CARBOFURAN

Analysis of Risks
to
Endangered and Threatened Salmon and Steelhead

December 1, 2004

Genifer Maree Tarkowski

Environmental Field Branch
Office of Pesticide Programs

Summary

Carbofuran is an n-methyl carbamate used as an insecticide and nematicide. It is formulated into flowable (liquid and wettable powder) and granular formulations for use on a wide variety of agricultural crops and for a number of non-agricultural uses. There are no homeowner uses of carbofuran. The majority of carbofuran usage is applied in the flowable form.

This assessment applies the preliminary findings of the Office of Pesticide Programs's Draft Environmental Risk Assessment developed for non-target fish and wildlife as part of the reregistration process to determine the potential risks to the 26 listed threatened and endangered Evolutionarily Significant Units (ESUs) of Pacific salmon and steelhead. Carbofuran use in the Pacific-Northwest and California will have no effect on 3 Pacific salmon and steelhead ESUs. The use of carbofuran may affect but is not likely to adversely affect 18 ESUs when used according to labeled application directions and may affect 3 ESU in this assessment.

Introduction

This analysis was prepared by the U.S. Environmental Protection Agency (EPA) Office of Pesticide Programs (OPP) to evaluate the risks of carbofuran to threatened and endangered Pacific salmon and steelhead.

The general aquatic risk assessment presented in the preliminary "Carbofuran Deterministic Environmental Risk Assessment" (appendix to the probabilistic assessment: "Reregistration Eligibility Science Chapter for Carbofuran") was the starting basis for this analysis. This preliminary document is presently being refined to be consistent with OPP's current guidance for ecological risk assessment as contained in the Overview Document (Overview of the Ecological Risk Assessment Process in the Office of Pesticide Program, U.S. Environmental Protection Agency - Endangered and Threatened Species Effects Determinations: January 23, 2004 at www.epa.gov/espp/consultation/ecorisk-overview.pdf). Subsequent, to these refinements, the document will be subjected to error correction and public comment through the standard reregistration review processes. Should our refinements or the error correction and public review result in changes to the risk assessment, those changes will be discussed with NOAA Fisheries in the context of our consultation with them on this effects determination.

Problem Formulation

The purpose of this analysis is to determine whether the registration of carbofuran as a insecticide and netamaticide may affect threatened and endangered (T&E or listed) Pacific anadromous salmon and steelhead and their designated critical habitat.

Scope

Although this analysis is specific to listed Pacific anadromous salmon and steelhead and the watersheads in which they occur, it is acknowledged that carbofuran is registered for uses that may occur outside their geographic scope and that additional analyses may be required to address other threatened and endangered species in the Pacific states as well as across the United States.

Contents

Attachments:

A. Nationally Registered Labels (section 3)
B. State and Local Needs Labels (section 24c)
C. Quatitative Usage Assessment (QUA) for Carbofuran (2002)
D. United States Geological Survey Usage Map of Carbofuran (1997)
E. Washington State Carbofuran Use Information (2004)
F. Carbofuran Use Closure Memo (2004)
G. Estimated Environmental Concentrations (EECs) for Selected Carbofuran Use Scenarios (2004)
H. Actual Carbofuran Usage in California Counties
I. Actual Carbofuran Usage in Pacific-Northwest States

1. Background

Under section 7 of the Endangered Species Act, the Office of Pesticide Programs (OPP) of the U. S. Environmental Protection Agency (EPA) is required to consult on actions that may affect Federally listed endangered or threatened species or that may adversely modify designated critical habitat. Situations where a pesticide may affect a fish, such as any of the salmonid species listed by the National Marine Fisheries Service (NMFS), include either direct or indirect effects on the fish. Direct effects result from exposure to a pesticide at levels that may cause harm.

Acute Toxicity - Relevant acute data are derived from standardized toxicity tests with lethality as the primary endpoint. These tests are conducted with what is generally accepted as the most sensitive life stage of fish, i.e., very young fish from 0.5-5 grams in weight, and with species that are usually among the most sensitive. These tests for pesticide registration include analysis of observable sublethal effects as well. The intent of acute tests is to statistically derive a median effect level; typically the effect is lethality in fish (LC50) or immobility in aquatic invertebrates (EC50). Typically, a standard fish acute test will include concentrations that cause no mortality, and often no observable sublethal effects, as well as concentrations that would cause 100% mortality. By looking at the effects at various test concentrations, a dose-response curve can be derived, and one can statistically predict the effects likely to occur at various pesticide concentrations; a well done test can even be extrapolated, with caution, to concentrations below those tested (or above the test concentrations if the highest concentration did not produce 100% mortality).

OPP typically uses qualitative descriptors to describe different levels of acute toxicity, the most likely kind of effect of modern pesticides (Table 1). These are widely used for comparative purposes, but must be associated with exposure before any conclusions can be drawn with respect to risk. Pesticides that are considered highly toxic or very highly toxic are required to have a label statement indicating that level of toxicity. The FIFRA regulations [40CFR158.490(a)] do not require calculating a specific LC50 or EC50 for pesticides that are practically non-toxic; the LC50 or EC50 would simply be expressed as >100 ppm. When no lethal or sublethal effects are observed at 100 ppm, OPP considers the pesticide will have "no effect" on the species.

Table 1. Qualitative descriptors for categories of fish and aquatic invertebrate toxicity (Zucker, 1985)

LC50 or EC50	Category description
< 0.1 ppm	Very highly toxic
0.1- 1 ppm	Highly toxic
>1 < 10 ppm	Moderately toxic
> 10 < 100 ppm	Slightly toxic
> 100 ppm	Practically non-toxic

Comparative toxicology has demonstrated that various species of scaled fish generally have equivalent sensitivity, within an order of magnitude, to other species of scaled fish tested under the same conditions. Exceptions are known to occur for only an occasional pesticide, as based on the several dozen fish species that have been frequently tested. Sappington et al. (2001), Beyers et al. (1994) and Dwyer et al. (1999), among others, have shown that endangered and threatened fish tested to date are similarly sensitive, on an acute basis, to a variety of pesticides and other chemicals as are their non-endangered counterparts.

Chronic Toxicity - OPP evaluates the potential chronic effects of a pesticide on the basis of several types of tests. These tests are often required for registration, but not always. If a pesticide has essentially no acute toxicity at relevant concentrations, or if it degrades very rapidly in water, or if the nature of the use is such that the pesticide will not reach water, then chronic fish tests may not be required [40CFR158.490]. Chronic fish tests primarily evaluate the potential for reproductive effects and effects on the offspring. Other observed sublethal effects are also required to be reported. An abbreviated chronic test, the fish early-life stage test, is usually the first chronic test conducted and will indicate the likelihood of reproductive or chronic effects at relevant concentrations. If such effects are found, then a full fish life-cycle test will be conducted. If the nature of the chemical is such that reproductive effects are expected, the abbreviated test may be skipped in favor of the full life-cycle test. These chronic tests are designed to determine a “no observable effect level” (NOEL) and a “lowest observable effect level” (LOEL). A chronic risk requires not only chronic toxicity, but also chronic exposure, which can result from a chemical being persistent and resident in an environment (e.g., a pond) for a chronic period of time or from repeated applications that transport into any environment such that exposure would be considered “chronic”.

As with comparative toxicology efforts relative to sensitivity for acute effects, EPA, in conjunction with the U. S. Geological Survey, has a current effort to assess the comparative toxicology for chronic effects also. Preliminary information indicates, as with the acute data, that endangered and threatened fish are again of similar sensitivity to similar non-endangered species.

Metabolites and Degradates - Information must be reported to OPP regarding any pesticide metabolites or degradates that may pose a toxicological risk or that may persist in the environment [40CFR159.179]. Toxicity and/or persistence test data on such compounds may be required if, during the risk assessment, the nature of the metabolite or degradate and the amount that may occur in the environment raises a concern. If actual data or structure-activity analyses are not available, the requirement for testing is based upon best professional judgement.

Inert Ingredients - OPP does take into account the potential effects of what used to be termed "inert" ingredients, but which are beginning to be referred to as "other ingredients". OPP has classified these ingredients into several categories. A few of these, such as nonylphenol, can no longer be used without including them on the label with a specific statement indicating the potential toxicity. Based upon our internal databases, there are no products in which nonylphenol is now an ingredient. Many others, including such ingredients as clay, soybean oil, many polymers, and chlorophyll, have been evaluated through structure-activity analysis or data and determined to be of minimal or no toxicity. There exist also two additional lists, one for inerts with potential toxicity which are considered a testing priority, and one for inerts unlikely to be toxic, but which cannot yet be said to have negligible toxicity. Any new inert ingredients are required to undergo testing unless it can be demonstrated that testing is unnecessary.

The inerts efforts in OPP are oriented only towards toxicity at the present time, rather than risk. It should be noted, however, that very many of the inerts are in exceedingly small amounts in pesticide products. While some surfactants, solvents, and other ingredients may be present in fairly large amounts in various products, many are present only to a minor extent. These include such things as coloring agents, fragrances, and even the printers ink on water soluble bags of pesticides. Some of these could have moderate toxicity, yet still be of no consequence because of the negligible amounts present in a product. If a product contains inert ingredients in sufficient quantity to be of concern, relative to the toxicity of the active ingredient, OPP attempts to evaluate the potential effects of these inerts through data or structure-activity analysis, where necessary.

For a number of major pesticide products, testing has been conducted on the formulated end-use products that are used by the applicator. The results of fish toxicity tests with formulated products can be compared with the results of tests on the same species with the active ingredient only. A comparison of the results should indicate comparable sensitivity, relative to the percentage of active ingredient in the technical versus formulated product, if there is no extra activity due to the combination of inert ingredients. Note that the "comparable" sensitivity must take into account the natural variation in toxicity tests, which is up to 2-fold for the same species in the same laboratory under the same conditions, and which can be somewhat higher between different laboratories, especially when different stocks of test fish are used.

