.26 mg/l) after almost four hours. After one year, there were still detectable, albeit slight, changes to the stream's water chemistry (Norris *et al.* 1978). Discernable levels of ammonia were detected at the farthest downstream (as much as 2730 meters) sampling sites when only a fraction of an actual load was placed in the stream (Norris *et al.* 1978). Simulations run by Norris and Webb (1989) showed ammonia concentrations could remain at lethal levels between 0 and 6.2 miles downstream, depending on stream characteristics and the size of the retardant load. Van Meter

and Hardy (1975) also found that concentrations of retardant high enough to kill 10% of the fish population were measurable over 4 miles downstream. Fire retardants used today are less toxic than those tested during the 1970s and 1980s; however, the immediate spike in ammonia in the first 24 hours after an intrusion is the likely cause of mortality. The spike in total ammonia and un-ionized ammonia caused by modern fire retardant chemicals is likely similar or slightly less toxic compared to those tested previously.

Ammonia is considered highly toxic to fish. Rainbow trout LC50s (the concentration at which half of the effected population will die in an established time period) for total ammonia range from 100 to 112 mg/L. Rainbow trout LC50s for un-ionized ammonia ranged from 0.08 to 1.1 mg/L (Ball 1967, Thurston *et al.* 1981a, Russo 1985). The differences in reported LC50s are likely due to differences in pH or water hardness. The LC50 for juvenile coho salmon has been recorded as 0.45 mg/L un-ionized ammonia (Buckley 1978).

While un-ionized ammonia is likely the lethal portion of the mixture, rainbow trout response to fire retardants currently in use or those developed in the future may be different because there are additional ingredients along with ammonium phosphate or diammonium phosphate which may be confounding or synergistic. Those ingredients are referred to as inert, which doesn't mean they have no effect to listed species, but that they don't affect the function of the fire retardant. These ingredients are used to thicken the retardant or to provide anti-corrosive properties making their transport on aircraft safer.

Backer *et al.* (2004) found the response of fish to fire retardants could be more significant than their response to fire. Fish response does not only depend on the amount of retardant to hit the water and variables within the stream, but also on interactive effects between the various ingredients in the retardant or on the interaction of retardant effects coupled with the effects of the nearby fire to the stream.

The responses of steelhead, Chinook salmon, and coho salmon to specific fire retardants and elevated levels of ammonia have been evaluated by various researchers. Johnson and Sanders (1977) found that for rainbow trout, most mortality occurs in the first 24 hours. As a result, the 24 hour and 96 hour LC50s were not significantly different, meaning that the values given below represent both the 24 hour and 96 hour LC50s.

For rainbow trout, more is known about their responses to fire retardants than for any other fish species. When exposed to Phos Chek 259, the LC50 caused by unionized ammonia (the less toxic form) was between 94 and 250 mg/l (Johnson and Sanders 1977). Buhl and Hamilton (2000) found the LC50 of rainbow trout to Phos Chek 259-F was 168 mg/l. In research on Phos Chek D75-R, the rainbow trout 96 hour LC50 was 168 mg/l (between 142 and 194 mg/l) (Calfee and Little 2003). Calfee and Little (2003) also showed that Phos Chek D75-F has a 96 hour LC50 of 228 mg/l (between 184 and 271 mg/l). Gaikowski *et al.* (1996) also tested Phos Chek D75-F and found similar results with a 96 hour LC50 of 218 mg/l (170 to 280 mg/l). Calfee and Little (2003) were also able to show that D75-R is equally toxic in UV light or dark, while D75-F is most toxic in UV light. Even though D75-F is affected by UV light, even in its most toxic environment, it is still less toxic than D75-R. Poulton *et al.* (1993) found that Phos Chek D75-F was twice as toxic to rainbow trout in hard water compared to soft water. Recent tests done to

authorize the use of Phos Chek 100F were conducted on juvenile rainbow trout and the LC50s were found to be considerably higher with LC50s between 1,494 and 1,932 mg/L total ammonia in soft water and hard water, respectively. Likewise, tests on another new chemical, LC-95A revealed LC50s of 435 and 960 mg/L total ammonia in soft water and hard water, respectively. The reason some retardants are more or less harmful despite having the same base chemicals is the concentration of the ammonia chemical base and the inert chemicals included in the mixture. As Little and Calfee (2003) showed, Phos Chek D75-R and D75-F have different toxicities despite being identical in every way except the colorant. For some long-term fire retardants, whether the water is hard or soft has an effect on the toxicity to resident fish (Poulton *et al.* 1993, Gaikowski *et al.* 1996). Prior to being purchased, all fire retardant chemicals are required to undergo toxicity testing and must have an LC50 exceeding 100 mg/L.

For Chinook salmon, less is known about their response to fire retardants, but there is still information available. In studies by Buhl and Hamilton (1998), there was no difference in the responses of Chinook salmon to Phos Chek D75-F in hard or soft water. Poulton *et al.* (1993) likewise found no significant difference in the response of Chinook salmon to Phos Chek D75-F in hard and soft water. Buhl and Hamilton (1998) also found that the LC50 of D75-F is approximately 218 mg/L (between 170 and 280 mg/L) for all early life stages from swim up fry to 90 days post hatch. These tolerance numbers are very similar to rainbow trout tolerances (also 218 mg/L, but with some differences in effects to life stage, pH level, and UV light). Poulton *et al.* (1993) also found that there was no significant difference between the LC50s of rainbow trout and Chinook salmon. The USFS, prior to purchasing a new long-term fire retardant chemical, uses rainbow trout as a surrogate to infer effects to Chinook salmon.

Very little research has been conducted on coho salmon and their response to fire retardant chemicals. In research by Johnson and Sanders (1977), coho were found to have the same LC50s in response to Phos Chek 259 as rainbow trout have, which was between 94 and 250 mg/l. Again, it is assumed that Phos Chek 259, studied by Johnson and Sanders (1977) is comparable to the Phos Chek brands 259-F and 259-R, as seems to be indicated by Buhl and Hamilton's (2000) research.

There is no information on green or shortnose sturgeon response to fire retardants and very little information on how sturgeon would respond to elevated levels of ammonia. Fontenot *et al.* (1998) showed that shortnose sturgeon have a 96 hour LC50 of under 150 mg/l for total ammonia. This is less tolerant than rainbow trout, Chinook salmon, or coho salmon, whose minimal tolerance is 168 mg/l. For un-ionized ammonia, the most toxic form to fish, the 96 hour LC50 for shortnose sturgeon was as toxic as 0.37 mg/l with a mean of 0.58 mg/l for shortnose sturgeon (Fontenot *et al.* 1998). The rainbow trout LC50 for un-ionized ammonia is between 0.03 and 0.2 mg/l (Alabaster *et al.* 1983, Wicks *et al.* 2002). The response of shortnose sturgeon to total ammonia and un-ionized ammonia is very similar to the response of salmonids.

Pacific eulachon response to long-term fire retardants has not been studied. There is also no information on eulachon response to ammonia toxicity. However, the delta smelt is in the same family and is a reasonable surrogate species to estimate the response of eulachon to a sudden spike in total ammonia and un-ionized ammonia. Research on 57 day old delta smelt revealed an LC50 caused by total ammonia of 13 mg/L and an LC50 caused by un-ionized ammonia of 0.147

mg/L (Connon *et al.* 2011). The LC10 (the point at which 10% of the affected population is killed) was reported as 6.77 mg/L of total ammonia and 0.105 mg/L of un-ionized ammonia to 47 day old delta smelt (Werner 2009). However, a New Zealand species, the common smelt is more tolerant of ammonia with LC50s of 1.76 mg/L un-ionized ammonia at a pH of 7.5 and an LC50 of 0.97 mg/L un-ionized ammonia at a pH of 8.1 (Richardson 1997). The response of smelt to total ammonia and un-ionized ammonia is more severe than salmonids or sturgeon.

Depending on the time of year the long-term fire retardant accidental intrusion occurs, any salmonid or sturgeon life stage could be affected. Eulachon juveniles don't spend much time in freshwater, so it is less likely that any stage other than adult would be affected by fire retardant applications into fresh water. Most toxicological research focuses on juvenile fish because of the cost associated with raising a fish to adulthood. While the LC50s for adult salmonid, sturgeon, or eulachon have not been determined, recent research on smolting salmon provides additional information about how different life stages respond to ammonia and fire retardants. The fire retardant 259F, was found to have an LC50 of 140.5 mg/L total ammonia when administered to smolting Chinook salmon (Dietrich *et al.* 2010). This same formulation had an LC50 of 168 mg/L total ammonia to juvenile rainbow trout, suggesting fire retardants may be slightly more toxic to smolting individuals than juveniles. Phos Check 259, which has the same chemical components but different coloration was shown to have an LC50 of between 94 to 250 mg/L for juvenile rainbow trout and juvenile coho salmon. When tested using LC-95A, the LC50 for smolts was 339.8 mg/L total ammonia, which is less toxic than the 259F mixture (Dietrich *et al.* 2010). As with 259F, LC-95A was more toxic to smolts than juvenile salmonids. The acute mortality of 259F was the result of un-ionized ammonia, confirming previous reports by Buhl (2000), but the LC-95A toxicity was the result of additional factors working synergistically with un-ionized ammonia (Dietrich *et al.* 2010).

While long-term fire retardants are more acutely toxic to smolt stages, they also present sub-lethal risks and can result in additional delayed mortality. Ammonia has been shown to affect eulachon and salmonid gill tissue (Dietrich *et al.* 2010, Connon *et al.* 2011). While juvenile eulachon are not likely to be subjected to intrusions of long-term fire retardants, juvenile salmonids can be present in fresh water systems all year. During toxicity tests, juvenile Chinook salmon subjected to fire retardant levels low enough to cause less than five percent mortality in fresh water were shown to suffer 35 to 40% mortality when transitioning to salt water due to impaired gill tissue (Dietrich *et al.* 2010).

Fire retardants, and the ammonia plume that develops when retardants enter a stream, do not persist above the lethal concentrations described above for long periods of time. Buhl and Hamilton (1998) showed that when 267 gallons of fire retardant enters a stream, about 1/10th of a full load, the ammonia concentration reaches 5,026 mg/l. At such extreme levels, mortality would be nearly immediate, but downstream as the plume is diluted, longer exposure to LC50 levels described above can be lethal. Buhl and Hamilton (1998) provide a case study of a 1995 Fire-Trol LCG-F misapplication in which 23,000 fish were killed, and although the retardant contained sodium ferrocyanide, the cause of mortality was determined to be un-ionized ammonia concentrations. Their research concluded that fire retardant misapplications have biologically significant effects to fish communities.

There is very little information on the sub-lethal response of salmonids, Pacific eulachon, green sturgeon, Atlantic sturgeon, or shortnose sturgeon to long-term fire retardant compounds. Guar gum is a known respiratory inhibitor, while the sub-lethal impacts of ammonia range from skin, eye, and gill damage to reduced hatching success; reduced growth rate; impaired morphological development; injury to liver and kidneys; and the development of hyperplasia. Ammonia can have sub-lethal impacts to delta smelt also, causing cell membrane impairment and gene replication errors at levels between 5 and 10 mg/L (Connon *et al.* 2011). Sub-lethal levels can persist for more than 6.2 miles downstream and for more than 15 months. All of these effects can have an adverse, long-term impact to listed fish, which is very difficult to measure without extensive long-term monitoring.

The Federal regulatory agencies, led by EPA, use five percent of the LC50 value to represent the no effect concentration (NOEC) for threatened and endangered species. Therefore the NOEC for rainbow trout in response to long-term fire retardant chemicals would be between 4.7 mg/L and 96.6 mg/L total ammonia depending on the fire retardant chemical being used. The NOEC for Chinook salmon in response to two brands (D75-F and 259F) of long-term fire retardants is between 8.5 and 14 mg/l total ammonia. And finally, the NOEC for coho salmon in response to the only long-term fire retardant chemical tested, Phos Chek 259, is between 4.7 and 12.5 mg/l total ammonia. The NOEC for sturgeon species is 7.5 mg/L total ammonia or between 0.019 and 0.029 mg/L un-ionized ammonia. Pacific eulachon NOEC concentrations are lower with a total ammonia NOEC of 0.65 and an un-ionized ammonia NOEC of between 0.007 and 0.088 mg/L.

Buhl and Hamilton (1998) found that following an accidental drop of only 267 gallons of Phos Chek D75-F, the ammonia would need to be diluted 660 times to reach the LC50 concentration and 13,200 times before it reaches a NOEC for Chinook salmon. McDonald *et al.* (1997) found that a larger load of D75-F would need to be diluted 2,713 times to reach the LC50 level. Buhl and Hamilton (2000) and USGS (2000) found that Phos Chek 259-F was even more toxic than D75-F and would need to be diluted 813 times, just to reach the LC50 concentration and 1,750 times to reach a 10% of the LC50, a level still above the safe NOEC for listed species.

Labat (2007), in a report to the USFS, attempted to describe the risk of long-term fire retardant chemicals to fish by identifying a risk quotient (RQ), which is the ratio of the estimated dose or water concentration (typically, the Expected Environmental Concentration (EEC) or peak water concentration) to an estimated threshold effect, in this case the LD50 or the LC50. Essentially, the RQ provides a generic assessment of the level at which exposure may affect listed species when the proper assumptions are applied. In this case, the assumptions were that 1) mortality would only occur if ammonia levels exceeded 10 mg/L an hour after intrusion, 2) rainbow trout were an acceptable surrogate for all species and juveniles were the most sensitive life stage, 3) different life history variables do not influence susceptibility to stressors, and 4) responses of organisms in a laboratory are similar to responses in the wild.

A comprehensive evaluation of these assumptions, plus any related assumptions, is necessary to understand if the risk approach used by the USFS generally produces protective decisions in the context of section 7 or if the approach generally underestimates potential risk. Simply, the use of lethality endpoints without consideration of potential sub-lethal effects from even short-term or transient exposures fails to acknowledge that sub-lethal and indirect effects on osmoregulation,

gamete development, or other endpoints can play an essential role in ensuring the survival and recovery of listed species.

All retardant formulations are tested to determine their toxicity to rainbow trout and the USFS is studying sub-lethal effects caused by fire retardants. Those studies are conducted in laboratory environments, but the response of fish to an accidental fire retardant drop in the natural environment with additional stressors, such as low DO, ash, hot water, and other conditions expected as the result of the nearby fire, has not been studied. Salmonids and shortnose sturgeon are particularly sensitive to elevated temperatures and are not very tolerant of water with low DO, and since warm water holds less oxygen, encountering water with low DO is a distinct possibility during a wildfire. There have been several studies done on the interactive effects of ammonia and DO; all showing the LC50s of rainbow trout to fall dramatically when DO is low. Alabaster *et al.* (1983) showed that at 10 ppm DO, rainbow trout wouldn't die until concentrations of un-ionized ammonia reached 0.2 mg/l, but when the DO fell to 3.5ppm, the lethal concentration of un-ionized ammonia became only 0.08 mg/l. Thurston *et al.* (1981b) showed that when DO dropped from 8.5ppm to 5ppm, rainbow trout became 30% less tolerant of ammonia. In other work on rainbow trout response to many toxins in a low DO environment, Lloyd (1961) found that the greatest response was to ammonia, besting other toxins such as lead, zinc, and copper.

Minshall and Brock (1991) believe that increased temperatures, which can range from 4 to 10°C (Gresswell 1999), can kill fish in first and second order streams, but doubt third order streams get hot enough to kill anything. Mortality in second and third order streams could be caused by smoke and ash (Minshall *et al.* 1989). In larger streams, the impacts are likely less (Gresswell 1999) for many of the same reasons as the impacts of fire retardant in larger streams are less. The quality of the critical habitat in all reaches of stream that experience changes in water quality will be reduced. Small isolated populations of fish have been extirpated by fires (Propst *et al.* 1989, Rieman *et al.* 1997), and similar responses would be expected if fire retardant was dropped in a headwater system. Larger, better connected populations are more resilient (Rieman *et al.* 1995, Dunham *et al.* 2003) so individuals from downstream that aren't harmed by the retardant may migrate back into the headwater system to spawn, helping fish re-establish in those areas.

Other impacts of fire could make salmonids more susceptible to fire retardants as well. Gresswell (1999) showed that smoke in the air is adsorbed by water and increases the ammonia concentrations in rivers even without an accidental application of retardant. Crouch *et al.* (2006) showed that in burning watersheds, prior to treatment with retardants, there is increased ammonia, phosphorous, and total cyanide. Since there is a greater background level of ammonia during a fire, the ammonia levels created by an accidental drop may be higher than experienced in a controlled setting and as the fire retardants are diluted, they may take longer to reach non-toxic levels. Wells *et al.* (2004) and Little *et al.* (2006) showed rainbow trout avoided concentrations of 1.3 mg/l (1% of LC50), which may mean fish are likely to swim away from areas of high ammonia concentrations. Recently, Wicks *et al.* (2002) found that rainbow trout and coho salmon swimming through water with elevated un-ionized ammonia levels experience reduced LC50s, declining from approximately 0.207 mg/l to 0.032 mg/l.

While un-ionized ammonia is the constant toxic component of fire retardants, there are no restrictions on the “inert” ingredients. Ash and guar gum, “inert” ingredients used to thicken the fire retardant formulation, have both been identified as respiratory inhibitors in the water. Ash has been identified as the cause of fish kills during wildfires and volcanic eruptions (Newcombe and Jensen 1996), while guar gum is an ingredient in fire retardants and would further exacerbate the effects of increased ammonia concentrations. Little *et al.* (2006) showed spikes in the salinity, as a result of the ammonia salts contained in the aerially applied fire retardants, which would negatively impact all fish living in freshwater environments, even adults. Buhl and Hamilton (1998) stated, “these results indicate that although ammonia is a major toxic component in D75-F, other components in the formulation may have had a significant influence on the toxicity of D75-F to Chinook salmon (p. 1594).”

Even though losses of all stages of fish are critical, losses of adults before they spawn is potentially the most devastating loss as they have generally lived three to five years at that point without being able to contribute to future populations levels. Every National Forest in the northwest and southwest and the rivers downstream of those forests will have adult salmon present during the April to October fire season, and any accidental application of fire retardant could kill migrating or spawning adults along with juvenile and recently hatched listed fish.

To evaluate the risk to listed species, NMFS evaluated the data provided by the USFS from the annual monitoring conducted between 2008 and 2010. Because all agencies receive retardant from the same bases and from those years, followed the same 2000 Guidelines, NMFS believes it is fair to assume that a misapplication has as good of a chance of occurring on Forest Service land as on other federal, state, or county land. Many salmonids spend several years in freshwater before migrating to sea. NMFS is not aware of any evaluations of the effects of multiple year classes lost, multiple year classes suffering sub-lethal effects, multiple portions of a species’ range being impacted simultaneously, or what the cumulative effects of multiple retardant misapplications to a DPS or ESU over a single generation would mean.

The hardest to measure and potentially most significant effects of fire retardant misapplication could be sub-lethal impacts to fish and the duration of the impacts to critical habitat. We expect that the extent of the sub-lethal impacts will extend downstream much farther than the 6.2 miles (Norris and Webb 1989), due to the fact that ammonia concentrations below lethal limits will persist beyond the extent of lethal concentrations. The distance and the extent of sub-lethal effects from elevated ammonia levels is not known, but may extend for some distance downstream and is an area of research that should be analyzed in the future. Laboratory studies show that rainbow trout exposed to NH₃ levels over 0.1 mg/l un-ionized developed skin, eye, and gill damage. Other reactions to sub-lethal levels of ammonia are reduced hatching success, reduced growth rate; impaired morphological development; injury to gill tissue, liver, and kidneys; and the development of hyperplasia. Hyperplasia in fingerling salmonids can result from exposure of ammonia levels as low as 0.002 mg/l for six weeks. Considering the research in California (Norris *et al.* 1978) that showed detectable levels of ammonia for an entire year following retardant introduction, it is possible that hyperplasia could be a concern for listed salmonids. The presence of ammonia in the water can also lead to suppression of normal ammonia excretion and a buildup of ammonia on the gills. Fire retardants may also inhibit the upstream movement of spawning salmon (Wells *et al.* 2004).

Risk to Listed Species

The USFS has proposed to continue aerial application of long-term fire retardants on USFS and adjacent lands using the proposed 2011 Guidelines to establish a 300 foot buffer on either side of rivers on USFS land, beyond which NMFS and the USFS assume long-term retardant application has no effect on listed aquatic species. This proposed action is narrowly constrained to only include aerially applied long-term fire retardants applied to USFS lands despite the fact that the USFS is the only agency that purchases fire retardants across the United States. These long-term fire retardants are stored at air bases and can later be ordered by other Federal and state agencies to fight fires on their respective lands. There is considerable program overlap between the USFS and other Federal and state agencies because the USFS supplies long term fire retardants and at least partially funds the contractors at the aerial retardant tanker bases. The USFS also evaluates applications when new products are requested to be introduced to the QPL. While this proposed action considers aerially applied long-term fire retardants, there are also QPLs for foam formulations (Forest Service Specification 5100-307A) and water enhancer formulations (Forest Service Specification 5100-306A) that were not considered in this consultation. Therefore, because this is outside of the scope of the EIS, NMFS has not included an assessment of these potential effects in the Opinion despite what appear to be interrelated and interdependent actions.

The Pacific salmonids, green sturgeon, Atlantic sturgeon, and shortnose sturgeon are sensitive species, being adversely affected by impaired water quality that may not affect other species. For that reason, NMFS conducted a thorough analysis of the baseline conditions in the major rivers of these species' ranges. As described in the baseline section, these fish are listed due to past anthropogenic actions, in large part initially due to excessive fishing. After the initial population reductions, several populations of Pacific salmonids continue to decline due to ongoing actions while populations of sturgeon are so reduced that reliable population estimates have not been made. These listed fish are negatively impacted by sedimentation in their spawning areas; reduced fish passage between their spawning areas and the ocean; bycatch in ocean fisheries; and impaired water quality as a result of mining, industrial waste, stormwater discharge, agricultural runoff, and urban runoff. Furthermore, Pacific salmonids are also impacted by predation from both native and non-native species around dams and impairment of critical habitat. When fires are burning, the heat and smoke generated typically reduces DO, increases temperature, increases ammonia, and adds other pollutants that are problematic to fish such as the toxin cyanide and ashes that clog their gills. NMFS acknowledges these species benefit when these fires are extinguished but can also be harmed if fire fighting accidents occur.

In order to evaluate the risk of the USFS long-term fire retardant program it is necessary to understand the potential exposure of listed species to fire retardants, and then to understand their likely response to those long-term fire retardant chemicals. Then to determine the amount of take likely for each listed species that may be affected by long term fire-retardants (Table 1), we synthesize the exposure and response sections of the effects analysis, with a summary of each species below.

California Coastal Chinook salmon

CC Chinook salmon are a threatened species with critical habitat present on or immediately downstream of the Mendocino, Shasta-Trinity, and Six Rivers National Forests. The population is broken into independent and dependent populations. Of the 21 independent populations, only four are not extirpated or at high risk of extirpation. Of those four, one is at moderate risk of extirpation and there isn't enough information about the other three populations to determine their status. The spring-run component of the species was recently extirpated (Williams *et al.* 2011). The Eel River likely supports the healthiest remaining population of CC Chinook salmon and its watershed flows through the Mendocino and Six Rivers National Forests. During the fire season in northern California, all life stages of CC Chinook salmon can be encountered except for eggs. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for CC Chinook salmon to have fire retardant applied to them between 9 and 572 times in a single year. Therefore, there is between a 2.88 and 84.44 percent chance an errant application of fire retardant reaches water on one of these three forests.

Six Rivers National Forest receives the least fire retardant of the three forests CC Chinook salmon inhabit. During 60% of the fire seasons of the past decade, this forest received 11 or fewer retardant applications. The Mendocino receives the second most fire retardant of these three forests but during the past decade, 44% of the fire seasons have resulted in applications of 16 or fewer applications. The Shasta-Trinity National Forest receives the most fire retardant of USFS lands with CC Chinook salmon. Despite some years with high applications, 33% of the time the forest receives 10 or fewer applications. The median application rate for retardants was 10, 34, and 129 on Six Rivers, Mendocino, and Shasta-Trinity National Forests, respectively. Those 173 applications that could be expected in any given year would result in a 43% chance of an intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak retardant application, but adjacent forests often experience less severe fire seasons. Additionally, CC Chinook salmon do not reside in every waterway on all three National Forests. Because all spring Chinook salmon populations have been extirpated and only fall Chinook salmon persist, the adults only use the larger mainstem reaches of rivers on these forests for spawning. It is entirely possible an errant application that results in an intrusion may be applied to a water body upstream of CC Chinook salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely CC Chinook salmon habitat could receive an intrusion during any given fire season.

Currently, CC Chinook salmon occupy 1,634 miles of streams throughout their range. Of these stream miles, 79.8% of that habitat is on private lands, while 16.4% of their habitat is on Federal

lands, some of which is USFS land. Therefore, only approximately 268 total stream miles of CC Chinook salmon habitat is on Federal land, which is a small portion of the overall stream miles on the three National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on CC Chinook salmon. As is stated above, NMFS believes an intrusion event to CC Chinook salmon habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.38% of CC Chinook salmon's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the ESU that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the ESU, then it stands to reason the other healthier populations would also not be extirpated. The dependent populations that are either very small or extirpated are in Ten Mile, Noyo, Big, Navarro, Garcia, and Gualala Rivers. Ten Mile River is approximately 37 miles long and is only thought to currently provide habitat for coho salmon and steelhead. Noyo River is approximately 30 miles long and still likely supports CC Chinooks salmon. Big River is approximately 42 miles long and is still thought to support CC Chinook salmon. Navarro River is approximately 28 miles long but it is unknown if it still supports CC Chinook salmon habitat. Garcia River has a wide, deep 44 mile long mainstem but a lack of information makes it unclear if this river still supports CC Chinook salmon. The Gualala River is approximately 40 miles long but it is unknown if CC Chinook salmon still reproduce in this river.

While these systems are relatively short and support small extant populations of CC Chinook salmon, these systems are not on USFS lands. Any impacts to CC Chinook salmon would be to larger (in volume and width) systems with healthier populations of CC Chinook salmon. Because of the size of the systems, long-term fire retardants are expected to dilute more quickly. This extent of an intrusion to the CC Chinook salmon species is not likely to appreciably reduce their likelihood of survival or recovery, however, a second intrusion event before the affected year class is able to reproduce could appreciably reduce their viability. While NMFS determined this would likely result in jeopardy to CC Chinook salmon in the 2008 Opinion, the USFS has addressed these concerns by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications.

Central Valley Spring-Run Chinook Salmon

CV Chinook salmon are a threatened species with critical habitat present on Lassen National Forest. Originally 18 or 19 independent populations but only three extant populations remain in

Deer, Mill, and Butte Creek. All remaining populations are in the northern sierra diversity group, which is one of four diversity groups that were originally inhabited. In the past decade, between 6,000 and 10,000 adults have returned to the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (DFG 1998), but since 2006 declining returns have put the population at greater risk of extinction. During the fire season in northern California, all life stages of CV Chinook salmon can be encountered except for eggs. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible Lassen National Forest habitat for CV Chinook salmon to have fire retardant applied between 1 and 60 times in a single year. Therefore, there is between a 0.32 and 17.73 percent chance an errant application of fire retardant reaches water on one of this forest.

During 60% of the fire seasons of the past decade, Lassen National Forest received 14 or fewer retardant applications. Assuming median application rates over the past 10 years do a better job of estimating expected annual events, while peak applications in the last decade likely predict peak applications this decade, then the median application rate was 35 on Lassen National Forest. Using the median application rate, there is a 10.76% chance of an intrusion. CV Chinook salmon do not reside in every waterway on Lassen National Forest so it is possible an errant application that results in an intrusion may be applied to a water body upstream of CV Chinook salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being recorded as an intrusion on Lassen National Forest.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinitiate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely CV Chinook salmon habitat could receive an intrusion during any given fire season.

Currently, CV Chinook salmon occupy 1,373 miles of streams throughout their range. Of these stream miles, 84.5% of that habitat is on private lands, while 12.1% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 166 total stream miles of CV Chinook salmon habitat is on Federal land, which is a small portion of the overall stream miles in Lassen National Forest. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on CV Chinook salmon. As is stated above, NMFS believes an intrusion event to CV Chinook salmon habitat in the near future is possible and that lethal and sub-lethal impacts from aerially

applied long-term fire retardants would affect up to 6.2 miles, or 0.45% of CV Chinook salmon's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the ESU that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the ESU, then it stands to reason the other healthier populations would also not be extirpated. The three extant populations for this species are on Mill, Deer, and Butte Creeks in the upper Sacramento River. Mill Creek is approximately 56.5 miles with its headwaters in Lassen Volcanic National Park and Lassen National Forest. Deer Creek is approximately 69 miles long with its headwaters in Lassen National Forest. Butte Creek is 93 miles long with its headwaters in Lassen National Forest.

Most of the CV Chinook life cycle occurs outside of Lassen National Forest. However, the creeks on Lassen National Forest are used for spawning and rearing. Because of the size of the spawning creeks, long-term fire retardants are expected to dilute more quickly. While deeper water, greater water volume, and faster dilution may reduce the downstream extent of impacts (Norris *et al.* 1991), a misapplication to one of these creeks would still likely result in mortality and sub-lethal effects. This extent of an intrusion to the 56 miles of Mill Creek, the 69 miles of Deer Creek, or the 93 miles of Butte Creek would have negative impacts to that portion of the year class or adult spawners.

In the case of an intrusion event affecting adults, spawning would still occur in the other two systems as well as other areas of the impacted system. NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt age would depend more on intraspecific competition. If juveniles were affected by an intrusion, fewer smolts may leave the system, possibly resulting in fewer adults returning to spawn from that year class. The impact of that loss would be naturally mitigated by staggered return intervals for adult Chinook salmon, such that individuals from the previous and next year classes may also return to spawn with individuals from this year class.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. Therefore, this extent of impact to the CV Chinook salmon species is not likely to appreciably reduce their likelihood of survival or recovery.

Lower Columbia River Chinook Salmon

LCR Chinook salmon are a threatened species with critical habitat present on or immediately

downstream of the Mt. Hood and Gifford-Pinchot National Forests and Columbia River Gorge National Scenic Area. There are 32 historical spawning populations in this ESU and 28 of them are extirpated or at “very high risk” of being extirpated. Twenty of 21 populations of fall Chinook salmon are either extirpated or at very high risk of extinction, with the Sandy River population at high risk. Eight of nine spring Chinook salmon populations in this ESU are at “very high risk” of extinction, while the Sandy population was at “moderate” or “high” risk of extinction. The two populations of late fall Chinook salmon, Lewis and Sandy Rivers, were determined to be at “very low risk” and “low risk” of extinction, respectively. Near loss of both fall runs and spring runs remains an important concern. Generally, LCR Chinook salmon populations in 2009 are not significantly changed from historically low levels seen in 2000.

During the fire season in coastal Oregon and Washington, all life stages of LCR Chinook salmon can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for LCR Chinook salmon to have fire retardant applied to them between 13 and 115 times in a single year. Therefore, there is between a 4.14 and 31.21 percent chance an errant application of fire retardant reaches water on one of these three forests.

Columbia River Gorge receives the least fire retardant of the three forests LCR Chinook salmon inhabit, never exceeding 14 applications. Gifford Pinchot National Forest receives the second most fire retardant of these three forests but during the past decade, 50% of the fire seasons have resulted in two applications or less. The median number of applications over the past decade on the Gifford Pinchot National Forest is 12. Mt. Hood National Forest receives the most fire retardant of USFS lands with LCR Chinook salmon. Despite some years with high applications, 62.5% of the time the forest receives 16 or fewer applications. The median number of fires on these three forests in the past decade is 39, which translates to a 12% chance of an intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, LCR Chinook salmon do not reside in every waterway on all three National Forests. It is entirely possible an errant application that results in an intrusion may be applied to a water body upstream of LCR Chinook salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is possible LCR Chinook salmon habitat could receive an intrusion during any given fire season.