The comparison of formulated product and technical ingredient test results may not provide specific information on the individual inert ingredients, but rather is like a "black box" which sums up the effects of all ingredients. This approach is more appropriate than testing each individual inert and active ingredient because it incorporates any additivity, antagonism, and synergism effects that may occur and which might not be correctly evaluated from tests on the individual ingredients. We do not have aquatic data on most formulated products, although we often have testing on one or perhaps two formulations of an active ingredient.

Risk - An analysis of toxicity, whether acute or chronic, lethal or sublethal, must be combined with an analysis of how much will be in the water, to determine risks to fish. Risk is a combination of exposure and toxicity. Even a very highly toxic chemical will not pose a risk if there is no exposure, or very minimal exposure relative to the toxicity. OPP uses a variety of chemical fate and transport data to develop "estimated environmental concentrations" (EECs) from a suite of established models. The development of aquatic EECs is a tiered process.

The first tier screening model for EECs is with the GENEEC program, developed within OPP, which uses a generic site (in Yazoo, MS) to stand for any site in the U. S. The site choice was intended to yield a maximum exposure, or "worst-case," scenario applicable nationwide, particularly with respect to runoff. The model is based on a 10 hectare watershed that surrounds a one hectare pond, two meters deep. It is assumed that all of the 10 hectare area is treated with the pesticide and that any runoff would drain into the pond. The model also incorporates spray drift, the amount of which is dependent primarily upon the droplet size of the spray. OPP assumes that if this model indicates no concerns when compared with the appropriate toxicity data, then further analysis is not necessary as there would be no effect on the species.

It should be noted that prior to the development of the GENEEC model in 1995, a much more crude approach was used to determining EECs. Older reviews and Reregistration Eligibility Decisions (REDs) may use this approach, but it was excessively conservative and does not provide a sound basis for modern risk assessments. For the purposes of endangered species consultations, we will attempt to revise this old approach with the GENEEC model, where the old screening level raised risk concerns.

When there is a concern with the comparison of toxicity with the EECs identified in GENEEC model, a more sophisticated PRZM-EXAMS model is run to refine the EECs if a suitable scenario has been developed and validated. The PRZM-EXAMS model was developed with widespread collaboration and review by chemical fate and transport experts, soil scientists, and agronomists throughout academia, government, and industry, where it is in common use. As with the GENEEC model, the basic model remains as a 10 hectare field surrounding and draining into a 1 hectare pond. Crop scenarios have been developed by OPP for specific sites, and the model uses site-specific data on soils, climate (especially precipitation), and the crop or site. Typically, site-scenarios are developed to provide for a worst-case analysis for a particular crop in a particular geographic region. The development of site scenarios is very time consuming; scenarios have not yet been developed for a number of crops and locations. OPP attempts to match the crop(s) under consideration with the most appropriate scenario. For some of the older OPP analyses, a very limited number of scenarios were available. As more scenarios become available and are geographically appropriate to selected T&E species, older models used in previous analyses may be updated.

Finally, the applicability of the overall EEC scenario, i.e., the 10 hectare watershed draining into a one hectare farm pond, may not be appropriate for a number of T&E species living in rivers or lakes. This scenario is intended to provide a "worst-case" assessment of EECs, but very many T&E fish do not live in ponds, and very many T&E fish do not have all of the habitat surrounding their environment treated with a pesticide. OPP does believe that the EECs from the farm pond model do represent first order streams, such as those in headwaters areas (Effland, et al. 1999). In many agricultural areas, those first order streams may be upstream from pesticide use, but in other areas, or for some non-agricultural uses such as forestry, the first order streams may receive pesticide runoff and drift. However, larger streams and lakes will very likely have lower, often considerably lower, concentrations of pesticides due to more dilution by the receiving waters. In addition, where persistence is a factor, streams will tend to carry pesticides away from where they enter into the streams, and the models do not allow for this. The variables in size of streams, rivers, and lakes, along with flow rates in the lentil waters and seasonal variation, are large enough to preclude the development of applicable models to represent the diversity of T&E species' habitats. We can simply qualitatively note that the farm pond model is expected to overestimate EECs in larger bodies of water.

Indirect Effects - We also attempt to protect listed species from indirect effects of pesticides. We note that there is often not a clear distinction between indirect effects on a listed species and adverse modification of critical habitat (discussed below). By considering indirect effects first, we can provide appropriate protection to listed species even where critical habitat has not been designated. In the case of fish, the indirect concerns are routinely assessed for food and cover.

The primary indirect effect of concern would be for the food source for listed fish. These are best represented by potential effects on aquatic invertebrates, although aquatic plants or plankton may be relevant food sources for some fish species. However, it is not necessary to protect individual organisms that serve as food for listed fish. Thus, our goal is to ensure that pesticides will not impair populations of these aquatic arthropods. In some cases, listed fish may feed on other fish. Because our criteria for protecting the listed fish species is based upon the most sensitive species of fish tested, then by protecting the listed fish species, we are also protecting the species used as prey.

In general, but with some exceptions, pesticides applied in terrestrial environments will not affect the plant material in the water that provides aquatic cover for listed fish. Application rates for herbicides are intended to be efficacious, but are not intended to be excessive. Because only a portion of the effective application rate of an herbicide applied to land will reach water through runoff or drift, the amount is very likely to be below effect levels for aquatic plants. Some of the applied herbicides will degrade through photolysis, hydrolysis, or other processes. In addition, terrestrial herbicide applications are efficacious in part, due to the fact that the product will tend to stay in contact with the foliage or the roots and/or germinating plant parts, when soil applied. With aquatic exposures resulting from terrestrial applications, the pesticide is not placed in immediate contact with the aquatic plant, but rather reaches the plant indirectly after entering the water and being diluted. Aquatic exposure is likely to be transient in flowing waters. However, because of the exceptions where terrestrially applied herbicides could have effects on aquatic plants, OPP does evaluate the sensitivity of aquatic macrophytes to these herbicides to determine if populations of aquatic macrophytes that would serve as cover for T&E fish would be affected.

For most pesticides applied to terrestrial environment, the effects in water, even lentil water, will be relatively transient. Therefore, it is only with very persistent pesticides that any effects would be expected to last into the year following their application. As a result, and excepting those very persistent pesticides, we would not expect that pesticidal modification of the food and cover aspects of critical habitat would be adverse beyond the year of application. Therefore, if a listed salmon or steelhead is not present during the year of application, there would be no concern. If the listed fish is present during the year of application, the effects on food and cover are considered as indirect effects on the fish, rather than as adverse modification of critical habitat.

Designated Critical Habitat - OPP is also required to consult if a pesticide may adversely modify designated critical habitat. In addition to the indirect effects on the fish, we consider that the use of pesticides on land could have such an effect on the critical habitat of aquatic species in a few circumstances. For example, use of herbicides in riparian areas could affect riparian vegetation, especially woody riparian vegetation, which possibly could be an indirect effect on a listed fish. However, there are very few pesticides that are registered for use on riparian vegetation, and the specific uses that may be of concern have to be analyzed on a pesticide by pesticide basis. In considering the general effects that could occur and that could be a problem for listed salmonids, the primary concern would be for the destruction of vegetation near the stream, particularly vegetation that provides cover or temperature control, or that contributes woody debris to the aquatic environment. Destruction of low growing herbaceous material would be a concern if that destruction resulted in excessive sediment loads getting into the stream, but such increased sediment loads are insignificant from cultivated fields relative to those resulting from the initial cultivation itself. Increased sediment loads from destruction of vegetation could be a concern in uncultivated areas. Any increased pesticide load as a result of destruction of terrestrial herbaceous vegetation would be considered a direct effect and would be addressed through the modeling of estimated environmental concentrations. Such modeling can and does take into account the presence and nature of riparian vegetation on pesticide transport to a body of water.

Risk Assessment Processes - All of our risk assessment procedures, toxicity test methods, and EEC models have been peer-reviewed by OPP's Science Advisory Panel. The data from toxicity tests and environmental fate and transport studies undergo a stringent review and validation process in accordance with "Standard Evaluation Procedures" published for each type of test. In addition, all test data on toxicity or environmental fate and transport are conducted in accordance with Good Laboratory Practice (GLP) regulations (40 CFR Part 160) at least since the GLPs were promulgated in 1989.

The risk assessment process is described in "Hazard Evaluation Division - Standard

Evaluation Procedure - Ecological Risk Assessment" by Urban and Cook (1986) (termed Ecological Risk Assessment SEP below), which has been separately provided to National Marine Fisheries Service staff. Although certain aspects and procedures have been updated throughout the years, the basic process and criteria still apply. In a very brief summary: the toxicity information for various taxonomic groups of species is quantitatively compared with the potential exposure information from the different uses and application rates and methods. A risk quotient of toxicity divided by exposure is developed and compared with criteria of concern. The criteria of concern presented by Urban and Cook (1986) are presented in Table 2.

Table 2. Risk quotient criteria for direct and indirect effects on T&E fish

Test data	Risk quotient	Presumption
Acute LC_{50}	>0.5	Potentially high acute risk
Acute LC_{50}	>0.1	Risk that may be mitigated through restricted use classification
Acute LC_{50}	>0.05	Endangered species may be affected acutely, including sublethal effects
Chronic NOEC	>1	Chronic risk; endangered species may be affected chronically, including reproduction and effects on progeny
Acute invertebrate LC_{50}[a]	>0.5	May be indirect effects on T&E fish through food supply reduction
Aquatic plant acute EC_{50}[a]	>1[b]	May be indirect effects on aquatic vegetative cover for T&E fish

a. Indirect effects criteria for T&E species are not in Urban and Cook (1986); they were developed subsequently.
b. This criterion has been changed from our earlier requests. The basis is to bring the endangered species criterion for indirect effects on aquatic plant populations in line with EFED's concern levels for these populations.

The Ecological Risk Assessment SEP (pages 2-6) discusses the quantitative estimates of how the acute toxicity data, in combination with the slope of the dose-response curve, can be used to predict the percentage mortality that would occur at the various risk quotients. The discussion indicates that using a "safety factor" of 10, as applies for restricted use classification, one individual in 30,000,000 exposed to the concentration would be likely to die. Using a "safety factor" of 20, as applies to aquatic T&E species, would exponentially increase the margin of safety. It has been calculated by one pesticide registrant (without sufficient information for OPP to validate that number), that the probability of mortality occurring when the LC50 is 1/20th of the EEC is 2.39×10^{-9}, or less than one individual in ten billion. It should be noted that the discussion (originally part of the 1975 regulations for FIFRA) is based upon slopes of primarily organochlorine pesticides, stated to be 4.5 probits per log cycle at that time. As organochlorine pesticides were phased out, OPP undertook an analysis of more current pesticides based on data reported by Johnson and Finley (1980), and determined that the "typical" slope for aquatic toxicity tests for the "more current" pesticides was 9.95. Because the slopes are based upon logarithmically transformed data, the probability of mortality for a pesticide with a 9.95 slope is again exponentially less than for the originally analyzed slope of 4.5.

The above discussion focuses on mortality from acute toxicity. OPP is concerned about other direct effects as well. For chronic and reproductive effects, our criteria ensures that the EEC is below the no-observed-effect-level, where the "effects" include any observable sublethal effects. Because our EEC values are based upon "worst-case" chemical fate and transport data and a small farm pond scenario, it is rare that a non-target organism would be exposed to such concentrations over a period of time, especially for fish that live in lakes or in streams (best professional judgement). Thus, there is no additional safety factor used for the no-observed-effect-concentration, in contrast to the acute data where a safety factor is warranted because the endpoints are a median probability rather than no effect.

Sublethal Effects - With respect to sublethal effects, Tucker and Leitzke (1979) did an extensive review of existing ecotoxicological data on pesticides. Among their findings was that sublethal effects as reported in the literature did not occur at concentrations below one-fourth to one-sixth of the lethal concentrations, when taking into account the same percentages or numbers affected, test system, duration, species, and other factors. This was termed the "6x hypothesis". Their review included cholinesterase inhibition, but was largely oriented towards externally observable parameters such as growth, food consumption, behavioral signs of intoxication, avoidance and repellence, and similar parameters. Even reproductive parameters fit into the hypothesis when the duration of the test was considered. This hypothesis supported the use of lethality tests for use in assessing acute ecotoxicological risk, and the lethality tests are well enough established and understood to provide strong statistical confidence, which can not always be achieved with sublethal effects. By providing an appropriate safety factor, the concentrations found in lethality tests can therefore generally be used to protect from sublethal effects. As discussed earlier, the entire focus of the early-life-stage and life-cycle chronic tests is on sublethal effects.

In recent years, Moore and Waring (1996) challenged Atlantic salmon with diazinon and observed effects on olfaction as relates to reproductive physiology and behavior. Their work indicated that diazinon could have sublethal effects of concern for salmon reproduction. However, the nature of their test system, direct exposure of olfactory rosettes, could not be quantitatively related to exposures in the natural environment. Subsequently, Scholz et al. (2000) conducted a non-reproductive behavioral study using whole Chinook salmon in a model stream system that mimicked a natural exposure that is far more relevant to ecological risk assessment than the system used by Moore and Waring (1996). The Scholz et al. (2000) data indicate potential effects of diazinon on Chinook salmon behavior at very low levels, with statistically significant effects at nominal diazinon exposures of 1 ppb, with apparent, but non-significant effects at 0.1 ppb.

It would appear that the Scholz et al (2000) work contradicts the 6x hypothesis for acute effects. The research design, especially the nature and duration of exposure, of the test system used by Scholz et al (2000), along with a lack of dose-response, precludes comparisons with lethal levels in accordance with the 6x hypothesis as used by Tucker and Leitzke (1979). Nevertheless, it is known that olfaction is an exquisitely sensitive sense. And this sense may be particularly well developed in salmon, as would be consistent with its use by salmon in homing (Hasler and Scholz, 1983). So the contradiction of the 6x hypothesis is not surprising. As a result of these findings, the 6x hypothesis needs to be re-evaluated with respect to olfaction. At the same time, because of the sensitivity of olfaction and because the 6x hypothesis has generally stood the test of time otherwise, it would be premature to abandon the hypothesis for other acute sublethal effects until there are additional data.

2. Description of CARBOFURAN:

A. Chemical Overview:

Common Name:	Carbofuran
Chemical Name:	2,3-dihydro-2,2-dimethyl-7-benzofuranylmethylcarbamate
Chemical Family:	N-methyl carbamate
CAS Registry Number:	1536-66-2
OPP Chemical Code:	090601
Empirical Formula:	$C_{12}H_{15}NO_3$
Basic Manufacturers:	FMC
Trade and Other Names:	Carbofuran, Furadan

B. Registered Uses:

Carbofuran is a N-methyl carbamate. It is a contact and systemic pesticide that operates by inhibiting cholinesterase. Carbofuran is registered as a restricted use broad spectrum insecticide, nematicide, and miticide for use on a wide variety of agricultural and non-agricultural crops. It is formulated into flowable, wettable powder, and granular forms. The flowable formulation constitutes the vast majority of the carbofuran currently used.

Registered agricultural uses of carbofuran include alfalfa, artichokes, bananas, coffee, corn (field, pop, and sweet), cotton, cucumbers, grapes, melons, peppers, plantain, potatoes, pumpkins, small grains (wheat, oats, and barley), sorghum, soybeans, squash, sugar beets, sugarcane, sunflowers, and tobacco. Registered non-agricultural uses include fallow/idle agricultural land, forest trees (pine plantations and pine seed orchards), and other ornamentals (herbaceous, woody shrubs, and vines).

Historically, granular carbofuran was used extensively on rice. However, the section 3 registration for use of carbofuran on rice was discontinued in 1997. Additional use of carbofuran on rice since that time has been from existing stock or in connection with emergency exemption requests.

C. Application Rates and Methods

Table 3 provides carbofuran uses and maximum application rates for the national labels (section 3 labels; see attachment A). Application rates for flowable carbofuran range from 0.05 pounds of active ingredient per acre (lbs a.i./A) for pine seedlings to 10.0 lbs a.i./A for grapes and ornamentals. Depending on the crop, flowable carbofuran may be applied with aircraft or ground equipment by various methods including broadcast, banded, in-furrow, and drip irrigation. Multiple applications are allowed for several crops.

The labeled application rates for the granular formulation range from 0.002 lbs a.i./A for pine seedlings to a maximum of approximately 2.5 lbs a.i./A with 48 inch row spacing for cucurbits. These rates fall within the range for flowable formulation rates.

Table 3. Maximum Application Rates of Carbofuran for National Uses (Section 3 Labels)

Crop or Site (Label #)	Highest Label Rate per Application (lb a.i./A)	Number of Applications	Maximum Amount per Year (lb a.i./A)
Flowable Carbofuran			
Alfalfa (279-2876)	1.0 lbs a.i./A	One application	1.0 lbs a.i./A
Corn (279-2876)	1.0 lbs a.i./A	One application	1.0 lbs a.i./A
Cotton (279-2876)	1.0 lbs a.i./A	One application	1.0 lbs a.i./A
Ornamentals (container grown) (279- 2876)	0.06 lbs a.i.	NS	0.06 lbs a.i.
Pine seedlings (279-2876)	0.05 lbs a.i.	NS	Prepare slurry: Add 0.05 lbs a.i., 0.5 gallons water, and 2.0 lbs clay; Slurry sufficient to treat roots of 150 to 200 seedlings
Potatoes (279-2876)	1.0 lbs a.i./A	Two applications	2.0 lbs a.i./A
Small grains (barley, oats, wheat) (279-2876)	0.25 lbs a.i./A	Two applications	0.5 lbs a.i./A
Soybeans (279-2876)	0.25 lbs a.i./A	Two applications	0.5 lbs a.i./A

Sugarcane (279-2876)	0.75 lbs a.i./A	Two applications	1.5 lbs a.i./A
Sunflowers (279-2876)	1.4 lbs a.i./A	One application	1.4 lbs a.i./A
Tobacco (279-2876)	6.0 lbs a.i./A	NS	6.0 lbs a.i./A
Granular Carbofuran			
Bananas (279-2922)	0.006 lbs a.i. / unit of production (cepa)	Two applications	0.012 lbs a.i. / unit of production (cepa)
Cucurbits - southeastern states only (cucumbers, melons, squash, pumpkins) (279-3023)	2.5 lb a.i./A with 48 inch row spacing	NS	2.5 lbs a.i./A with 48 inch row spacing
Pine Seedlings (pine progeny test) (279-3023)	0.002 lbs a.i./A	NS	0.002 lbs a.i./A
Rice (279-2874) -Do not use this product on rice after 8/31/97 -FMC will not sell, nor release for shipment this product for use on rice after 8/31/96 -Product in channels of trade many be sold and used until 8/31/97	0.5 lbs a.i./A	One application	0.5 lbs a.i./A

NS = Not stated on the label; Maximum amount per year (lbs a.i./A) determined by application method and crop type

Table 4 depicts the maximum application rates for state and local need labels (section 24c labels) registered in the Pacific-Northwest and California (see attachment B). The application rates may differ from the national label by changing the application rate or the application method.