Currently, LCR Chinook salmon occupy 1,655 miles of streams throughout their range. Of these stream miles, 54.7% of that habitat is on private lands, while 37.3% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 617 total stream miles of

LCR Chinook salmon habitat is on Federal land, which is a small portion of the overall stream miles on the three National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on LCR Chinook salmon. NMFS believes an intrusion event to LCR Chinook salmon habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.37% of LCR Chinook salmon's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the ESU that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the ESU, then it stands to reason the other healthier populations would also not be extirpated. Twenty eight of the 32 historic spawning populations (comprising all three run types) are either extirpated or at high risk of extirpation. Many of these high risk populations are supported only by hatchery straying (Ford *et al.* 2010). Of the populations that have any abundance remaining (i.e., not extirpated), none are at very high risk or high risk due to limited spatial structure, rather they are all at moderate risk or better. Because these small populations are moderately well distributed, a fire retardant intrusion would be problematic to a portion of one of these populations, but not to any of these populations in their entirety. The real risk likely stems from multiple intrusions into a single system or over sequential years.

The 2008 Opinion determined the USFS aerial application of long-term fire retardant program was likely to jeopardize this species because of a lack of monitoring and reporting and a proposed action that did not limit the number of potential misapplications. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. Therefore, this extent of impact to the LCR Chinook salmon species is not likely to appreciably reduce their likelihood of survival or recovery.

Snake River Fall-Run Chinook Salmon

Snake River fall-run Chinook salmon are a threatened species with critical habitat present on or immediately downstream of the Nez Perce, Umatilla, Wallowa-Whitman, and Clearwater National Forests and Columbia River Gorge National Scenic Area. The population has been increasing since the 1990s, and the most recent five year geometric mean for the Snake River fall Chinook salmon ESU is 11,321. During the fire season in the Snake River, all life stages of Snake River fall-run Chinook salmon can be encountered. Adults enter the Columbia when fire season begins and spend the fire season in the Snake River before spawning at the end of the fire season. Fry emerge at the start of the next fire season and juveniles grow and rear in the river

through fire season. The biggest threat would come from an intrusion event when adults are making their upstream spawning migration or are holding in the Snake River during the summer because adults would have the most ecological value to the recovery of the species.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for Snake River fall-run Chinook salmon to have fire retardant applied to them between 22 and 463 times in a single year. Therefore, there is between a 6.91 and 77.82 percent chance an errant application of fire retardant reaches water on one of these five forests.

Columbia River Gorge receives the least fire retardant of the five forests Snake River fall-run Chinook salmon inhabit, never exceeding 14 applications. The Clearwater National Forest also receives limited retardant use, with 78% of the past 10 fire seasons receiving 8 or fewer applications. The Nez Perce also receives limited fire retardant applications despite a 10 year maximum of 78. Over the past decade, during 66% of the fire seasons the Nez Perce National Forest received 14 or fewer applications with a median application rate of 7 per year. The Umatilla and Wallowa-Whitman National Forests receive moderate applications every year. The Umatilla has had 10 or fewer applications during 33% of the past 10 fire seasons. The Wallowa-Whitman has received a median application rate of 61 per year despite a maximum of 203. The risk associated with median applications is likely a better indicator of annual expectations and for these five forests, the median application rate is 112, which results in a 30.5% chance of a single intrusion and 5.2% chance of multiple intrusions. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, Snake River fall-run Chinook salmon do not reside in every waterway on all five National Forests. Adult fall-run Chinook salmon only use the larger mainstem reaches of rivers on these forests for spawning. It is entirely possible an errant application that results in an intrusion may be applied to a water body upstream of Snake River fall-run Chinook salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely Snake River fall-run Chinook salmon habitat could receive an intrusion during any given fire season.

Currently, Snake River fall-run Chinook salmon occupy 84 miles of USFS land, approximately 17%, out of a total of approximately 495 miles of streams above Little Goose Dam. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Snake River fall-run Chinook salmon. The 2008 Opinion determined the USFS aerially applied long-term fire

retardant program was likely to jeopardize this species because there was no plan in place to monitor their applications or the appropriate set of actions to take in the event of an intrusion. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. As is stated above, NMFS believes an intrusion event to Snake River fall-run Chinook salmon habitat in the near future is likely but due to the volume of water in the mainstem Snake River, any effects to Snake River fall-run Chinook salmon would likely be sub-lethal and localized. The impact to the Snake River fall-run Chinook salmon species is not likely to appreciably reduce their likelihood of survival or recovery.

Snake River Spring/Summer-Run Chinook Salmon

Snake River spring/summer-run Chinook salmon are a threatened species with critical habitat present on or immediately downstream of the Boise, Payette, Salmon-Challis, Nez Perce, Umatilla, Wallowa-Whitman, and Clearwater National Forests and Columbia River Gorge National Scenic Area. The 1997 to 2001 geometric mean total return for the summer run component was slightly more than 6,000 fish, compared to the geometric mean of 3,076 fish for the years 1987 to 1996. Only 4 of 31 populations have been extirpated; however, Good *et al.* (2005) reported that risks to individual populations within the ESU may be greater than the extinction risk for the entire ESU due to low levels of annual abundance and the extensive production areas within the Snake River basin. During the fire season in the Snake River, all life stages of Snake River spring/summer Chinook salmon can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for Snake River spring/summer Chinook salmon to have fire retardant applied to them between 27 and 1,035 times in a single year. Therefore, there is between a 8.41 and 96.55 percent chance an errant application of fire retardant reaches water on one of these eight forests.

Columbia River Gorge receives the least fire retardant of the five forests Snake River spring/summer Chinook salmon inhabit, never exceeding 14 applications. The Clearwater National Forest also receives limited retardant use, with 78% of the past 10 fire seasons receiving 8 or fewer applications. The Nez Perce also receives limited fire retardant applications despite a 10 year maximum of 78. Likewise, the Salmon-Challis National Forest has had a peak year of 119 applications while having a 10 year median application rate of 22 per year. Over the past decade, during 66% of the fire seasons the Nez Perce National Forest received 14 or fewer applications with a median application rate of 7 per year. The Boise, Umatilla, and Wallowa-Whitman National Forests receive moderate applications every year. The Boise National Forest receives a median application rate of 61 applications per year with 20% of the years receiving 6 or fewer applications. The Umatilla National Forest has had 10 or fewer applications during 33% of the past 10 fire seasons. The Wallowa-Whitman has received a median application rate of 61 per year despite a maximum of 203. The Payette National Forest received the highest application rate of the eight forests with Snake River spring/summer Chinook salmon with a

median of 96 applications and only 27% of the years having 2 or fewer applications. Using the cumulative median application rate of 291, there is a resulting 61.2% chance of a single intrusion and a 24.4% chance of multiple intrusions. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, Snake River spring/summer Chinook salmon do not reside in every waterway on all eight National Forests. It is entirely possible an errant application that results in an intrusion may be applied to a water body upstream of Snake River spring/summer Chinook salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinitiate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely Snake River spring/summer Chinook salmon habitat could receive an intrusion during any given fire season.

Currently, Snake River spring/summer Chinook salmon occupy 1,370 miles of USFS land, approximately 64%, out of a total of approximately 2,141 miles of streams above Little Goose Dam. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Snake River spring/summer-run Chinook salmon. As is stated above, NMFS believes an intrusion event to Snake River spring/summer-run Chinook salmon habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.28% of Snake River spring/summer-run Chinook salmon's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the ESU that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the ESU, then it stands to reason the other healthier populations would also not be extirpated. Snake River spring/summer Chinook salmon are a wide-ranging species, composed of five major population groups (Ford *et al.* 2010). Only four spawning populations have been extirpated. One of those extirpated populations is in the Lower Snake River major population group, which was historically made up of two populations, the Asotin and Tucannon Rivers. The greatest impact of an intrusion of long-term fire retardant would be if it entered the Tucannon River, affecting the last extant population in that population group. The Tucannon River is 62.3 miles long and the Snake River spring/summer Chinook salmon population in this river has had a sharply positive growth trend over the past 15 years with consecutive five year geometric mean spawner populations of 120, 176, and 469 (Ford *et al.*

2010). Given the recent increases in abundance, the population is still below the objective of 750 natural spawners and remains at high risk of extirpation.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, fewer smolts may leave the system, possibly resulting in fewer adults returning to spawn from that year class. The impact of that loss would be naturally mitigated by staggered return intervals for adult Chinook salmon, such that individuals from the previous and next year classes may also return to spawn with individuals from this year class.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. Therefore, the extent of impact caused by a single intrusion event to the Snake River spring/summer Chinook salmon species' habitat is not likely to appreciably reduce their likelihood of survival or recovery.

Upper Columbia River Spring-Run Chinook Salmon

UCR Chinook salmon are an endangered species with critical habitat present on or immediately downstream of the Okanogan-Wenatchee National Forest. UCR Chinook salmon currently spawn in only three river basins above Rock Island Dam. The populations of UCR spring-run Chinook salmon reached a critically low point in 1994 and the population has been gradually increasing through 2008. In the most recent 5-year geometric mean (2003 to 2008), spawning escapements were 489 for the Wenatchee population, 111 for the Entiat population, and 402 for the Methow population. During the fire season in central Washington, all life stages of UCR Chinook salmon can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible Okanogan-Wenatchee National Forest will have fire retardant applied to it between 15 and 358 times in a single year. Therefore, there is between a 4.76 and 68.79 percent chance an errant application of fire retardant reaches water on that forest.

The Okanogan-Wenatchee National Forest has a median application rate of 57 drops. It is most likely that the median retardant application rate would be administered as opposed to the 10 year peak rate. The median application rate of 57 results in a 16.9% chance of a single intrusion and a 1.5% chance of multiple intrusions in a single year. Additionally, UCR Chinook salmon do not reside in every waterway on the forest. It is entirely possible an errant application that results in an intrusion may be applied to a water body upstream of UCR Chinook salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinitiate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is possible UCR Chinook salmon habitat could receive an intrusion during any given fire season.

Currently, UCR Chinook salmon occupy 1,002 miles of streams throughout their range. Of these stream miles, 39.2% of that habitat is on private lands, while 53.4% of their habitat is on Federal lands, some of which is USFS land. Therefore, approximately 535 total stream miles of UCR Chinook salmon habitat is on Federal land, which is a small portion of the overall stream miles on the Okanogan-Wenatchee National Forest. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future.

Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on UCR Chinook salmon.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the ESU that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the ESU, then it stands to reason the other healthier populations would also not be extirpated.

UCR Chinook salmon habitat is restricted to the Methow, Entiat, and Wenatchee Rivers. As is stated above, NMFS believes an intrusion event to UCR Chinook salmon habitat in the near future is likely. The impacts of an intrusion would likely result in lethal and sub-lethal effects extending downstream up to 6.2 miles. Any impacts to this species from long-term fire retardant intrusions that would make it likely that one of these spawning populations would be extirpated would constitute an appreciable reduction in their likelihood of survival or recovery. The Entiat River population is the smallest of the three extant populations in this region and the most vulnerable to being extirpated. The most recent five year geometric mean of the Entiat River population is approximately 250 spawners with 111 of those being of natural origin. This recent population estimate is more than twice as large as the previous estimate and larger than the size of the population at the time of listing. One of the main reasons the returns are limited is because there is poor juvenile rearing habitat in the lower Entiat River mainstem. An application to the lower mainstem in juvenile Chinook salmon rearing habitat would be mitigated by the volume of water at the mouth of the river where it enters Entiat Reservoir on the mainstem of the Columbia River.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles living upstream of

the lower Entiat River were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possibly fewer adults would return to spawn from that year class. The mainstem Entiat River is 57 miles long and while 6.2 miles of effects would constitute approximately 10% of the available habitat, the impact of that loss would be naturally mitigated by immigration/emigration from the affected area, a deep and voluminous mainstem system with an average flow of 471 cubic feet per second, and staggered return intervals for adult Chinook salmon, such that individuals from the previous and next year classes may also return to spawn with individuals from the affected year class. A single retardant intrusion would not cause the extirpation of the Entiat River population and the USFS will insure multiple intrusions into the same watershed do not occur.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications to allow the adverse effects of an intrusion to no longer impact this ESU's survival or recovery. This extent of impact from a single fire retardant intrusion to the UCR Chinook salmon species is not likely to appreciably reduce their likelihood of survival or recovery.

Upper Willamette River Chinook Salmon

Upper Willamette River Chinook salmon are a threatened species with critical habitat present on or immediately downstream of the Mt. Hood and Willamette National Forests. Natural spawner abundance in this population between 2005 and 2009 had a geometric mean of below 2,000, while total adult returns have been steady at approximately 40,000. Only seven rivers in the Upper Willamette River system still support spawning populations, and due to low natural reproduction, lost spawning habitat above dams, and hatchery influence, this ESU is not considered a viable population. During the fire season in coastal Oregon and Washington, all life stages of Upper Willamette River Chinook salmon can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for Upper Willamette River Chinook salmon to have fire retardant applied to them between 11 and 190 times in a single year. Therefore, there is between a 3.52 and 46.1 percent chance an errant application of fire retardant reaches water on one of these two forests.

Mt. Hood National Forest receives the least fire retardant of the two forests Upper Willamette River Chinook salmon inhabit. Despite some years with high applications, 62.5% of the time the forest receives 16 or fewer applications. The Willamette National Forest receives the most fire retardant of these forests with a median application rate of 34 drops per year. The total median application rate for both forests is 49, which results in a 14.7% chance of an intrusion. Based on

the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, Upper Willamette River Chinook salmon do not reside in every waterway on both National Forests. It is entirely possible an errant application that results in an intrusion may be applied to a water body upstream of Upper Willamette River Chinook salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinitiate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is possible Upper Willamette River Chinook salmon habitat could receive an intrusion during any given fire season.

Currently, Upper Willamette River Chinook salmon occupy 1,796 miles of streams throughout their range. Of these stream miles, 60.1% of that habitat is on private lands, while 38.6% of their habitat is on Federal lands, some of which is USFS land. Therefore, approximately 693 total stream miles of Upper Willamette River Chinook salmon habitat is on Federal land, which is a small portion of the overall stream miles on the two National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Upper Willamette River Chinook salmon. As is stated above, NMFS believes an intrusion event to Upper Willamette River Chinook salmon habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.35% of Upper Willamette River Chinook salmon's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the ESU that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the ESU, then it stands to reason the other healthier populations would also not be extirpated.

Upper Willamette River Chinook salmon are restricted to the Willamette River and its tributaries. Five of the seven spawning populations comprising the species are at very high risk of extinction or already extirpated. The Calapooia and Middle Fork Willamette Rivers have the lowest overall status of the seven populations and the lowest abundances and are therefore at the greatest risk of extirpation and range contraction. Of those two, the Calapooia River population

has the most impaired spatial structure. The Calapooia River is 72 miles long and almost entirely composed of hatchery spawners.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possibly fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by staggered return intervals for adult Chinook salmon, such that individuals from the previous and next year classes may also return to spawn with individuals from this year class. Somewhat fewer adults returning in the future may be good or bad depending on the perspective because hatchery fish are one of the primary threats to this species. A single retardant intrusion would not cause the extirpation of the Calapooia River because of its size and the USFS will insure multiple intrusions into the same watershed do not occur.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the Upper Willamette River Chinook salmon species is not likely to appreciably reduce their likelihood of survival or recovery.

Puget Sound Chinook Salmon

Puget Sound Chinook salmon are a threatened species with critical habitat present on or immediately downstream of the Mt. Baker-Snoqualmie and Olympic National Forests. The Puget Sound ESU comprises 38 historic populations, of which 22 are believed to be extant. During a recent five-year period, the geometric mean of natural spawners in populations of Puget Sound Chinook salmon ranged from 81 to just over 10,345 fish. Most populations had natural spawners numbering in the hundreds between 2005 and 2009 (median recent natural escapement is 909); however, 2009 natural spawners were the lowest since 1997. During the fire season in coastal Oregon and Washington, all life stages of Puget Sound Chinook salmon can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for Puget Sound Chinook salmon to have fire retardant applied to them between zero and seven times in a single year. Therefore, there is between a 0 and 2.25 percent chance an errant application of fire retardant reaches water on one of these two forests.