Table 4. Maximum Application Rates of Carbofuran for California, Idaho, Oregon, and Washington Uses (Section 24c Labels)

Crop (Label)	Highest Label Rate per Application (lb a.i./A)	Number of Applications	Maximum Amount per Year (lb a.i./A)
California - Flowable Carbofuran			

Artichokes (CA860037)	1.0 lbs a.i./A	Two applications	2.0 lbs a.i./A
Grapes (CA980001;CA940005; CA980012)	10.0 lbs a.i./A	One application	10.0 lbs a.i./A
Ornamentals (greenhouse or field grown) (CA830058)	10.0 lbs a.i./A	NS	10.0 lbs a.i./A
Idaho - Flowable Carbofuran			
Potatoes (ID910007)	3.0 lbs a.i./A	Two applications	6.0 lbs a.i./A
Sugar beets (ID920002)	2.0 lbs a.i./A	One application	2.0 lbs a.i./A
Oregon - Flowable Carbofuran			
Potatoes (OR910006)	3.0 lbs a.i./A	Two applications	6.0 lbs a.i./A
Nursery stock (field grown, production for wholesale) (OR830036)	10.0 lbs a.i./A	NS	10.0 lbs a.i./A
Sugar beets (OR920014)	2.0 lbs a.i./A	One application	2.0 lbs a.i./A
Oregon - Granular Carbofuran			
Watermelons (OR830016)	1.0 lbs a.i./A	NS	1.0 lbs a.i./A
Washington - Flowable Carbofuran			
Potatoes (WA910006)	3.0 lbs a.i./A	Two applications	6.0 lbs a.i./A
Washington - Granular Carbofuran			
Spinach (grown for seed) (WA860012)	1.0 lbs a.i./A	One application	1.0 lbs a.i./A

NS = Not stated on the label; Maximum amount per year (lbs a.i./A) determined by application method and crop type

Table 5 presents the application methods used to apply flowable and granular carbofuran to agricultural and non-agricultural crops.

Table 5. Application Methods for Carbofuran Uses

Crop	Application Methods / Equipment
Flowable Carbofuran	
Alfalfa	Foliar application w/ground equipment or aircraft
Artichokes	Ground spray
Corn	Foliar application; Band over the row; Injecting each side of row; In-seed furrow with 40 inch row spacing
Cotton	In-seed furrow with 40 inch row spacing
Grapes	Broadcast; Drip irrigation; Soil drench
Nursery stock (container or field grown - production for wholesale)	Soil drench; High volume spray
Ornamentals (container grown in greenhouse or field)	Soil drench; spray
Pine Seedlings	Dip roots into slurry prior to transplanting
Potatoes	Foliar application; Band to side or below seed piece; Shank
Small grains (barley, oats, wheat)	Foliar application
Soybeans	Foliar spray
Sugarcane	Foliar spray using ground or aerial equipment
Sugar beets	Band over plant row
Sunflowers	In-seed furrow with 30 inch row spacing
Tobacco	Broadcast spray
Granular Carbofuran	
Bananas	Apply to hole & soil surface
Curcurbits (cucumbers, melons, pumpkins, squash) (southeastern states only)	Band & incorporate into soil with 48 to 96 inch row spacing
Pine Seedlings (pine progeny test)	Distribute granules on soil around seedling
Rice (Arkansas, California, Louisiana, Mississippi, Texas) (do not use after 08/31/97)	Apply before or within 21 days after flooding
Spinach	Seed-furrow with 1,000 linear feet of row
Watermelons	Band & incorporate into soil prior to planting

D. Carbofuran Usage

The Biological and Economic Analysis Division (BEAD), within the Office of Pesticide Programs (OPP), executed a Quantitative Usage Assessment (QUA) for carbofuran based on available pesticide survey usage information for the years 1990 through 1999 (Attachment C). The QUA states that total carbofuran usage is approximately 1.9 million pounds of active ingredient per year on about 2.6 million acres treated. Corn accounts for the most usage (620,000 lbs a.i. treating 860,000 acres), with lesser amounts being used on other grain, fiber and forage crops including alfalfa (400,000 lbs a.i. treating 720,000 acres), potatoes (280,000 lbs a.i. treating 240,000 acres), cotton (190,000 lbs a.i. treating 220,000 acres), and sorghum (93,000 lbs a.i. treating 160,000 acres). Lesser amounts of carbofuran are used on a wide range of other crops including cucumbers, grapes, soybeans, sugarcane, sunflower, sweet corn, and tobacco. Although corn dominates usage, carbofuran is used on only a small proportion (1%) of corn acreage and is typically applied one time per season at a rate of approximately 0.7 lbs a.i./A. When carbofuran is used on other crops, it is typically applied once per season at rates less than the maximum label rates, with application rates ranging from 0.2 lbs a.i./A (spring wheat) to 2.5 lbs a.i./A (tobacco). Most carbofuran is applied in a liquid flowable form, but up to 2,500 pounds of granular formulation may be sold.

Table 6 presents the use sites for which either California, Idaho, Oregon, or Washington is a state of high usage as reported in the QUA. The crops with the largest quantity of acres treated with carbofuran are alfalfa, potatoes, and wheat.

Table 6. Usage of Carbofuran in California, Idaho, Oregon, and Washington from 1992 to 1999. Tabulated Values are Weighted Averages[1] (OPP/BEAD Quantitative Usage Analysis for Carbofuran 2002) (Attachment C)

Site	Acres Grown	Acres Treated	% Crop Treated	lbs a.i. applied	States of Most Usage (% of total lbs a.i. used on the crop)
Alfalfa	23,176,000	720,000	3.0	400,000	**CA**, OK, KS, UT, CO, KY (53%)
Barley	6,378,000	9,000	0.0[4]	3,000	**ID**, KY, ND, MT (81%)
Grapes	877,000	17,000	2.0	21,000	**CA** (100%)
Potatoes, fall	1,221,000	240,000	20.0	280,000	**WA**, **ID**, ND, **OR** (88%)
Rice[2]	3,193,000	210,000	7.0	200,000	LA, **CA**, TX (90%)
Strawberries[3]	32,000	1,000	2.0	1,000	**OR**, **CA**, PA, **WA** (89%)
Wheat, winter	43,213,000	33,000	0.0[4]	11,000	OK, KY, **ID**, TX, MT, NC (69%)

1 Weighted Average - The most recent years and more reliable data are weighted more heavily
2 Usage on this site is historical. Carbofuran registration for rice has been cancelled.
3 Usage on this site is historical. Carbofuran registration for strawberries has been cancelled.
4 Numbers are rounded to the nearest whole percentage point for % of crop treated (Therefore 0% = < 0.5%).

We are not aware of any comprehensive sources of annual pesticide-usage information for Idaho, Oregon, or Washington.

Information for selected crops in California, Idaho, Oregon, and Washington is available from the Untied States Department of Agriculture's National Agricultural Statistics Service (USDA/NASS) in their "Agricultural Chemical Usage" reports (http://jan.mannlib.cornell.edu/reports/nassr/other/pcu-bb/), but the data are not reported at the county level. The data for 2003 indicate that carbofuran usage is small compared to usage of other insecticides registered for the same field crops, fruits, and nursery or floriculture. The field crop summary provides that for fall potatoes carbofuran usage includes the following: Idaho (22,000 lbs); Oregon (4,000 lbs); and Washington (3,000 lbs). For each state, the usage of carbofuran on fall potatoes did not exceed 7.0% of the crop area. The fruit summary denotes the usage of carbofuran on grapes, but usage data is not provided. For nursery and floriculture practices, usage on nursery, nursery propagation or lining-out stock, broadleaf and coniferous evergreens, and deciduous shrubs were reported for Oregon. The usage of carbofuran on nursery and floriculture practices was 2.0% or less of all operations in Oregon. The data on pounds applied was not available. Another report, the restricted use summary, did not characterize the data at a state level. Table 7 depicts carbofuran usage on crops grown in the Pacific-Northwest or California based on the USDA/NASS data. Potatoes had the largest amount of total carbofuran applied with Idaho, Oregon, and Washington reporting usage of carbofuran on potatoes.

Table 7. Carbofuran Usage as Reported in the USDA/NASS Restricted Use Summary for California, Idaho, Oregon, and Washington

Crop	% Area Applied	Total Acres of Crop[1]	Total Applied (lbs)	Program States
Barley	< 0.5 %	4.9 million	3,000	**CA**, **ID**, MN, MI, ND, PA, SD, UT, **WA**, WI, WY
Corn	< 0.5 %	72.8 million	332,000	CO, IL, IN, IA, KS, KY, MI, MN, MO, NE, NY, NC, ND, OH, PA, SD, TX, WI
Cotton	1.0 %	12.8 million	21,000	AL, AZ, AR, **CA**, GA, LA, MS, MO, NC, SC, TN, TX
Potatoes	4.0 %	1.0 million	31,000	CO, **ID**, ME, MI, MN, ND, **OR**, PA, **WA**, WI

1 Total acres of crop includes all crop acres within the program states (states included in the analysis).

There is use of carbofuran on container and field grown ornamentals, pine seedlings, and nursery stock. The United States Department of Agriculture (USDA) 2000 Nursery Floricultural Summary of Agricultural Chemical Usage provides some carbofuran usage statistics for California, Florida, Michigan, Oregon, Pennsylvania, and Texas (URL http://jan.mannlib.cornell.edu/reports/nassr/other/pcu-bb/#field). The summary notes that for all nursery and floriculture carbofuran is applied to 1% of Oregon operations and less then 1% of California operations. In Oregon, carbofuran is applied to 4% of broadleaf evergreen operations and 1% of deciduous shade tree and deciduous shrub operations. In California, carbofuran is applied to 7% of coniferous evergreen operations. The CA DPR lists 1,528 lbs a.i. of carbofuran being applied to 894 acres of outdoor nursery containerized plants and transplants in 2002.

Based on the information from USDA/NASS and CA DPR reporting a relatively small number of acres treated with carbofuran, it is my professional judgment that use of carbofuran on ornamentals and nursery stock will have no effect on salmon and steelhead.

As for pine seedlings, the low application rate of carbofuran and expected low rate of release (which we cannot quantitate) results in no concern. I conclude there will be no effect of carbofuran from use on pine seedlings.

Additional data compiled in the 1990s is available from the United States Geological Survey (USGS). The USGS estimated county pesticide use for the conterminous United States by combining: (1) state-level information on pesticide use rates available from the National Center for Food and Agricultural Policy from pesticide use information collected by state and federal agencies over a 3-year period (1995-1998) and (2) county-level information on harvested crop acreage from the 1997 Census of Agriculture. The average annual pesticide use, the total amount of pesticide applied (in pounds), and the corresponding area treated (in acres) were compiled for over 200 pesticide compounds that are applied to crops in the conterminous United States. Pesticide use was ranked by compound and crop on the basis of the amount of each compound applied to 86 selected crops. The data indicates that the agricultural crops of highest carbofuran usage during the mid-1990s were corn (~ 1.7 million lbs a.i.), alfalfa hay (~ 610,000 lbs a.i.), rice (~ 280,000 lbs a.i.), and potatoes (~ 228,000 lbs a.i.). These four crops comprise 84.7% of the total national usage of carbofuran in the mid-1990s. The remaining crops, according to the USGS, were cotton, grapes, sorghum, wheat, sweet corn, and barley. USGS also mapped carbofuran usage on selected crops (Attachment D; URL http://ca.water.usgs.gov/cgi-bin/pnsp/pesticide_use_maps_1997.pl?map=W6007). The map is included as a visual depiction of carbofuran usage on agricultural crops. However, the map should not be used for any quantitative analysis because it is based on 1997 crop acreage data along with 1995-1998 statewide estimates of use without consideration of local practices and usage.

The above mentioned data support that bananas, oats, soybeans, sugar beets, sugar cane, sunflowers, and tobacco are crops that are not grown in the Pacific-Northwest or California. Therefore, further analysis of these crops is not necessary. With regard to cucurbits (including watermelons), pine seedlings, and spinach, the QUA and the USDA/NASS data suggests these are minor crops for which no-state specific data are available at this time. Therefore, further analysis of these crops is not necessary.

The latest information for California pesticide usage is for the year 2002 (URL: http://www.cdpr.ca.gov/docs/pur/purmain.htm). The reported information to the County Agricultural Commissioners includes pounds used, acres treated for agricultural and certain other uses, and the specific location treated. The pounds and acres are reported to the state, but the specific location information is retained at the county level and is not readily available. Tables 8 and 9 report carbofuran usage and acres treated from 1993 to 2002. The above mentioned tables denote a decrease in usage and fewer acres treated with carbofuran during the time period 1993 to 2002.

Table 8. Reported Usage of Carbofuran in California, 1993-2002 (lbs a.i.)

1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
289,807	278,579	243,339	220,642	183,606	161,689	139,098	132,452	95,927	81,486

Table 9. Reported Cumulative Acres Treated with Carbofuran in California, 1993-2002 (acres)

1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
396,690	460,303	449,260	363,635	321,924	303,820	272,107	258,411	246,082	182,567

Table 10 provides the usage of carbofuran in California as surveyed by the California Department of Pesticide Regulation (CA DPR). In California, the largest amount of carbofuran was used on alfalfa and cotton crops. As reported in 2002, there were 1,580 and 858 applications of carbofuran on alfalfa and cotton respectively, totaling over 170,000 acres treated with approximately 63,800 pounds of carbofuran. As seen in table 10 the total amount of active ingredient used in California in 2002 was 81,578 pounds on 182,564 acres (approximately 0.45 lbs/acre).

Table 10. Usage of Carbofuran by Crop or Site in California

	2002			2001		
Crop or Site	**lbs a.i. applied**	**Number of Application**	**Acres Treated**	**lbs a.i. applied**	**Number of Applications**	**Acres Treated**
Alfalfa	41,920	1,580	92,465	39,316	1,541	92,899
Artichoke, globe	527	61	1,662	715	74	1,223
Corn (forage - fodder)	215	5	663	31	2	58
Cotton	21,897	858	80,891	38,829	1,549	145,585
Grape	662	4	66	779	4	73
Grape (wine)	14,214	103	5,409	14,614	140	5,348
Grasses (bermuda)	74	1	72	15	1	35
Outdoor plants (containers)	2	1	13	1	1	0.21
Outdoor plants (transplants)	1,524	67	881	1,523	77	895
Potato	540	16	442	35	1	33

Right of way	3					
Research commodity				3		
TOTAL	81,578	2,696	182,564	95,861	3,390	246,149.21

The Washington State Department of Agriculture (WSDA) provided information on the acreage of major carbofuran treated crops and additional details on amounts used for certain of these crops (WSDA, 2004). The Washington usage data is in Table 11; the full report prepared by the State of Washington's Department of Agriculture is included as attachment E. According to the WSDA data, the crops with the estimated largest amount of carbofuran applied were wheat, barley, and alfalfa. According to a WSDA memo from November 2004 wheat producers in Washington state do not apply carbofuran to their crops (Attachment E), although the WSDA carbofuran use summary included estimates of carbofuran use on wheat. Since the use summary, WSDA has had direct contact with crop consultants and Washington State University Extension Scientists who noted that insecticides are rarely used on wheat and carbofuran has not been used on wheat in Washington for over 15 years.

Table 11. Major Usage of Carbofuran in Washington (WSDA, 2004)

Crop	WASS[1] 2002 Est. Acres	Est. % Acres Treated	Est. lbs a.i./A	# of Applications	Est. Acres Treated	Est. lbs a.i. Applied
Alfalfa, hay[2]	490,000	< 5.0	0.25	1	24,500	6,125
Alfalfa, seed[2]	12,000	< 5.0	0.25	2	500	250
Barley[2]	350,000	< 5.0	0.20	2	17,500	7,000
Corn, grain & silage[2]	130,000	-	-	-	-	-
Corn, sweet[2]	97,900	-	-	-	-	-
Cranberry	1,600	-	-	-	-	-
Oats[2]	35,000	< 5.0	2.0	2	1,750	700
Potato, Irish[3]	163,000	7.0	1.0	1	11,410	3,000
Spinach, seed[2]	1,500	-	-	-	-	-
Wheat[2]	2,240,000	< 5.0	0.20	2	121,000	48,400

1 Washington Agricultural Statistics Service
2 As reported by the State of Washington's Department of Agriculture, information for alfalfa, barley, corn, oats, potatoes, spinach, and wheat have not been peer reviewed.
3 USDA National Agricultural Statistics Service - 2003 crop data
"-" indicates information was not provided by Washington state.

Based on the above mentioned data, including the USDA/NASS, QUA, CA DPR, and WSDA values, the only uses of concern in California, Idaho, Oregon, and Washington are alfalfa, artichokes, cotton, grapes, and potatoes. As for barley, the USDA/NASS data denotes that less than 0.5% of the crop is treated with 3,000 pounds of carbofuran. The QUA indicates that 11,000 pounds of carbofuran is applied to less than 0.5% of wheat grown in the United. States. Note that USDA/NASS data nor the QUA characterize usage amounts for particular states. Thus, it is my professional judgment that barley and wheat will have no effect on salmon and steelhead in the Pacific-Northwest and California because of the small percentage of crop treated with modest amounts of carbofuran. To summarize, the only uses of concern in California, Idaho, Oregon, and Washington are alfalfa, artichokes, cotton, grapes, and potatoes.

3. General Aquatic Risk Assessment for Endangered Species and Threatened

A. Aquatic Toxicity of Carbofuran

There is a modest amount of aquatic toxicity data on carbofuran. Data from the EFED Science Chapter is presented in tables 12-19. Data submitted to support registration was generated in accordance with Good Laboratory Practice regulations and have been through OPP's rigorous validation requirements for data used in assessments; these data are used in preference to other data.

i. Freshwater Fish, Acute

Two freshwater fish toxicity studies using the technical grade of the active ingredient are required to establish the toxicity of a pesticide to fish. The preferred test species are rainbow trout (a cold-water fish) and bluegill sunfish (a warm-water fish). Results of these tests are tabulated below. There is currently no required amphibian acute toxicity test, it is assumed that the required guideline fish tests are protective of amphibians.

Table 12 shows that the 96-hour acute toxicity of technical grade carbofuran to freshwater fish ranges from 88 ppb for bluegill sunfish to 1,990 ppb for fathead minnow. Several tests with formulations were reported. The acute toxicity of wettable powder formulations for 50% and 75% active ingredient to freshwater bluegill sunfish ranges from 240 ppb to 650 ppb. The data indicates that carbofuran is highly toxic to freshwater fish. The EFED Science Chapter denotes that when the formulations are adjusted to ppb of active ingredient for existing granular, wettable powder, and flowable formulations, they do not appear to be more toxic than the technical grade.