These two forests received a cumulative total of seven fire retardant applications in the past decade and most years there were no applications at all. Based on the past 10 years of long-term

fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, Puget Sound Chinook salmon do not reside in every waterway on both National Forests. It is entirely possible an errant application that results in an intrusion may be applied to a water body upstream of Puget Sound Chinook salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes there is a small chance Puget Sound Chinook salmon habitat could receive an intrusion during any given fire season but the risk of multiple misapplications is negligible.

Currently, Puget Sound Chinook salmon occupy 2,216 miles of streams throughout their range. Of these stream miles, 42.6% of that habitat is on private lands, while 46.4% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 1,028 total stream miles of Puget Sound Chinook salmon habitat is on Federal land, which is a small portion of the overall stream miles on the two National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Puget Sound Chinook salmon. As is stated above, NMFS believes an intrusion event to Puget Sound Chinook salmon habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.28% of Puget Sound Chinook salmon's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the ESU that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the ESU, then it stands to reason the other healthier populations would also not be extirpated. Puget Sound Chinook salmon are restricted to five geographic areas in the Puget Sound. Spawning populations persist in all of those locations. The smallest spawning population in the Puget Sound ESU is in the South Fork-Mainstem Stillaguamish River with a 15 year mean of approximately 250 spawners and in the past 4 years, returns have ranged from 100 to 300. This system flows 52 miles with 22 miles being in the mainstem.

Because Puget Sound Chinook salmon spawn over most of this 52 mile river and in deep sections, impacts will be less severe than reported in the literature, but there is no way to predict the effects, so the maximum impact of 6.2 miles is assumed. In the case of an intrusion event

affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possibly fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by staggered return intervals for adult Chinook salmon, such that individuals from the previous and next year classes may also return to spawn with individuals from this year class. A single long-term fire retardant intrusion would not cause the extirpation of the South Fork – Mainstem Stillaguamish River because of its size and the USFS will insure multiple intrusions into the same watershed do not occur.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the Puget Sound Chinook salmon species is not likely to appreciably reduce their likelihood of survival or recovery.

Columbia River Chum Salmon

Columbia River chum salmon are a threatened species with critical habitat present on or immediately downstream of the Columbia River Gorge National Scenic Area. Significant spawning occurs in only three of the 17 historical populations: Grays River, Hardy, and Hamilton Creek in Washington State. They appear to be extirpated from the Oregon portion of this ESU. Recent population estimates are similar to estimates from the 1980s and 1990s with total populations below 4,000 adults. During the fire season in coastal Oregon and Washington, adult Columbia River chum salmon enter the Columbia River in October at the end of fire season. They spawn in December and fry emerge between February and April. Juveniles leave the Columbia River quickly with the end of the emigration occurring in May, which is right at the start of fire season.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible the Columbia River Gorge National Scenic Area will have fire retardant applied to it between 9 and 14 times in a single year. Therefore, there is between a 2.88 and 4.45 percent chance an errant application of fire retardant reaches water in that location.

The Columbia River Gorge National Scenic Area has a median application rate of 12 drops. The Columbia River near the mouth is a very wide and very obvious river. There are no reports in the past three years of monitoring of a misapplication into the Columbia River. Additionally, Columbia River chum salmon do not reside in freshwater during peak fire season. It is possible an errant application could result in an intrusion just before or after peak fire season when

Columbia River chum salmon would be present. However, due to the volume of water and flow of the Columbia River near its mouth, any intrusion event would be expected to rapidly dilute.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is possible Columbia River chum salmon habitat could receive an intrusion during any given fire season, a negligible risk of multiple misapplications to the Columbia River, and even if an intrusion occurred to the mouth of the Columbia River, the effects to Columbia River chum salmon would be discountable. Therefore, while the USFS long-term fire retardant program may affect Columbia River chum salmon, it is not likely to adversely affect them.

Hood Canal Summer-Run Chum Salmon

Hood Canal summer-run chum salmon are a threatened species with critical habitat present on or immediately downstream of the Mt. Baker-Snoqualmie and Olympic National Forests. Of an estimated 18 historical populations in the ESU, seven populations are believed to have been extirpated or nearly extirpated. The recent five-year mean abundance for the two main populations in the ESA are 5,433 and 13,903 total spawners for Strait of Juan de Fuca and Hood Canal populations, respectively. During the fire season in coastal Washington, all life stages of Hood Canal summer-run chum salmon can be encountered. The biggest threat would come from an intrusion event when adults are making their upstream spawning migration resulting in mortality of adults as adults would have the most ecological value to the recovery of the species.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for Hood Canal summer-run chum salmon to have fire retardant applied to them between zero and seven times in a single year. Therefore, there is between a 0 and 2.25 percent chance an errant application of fire retardant reaches water on one of these two forests.

These two forests received a cumulative total of seven fire retardant applications in the past decade and most years there were no applications at all. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, Hood Canal summer-run chum salmon do not reside in every waterway on both National Forests. An errant application could be dropped that results in an intrusion to a water body upstream of Hood Canal summer-run chum salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes there is a small chance

Hood Canal summer-run chum salmon habitat could receive an intrusion during any given fire season.

Currently, Hood Canal summer-run chum salmon occupy 88 miles of streams throughout their range. Of these stream miles, 37.6% of that habitat is on private lands, while 49.1% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 43 total stream miles of Hood Canal summer-run chum salmon habitat is on Federal land, which is a small portion of the overall stream miles on the two National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Hood Canal summer-run chum salmon. As is stated above, NMFS believes there is a small chance an intrusion event to Hood Canal summer-run chum salmon habitat occurs in the near future. Because they occupy the mouths of these rivers with large volumes and high flows, NMFS expects only sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 7.05% of Hood Canal summer-run chum salmon's entire freshwater range under the most extreme conditions. This extent of impact to the Hood Canal summer-run chum salmon species is not likely to appreciably reduce their likelihood of survival or recovery.

Lower Columbia River Coho Salmon

LCR coho salmon are a threatened species on or immediately downstream of the Mt. Hood and Gifford-Pinchot National Forests and Columbia River Gorge National Scenic Area. The two populations with any significant natural production (Sandy and Clackamas Rivers) are at appreciable risk because of low abundance, declining trends and failure to respond after a dramatic reduction in harvest. The Sandy population had a mean abundance of 870 spawners and a very low fraction of hatchery-origin spawners between 2006 and 2008. The Clackamas population is larger with a recent (2006-2008) estimated at 3,799 natural origin spawners but nearly 35% of the total population is composed of hatchery fish, well above the viability standard of 10% (Ford *et al.* 2010). During the fire season in coastal Oregon and Washington, all life stages of LCR coho salmon can be encountered except for eggs and alevin. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for LCR coho salmon to have fire retardant applied to them between 13 and 115 times in a single year. Therefore, there is between a 4.14 and 31.21 percent chance an errant application of fire retardant reaches water on one of these three forests.

Columbia River Gorge receives the least fire retardant of the three forests LCR coho salmon inhabit, never exceeding 14 applications. Gifford Pinchot National Forest receives the second most fire retardant of these three forests but during the past decade, 50% of the fire seasons have resulted in two applications or less. The median number of applications over the past decade on

the Gifford Pinchot National Forest is 12. Mt. Hood National Forest receives the most fire retardant of USFS lands with LCR coho salmon. Despite some years with high applications, 62.5% of the time the forest receives 16 or fewer applications. The median number of fires on these three forests in the past decade is 39, which translates to a 12% chance of an intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, LCR coho salmon do not reside in every waterway on all three National Forests. It is possible an errant application that results in an intrusion may be applied to a water body upstream of LCR coho salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinitiate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is possible LCR coho salmon habitat could receive an intrusion during any given fire season.

Currently, LCR coho salmon occupy a total of 3,352 miles of streams throughout their range. Of these stream miles, 48.6% of that habitat is on private lands, while 43.1% of their habitat is on Federal lands, some of which is USFS land. Therefore, approximately 1,445 total stream miles of LCR coho salmon habitat is on Federal land, which is a small portion of the overall stream miles on the three National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on LCR coho salmon. As is stated above, NMFS believes an intrusion event to LCR coho salmon habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.18% of LCR coho salmon's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the ESU that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the ESU, then it stands to reason the other healthier populations would also not be extirpated. LCR coho salmon have been extirpated from approximately 90% of their historic range. There are essentially three spawning populations remaining within this species' range, the Scappoose, Clackamas, and Sandy River populations. Of those three populations, the Sandy River has the lowest overall status and has the least spatial structure. Mean Sandy River population abundance over the past three years has been approximately 870 spawning adults with a positive growth trend over the past 15 years.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possibly fewer adults would return to spawn from that year class. Because coho salmon have a rigid 3 year life cycle, any loss from an intrusion event that affected the number of returning adults would affect the number of spawners in the next generation, leading to similar effects as would be seen if adults were killed. A single long-term fire retardant intrusion would not cause the extirpation of the Sandy River population because of its length, the number of returning spawners each year, and the positive 15 year growth trend. An intrusion would not cause that growth trend to turn negative (it is currently 1.13) but it may lower that growth trend for up to two generations. Because the growth trend would remain positive, there would be no risk of a range contraction from a single intrusion.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the LCR coho salmon species is not likely to appreciably reduce their likelihood of survival or recovery.

Southern Oregon Northern California Coast Coho Salmon

SONCC coho salmon are a threatened species with critical habitat present on or immediately downstream of the Rogue, Siskiyou, Klamath, Los Padres, Shasta-Trinity, Six Rivers, Mendocino National Forests. Data on population abundance and trends are limited for the California portion of this ESU. No regular estimates of natural spawner escapement are available. Brown *et al.* (1994) estimated that the California portion of this ESU was represented by about 7,000 wild and naturalized coho salmon (see Good *et al.* 2005). Approximately 7,000 wild fish have returned past the Gold Ray Dam to the upper Rogue River in recent years. During the fire season in coastal Oregon and Washington, all life stages of LCR coho salmon can be encountered except for eggs and alevin. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for SONCC coho salmon to have fire retardant applied to them between 14 and 1,587 times in a single year. Therefore, there is between a 4.45 and 99.43 percent chance an errant application of fire retardant reaches water on one of these seven forests.

Rogue/Siskiyou National Forests combined have 14 or fewer applications of fire retardant 60% of the past decade with a median of 12. Klamath National Forest has 12 or fewer applications 50% of the past 11 years with a median of 15. Los Padres National Forest has 16 or fewer

applications 36% of the past decade with a median of 35 applications. Six Rivers National Forest had 11 applications or fewer 60% of the time with a median of 10. The Mendocino National Forest receives 16 or fewer applications 44% of the fire seasons with a median of 34. The Shasta-Trinity National Forest has some years with high applications but 33% of the time the forest receives 10 or fewer applications with a median application rate of 129. The median number of fires on these seven forests in the past decade is 235, which translates to a 53% chance of an intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, SONCC coho salmon do not reside in every waterway on all seven National Forests. It is possible an errant application that results in an intrusion may be applied to a water body upstream of SONCC coho salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely SONCC coho salmon habitat could receive an intrusion during a fire season.

Currently, SONCC coho salmon occupy 950 miles of USFS land, approximately 34%, out of a total of approximately 2,794 miles of streams along the California and Oregon Coasts. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on SONCC coho salmon. As is stated above, NMFS believes an intrusion event to SONCC coho salmon habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.60% of SONCC coho salmon's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the ESU that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the ESU, then it stands to reason the other healthier populations would also not be extirpated.

SONCC coho salmon occupy a wide range of coastal streams in California and Oregon. Few of these rivers are long enough to reach USFS lands and those that do are some of the larger rivers with larger populations, such as the Klamath, Shasta, Trinity, and Rogue Rivers. In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and

fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possibly fewer adults would return to spawn from that year class. Because coho salmon have a rigid 3 year life cycle, any loss from an intrusion event that affected the number of returning adults would affect the number of spawners in the next generation, leading to similar effects as would be seen if adults were killed. A single long-term fire retardant intrusion would not cause the extirpation of coho salmon from a larger river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the SONCC coho salmon species is not likely to appreciably reduce their likelihood of survival or recovery.

Oregon Coast Coho Salmon

Oregon Coast coho salmon are a threatened species with critical habitat present on or immediately downstream of the Umpqua, Siskiyou, Siuslaw National Forests. The recent 5-year geometric mean abundance (2002-2006) of approximately 152,960 total natural spawners remains well above that of a decade ago (approximately 52,845 from 1992-1996). However, the decline in productivity from 2003 to 2006, despite generally favorable marine survival conditions and low harvest rates, is of concern. During the fire season in coastal Oregon, all life stages of Oregon Coast coho salmon can be encountered except for eggs and alevin. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for Oregon Coast coho salmon to have fire retardant applied to them between 16 and 231 times in a single year. Therefore, there is between a 5.07 and 52.83 percent chance an errant application of fire retardant reaches water on one of these three forests.

Umpqua National Forest had 12 or fewer fire retardant applications 50% of the past decade with a median of 15. Siskiyou National Forest had 7 or fewer applications 60% of the time with a median of 6. The Siuslaw National Forest lacked data for individual years, but the decade average application rate was 13 applications per year. The median number of fires on these three forests in the past decade is 34, which translates to a 10.5% chance of an intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, Oregon Coast coho salmon do not reside in every waterway on all three National Forests. It is possible an errant application that results in an intrusion may be

applied to a water body upstream of Oregon Coast coho salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is possible Oregon Coast coho salmon habitat could receive an intrusion during any given fire season.

Currently, Oregon Coast coho salmon occupy 1,630 miles of USFS land, approximately 24%, out of a total of approximately 6,792 miles of streams along the Oregon Coast. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Oregon Coast coho salmon. As is stated above, NMFS believes an intrusion event to Oregon Coast coho salmon habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.09% of Oregon Coast coho salmon's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the ESU that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the ESU, then it stands to reason the other healthier populations would also not be extirpated.

Oregon Coast coho salmon occupy a long stretch of the Oregon Coast including many small rivers to the west of the Willamette River. The listing determination for Oregon Coast coho salmon states that most members of the biological review team (94%) thought the species was either at moderate risk or low risk of becoming endangered in the future (76 FR 35755). The majority of the land with high intrinsic value to the recovery of the species is downstream of USFS lands, but the most pristine habitat in this species' range is on USFS lands (Burnett *et al.* 2007). This species has recently increased in abundance and remains well distributed across its range with healthy populations in each of the five major geographic areas.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possible fewer adults would return to spawn from that year class. Because coho salmon have a rigid 3 year life cycle, any loss from an intrusion event that affected the number of returning adults would affect the

number of spawners in the next generation, leading to similar effects as would be seen if adults were killed. A single long-term fire retardant intrusion would not cause the extirpation of coho salmon from any river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the Oregon Coast coho salmon species is not likely to appreciably reduce their likelihood of survival or recovery.

Snake River Sockeye Salmon

Snake River sockeye salmon are an endangered species with critical habitat present on or immediately downstream of the Salmon-Challis, Nez Perce, Wallowa-Whitman, and Sawtooth National Forests. Only 18 natural origin sockeye salmon have returned to the Stanley Basin since 1987 but no natural origin anadromous adults have returned since 1998. The first adult returns from the captive brood stock program returned to the Stanley Basin in 1999. From 1999 through 2005, a total of 345 captive brood program adults that had migrated to the ocean returned to the Stanley Basin. This species is entirely supported by adults produced through the captive propagation program at the present time. However, returns of hatchery-origin sockeye salmon in 2008 and 2009 are the highest since the program began with 650 and 809 individuals, respectively. During the fire season in the Snake River, all life stages of Snake River sockeye salmon can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for Snake River sockeye salmon to have fire retardant applied to them between 9 and 511 times in a single year. Therefore, there is between a 2.88 and 81.03 percent chance an errant application of fire retardant reaches water on one of these four forests.