Table 12. Acute Toxicity of Carbofuran to Freshwater Fish (EFED Science Chapter)

Species	Scientific name	% a.i.	96-hour LC 50 (ppb a.i.)	Toxicity Category
Technical Grade				

Bluegill sunfish	*Lepomis macrochirus*	Technical	88	very highly toxic
Bluegill sunfish	*Lepomis macrochirus*	Technical	126	highly toxic
Yellow perch	*Perca flavescens*	99	120	highly toxic
Yellow perch	*Perca flavescens*	99	147	highly toxic
Yellow perch	*Perca flavescens*	99	240	highly toxic
Yellow perch	*Perca flavescens*	99	400	highly toxic
Lake trout	*Salvelinus namaycush*	99	164	highly toxic
Channel catfish	*Ictalurus punctatus*	99	248	highly toxic
Brown trout	*Salmo trutta*	99	280	highly toxic
Brown trout	*Salmo trutta*	99	560	highly toxic
Brown trout	*Salmo trutta*	99	560	highly toxic
Rainbow trout	*Oncorhynchus mykiss*	Technical	362	highly toxic
Rainbow trout	*Oncorhynchus mykiss*	99	380	highly toxic
Rainbow trout	*Oncorhynchus mykiss*	Technical	5-day >391	highly toxic
Rainbow trout	*Oncorhynchus mykiss*	99	420	highly toxic
Steelhead	*Oncorhynchus mykiss*	99	600	highly toxic
Coho salmon	*Oncorhynchus kisutch*	99	530	highly toxic
Fathead minnow	*Pimephales promelas*	99	872	highly toxic
Fathead minnow	*Pimephales promelas*	99	1,990	moderately toxic
Fathead minnow	*Pimephales promelas*	99	1,180	moderately toxic
Formulation				
Bluegill sunfish	*Lepomis macrochirus*	50 WP	240	highly toxic

Bluegill sunfish	*Lepomis macrochirus*	10 G	3,100	moderately toxic
Bluegill sunfish	*Lepomis macrochirus*	44	960	highly toxic
Bluegill sunfish	*Lepomis macrochirus*	75 WP	640	highly toxic
Bluegill sunfish	*Lepomis macrochirus*	75 WP	650	highly toxic
Rainbow trout	*Oncorhynchus mykiss*	75 WP	610	highly toxic

ii. Freshwater Fish, Chronic (Partial & Full Life-Cycle Toxicity)

Early-life stage and life-cycle studies denote the no observable adverse effects concentration (NOAEC) and the lowest observable adverse effects concentration (LOAEC). The fish early life-stage test is an in-laboratory test designed to estimate the highest quantity of a substance in water required which will not adversely effect the reproductive capabilities of a test population of fish (NOAEC) and the lowest quantity of a substance in water which will adversely effect the reproductive capabilities of the test population (LOAEC). There are no life-cycle tests for freshwater fish.

Table 13. Partial Life-Cycle Toxicity of Carbofuran to Freshwater Fish (EFED Science Chapter)

Species	Scientific name	% a.i.	Toxicity Value (ppb a.i.)	Endpoint Affected
Rainbow trout	*Oncorhynchus mykiss*	99.6	NOAEC = 24.8 LOAEC = 56.7 MATC = 40.8	Based on survival and growth (length and weight) effects. After 60, 75, and 90 days of exposure at dose levels of 56.7 and 88.7 ppb trout survival and length was significantly reduced. Weight was significantly reduced after 75 days at test concentrations of 56.7 and 88.7 ppb.

iii. Freshwater Invertebrates, Acute

Carbofuran is moderately to very highly toxic to freshwater invertebrates. Carbofuran is very highly toxic to *Daphnia magna*. Invertebrates serve as a food source for juvenile salmon and steelhead. Carbofuran exhibits greater toxicity to freshwater invertebrates than it does to fish. Consideration should be given to invertebrates that may serve as a food supply for threatened and endangered salmon and steelhead.

Table 14. Acute Toxicity of Carbofuran to Freshwater Invertebrates (EFED Science Chapter)

Species	Scientific Name	% a.i.	48-hour EC50 (ppb a.i.)	Toxicity Category
Technical Grade				
Water flea	*Daphnia magna*	96.5	29	very highly toxic
Water flea	*Daphnia magna*	Technical	38.6	very highly toxic
Red crayfish	*Procambarus clarkii*	98.5	96-hour LC50 = 2,700	moderately toxic
Formulations				
Water flea	*Daphnia magna*	5G	41	very highly toxic

iv. Freshwater Invertebrates, Chronic (Life-Cycle Toxicity)

Table 15 indicates that freshwater invertebrates, such as daphnids, exposed to 27 ppb carbofuran have reduced length, fecundity, and survivability.

Table 15. Life-Cycle Toxicity of Carbofuran to Freshwater Invertebrates (EFED Science Chapter)

Species	Scientific Name	% a.i.	21-day NOAEC / LOAEC (ppb a.i.)	Endpoints Affected
Water flea	*Daphnia magna*	96.5	9.8 / 27	Most sensitive endpoint(s): adult length, survival, and reproduction

v. Estuarine and Marine Fish, Acute

Below are the acute and life stage toxicity tests for estuarine and marine fish from the EFED Science Chapter. There are no life-cycle tests for saltwater fish.

Table 16 indicates that the technical grade carbofuran is highly to very highly toxic to estuarine and marine fish on an acute basis.

Table 16. Acute Toxicity of Carbofuran to Estuarine and Marine Fish (EFED Science Chapter)

Species	Scientific name	% a.i.	96-hour LC 50 (ppb a.i.)	Toxicity Category
Technical Grade				
Atlantic silverside	*Menidia menidia*	96.1	33	very highly toxic
Longnose killifish	*Fundulus similis*	99.2	>100	highly toxic

Sheepshead minnow	*Cyprinodon variegatus*	99.2	48-hour >100	highly toxic
Formulations				
Atlantic silverside	*Menidia menidia*	14.2	64	very highly toxic
Atlantic silverside	*Menidia menidia*	44	36	very highly toxic

Table 17 depicts the early-life stage studies of carbofuran to estuarine and marine fish with data reporting growth and mortality endpoints.

Table 17. Early-Life Stage Studies of Carbofuran to Estuarine and Marine Fish (EFED Science Chapter)

Species	Scientific name	% a.i.	35-day Toxicity Value (ppb a.i.)	Endpoints Affected
Technical Grade				
Sheepshead minnow	*Cyprinodon variegatus*	98	NOAEC = 2.6 LOAEC = 6.6 MATC = 3.9	Based on survival of young (35 day exposure) mortality to one sheepshead minnow young occurred after 11 days of exposure to 6.0 ppb. Over 50% mortality occurred after 7 days exposure to 16.0 ppb.
Sheepshead minnow	*Cyprinodon variegatus*	98.9	NOAEC < 9.7	Most sensitive endpoint: Hatching success and larval growth (8% reduction in length and 23% reduction in weight)
Sheepshead minnow	*Cyprinodon variegatus*	96.9	NOAEC < 17.6	Most sensitive indicator: Growth (length)

vi. Estuarine and Marine Invertebrates, Acute

The acute toxicity tests with estuarine and marine invertebrates, table 18, indicate that technical grade carbofuran is very highly toxic to pink shrimp and moderately toxic to eastern oysters. As with freshwater species, the estuarine and marine invertebrates may serve as a food source for salmon and steelhead fish.

Table 18. Acute Toxicity of Carbofuran to Estuarine and Marine Invertebrates (EFED Science Chapter)

Species	Scientific name	% a.i.	96-hour LC 50 (ppb a.i.)	Toxicity Category
Technical Grade				

Pink Shrimp	*Penaeus duorarum*	99.2	48-hour 4.6	very highly toxic
Pink Shrimp	*Penaeus duorarum*	98.6	7.31	very highly toxic
Eastern Oyster	*Crassostrea virginica*	99.2	EC50 >1,000	moderately toxic
Eastern Oyster	*Crassostrea virginica*	96.1	48-hour EC50 > 5,000	moderately toxic
Formulations				
Pink shrimp	*Penaeus duorarum*	14.24	13.3	very highly toxic

vii. Estuarine and Marine Invertebrates, Chronic

Table 17 reports the most sensitive endpoint is survival of the parental generation for estuarine and marine invertebrates exposed to concentrations of 0.98 ppb carbofuran.

Table 17. Partial or Full Life-Cycle Study of Carbofuran to Estuarine and Marine Invertebrates (EFED Science Chapter)

Study type	Species	Scientific name	% a.i.	Toxicity Value (ppb a.i.)	Toxicity Category
Technical Grade					
28-day	Mysid	*Mysidopsis bahia*	98.6	NOAEC = 0.40 LOAEC = 0.98	Most sensitive endpoint: Survival of parental generation

viii. Aquatic Plant Studies

The EFED Science Chapter does not include aquatic plant studies. Aquatic plant toxicity studies and associated risk analysis on aquatic plants are not required for registration of a pesticide unless it meets specific use and pesticide classification criteria (CFR Part 158) which would trigger potential impacts. Carbofuran does not meet these criteria and no quantitative risk assessment was performed for aquatic plants.

ix. AQUIRE Database

Additional aquatic toxicity data for carbofuran is available from EPA's AQUIRE database (http://www.epa.gov/ecotox/). Data from the AQUIRE database is presented in table 18. We did not look at the original papers but report the toxicity values for the toxicity test periods that are analogous to those required by OPP testing requirements as a means of comparison. The AQUIRE reference numbers for each reported value are provided. The data corroborate the toxicity values reported in EFED's database and the carbofuran EFED Science Chapter. The range of acute toxicity values for the active ingredient from AQUIRE are 1.96 ppb to 10,250 ppb for freshwater fish and 0.119 ppb to 44,600 ppb for freshwater invertebrates compared to 88 ppb to 1,990 ppb and 29 ppb to 2,700 ppb for freshwater fish and freshwater invertebrates, respectively, from OPP data. Most of the data in AQUIRE is reported from studies conducted with formulated products, however, the types of formulations and percentage of active ingredient were not reported. Therefore, it is difficult to compare these data with those reported by OPP.