The Nez Perce National Forest receives limited fire retardant applications despite a 10 year maximum of 78. Over the past decade, during 66% of the fire seasons the Nez Perce National Forest received 14 or fewer applications with a median application rate of 7 per year. Likewise, the Salmon-Challis National Forest has had a peak year of 119 applications while having a 10 year median application rate of 22 per year. The Sawtooth National Forest receives a median of 25 applications per year with 37.5% of the years receiving 13 or fewer applications. The Wallowa-Whitman National Forest receives the most applications of these four forests every year with a median application rate of 61 per year despite a maximum of 203. The median number of fires on these four forests in the past decade is 115, which translates to a 31.2% chance of an intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, Snake River sockeye salmon do

not reside in every waterway on all four forests. It is possible an errant application that results in an intrusion may be applied to a water body upstream of Snake River sockeye salmon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinitiate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely Snake River sockeye salmon habitat could receive an intrusion during any given fire season.

Currently, Snake River sockeye salmon occupy 210 miles of USFS land, approximately 39%, out of a total of approximately 539 miles of streams above the Little Goose Dam, the majority of which is large, mainstem systems leading to Redfish Lake, the headwaters of the Snake River. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Snake River sockeye salmon. As is stated above, NMFS believes an intrusion event to Snake River sockeye salmon habitat in the near future is possible but due to the volume of water in the mainstem Snake River and Redfish Lake, any effects to Snake River sockeye salmon would likely be sub-lethal and localized. Even if aerially applied long-term fire retardants would affect up to 6.2 miles, or 1.15% of Snake River sockeye salmon's entire range under the most extreme conditions, that extent of impact to the Snake River sockeye salmon species is not likely to appreciably reduce their likelihood of survival or recovery.

California Central Valley Steelhead

CCV steelhead are a threatened species with critical habitat present on or immediately downstream of the Mendocino, Shasta-Trinity, Eldorado, Tahoe, and Lassen National Forests. The estimated total annual run size for the entire Sacramento-San Joaquin system, based on Red Bluff Diversion Dam counts in 1993 is no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Since that estimate from the 1990s, it is estimated the most recent 10 year trend has resulted in a 17% reduction per year. The species was recently proposed to be listed as endangered, but habitat restoration activities were proposed to protect the species. During the fire season in central California, all life stages of CCV steelhead can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for CCV steelhead to have fire retardant applied to them between 12 and 869 times in a single year. Therefore, there is between a 3.83 and 94.08 percent chance an errant application of fire retardant reaches water on one of these five forests.

Tahoe National Forest receives 10 or fewer fire retardant applications during 70% of the fire seasons in the past decade. Eldorado National Forest does not receive much fire retardant with a median application rate of five per year and 50% of the fire seasons in the past 11 years have had 2 or fewer applications. During 60% of the fire seasons of the past decade, the Lassen National Forest has received 14 or fewer retardant applications with a median of 12. The Mendocino National Forest receives 16 or fewer applications during 44% of the fire seasons this past decade with a median of 34. The Shasta-Trinity National Forest has some years with high applications but 33% of the time the forest receives 10 or fewer applications with a median application rate of 129. The median number of fires on these five forests in the past decade is 190, which translates to a 46.1% chance of an intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, CCV steelhead do not reside in every waterway on all five National Forests. It is possible an errant application that results in an intrusion may be applied to a water body upstream of CCV steelhead habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely CCV steelhead habitat could receive an intrusion during any given fire season.

Currently, CCV steelhead occupy 2,604 miles of streams throughout their range. Of these stream miles, 88.3% of that habitat is on private lands, while 8.6% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 224 total stream miles of CCV steelhead habitat is on Federal land, which is a small portion of the overall stream miles on the five National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on CCV steelhead. As is stated above, NMFS believes an intrusion event to CCV steelhead habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.24% of CCV steelhead's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the DPS that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the DPS, then it stands to reason the other healthier populations would also not be extirpated.

CCV steelhead occupy a wide range of habitats from large rivers to small tributaries. Of the systems with consistent monitoring data, several hundred redds are made each year. However, the percentage of the entire population made up of hatchery fish has been increasing to approximately 95% in 2010 (Williams *et al.* 2011). The 2005 review team determined this species was in danger of extinction and the 2010 review team determined the species status has only become worse in the past five years. The main threat to this species is the number of hatchery fish. However, this species has good spatial distribution, making it able to withstand an intrusion event into a section of its habitat.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possibly fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by steelhead life history, where juveniles spend multiple years in freshwater before leaving and variable amounts of time in salt water before returning, such that individuals from multiple year classes may return to spawn with individuals from the impacted year class. A single long-term fire retardant intrusion would not cause the extirpation of steelhead from any river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the CCV steelhead species is not likely to appreciably reduce their likelihood of survival or recovery.

Lower Columbia River Steelhead

LCR Chinook salmon are a threatened species with critical habitat present on or immediately downstream of the Mt. Hood and Gifford-Pinchot National Forests and Columbia River Gorge National Scenic Area. Currently, only two of the 26 populations are considered viable, the Wind River summer-run and Clackamas River winter-run. Three recent evaluations all determined that the DPS is at high risk of extinction (McElhany *et al.* 2007, ODWF 2010, LCFRB 2010). During the fire season in coastal Oregon and Washington, all life stages of LCR Chinook salmon can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for LCR steelhead to have fire retardant applied to them between 13 and 115 times in a single year. Therefore, there is between a 4.14 and 31.21 percent chance an errant application of fire retardant reaches water on one of these three forests.

Columbia River Gorge receives the least fire retardant of the three forests LCR steelhead inhabit, never exceeding 14 applications. Gifford Pinchot National Forest receives the second most fire retardant of these three forests but during the past decade, 50% of the fire seasons have resulted in two applications or less. The median number of applications over the past decade on the Gifford Pinchot National Forest is 12. Mt. Hood National Forest receives the most fire retardant of USFS lands with LCR steelhead. Despite some years with high applications, 62.5% of the time the forest receives 16 or fewer applications. The median number of fires on these three forests in the past decade is 39, which translates to a 12% chance of an intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, LCR steelhead do not reside in every waterway on all three National Forests. It is possible an errant application that results in an intrusion may be applied to a water body upstream of LCR steelhead habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinitiate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is possible LCR steelhead habitat could receive an intrusion during any given fire season.

Currently, LCR steelhead occupy 1,655 miles of streams throughout their range. Of these stream miles, 54.7% of that habitat is on private lands, while 37.3% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 617 total stream miles of LCR steelhead habitat is on Federal land, which is a small portion of the overall stream miles on the three National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on LCR steelhead. As is stated above, NMFS believes an intrusion event to LCR steelhead habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.37% of LCR steelhead's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the DPS that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the DPS, then it stands to reason the other healthier populations would also not be extirpated.

LCR steelhead occupy a wide range of habitats from large rivers to small tributaries. Eleven spawning populations are at very high risk of extinction. The two most at risk are the North Fork Lewis River and Salmon Creek because they are above impassable dams and in densely populated areas, respectively (Ford *et al.* 2010). The North Fork Lewis River is a large system with many tributaries, limiting the potential affect of long-term fire retardants. Following an intrusion, steelhead could migrate freely between other tributaries in the North Fork Lewis River system. Steelhead in Salmon Creek are at more risk from long-term fire retardants because of the proximity to people and therefore a greater likelihood fire retardants could be used to protect lives. Steelhead in Salmon Creek are well distributed, still occupying 222 miles of habitat, which is 88% of their historic habitat.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possible fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by steelhead life history, where juveniles spend multiple years in freshwater before leaving and variable amounts of time in salt water before returning, such that individuals from multiple year classes may return to spawn with individuals from the impacted year class. A single long-term fire retardant intrusion would not cause the extirpation of steelhead from any river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the LCR steelhead species is not likely to appreciably reduce their likelihood of survival or recovery.

Middle Columbia River Steelhead

MCR steelhead are a threatened species with critical habitat present on or immediately downstream of the Okanogan-Wenatchee, Ochoco, Malheur, Umatilla National Forests and Columbia River Gorge National Scenic Area. MCR steelhead maintain 17 extant populations in four major population groups with only two extirpated populations. The most recent (2005-2009) 5-year geometric mean for this DPS is approximately 14,364 total steelhead; however, there is no data for some rivers (Ford *et al.* 2010). During the fire season in coastal Oregon and Washington, all life stages of MCR steelhead can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for MCR steelhead to have fire retardant applied to them between 34 and 616 times in a single year. Therefore, there is

between a 10.47 and 86.52% chance an errant application of fire retardant reaches water on those five forests.

Umatilla National Forest receives a median application rate of 24 with 33% of the past decade receiving 10 or fewer applications. Ochoco National Forest has a median application rate of 4 drops per year with 62.5% of the past decade receiving 4 or fewer applications. Columbia River Gorge in the past 10 years has never exceeded 14 applications. Malheur National Forest has a median application rate of 22 drops per year with 50% of the past 10 years having 20 or fewer applications. The Okanogan-Wenatchee National Forest has a median application rate of 57 drops. The median number of fires on these five forests in the past decade is 109, which results in a 29.9% chance of an intrusion. Additionally, MCR steelhead do not reside in every waterway on the forest. It is possible an errant application that results in an intrusion may be applied to a water body upstream of MCR steelhead habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinitiate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely MCR steelhead habitat could receive an intrusion during any given fire season.

Currently, MCR steelhead occupy 6,529 miles of streams throughout their range. Of these stream miles, 57.1% of that habitat is on private lands, while 26.0% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 1,698 total stream miles of MCR steelhead habitat is on Federal land, which is a small portion of the overall stream miles on the five National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on MCR steelhead. As is stated above, NMFS believes an intrusion event to MCR steelhead habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.09% of MCR steelhead's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the DPS that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the DPS, then it stands to reason the other healthier populations would also not be extirpated.

MCR steelhead occupy a wide range of habitats from large rivers to small tributaries. The species is composed of four major population groups. While some populations have decreased in abundance since the 2005 status review, populations in three of the four population groups have had an increase in natural spawners. The John Day population group had a decline in total spawners and natural origin spawners. In this ESU, the upper Mainstem Yakima River population is at the greatest risk of extirpation because of spawning abundance of approximately 150 adults, limited diversity, and limited spatial structure. However, the mainstem of the Yakima River also has high flows and deep water relative to other nearby systems, which would reduce the impact of an intrusion. Additionally, steelhead could migrate freely between other tributaries in the upper Mainstem Yakima River system.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possibly fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by steelhead life history, where juveniles spend multiple years in freshwater before leaving and variable amounts of time in salt water before returning, such that individuals from multiple year classes may return to spawn with individuals from the impacted year class. A single long-term fire retardant intrusion would not cause the extirpation of steelhead from any river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the MCR steelhead species is not likely to appreciably reduce their likelihood of survival or recovery.

Northern California Steelhead

Northern California steelhead are a threatened species with critical habitat present on or immediately downstream of the Mendocino, Shasta-Trinity, and Six Rivers National Forests. This species is made up of a summer-run and winter-run steelhead population; though there is a high risk the summer-run portion of the species will be extinct within 25 years. Recent population estimates are conducted by snorkel counts, representing a fraction of the actual population. Recent estimates suggest the population may be as small as 12,000 returning adults, made up mostly of hatchery fish. During the fire season in northern California, all life stages of Northern California steelhead can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for Northern California steelhead to have fire retardant applied to them between 9 and 572 times in a single year.

Therefore, there is between a 2.88 and 84.44 percent chance an errant application of fire retardant reaches water on one of these three forests.

Six Rivers National Forest receives the least fire retardant of the three forests Northern California steelhead inhabit. During 60% of the fire seasons of the past decade, this forest received 11 or fewer retardant applications, with a median of 10. The Mendocino receives the second most fire retardant of these three forests but during the past decade, 44% of the fire seasons have resulted in applications of 16 or fewer applications with a median of 34. The Shasta-Trinity National Forest receives the most fire retardant of USFS lands with Northern California steelhead. Despite some years with high applications, 33% of the time the forest receives 10 or fewer applications but a median of 129. The median number of fires on these three forests in the past decade is 173, which reduces the risk of an intrusion to a 43% chance. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, Northern California steelhead do not reside in every waterway on all three National Forests. It is possible an errant application that results in an intrusion may be applied to a water body upstream of Northern California steelhead habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinitiate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely Northern California steelhead habitat could receive an intrusion during any given fire season.

Currently, Northern California steelhead occupy 3,148 miles of streams throughout their range. Of these stream miles, 77.1% of that habitat is on private lands, while 18.8% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 592 total stream miles of Northern California steelhead habitat is on Federal land, which is a small portion of the overall stream miles on the three National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Northern California steelhead. As is stated above, NMFS believes an intrusion event to Northern California steelhead habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.20% of Northern California steelhead's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the DPS that is most at risk of extirpation to assess the likely effects of 6.2

miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the DPS, then it stands to reason the other healthier populations would also not be extirpated.

Northern California steelhead occupy a wide range of habitats from large rivers to small tributaries. There are 42 independent populations of winter-run steelhead in five diversity stratum and 10 independent populations of summer-run steelhead. Summer-run steelhead are limited by over summering habitat, while winter-run steelhead are limited by spawning success. Summer-run steelhead populations in Mattole River and Redwood Creek are at high risk of extirpation, making them the most vulnerable populations in this DPS. Redwood Creek has the smaller population with a mainstem snorkel count of only 10 adults per year over the past 30 years and a five year average of only 64 adults in Prairie Creek, a tributary. Neither of these at risk systems is on USFS land, however Redwood Creek is on National Park land. The other independent populations in this DPS have healthier populations and many tributaries, reducing the effects of a fire retardant intrusion.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possibly fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by steelhead life history, where juveniles spend multiple years in freshwater before leaving and variable amounts of time in salt water before returning, such that individuals from multiple year classes may return to spawn with individuals from the impacted year class. A single long-term fire retardant intrusion would not cause the extirpation of steelhead from any river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the Northern California steelhead species is not likely to appreciably reduce their likelihood of survival or recovery.

Snake River Basin Steelhead

Snake River Basin steelhead are a threatened species with critical habitat present on or immediately downstream of the Boise, Payette, Salmon-Challis, Sawtooth, Nez Perce, Umatilla, Wallowa-Whitman, Bitterroot, and Clearwater National Forests and Columbia River Gorge National Scenic Area. This species is composed of 24 extant populations in six major population groups. The species remains well distributed across the six population groups and has a 5 year geometric mean population estimate of approximately 165,700 adult returns but fewer than 20,000 of those adults are natural spawners. During the fire season in the Snake River, all life stages of Snake River Basin steelhead can be encountered. The biggest threat to the species is

from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for Snake River Basin steelhead to have fire retardant applied to them between 30 and 1,226 times in a single year. Therefore, there is between a 9.30 and 98.15 percent chance an errant application of fire retardant reaches water on one of these 10 forests.

Columbia River Gorge receives the least fire retardant of the 10 forests Snake River Basin steelhead inhabit, never exceeding 14 applications. The Clearwater National Forest also receives limited retardant use, with 78% of the past 10 fire seasons receiving 8 or fewer applications. The Bitterroot National Forest receives a median of 19 applications per year with 33% of the past 10 fire years receiving 3 or fewer applications. The Sawtooth National Forest has a median application rate of 25 but 37.5% of the fire seasons in the past decade resulted in 13 or fewer applications. The Nez Perce also receives limited fire retardant applications despite a 10 year maximum of 78. Likewise, the Salmon-Challis National Forest has had a peak year of 119 applications while having a 10 year median application rate of 22 per year. Over the past decade, during 66% of the fire seasons the Nez Perce National Forest received 14 or fewer applications with a median application rate of 7 per year. The Boise, Umatilla, and Wallowa-Whitman National Forests receive moderate applications every year. The Boise National Forest receives a median application rate of 61 applications per year with 20% of the years receiving 6 or fewer applications. The Umatilla National Forest has had 10 or fewer applications during 33% of the past 10 fire seasons. The Wallowa-Whitman has received a median application rate of 61 per year despite a maximum of 203. The Payette National Forest received the highest application rate of the 10 forests with Snake River Basin steelhead with a median of 96 applications and only 27% of the years having 2 or fewer applications. The median number of fires on these 10 forests in the past decade is 362, which reduces the risk of an intrusion to a 69.2% chance. While it is most likely that one forest may have a severe fire year that requires peak retardant application, the other forests may be experiencing less severe fire seasons. Additionally, Snake River Basin steelhead do not reside in every waterway on all 10 National Forests. It is possible an errant application that results in an intrusion to one of these 10 forests may be applied to a water body upstream of Snake River Basin steelhead habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely Snake River Basin steelhead habitat could receive an intrusion during any given fire season.

Currently, Snake River Basin steelhead occupy 8,225 miles of streams throughout their range. Of these stream miles, 28.3% of that habitat is on private lands, while 65.7% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 5,404 total stream miles of Snake River Basin steelhead habitat is on Federal land, which is a small portion of the

overall stream miles on the 10 National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Snake River Basin steelhead. As is stated above, NMFS believes an intrusion event to Snake River Basin steelhead habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.08% of Snake River Basin steelhead's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the DPS that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the DPS, then it stands to reason the other healthier populations would also not be extirpated.

Snake River steelhead occupy a wide range of habitats from large rivers to small tributaries along many miles of the Snake River. This species is broken into two types, A run and B run, and has five major population groups. A run fish generally reproduce in lower elevation systems, which have higher volumes of water and pose little risk to the species in the event of a fire retardant intrusion. B run fish migrate to higher elevation, where there are smaller systems and therefore a greater chance of mortality along a 6.2 mile segment of stream. B run fish primarily return to tributaries of the Salmon and Clearwater Rivers. Approximately 33,000 adult B run fish pass Lower Granite Dam returning to the headwaters of those two large river systems. Any fire retardant intrusion into a tributary of one of these systems may kill fish in 6.2 miles of a system, but with so many adults and juveniles, the impacts of a single intrusion would not cause the extirpation of these systems.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possible fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by steelhead life history, where juveniles spend multiple years in freshwater before leaving and variable amounts of time in salt water before returning, such that individuals from multiple year classes may return to spawn with individuals from the impacted year class. A single long-term fire retardant intrusion would not cause the extirpation of steelhead from any river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by

proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the Snake River Basin steelhead species is not likely to appreciably reduce their likelihood of survival or recovery.

South Central California Coast Steelhead

SCCC steelhead are a threatened species with critical habitat present on or immediately downstream of the Los Padres National Forests. Most of this species' habitat is located on private land with only portions of one river population on the Los Padres National Forest which is located upstream of two dams on the Carmel River. Population estimates in the 5 largest rivers in this DPS are all approximately 500 returning adults. During the fire season in coastal California, all life stages of SCCC steelhead can be encountered except for eggs and alevin. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for the Los Padres National Forest to have fire retardant applied to it between 1 and 882 times in a single year. Therefore, there is between a 0.32 and 94.33 percent chance an errant application of fire retardant reaches water on this forest.

Los Padres National Forest has 16 or fewer applications 36% of the past decade with a median of 35 applications. The median number of applications during the past decade may be a better predictor for the number of applications that are likely, while the peak number of applications is a better approximation for the peak application potential in the next decade. The median number of fires on this forest in the past decade is 35, which results in a 10.7% chance of an intrusion. The Los Padres National Forest is a large forest with SCCC steelhead occupying a small fraction of its land with only one SCCC steelhead river potentially affected by misapplications on that forest. It is possible an errant application that results in an intrusion may be applied to a water body upstream or in a different watershed of SCCC steelhead habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes there is a small chance SCCC steelhead habitat could receive an intrusion during a fire season as a result of the USFS fire retardant program.

Currently, SCCC steelhead occupy 1,251 miles of streams throughout their range. Of these stream miles, 81.6% of that habitat is on private lands, while 16.3% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 204 total stream miles of SCCC steelhead habitat is on Federal land, which is a small portion of the overall stream miles on the Los Padres National Forest. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS

anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on SCCC steelhead. As is stated above, NMFS believes an intrusion event to SCCC steelhead habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.49% of SCCC steelhead's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the DPS that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the DPS, then it stands to reason the other healthier populations would also not be extirpated.

SCCC steelhead occupy a wide range of habitats from large rivers to small tributaries. A small portion of their habitat is on USFS land above the San Clemente and Los Padres Dams on the Carmel River. This population is relatively small, but most reproduction occurs downstream of Los Padres Dam and rearing habitat is located here and at the lagoon near the mouth. The Carmel River is impaired by long stretches of dry river bed in the summer and reservoir above the San Clemente Dam that is completely filled by sediment. On November 2, 2011, CalAm Water issued a Request for Qualifications to remove San Clemente Dam. However, currently, an intrusion upstream of the Los Padres Dam on the Los Padres National Forest would affect a very small portion of the Carmel River population.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possible fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by steelhead life history, where juveniles spend multiple years in freshwater before leaving and variable amounts of time in salt water before returning, such that individuals from multiple year classes may return to spawn with individuals from the impacted year class. A single long-term fire retardant intrusion would not cause the extirpation of steelhead from any river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the SCCC steelhead species is not likely to appreciably reduce their likelihood of survival or recovery.

Southern California Steelhead

Southern California steelhead are an endangered species with critical habitat present on or immediately downstream of the Los Padres and Cleveland National Forests. Most of Southern California steelhead habitat has very small populations, ranging from near extirpated to the low hundreds. Approximately 46% of Southern California steelhead habitat is on the Los Padres National Forest and another 0.5% of Southern California steelhead habitat on the Cleveland National Forest. The 2005 relisting removed 95.8 miles of stream habitat from critical habitat designation because the streams are no longer occupied. These areas included Santa Ynez, San Mateo, San Juan, Carpenteria, Thatcher, Sespe, and Trabuco Rivers and Creeks. During the fire season in coastal California, all life stages of Southern California steelhead can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for both forests to have fire retardant applied to them between 3 and 1,002 times in a single year. Therefore, there is between a 0.97 and 96.16 percent chance an errant application of fire retardant reaches water on both forests.

Los Padres National Forest has 16 or fewer applications 36% of the past decade with a median of 35 applications. The Cleveland National Forest has received 12 or fewer applications 33% of the fire seasons in the past decade with a median application rate of 27. The median number of applications during the past decade may be a better predictor for the number of applications that are likely, while the peak number of applications is a better approximation for the peak application potential in the next decade. The median number of fires on these forests in the past decade is 62, which results in an 18.26% chance of an intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Southern California steelhead occupy several hundreds of stream miles in these two forests, accounting for approximately half of the total stream miles they inhabit. It is possible an errant application that results in an intrusion may be applied to a water body upstream or in a different watershed of Southern California steelhead habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes there is a small chance Southern California steelhead habitat could receive an intrusion during a fire season.

Currently, Southern California steelhead occupy 741 miles of streams throughout their range. Of these stream miles, approximately half of that habitat is on private lands, while 46.3% of their habitat is on USFS lands, some of which is USFS land. Therefore, only approximately 343 total stream miles of Southern California steelhead habitat is on Federal land, which is a small portion of the overall stream miles on the two National Forests. Due to the newly proposed action,

which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Southern California steelhead. As is stated above, NMFS believes an intrusion event to Southern California steelhead habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.84% of Southern California steelhead's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the DPS that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the DPS, then it stands to reason the other healthier populations would also not be extirpated.

Southern California steelhead occupy a wide range of habitats from large rivers to small tributaries. Because of water withdrawals, large sections of the downstream section of Southern California steelhead habitat are dry during the summer. The Los Padres and Cleveland National Forests provide high quality spawning and rearing habitat for this species in the headwaters of several important rivers. Because of the downstream impairments, there are very few juveniles that survive to smoltification and enter the ocean and therefore very few adults that return. This is the most imperiled steelhead along the Pacific Coast and also along the southernmost extent of their range. While the headwater streams on USFS land provide the best habitat for steelhead in these systems, forage is limited. Because of the topography and only being able to apply retardants along ridge tops, despite receiving more fire retardant applications than any other forests in the past three years of monitoring, there have been no intrusions into water.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition due to inadequate food resources in the small headwater streams. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possible fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by steelhead life history, where juveniles spend multiple years in freshwater before leaving and variable amounts of time in salt water before returning, such that individuals from multiple year classes may return to spawn with individuals from the impacted year class. A single long-term fire retardant intrusion would not cause the extirpation of steelhead from any river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by

proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the Southern California steelhead species is not likely to appreciably reduce their likelihood of survival or recovery.

Upper Columbia River Steelhead

UCR steelhead are a threatened species with critical habitat present on or immediately downstream of the Okanogan-Wenatchee National Forest and Columbia River Gorge National Scenic Area. The natural component of the annual steelhead run over Priest Rapids Dam increased from an average of 1,040 (1992-1996), representing about 10% of the total adult count, to 2,200 (1997-2001), representing about 17% of the adult count during this period of time (ICBTRT 2003), and increasing to 3,600 (2005-2009), representing 19% of the adult count (Ford *et al.* 2010). A 5-year geometric mean (2005 to 2009) of approximately 935 naturally produced steelhead returned to the Wenatchee and Entiat rivers (combined). For the Methow population, the 5-year geometric mean of natural returns over Wells Dam was 505. The Okanogan has a 5-year geometric mean return of 152 UCR steelhead. This DPS is failing to meet viability criteria in all four categories; productivity, abundance, spatial structure, and genetic diversity, and is considered to be at high risk (Ford *et al.* 2010). During the fire season in central Washington, all life stages of UCR steelhead can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible these two forests will have fire retardant applied to them between 24 and 372 times in a single year. Therefore, there is between a 7.51 and 70.18 percent chance an errant application of fire retardant reaches water on both forests.

Columbia River Gorge in the past 10 years has never exceeded 14 applications. The Okanogan-Wenatchee National Forest has a median application rate of 57 drops and regularly exceeds 15 applications. The median number of fires on these two forests in the past decade is 69, which results in a 20.1% chance of an intrusion. Additionally, UCR steelhead do not reside in every waterway on the Okanogan-Wenatchee National Forest. It is possible an errant application that results in an intrusion may be applied to a water body upstream of UCR steelhead habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is possible UCR steelhead habitat could receive an intrusion during any given fire season.

Currently, UCR steelhead occupy 1,332 miles of streams throughout their range. Of these stream miles, 40.7% of that habitat is on private lands, while 45.3% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 603 total stream miles of

UCR steelhead habitat is on Federal land, which is a small portion of the overall stream miles on the Okanogan-Wenatchee National Forest. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on UCR steelhead. As is stated above, NMFS believes an intrusion event to UCR steelhead habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.47% of UCR steelhead's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the DPS that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the DPS, then it stands to reason the other healthier populations would also not be extirpated.

UCR steelhead occupy a wide range of habitats from large rivers to small tributaries. There are four remaining extant populations, the Wenatchee, Methow, Entiat, and Okanogan River populations, all downstream of Chief Joseph and Grand Coulee Dam. During the most recent five year population geometric mean, all populations had an increase in spawner returns. The Entiat River population is the smallest with 530 spawners and 116 of those being natural origin. From 1987 to 1997, all four populations had a negative growth trend. However, starting in 1990, growth trends turned somewhat positive and since 2001, growth trends have exceeded 10% per year for all four populations. The mainstem Entiat River is 57 miles long with a watershed of tributaries covering 466 square miles. Steelhead use the mainstem for migration and rearing and the tributaries for spawning and rearing.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possible fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by steelhead life history, where juveniles spend multiple years in freshwater before leaving and variable amounts of time in salt water before returning, such that individuals from multiple year classes may return to spawn with individuals from the impacted year class. Additionally, resident rainbow trout are considered a mitigating factor for this population by the biological review team. A single long-term fire retardant intrusion would not cause the extirpation of steelhead from any river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred.

The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the UCR steelhead species is not likely to appreciably reduce their likelihood of survival or recovery.

Upper Willamette River Steelhead

Upper Willamette River steelhead are a threatened species with critical habitat present on or immediately downstream of the Willamette National Forest. The present day population's abundance has returned to historic low levels seen in the early 1990s (Ford *et al.* 2010), with an abundance estimate for the entire ESU in 2009 of 2,110 steelhead. During the fire season in coastal Oregon, all life stages of Upper Willamette River steelhead can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for the Willamette National Forest to have fire retardant applied to them between 8 and 130 times in a single year. Therefore, there is between a 2.56 and 34.49 percent chance an errant application of fire retardant reaches water on this forest.

The Willamette National Forest receives a median application rate of 34 drops per year. The median rate may better predict the expected annual application rate, while the peak rate likely predicts the approximate 10 year maximum. The median application rate results in a 10.47% chance of an intrusion. Upper Willamette River Chinook salmon do not reside in every waterway on the Willamette National Forests. It is entirely possible an errant application that results in an intrusion may be applied to a water body upstream of Upper Willamette River steelhead habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is possible Upper Willamette River steelhead habitat could receive an intrusion during any given fire season.

Currently, Upper Willamette River steelhead occupy 1,830 miles of streams throughout their range. Of these stream miles, 88.1% of that habitat is on private lands, while 9.7% of their habitat is on Federal lands, some of which is USFS land. Therefore, only approximately 178 total stream miles of Upper Willamette River steelhead habitat is on Federal land, which is a small portion of the overall stream miles on the Willamette National Forest. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able

to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Upper Willamette River steelhead. As is stated above, NMFS believes an intrusion event to Upper Willamette River steelhead habitat in the near future is likely and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.34% of Upper Willamette River steelhead's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the DPS that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the DPS, then it stands to reason the other healthier populations would also not be extirpated.

Upper Willamette River steelhead occupy a wide range of habitats from large rivers to small tributaries. There are four steelhead populations in this DPS, the Calapooia, Molalla, North Santiam, and South Santiam populations. The Calapooia has the smallest population with a 30 year average of approximately 300 spawners. The other three populations have several thousand spawners a year and better spatial structure, limiting their risks of extirpation. Even though the Calapooia population is the population at greatest risk of being extirpated, the biological review team in 2010 determined that population was only at moderate risk.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possible fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by steelhead life history, where juveniles spend multiple years in freshwater before leaving and variable amounts of time in salt water before returning, such that individuals from multiple year classes may return to spawn with individuals from the impacted year class. A single long-term fire retardant intrusion would not cause the extirpation of steelhead from any river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the Upper Willamette River steelhead species is not likely to appreciably reduce their likelihood of survival or recovery.

Puget Sound Steelhead

Puget Sound steelhead are a threatened species on or immediately downstream of the Mt. Baker-Snoqualmie and Olympic National Forests. Of the 15 populations monitored between 2005 and 2009, seven of the populations have a geometric mean population below 250 individuals and only two of those have more than 1,000 individuals return to spawn (Ford *et al.* 2010). Most populations within this DPS are declining by 3 to 10% annually. During the fire season in northwest Washington, all life stages of Puget Sound steelhead can be encountered. The biggest threat to the species is from range contraction, which in this case could occur due to an intrusion event in a system at high risk of extirpation.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for Puget Sound Chinook salmon to have fire retardant applied to them between 0 and 7 times in a single year. Therefore, there is between a 0 and 2.25 percent chance an errant application of fire retardant reaches water on one of these two forests.

These two forests received a cumulative total of seven fire retardant applications in the past decade and most years there were no applications at all. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, Puget Sound steelhead do not reside in every waterway on both National Forests. It is possible an errant application that results in an intrusion may be applied to a water body upstream of Puget Sound steelhead habitat, resulting in little or no affect to the species despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes there is a small chance Puget Sound steelhead habitat could receive an intrusion during any given fire season.

Puget Sound steelhead occupy a similar range as Puget Sound Chinook salmon, amounting to about 3,636 miles approximately 44.4% of which is on private lands and 44.9% is on Federal lands. Therefore, approximately 1,633 total stream miles of Puget Sound steelhead habitat is on Federal land, which is a small portion of the overall stream miles on the two National Forests. Due to the newly proposed action, which restricts exceptions to the 2000 Guidelines, and adaptive management strategies to protect listed species, NMFS anticipates that the intrusion rate of 0.0032477 will be reduced in the future. Additionally, the USFS, by proposing to immediately re-initiate consultation between local forests and regulatory agencies following any intrusion events, is able to insure no more than a single intrusion event will occur without re-evaluating the effect of that event as well as the risk posed by potential future events on Puget Sound steelhead. As is stated above, NMFS believes there is a small chance of an intrusion event to Puget Sound steelhead habitat in the near future and that lethal and sub-lethal impacts from aerially applied long-term fire retardants would affect up to 6.2 miles, or 0.17% of Puget Sound steelhead's entire range under the most extreme conditions.