Table 18. Summary of Acute Toxicity Data from the EPA AQUIRE Database.

Species	**Scientific Name**	**Test Chemical**[1]	**96-hr LC_{50} (ppb)**	**Reference #**
		Freshwater Fish		
Climbing perch	*Anabas testudineus*	Form.	910	11026
Goldfish	*Carassius auratus*	Form. Active	10,250 7,900	6353
Catla	*Catla catla*	Form.	5,100	2520
Snake-head catfish	*Channa punctata*	Form.	180	6388
Carp, hawk fish	*Cirrhinus mrigala*	Form.	4,700	2520
Carp, hawk fish	*Cirrhinus mrigala*	Active	260	10575
Carp	*Cyprinus carpio*	Active	270	10385
Carp	*Cyprinus carpio*	Form.	160	11812
Carp	*Cyprinus carpio*	Active	3,000	3296
Carp	*Cyprinus carpio*	Active	1,090 - 1,550	6999
Carp	*Cyprinus carpio*	Active	1,400	13451
Western mosquitofish	*Gambusia affinis*	Form.	300	942
Scud	*Gammarus italicus*	Form.	12	18621
Scud	*Gammarus pulex*	Form.	9	15357
Indian catfish	*Heteropneustes fossilis*	Form.	547	15179
Rohu	*Labeo rohita*	Form.	4,800	2520
Loach	*Lepidocephalichthys thermalis*	Form.	3,400 - 4,800	12518
Loach	*Lepidocephalichthys thermalis*	Active	3,400	19775

Bluegill	*Lepomis macrochirus*	Form.	80	942
Striped bass	*Morone saxatilis*	Form.	130 - 370	15472
Striped catfish	*Mystus vittatus*	Form.	310	6388
Striped catfish	*Mystus vittatus*	Form.	310	463
Asiatic knifefish	*Notopterus notopterus*	Active	1,442	4022
Medaka, high-eyes	*Oryzias latipes*	Form.	1,810	16929
Fathead minnow	*Pimephales promelas*	Active	844	3217
Fathead minnow	*Pimephales promelas*	Active	844	17263
Flathead chub	*Platygobio gracilis*	Form.	1.96 - 2.64	20655
Mozambique tilapia	*Tilapia mossambica*	Active	460 - 540	3296
Nile tilapia	*Tilapia nilotica*	Active	200 - 480	11057
Freshwater Amphibians				
Frog	*Microhyla ornata*	Form.	13,470 - 44,230	10922
Frog	*Microhyla ornata*	Form.	13,470	17134
Frog	*Rana hexadactyla*	Active	112,700	11521
Freshwater Invertebrates				
Back swimmer	*Anisops bouvieri*	Form.	48-hour 1,590	8303
Dragonfly	*Brachythermis contaminata*	Form.	0.119	17128
Dragonfly	*Ophiogomphus sp.*	Active	220	17129
Freshwater prawn	*Caridina rajadhari*	Form.	0.3324	10265
Water flea	*Ceriodaphnia dubia*	Form.	48-hour EC50 = 2	17097
Water flea	*Ceriodaphnia dubia*	Active	48-hour 2.6	13467
Water flea	*Ceriodaphnia dubia*	Active	48-hour EC50 = 48	12280
Water flea	*Ceriodaphnia dubia*	Active	48-hour EC50 = 86.1	17129

Water flea	*Ceriodaphnia dubia*	Form.	48-hour EC50 = 35 - 45	11433
Amphipod	*Echinogammarus tibaldii*	Form.	4.6	18621
Tubificid worm, Oligochaete	*Limnodrilus hoffmeisteri*	Form.	EC50 = 1,100	2723
Tubificid worm, Oligochaete	*Limnodrilus hoffmeisteri*	Form.	5,294	10265
Midge	*Chironomus thummi*	Active	48-hour EC50 = 56	12280
Pond Snail	*Lymnaea acuminata*	Form.	3097	10265
Shrimp	*Macrobrachium kistnensis*	Form.	157.30	10265
Crab	*Oziotelphusa senex senex*	Form.	31,100 - 44,600	3430
Crab	*Paratelphusa jacquemontii*	Form.	1.527	5819
White river crayfish	*Procambarus acutus acutus*	Form.	500	942
Tubificid worm	*Tubifex tubifex*	Form.	EC50 = 14,000	2723
Snail	*Viviparus bengalensis*	Form.	3,808	10265
Estuarine and Marine Fishes				
Sheepshead minnow	*Cyprinodon variegatus*	Form.	386	5074
Estuarine and Marine Invertebrates				
Brine shrimp	*Artemia salina*	Form.	24-hour 1.83	19998
Dungeness or Edible crab	*Cancer magister*	Active	1.5 - 190	6793
Opposum shrimp	*Neomysis mercedis*	Active	2.7 - 27	9936
Harpacticoid copepod	*Tigriopus brevicornis*	Active	17.7 - 29.9	19281

1 Form. = Test was conducted with formulated products. The product composition and percent active ingredient were not reported. Active = Test was conducted with the active ingredient, but the percent carbofuran was not reported.

The AQUIRE database is not always reliable documenting whether the study was conducted with a formulation or the active ingredient (i.e., technical material); unless the test indicates an active ingredient, it is recorded in AQUIRE as formulation testing. However, we have seen values reported in Mayer & Ellersieck (1996) as the technical material and reported in AQUIRE as a formulation test. We report the information on formulation versus active ingredient, but we need to note that it is not completely reliable.

x. Toxicity of Metabolites and Degradation Products

Toxicity data to calculate risk quotient values for aquatic fish or invertebrates does not exist for the metabolites and degradation products of carbofuran. The EFED Science Chapter notes that inclusion of environmental transformation products in the risk analysis of carbofuran would not be expected to result in substantive changes to conclusions drawn using the parent alone. The major transformation product in water and aerobic aquatic metabolism is the hydrolysis product, carbofuran 7-phenol, which is expected to be much less toxic than the parent (i.e., the carbamylating radical is missing). It also appears to be the transformation endpoint prior to conversion to CO_2 and is shorter lived in water than the parent. Other major expected environmental transformation products in soils that have potential to reach the aquatic environment are 3-hydroxycarbofuran and 3-ketocarbofuran, which typically occur in small amounts (i.e., < 5.0 % of applied) and are relatively short lived as compared to the parent.

xi. Field Effects

According to the EFED Science Chapter there are a limited number of field studies that examine impacts to aquatic organisms from application of carbofuran (see Aquatic Field Studies section from the EFED Science Chapter). Two studies examined effects to selected aquatic organisms following runoff events from treated areas (Bush *et al.*, 1986; Mathiessan *et al.*,1995). Bush monitored for fish mortality in a Georgia hydroelectric lake following runoff from a carbofuran treated (17 lbs a.i./A) loblolly pine seed orchard. One fish kill incident, involving a few fish, was detected. Carbofuran concentrations up to 7,820 ppb were detected in stormflow, but concentrations in the lake were not reported. In a separate study, Mathiessan placed caged invertebrates, *Gammarus pulex*, in a stream draining a field planted with an oilseed rape crop treated with carbofuran (granular) at 2.7 lbs a.i./A. Following a rainfall event all the caged *G. pulex* died. During the event, carbofuran was detected in a nearby headwater stream at up to 26 ppb.

Three additional studies examined effects following direct application of carbofuran to surface waters (Flickinger *et al.*, 1980, Wayland and Boag 1990, Mullie *et al.* 1991). The Flickinger study looked at granular carbofuran applied to flooded rice fields at 0.5 lbs a.i./A in Texas. Searchers found bird, fish, frog, crayfish, earthworm, and non-target insect fatalities after application. Wayland and Boag applied flowable carbofuran to prairie ponds at 5 ppb and 25 ppb. In shallow zones, the invertebrates *Hyallea azteca*, *Gammarus lacustris*, *Chironmus tentans*, and *Limnephilus* showed significantly reduced survival at the 25 ppb concentration as compared to controls and significant reduction in survival in *H. azetaca* was also observed in the ponds treated at 5 ppb as compared to the controls. The third study by Mullié involved applying granular carbofuran at an application rate of 0.89 lbs a.i./A to flooded rice fields in Senegal, Africa. Within 4 hours of application, abnormal behavior in frogs was visually observed and at 24 hours a number of dead frogs were observed. The study also noted a significant reduction in the number of Odonata (dragonflies), Ephemeroptera (mayflies), Nematocera (Diptera, flies), and Hydrocorisae (Hemiptera).

Additional field studies include microcosm and pond enclosure studies. Johnson (1986) conducted a 30-day exposure microcosm study using 4-liter containers containing the freshwater invertebrates *D. magna* and *Chironomus riparius* and the green algae, *Selenastrium capricornutum*. The microcosms were treated initially with 10 ppb a.i., 100 ppb a.i., and 1,000 ppb a.i. No mortalities in invertebrates or effects on the reproductive life-cycle of *D. magna* were detected. In a pond enclosure study, Wayland (1991) observed a significant decrease in *H. azeteca* abundance and biomass and chironomid biomass at 25 ppb.

B. Environmental Fate and Transport

The aquatic environmental fate and transport of carbofuran are presented in the EFED Science Chapter.