As is stated above, the biggest threat to the species is from range contraction. The following analysis will analyze the likelihood of a long-term fire retardant intrusion causing effects large enough to lead towards range contraction, and therefore towards extinction. NMFS chose the population within the DPS that is most at risk of extirpation to assess the likely effects of 6.2 miles of mortality and habitat affects because if an intrusion would not likely extirpate the most threatened population within the DPS, then it stands to reason the other healthier populations would also not be extirpated.

Puget Sound steelhead occupy a wide range of habitats from large rivers to small tributaries. There are 16 populations in this DPS and eight of them have spawner returns under 250 individuals per year. The Lake Washington population has by far the lowest abundance with a recent five year geometric mean of only 12 returning spawners, ranging annually between 3 and 55 adults. However, Lake Washington is not on USFS land. The populations on Olympic and Mt. Baker Snoqualmie National Forests have several hundred to several thousand adult spawners each year. The Port Angeles population on the Olympic National Forest has the smallest recent five year geometric mean population estimate of approximately 150 spawners per year.

In the case of an intrusion event affecting adults, NMFS would expect that fewer eggs would be produced and fewer fry would emerge; however, NMFS believes the number of fry that survive to smolt stage would depend more on intraspecific competition. If juveniles were affected by an intrusion, it is possible that fewer juveniles would reach smolt stage and possible fewer adults would return to spawn from that year class. The impact of that loss would be naturally mitigated by steelhead life history, where juveniles spend multiple years in freshwater before leaving and variable amounts of time in salt water before returning, such that individuals from multiple year classes may return to spawn with individuals from the impacted year class. A single long-term fire retardant intrusion would not cause the extirpation of steelhead from any river on USFS land.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely jeopardize this species because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications. This extent of impact to the Puget Sound steelhead species is not likely to appreciably reduce their likelihood of survival or recovery.

Shortnose Sturgeon

Shortnose sturgeon are an endangered species on or immediately downstream of the Croatan, Sumter, Francis-Marion, and Ocala National Forests. The shortnose sturgeon populations in all North Carolina rivers as well as in the St. Johns River in Florida are severely depressed if not extirpated from those systems. The populations in the Savannah River are approximately 3000 total fish ranging from juveniles to adults and the population in the Santee-Cooper River is approximately 300 to 500 individuals of all age classes. During the fire season in the southeast, all life stages of shortnose sturgeon can be encountered. The biggest threat would come from an

intrusion into smaller systems during times with low flows so the concentrated ammonia persists in the environment for a longer time.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for shortnose sturgeon to have fire retardant applied to them between 9 and 378 times in a single year. However, data for North Carolina and Florida is only available for USFS lands in the entire state, not for each forest. Therefore, there is between a 2.88 and 70.76 percent chance an errant application of fire retardant reaches water on one of these four forests.

The median application rate for all Florida forests is 23 applications. The median rate for all North Carolina forests is 47. In both of those states, those totals are statewide, so it is likely a subset of those numbers would occur on the Croatan or Ocala National Forests. On Sumter and Francis Marion National Forests, the median application rate is 6 per year. If these forests received the median application rate, which is the most likely annual application amount while the peak application from the past 10 years is a better predictor of the peak usage in the next 10 years. Considering the median amounts expected, those 76 applications per year would likely result in a 21.9% chance of a single intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, shortnose sturgeon do not reside in every waterway on these four National Forests, instead occupying the large mainstem systems which would buffer many adverse effects with the large volume of water to dilute the fire retardants. It is possible an errant application that results in an intrusion may be applied to a water body upstream of shortnose sturgeon habitat, resulting in a minimal potential effect to the species despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely shortnose sturgeon habitat could receive an intrusion during any given fire season; however, due to the fact they utilize large rivers any misapplication into shortnose sturgeon habitat will likely have sub-lethal impacts for a short duration.

Atlantic Sturgeon

Atlantic sturgeon were broken into five DPSs, the four southernmost DPSs were proposed as endangered and the Gulf of Maine DPS is proposed as threatened. Atlantic sturgeon display high spawning fidelity to their natal rivers; however, all five DPSs of Atlantic sturgeon species utilize the same marine habitat, overlapping completely along the Atlantic seaboard. During their sub-adult and adult residency in marine waters, individual fish will make occasional migrations into lower salinity portions of many coastal rivers. In addition to sub-adult and adult Atlantic sturgeon, juveniles from the Carolina DPS will be present. The five DPSs of Atlantic sturgeon can be found on or immediately downstream of the Croatan and Francis-Marion National Forests. During periodic sampling between 2000 and 2010, the proportions of Atlantic sturgeon DPSs off the North Carolina and South Carolina coasts are roughly 20% New York Bight, 50%

Chesapeake Bay, 25% South Atlantic, and 5% Carolina. During the fire season in the southeast, all life stages of shortnose sturgeon can be encountered. The biggest threat would come from an intrusion into smaller systems near their confluence with mainstem rivers during times with low flows so the concentrated ammonia persists in the environment for a longer time.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for Atlantic sturgeon to have fire retardant applied to them between 9 and 130 times in a single year. However, data for North Carolina is only available for USFS lands in the entire state, not for each forest. Therefore, there is between a 2.88 and 34.5 percent chance an errant application of fire retardant reaches water on one of these two forests.

The median application rate for all North Carolina forests is 47, however those totals are statewide, so it is likely a subset of those numbers would occur on the Croatan National Forest. On Francis Marion National Forest, the median application rate is approximately three per year. If these forests received the median application rate, which is the most likely annual application amount while the peak application from the past 10 years is a better predictor of the peak usage in the next 10 years. Considering the median amounts expected, those 50 applications per year would likely result in a 15% chance of a single intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, Atlantic sturgeon do not reside in every waterway on these two National Forests, instead occupying the mouths of large mainstem systems which would buffer many adverse effects with the large volume of water to dilute the fire retardants. It is possible an errant application that results in an intrusion may be applied to a water body upstream of Atlantic sturgeon habitat, resulting in a minimal effect to the species despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is possible Atlantic sturgeon habitat could receive an intrusion during any given fire season. Because of the volume of water in these locations, any impacts to Atlantic sturgeon would be expected to be sub-lethal and of short duration.

Green Sturgeon

The southern DPS of Green sturgeon is listed as threatened and individual animals as well as critical habitat is located on and downstream of Shasta-Trinity, Rogue, Siskiyou, and Siuslaw National Forests. The spawning population is located in the Sacramento River, but adults and sub-adults utilize habitat along coastal Oregon, Washington, and British Columbia. Occasionally green sturgeon will venture short distances up their non-natal rivers where they may be exposed to fire retardants. During the fire season in the coastal Oregon and Washington as well as in the central valley of California, all life stages of green sturgeon can be encountered. The biggest threat would come from an intrusion into smaller systems near their confluence with mainstem

rivers during times with low flows so the concentrated ammonia persists in the environment for a longer time.

Using the minimum and maximum retardant use years in the dataset to anticipate the conditions likely to be faced in the future, it is possible for forests providing habitat for green sturgeon to have fire retardant applied to them between 8 and 509 times in a single year. Therefore, there is between a 2.56 and 80.91 percent chance an errant application of fire retardant reaches water on one of these four forests.

Rogue/Siskiyou National Forests combined have 14 or fewer applications of fire retardant 60% of the past decade with a median of 12. The Shasta-Trinity National Forest has some years with high applications but 33% of the time the forest receives 10 or fewer applications with a median application rate of 129. Data for the Siuslaw is unavailable in annual numbers and only available as 143 applications over 10 years. The mean and median number of fires on these four forests in the past decade is 156, which translates to a 39.8% chance of an intrusion. Based on the past 10 years of long-term fire retardant application data, it is most likely that one forest may require peak long-term fire retardant application, but adjacent forests often experience less severe fire seasons. Additionally, green sturgeon only reside year round in the Sacramento River, while spending intermittent periods of time in river systems along the Oregon coast. It is possible an errant application that results in an intrusion may be applied to a water body upstream of green sturgeon habitat, resulting in little or no affect to the species or their critical habitat despite it being an intrusion.

The USFS has instituted mitigation measures to (1) increase monitoring of fires when no intrusion event is reported to insure no intrusion occurred, (2) immediately reinstate consultation on a local level when an intrusion occurs, (3) continue monthly compilation of intrusion reports, and (4) adaptively manage fires and fire fighting based on monthly intrusion reports. Given the proposed action and available monitoring information, NMFS believes it is likely green sturgeon and their critical habitat could receive an intrusion during a fire season. Because of the volume of water in these locations, any impacts to green sturgeon would be expected to be sub-lethal and of short duration.

General Assessment of Risks to All Species

The above exposure analysis and risk analysis are a generalized assessment and prediction of annual fire retardant application rates. As was shown, there is considerable variability in the amount of fire retardant applied annually on each forest, ranging from single digits to nearly 1,000 applications per year for a forest. In all cases, the peak fire retardant usage year between 1999 and 2010 exceeded the 99.99% confidence interval around the mean. NMFS assumes the reason for very large peak seasonal application is because fires are very unpredictable and it is impossible to predict when each forest will have peak fire retardant use years.

NMFS used a combination of peak usage, median usage, and minimum usage from the past decade to estimate potential effects to listed species. While predicting which forests are likely to have high fire retardant usage is only generally possible, estimating the intrusion events is even more speculative because in this analysis, we've assumed that each potential future application has an equal chance of entering a stream. Therefore, forests with higher predicted application

rates based on past activity will be predicted to have higher risk of a misapplication. While the assumptions made in this analysis are the most conservative and based on the best available information, some of these assumptions may be flawed or incorrect. For instance, we use the 2008-2010 dataset to calculate the probability of an intrusion event, but the proposed action improves on the previous guidelines and eliminates almost every potential exception, making it less likely retardant will enter water. Likewise, assuming each application has an equal chance of affecting a listed species from an intrusion is incorrect because some forests have more water than others or more habitat for listed species. Also, half of the calculation of probability for the future depends on the range of applications made during each fire season in the past decade. However, some of those fire seasons had very little fire and applied relatively little retardant. The next decade may be different as a pattern of extreme weather may continue in the United States over the next decade making it impossible to predict what is likely to occur.

The dataset of applications to each forest exists for the past 11 years, but the fire return interval for many of these forests ranges from 35 to 100 years, meaning the peak fire retardant usage has probably not been captured for every forest. And if it has been, predicting to see that level of usage again in the next decade is unlikely given the longer fire return intervals that exist in nature. In the exposure analysis, a forest was listed as potentially receiving a fire retardant intrusion that would impact a listed species if that listed species was found within 10 miles of that forest. We used that approach because it is possible to drop retardant along the forest boundary or even adjacent to the forest, leading to an impact to listed species downstream. However, every application of fire retardant on that forest would not be along that boundary, but there is no way to measure that probability.

Based on the general linear trend between 1977 and 2000 (Figure 10), there has been an increase in use of retardants by 16.15 million gallons over 23 years. This amount comes to an annual increase of 702,000 gallons of fire retardant used. The USFS recently stated that in the coming years they anticipate more fires and larger fires across much of the western landscape. As a result, NMFS anticipates that, as in the past, the usage of fire retardants will increase over the coming years.

In order to estimate the number of listed species likely to be affected by the USFS fire retardant program, NMFS would need to know where a fire is going to occur in the next season or decade or century; whether retardant would need to be used near the edge of buffers, creating the potential for a misapplication; where the misapplication was going to occur; the environmental conditions (temperature, pH, smoke, ash, DO, water volume, flow rate, stream width and depth, etc.) at that location; which life stages of which listed species would be present at the time of the misapplication; and the number of listed species present at that time during any given year given the population fluctuations of many of these species in the past 20 years. While the actual number of listed species affected may be unpredictable, the extent of habitat affected has been identified in the literature for several streams (Van Meter and Hardy 1975, Norris and Webb 1989, Labat 2007). Every citation that reports the downstream effects of fire retardant intrusions into water also notes that the extent of that intrusion depends primarily on the volume of retardant to enter the stream, the flow rate of the stream, and the volume of the stream. Since we cannot predict this, NMFS assumes the extent of take will correlate with the maximum reported zone of downstream effects.

Considering the unpredictable nature of fire retardants, which have an isolated area of impacts immediately downstream of the intrusion event, it would not be protective of listed species to attempt to analyze the impacts of multiple misapplications. Once an area has been impacted by fire retardant misapplication, there are local effects that must be analyzed immediately, which alter the environmental baseline of this Opinion. Rather than reinitiating this a national programmatic because of an isolated event altering the baseline at a local level, the local or regional staff of USFS and NMFS (depending on the range of the species affected) need to be prepared to initiate a step-down consultation to determine the reason for the intrusion, the new local baseline for the species in question, what can be done to prevent future incidents, whether more stringent protections are needed locally, whether there are mitigative measures the local USFS office could take to ameliorate some of the negative impacts of retardants, and then prepare a new Opinion based on the new conditions that species is facing, adaptive management strategies implemented by the USFS, and the likely exposure and risk future intrusions may pose to that species.

Indirect Effects

Fire retardants have negative indirect impacts to many resources on which ESA-listed resources depend. Many rivers along the West Coast are nutrient deficient whereas many rivers along the East Coast are impaired according to the EPA 303(d) water quality standards by excess nutrients. The fire retardants are nitrogen based and when they hit the water and break down, the retardants eventually become nitrogenous nutrients. Eutrophication can be a significant problem in many slack water areas along the course of a river. In rivers with large agricultural or urban development, nutrients are usually already a water quality problem, without having more nutrients accidentally introduced. The most likely places that are impacted by eutrophication and the biotic organisms that grow in poor water quality are reservoirs, estuaries, and bays. Eutrophication in those places impairs light penetration, submerged vegetation, and nursery habitat. The application of nutrients into these waters could lead to shifts in phytoplankton composition or provide a competitive advantage to organisms that are not naturally suited for the oligotrophic waters of the West Coast. The additional application of nutrients into rivers along the East Coast, as well as reservoirs and dams in the Pacific Northwest, could further degrade water quality and also lead to eutrophication. Increased nutrients can also impacts food resources, such as macroinvertebrate abundance and macroinvertebrate species composition, both in the area the retardant hits and downstream all the way to the ocean.

When fire retardant hits the water and ammonia concentrations increase quickly, macroinvertebrates, the main food source for juvenile salmonids and shortnose sturgeon, exhibit highly variable responses. Macroinvertebrates that react similarly to small amounts of ammonia have up to a four-fold difference in their resistance to acute toxicity (Williams *et al.* 1986). Adams and Simmons (1999) reported that mayflies and stoneflies in Australia were not affected by Phos Chek D75-F. McDonald *et al.* (1997) reported though, that D75-F 96 hr LC50 for *Hyalella azteca*, a very tolerant species of macroinvertebrate, was between 53 and 394 mg/l depending on pH, which would be lethal for up to 6.2 miles downstream when only a partial load hits the water, which is more lethal than for many species of fish. Almost all macroinvertebrates will drift in the presence of elevated ammonia, but even then, many die. It can take years (Minshall *et al.* 1997) for macroinvertebrates to re-colonize a stretch of stream that is negatively

impacted during a wildfire. As long as there is depressed individual and species abundance, fish that depend on those macroinvertebrates as a food source will not re-colonize.

Critical Habitat

Our critical habitat analysis determines whether the proposed action will destroy or adversely modify critical habitat for ESA-listed species by examining any change in the conservation value of the essential features of critical habitat. This analysis does not rely on the regulatory definition of ‘adverse modification or destruction’ of critical habitat. Instead, this analysis focuses on statutory provisions of the ESA, including those in Section 3 that define “critical habitat” and “conservation,” those in Section 4 that describe the designation process, and those in Section 7 setting forth the substantive protections and procedural aspects of consultation.

NMFS has not designated critical habitat for shortnose or Atlantic sturgeon. Critical habitat is designated for all listed Pacific salmon and steelhead except for LCR coho salmon and Puget Sound steelhead, and on all National Forest lands considered in this Opinion. The PCEs for each listed species, where they have been designated, are described in the *Status of Listed Resources* section of this Opinion. The PCEs identify those physical or biological features that are essential to the conservation of the species that may require special management considerations or protections. The species addressed in this Opinion have similar life history characteristics and therefore, many of the same PCEs.

The PCEs for green sturgeon focus on life history stages, rearing, migration, and spawning and contain physical and biological features essential to the conservation of the DPS. The PCEs for green sturgeon are:

1. abundant food resources for all larval, juvenile, sub-adult, and adult life stages;
2. water flow necessary for normal behavior, growth, and survival of all life stages;
3. water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages;
4. a migratory pathway necessary for the safe and timely passage of Southern DPS fish within riverine habitats and between riverine and estuarine habitats;
5. water depth in holding pools over five meters deep for both upstream and downstream holding of adult or sub-adult fish, with adequate water quality and flow to maintain the physiological needs of the holding adult or sub-adult fish; and
6. sediment quality (*i.e.*, chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.

These PCEs for salmonids and Pacific eulachon include sites essential to support one or more life stages (sites for spawning, rearing, migration and foraging) and contain physical or biological features essential to the conservation of the ESU/DPS, such as:

1. freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
2. freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks;

3. freshwater migration corridors free of obstruction, along with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
4. estuarine areas free of obstruction, along with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation;
5. nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and
6. offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

At the time that each habitat area was designated as critical habitat, that area contained one or more PCEs within the acceptable range of values required to support the biological processes for which the species use that habitat. Based on the preceding analysis, the proposed action will affect freshwater rearing, spawning, migration and foraging areas, and the PCEs that these habitat types provide listed fish. Of particular concern is the indirect affect the USFS' aerial application of the long-term fire retardants will have on the food resources and water quality in these areas.

Any exposure of fire retardant directly to waters or the riparian zone on these USFS lands will have an effect on Pacific salmon or steelhead critical habitat. As noted in the direct effects section above, there would be a lethal spike in ammonia concentration in the river that could persist at significantly elevated levels for days and cover over six miles of a river with listed fish. Ammonia levels could remain elevated for over a year. And for an unidentified period, as the ammonia level is returning to normal background levels, there could be sub-lethal effects to fish and food resources utilizing the critical habitat (Norris *et al.* 1978, Deiterich *et al.* 2010). Studies analyzing potential sub-lethal effects to growth, fecundity, equilibrium, and increased vulnerability to predation have not been conducted.

Norris *et al.* (1978) also reported increased runoff can be expected following a fire. Any soil that contains retardant would cause smaller spikes in ammonia concentration with every rainfall that causes runoff. The impacts to critical habitat could be fairly long-lived, remaining at an elevated detectable level for the duration of a 15 month study, but the study ended before ammonia concentrations in the system returned to the pre-misapplication rate. The extent of downstream impairment is also unknown, as only areas with lethal concentrations have been measured, neglecting areas with sub-lethal levels of ammonia. Nevertheless, under the proposed action, it is likely there will be reductions in water quality, reducing areas available for spawning, rearing, migrating, and foraging for California coastal Chinook salmon, Central Valley spring-run Chinook salmon, LCR Chinook salmon, Puget Sound Chinook salmon, Snake River fall-run Chinook salmon, Snake River spring/summer-run Chinook salmon, UCR spring-run Chinook salmon, Upper Willamette River Chinook salmon, Hood Canal summer run chum salmon,

Southern Oregon Northern Coastal California coho salmon, Oregon Coast coho salmon, Snake River sockeye salmon, California Central Valley steelhead, LCR steelhead, MCR steelhead, Northern California steelhead, Snake River Basin steelhead, SCCC steelhead, Southern California steelhead, UCR steelhead, and Upper Willamette River steelhead as well as green sturgeon and Pacific eulachon smelt. The precise change in the conservation value of critical habitat within the ESU/DPS from the proposed action cannot be quantified and will likely vary according to the specific designated critical habitat. However, based on the effects described above, it is reasonably likely that the proposed action will have at least a six mile long, local, negative reduction in that conservation value of the critical habitat designated for these species.

NMFS 2008 Opinion concluded that the USFS aerially applied long-term fire retardant program would likely adversely modify these species' critical habitats because there was no mitigation in place to prevent multiple intrusion events and no monitoring in place to determine whether an intrusion had even occurred. The USFS has addressed these concerns by establishing a thorough monitoring program and by proposing a step-down consultation with a local NMFS office in the event an intrusion occurs. At that time, and based on the actual effects of the intrusion, NMFS and the USFS will determine whether any area closures are appropriate and over what time frame those areas should remain closed to long-term fire retardant applications.

Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

There are several state, tribal, and local actions that will continue into the future. This consultation assesses the USFS long-term fire retardant program; however, fires are fought using long-term fire retardants by states, particularly the state of California, tribes, and local townships. At this time, while those activities likely take listed species, without a federal nexus, ESA section 7 consultation is inappropriate. Therefore those agencies should consult with NMFS to get a Habitat Conservation Plan and an Incidental Take Permit. Additionally, many fires that occur in wilderness areas or locations where they are not a threat to human populations are allowed to burn without using fire retardants. As the population continues to grow, particularly throughout California and along the Pacific Coast, the public demand for fighting fires with long-term fire retardants will increase. While these state, tribal, and local agencies currently use approximately half of the long-term fire retardants each year in the United States, it is reasonable to assume their usage will increase with that population growth.

At the large spatial scale of this consultation, we could not identify specific future State, tribal, local, or private actions that would be relevant at this scope. NMFS conducted electronic searches of business journals, trade journals, and newspapers using *First Search*, Google, and other electronic search engines. Those searches produced no evidence of future private action in the action area that would not require Federal authorization or funding and is reasonably certain to occur. Therefore, we are not aware of any actions besides fire fighting that are likely to occur in the action area during the foreseeable future.

Conclusion

After reviewing the current status of CC Chinook salmon, CV Chinook salmon, LCR Chinook salmon, Puget Sound Chinook salmon, Snake River fall-run Chinook salmon, UCR spring-run Chinook salmon, Upper Willamette River Chinook salmon, Puget Sound Chinook salmon, Hood Canal summer run chum salmon, LCR coho salmon, Oregon Coast coho salmon, SONCC coho salmon, Snake River sockeye salmon, California Central Valley steelhead, LCR steelhead, MCR steelhead, Puget Sound steelhead, Snake River Basin steelhead, South Central California coast steelhead, UCR steelhead, Upper Willamette River steelhead, Northern California steelhead, Southern California steelhead, green sturgeon, Atlantic sturgeon, and shortnose sturgeon, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' Opinion that the project, as proposed, is not likely to jeopardize the continued existence of these endangered or threatened species.

After reviewing the current status of Columbia River chum salmon or Pacific eulachon, the proposed action, the environmental baseline, the action area, and cumulative effects, it is NMFS' biological opinion that the project, as proposed, may affect but is not likely to adversely affect these threatened species.

After reviewing the current status of CC Chinook salmon, CV Chinook salmon, LCR Chinook salmon, Puget Sound Chinook salmon, Snake River fall-run Chinook salmon, Snake River spring/summer-run Chinook salmon, UCR spring-run Chinook salmon, Upper Willamette River Chinook salmon, Columbia River chum salmon, Hood Canal summer-run chum salmon, Oregon Coast coho salmon, SONCC coho salmon, Snake River sockeye salmon, CCV steelhead, LCR steelhead, MCR steelhead, Northern California steelhead, Snake River Basin steelhead, South Central California coast steelhead, Southern California steelhead, UCR steelhead, Upper Willamette River steelhead, Pacific eulachon, and green sturgeon, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' Opinion that the project, as proposed, is not likely to result in the destruction or adverse modification of critical habitat of these endangered and threatened species.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the USFWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act

provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Amount or Extent of Take

For this proposed action, take is authorized for each species identified in this section; therefore, for species with habitat on multiple forests, the USFS is expected to coordinate and communicate across forests and with NMFS to insure the amount of take authorized is not exceeded. As was explained in the *General Assessment of Risks to All Species*, there is considerable uncertainty as to the volume of intruding fire retardant on each misapplication, the location within a stream, the width and depth of the stream it enters, the flow velocity, environmental conditions at the time of the misapplication, local habitat quality, densities of fish at the intrusion site, etc. and therefore it is not possible to predict a number of listed fish affected by a misapplication in each DPS or ESU.

It is however, possible to predict a worst case scenario extent of intrusion. Simulations run by Norris and Webb (1989) showed ammonia concentrations could remain at lethal levels between 0 and 6.2 miles downstream, depending on stream characteristics and the size of the retardant load. Van Meter and Hardy (1975) also found that concentrations of retardant high enough to kill 10% of the fish population were measurable over 4 miles downstream. Fire retardants used today are less toxic than those tested during the 1970s and 1980s, however, the immediate spike in ammonia in the first 24 hours after an intrusion is the likely cause of mortality. The spike in total ammonia and un-ionized ammonia caused by modern fire retardant chemicals is likely similar or slightly less toxic compared to those tested previously. NMFS believes the maximum impact, given a small stream with limited flows or tributaries, could result in 6.2 miles of lethal impacts with surviving fish enduring sub-lethal impacts and increased mortality upon entering sea water.

CC Chinook salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. No more than 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

CV Chinook salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. No more than 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

LCR Chinook salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. No more than 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

Snake River fall-run Chinook salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. No more than 6.2 miles of sub-lethal effects as well as temporary impairment of critical habitat would be expected.

Snake River spring/summer-run Chinook salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. No more than 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

UCR Chinook salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. No more than 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

Upper Willamette River Chinook salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. No more than 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

Puget Sound Chinook salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

Columbia River chum salmon critical habitat is likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of temporary impairment of critical habitat would be expected.

Hood Canal summer-run chum salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of sub-lethal effects as well as minor, temporary impairment of critical habitat would be expected.

Lower Columbia River coho salmon are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects would be expected.

SONCC coho salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

Oregon Coast coho salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

Snake River sockeye salmon and their critical habitat are likely to be exposed to one intrusion event during the life of this project. No more than 6.2 miles of sub-lethal effects as well as temporary impairment of critical habitat would be expected.

CCV steelhead and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

LCR steelhead and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

MCR steelhead and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

Northern California steelhead and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

Snake River Basin steelhead and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

SCCC steelhead and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

Southern California steelhead and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

UCR steelhead and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

Upper Willamette River steelhead and their critical habitat are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects as well as temporary impairment of critical habitat would be expected.

Puget Sound steelhead are likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of direct lethal effects would be expected.

Pacific eulachon critical habitat is likely to be exposed to one intrusion event during the life of this project. Approximately 6.2 miles of temporary impairment of critical habitat would be expected.

Shortnose sturgeon are likely to be exposed to one intrusion event during the life of this project. Because they occupy large, mainstem habitats, approximately 6.2 miles of sub-lethal effects would be expected.

Atlantic sturgeon are likely to be exposed to one intrusion event during the life of this project. Because they occupy the mouths of large, mainstem habitats, approximately 6.2 miles of sub-lethal effects would be expected.

Green sturgeon are likely to be exposed to one intrusion event during the life of this project. Because they occupy large, mainstem habitats, approximately 6.2 miles of sub-lethal effects would be expected.

Reasonable and Prudent Measures

Reasonable and Prudent Measures (RPMs) are non-discretionary measures to minimize take that may or may not already be part of the description of the proposed action. They must be implemented as binding conditions for the exemption in section 7(o)(2) to apply. The USFS has the continuing duty to regulate the activities covered in this incidental take statement. If the USFS fails to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to this document, or fails to retain the oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. Activities which do not comply with all relevant RPMs will require further consultation.

NMFS believes that the following RPMs are necessary and appropriate to minimize take of listed fish resulting from implementation of this action.

The USFS shall:

1. Monitor and report aerially applied long-term fire retardant application on each forest identified in this Opinion.
2. Contact NMFS in the event of an intrusion event on any of the National Forests identified in this Opinion.

Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the action must be implemented in compliance with the following terms and conditions, which implement the RPMs described above for each category of activity. These terms and conditions are non-discretionary.

1. To implement RPM 1 (monitoring and reporting):
 - a. The Washington (DC) Office of the USFS must compile records of the annual number of fire retardant applications on each forest identified in this Opinion.
 - b. Each forest identified in this Opinion must record and report annually to NMFS HQ (address below) the number of long-term fire retardant applications and whether the application entered the buffer or intruded into water.
2. To implement RPM 2 (consultation):
 - a. The USFS must contact NMFS HQ in the event of an intrusion and initiate consultation with the local NMFS office in the area of the intrusion.

- b. The USFS must coordinate with the local NMFS office to identify which species and critical habitat may have been present at the intrusion site and/or immediately downstream.
- c. The USFS must notify all National Forests with that species or that species' critical habitat of the intrusion and the consultation that has resulted.
- d. The USFS must reinitiate consultation with the appropriate local NMFS office and based on the new baseline following the intrusion, obtain a new Opinion analyzing the risk of future intrusions to the affected species and identifying any local mitigation measures that should be implemented.
- e. The USFS must supply a copy of the final Opinion including appropriate local mitigation measures from the local NMFS office in an annual report to Office of Protected Resources, NMFS HQ, 1315 East West Highway, Silver Spring, Maryland, 20910.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. *Accuracy of drops.* Employ available flight navigation and guidance technologies that reduce the exposure of fish to fire retardants by increasing the precision and accuracy of retardant drops and the ability of pilots to avoid misapplication of fire retardants in streams. In order to determine this, the USFS should record the intended proximity of the application to water, whether the application was on target,
2. *Effectiveness of fire retardant.* To determine the effectiveness of fire retardants, the USFS should record the environmental conditions when long term fire retardants are determined to be necessary, the size of the fire at the time of application, and the size of the fire when contained.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the USFS should notify NMFS of any conservation recommendations they implement in their final action.

REINITIATION NOTICE

This concludes formal consultation on the USFS' National Fire Retardant Programmatic Consultation. As provided in 50 CFR '402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or

is authorized by law) and if: (1) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (2) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (3) a new species is listed or critical habitat designated that may be affected by the action. For each species, one misapplication is authorized at the programmatic level. As proposed by the USFS in their action, an intrusion event will initiate a consultation with the local NMFS office responsible for the species affected. If it is found that Pacific eulachon migration overlaps with fire season or that Columbia River chum salmon are adversely affected by long-term fire retardant applications, this programmatic consultation should be reinitiated. In the event USFS would authorize, fund, or carry out fire retardant drops or other fire suppression activities that may affect resources in a manner or to an extent not considered in this Opinion, USFS must reinitiate consultation to compensate for information that was not available for consideration during this consultation.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The MSA requires Federal agencies to consult with the Secretary of Commerce, through NMFS, with respect to “any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any EFH identified under this Act.” 16 U.S.C. § 1855(b)(2). When a Federal action agency determines that an action may adversely affect EFH, the Federal action agency must initiate consultation with NMFS (16 U.S.C. §1855(b)(2)). In order to carry out this EFH consultation, NMFS regulations at 50 C.F.R. § 600.920(e)(3) call for the Federal action agency to submit to NMFS an EFH assessment containing “a description of the action; an analysis of the potential adverse effects of the action on EFH and the managed species; the Federal agency’s conclusions regarding the effects of the action on EFH; and proposed mitigation, if applicable.” NMFS may request the Federal action agency include additional information in the EFH assessment such as results of on-site inspections, views of recognized experts, a review of pertinent literature, an analysis of alternatives and any other relevant information (50 C.F.R. § 600.920(e)(4)). Depending on the degree and type of habitat impact, compensatory mitigation may be necessary to offset permanent and temporary effects of the project. Should the project result in substantial adverse impacts to EFH, an expanded EFH consultation may be necessary (50 C.F.R. § 600.920(i)).

Promulgating regulations and implementing this proposed action may result in future, site-specific project applications that, if authorized by USFS, could have impacts on EFH and thereby trigger the requirements of the MSA. The analysis provided in the USFS EIS, future EAs, and this Opinion will be used to guide the development of any required EFH assessments for future EFH consultations on site-specific proposals. For any future, site-specific proposal requiring an authorization from USFS, USFS will make a determination on whether the proposal may adversely affect any EFH in the project area. If a proposal may adversely affect EFH, USFS will initiate an EFH consultation by providing an EFH assessment to the appropriate NMFS regional office.

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