Carbofuran is an N-methyl carbamate and is both a contact and systemic pesticide that operates by inhibiting cholinesterase. It currently is registered as a restricted use broad spectrum insecticide and nematicide. Pesticides registered for restricted use may only be applied by certified trained applicators. It is formulated into flowable (liquid and wettable powder) and granular formulations for use on a wide variety of agricultural crops and for a number of non-agricultural uses.

Direct application of carbofuran to streams, lakes, and ponds is forbidden by product labels. Carbofuran has the potential to indirectly reach surface waters via runoff, erosion, and/or spray drift from application at upland sites. Potential exposure routes for aquatic organisms include direct uptake (i.e., uptake across gills or integument) of the chemical in the water column or pore water of sediment, incidental ingestion of the chemical in sediment, or ingestion of the chemical in food items (i.e., accumulation in food). Because carbofuran has a high water solubility (700 mg/liter), low K_{ow} (30 mg/g), and low bioconcentration factor (2-12x), exposure to carbofuran via the food chain, pore water, and sediment ingestion were considered insignificant aquatic exposure pathways as compared to direct uptake from the water column.

Major factors influencing the fate and persistence of carbofuran are water and soil pH. Carbofuran is very mobile and persistent in acidic environments, but dissipates more rapidly in pHs that are more basic. Carbofuran is stable to hydrolysis at pHs < 6, but becomes increasingly susceptible to hydrolysis as the pH increases, hydrolyzing rapidly in alkaline pHs (half-lives of less than a day). The half-life for carbofuran is on the order of weeks at pH 7 (28 days), days at pH 8 (3 days), and hours at pH 9 (0.8 to 15 hours). Only one degradate, carbofuran phenol (7-phenol), was detected in the hydrolysis studies. The rate of carbofuran degradation in soils is also pH dependent. In an acidic soil (pH 5.7), carbofuran dissipated with a half-life of 321 days, but when the soil was limed to a pH of 7.7, the half-life dropped to 149 days. The major identified degradate was 3-keto carbofuran, which peaked at 12% of the amount applied after 181 days. The other degradation products formed during photolysis, soil, and aquatic metabolism studies are 3-hydroxy carbofuran, 3-hydroxy-7-phenol, and 3-keto-7-phenol.

Carbofuran is highly mobile in soils. The EFED Science Chapter noted that the Freundlich coefficient (K_f) ranged from 0.10 to 30.3 (median 0.72). The K_{oc} values ranged from 9 to 62 milliters per gram (ml/g) (median 30). Thus, carbofuran is mobile and can leach to ground water in many soils or reach surface waters via runoff.

The EFED Science Chapter also discussed both aqueous and soil photolysis data. Carbofuran photodegrades in neutral water (buffered [pH 7] solution) at 25 °C with a half-life of 6 days. In the soil photolysis study, carbofuran photodegraded with a half-life of 78 days on a sandy loam soil. Carbofuran is moderately persistent to microbial degradation, with half-lives on the order of a year. Near-surface photolysis is significant under laboratory conditions in aqueous solution, with a half-life on the order of days.

C. Incidents

OPP maintains two databases of reported incidents. The Ecological Incident Information System (EIIS) contains information on environmental incidents which are provided voluntarily to OPP by state and federal agencies and others. There have been periodic solicitations for information to the states and the U.S. Fish and Wildlife Service (FWS). The second database is a compilation of incident information known to pesticide registrants and any data conducted by them that shows results differing from those contained in studies provided to support registration. These data and studies (together termed incidents) are required to be submitted to OPP under regulations implementing FIFRA section 6(a)(2).

We are aware of seven aquatic incident reports for carbofuran. Five of the reported incidents involve more than one pesticide. However, none of the reported incidents identify carbofuran as the sole cause of the aquatic incident. Two incidents suggest that the use of carbofuran caused mortality to aquatic organisms. It is highly probable that application of carbofuran to alfalfa resulted in mortality of more than 500 channel catfish and more than 100 unspecified fish species after a heavy rain caused runoff into a pond. A separate incident involved application of carbofuran to rice and subsequent mortality to a number of minnows in a nearby pond.

D. Estimated and Actual Concentrations of Carbofuran in Water

i. United States Geological Survey - National Water Quality Assessment Data (NAWQA)

Monitoring data on carbofuran is available from the NAQWA program as obtained from "USGS data warehouse" (URL http://infotred.er.usgs.gov/servlet/page?_pageid=543&_dad=portal30&_schema=PORTAL30). The EFED Science Chapter summarized the NAWQA data from all surface water sites for the period from 1991 to 2001 (see EFED Science Chapter). Table 19 summarizes the national statistics for carbofuran data. The data includes sites sampled many times over several years, as well as sites sampled only once or twice. Note that statistics reported for detection frequency may be skewed due to false negatives and concentrations could be higher. The maximum concentrations in table 19 are the highest concentration observed in all NAWQA surface water samples. The maximum concentration for agricultural land use was reported at 7.0 ug/L.

Table 19. USGS NAWQA National Statistics for Carbofuran in Surface Water (EFED Science Chapter)

Land Use	Max. Reporting Limit (RL[1]) (ug/L)	# Site	# Samples	Frequency of Detection[2] (%)				Max. Conc. (ug/L)[3]
				All ug/L	≥0.01 ug/L	≥0.1 ug/L	≥1.0 ug/L	
Agricultural Land Use	0.02	78	1,885	9.6	≥8.35	3	0.47	7
Mixed Land Use	0.02	44	949	3.28	≥2.60	0.22	0	0.678
Undeveloped Land Use	0.02	4	60	3.97	≥3.97	0	0	0.034
Urban Land Use	0.02	33	901	2.12	≥1.80	0	0	0.062

1 The limit reported (RL) in this table is the maximum value routinely used to report non-detections during the period 1991-2001.
2 The analytical reporting limit for the compound is greater than the threshold concentration used for computing detection frequency. Therefore, the reported percentage may be an underestimate of the actual percentage of time-weighted concentrations that are greater than the threshold concentration
3 Due to QA/QC consideration of the analytical method for carbofuran, all concentrations are tagged as "E" or estimated.

Table 20 presents a summary of the NAQWA monitoring data for the entire U.S. (national), the Pacific-Northwest states, and California that are inhabited by Pacific salmon and steelhead. The table summarizes data collected from 1984 to 2004 as assessed on November 9, 2004. On a national scale, there were 24,043 samples for carbofuran from 1984 to 2004. The maximum residue reported was 32.2 ug/L taken on April 17, 2002 from surface water around Zollner Creek near Mt. Angel, Oregon.

Table 20. Carbofuran Residues: Detection Frequency and Maximum Amounts (USGS/NAWQA)

State	# Samples	% Detects	Max. Residue (ug/L)	# > 1.0 ug/L
National	24,043	5.4	32.2	44
California	2,086	8.4	0.98	0

Idaho	480	0.4	0.07	0
Oregon	671	28.5	32.2	22
Washington	1,460	2.2	0.14	0

Please note that the NAWQA sampling data, while considered high quality, are not targeted to sites and times where carbofuran is used. Even regular sampling according to a predetermined schedule may not detect peak residues unless the samples happen to be taken shortly afterwards and adjacent to sites treated with carbofuran. It seems likely, but may not be correct, that when thousands of samples are taken, the highest NAWQA residues may actually represent peaks that occur in natural waters.

Table 21 depicts data collected by California's Department of Pesticide Regulation (CA DPR) (http://www.cdpr.ca.gov/docs/sw/surfdata.htm) from August 1990 to September 2003. The data denote a peak concentration in California of 5.15 ug/L and 20 detections measuring carbofuran above 1 ug/L.

Table 21. California Department of Pesticide Regulation Residue Concentrations for Surface Waters (August 1990 - September 2003)

Site	# of Samples	% Detects	Max. Residue (ug/L)	# > 1.0 ug/L
California[1]	3,963	9.64	5.15[2]	20
Butte	12	83.3	0.94	
Colusa	210	41.0	3.6	10
Contra Costa	1	0	0	
Merced	294	0	0	
Monterey	73	0	0	
Sacramento	928	0.75	0.109	
San Joaquin	899	3.56	1.9	1
Santa Cruz	6	0	0	
Shasta	4	0	0	
Solano	4	25.0	1.0	1
Sonoma	51	0	0	
Stanislaus	715	0.14	0.8	
Sutter	444	20.9	1.04	1
Tehama	1	0	0	

Yolo	136	22.8	0.41	
Yuba	20	70.0	0.37	

1 Only the counties in the ESUs are referenced in the table, however the California total includes all data available.
2 The maximum residue for California was detected in Imperial county which is not designated as an ESU for salmon and steelhead.

ii. Targeted Studies

a. Surface Water

The EFED Science Chapter states targeted surface water monitoring has been more limited than for groundwater, with most of the monitoring data collected in the 1980s and early 1990s (see EFED Science Chapter). Importantly, none of the surface water monitoring data (targeted or non-targeted) is of adequate spatial resolution to estimate peak concentrations. In most targeted surface water studies, carbofuran was applied in granular formulation. Targeted data available for surface water includes a runoff study from rice fields in California and a study of discharge in tile drains (which may affect surface water quality).

The state of California conducted a study (Nicosia *et al.*, 1991) in 1988 for the purpose of measuring carbofuran in runoff water from rice fields in the Sacramento Watershed. Maximum daily concentrations of carbofuran in runoff water from all fields ranged from 16 ppb to 28 ppb and occurred within 26 days after flooding. Researchers reported that daily concentrations in runoff water declined with time and generally remained below 5 ppb by 37 days after flooding in all fields. Note that use of carbofuran on rice has been discontinued since 1997.

In Indiana, a study was conducted from 1985 to 1991 to determine field-scale pesticide and nutrient losses to subsurface tile drains as a function of tile drain spacing. Granular carbofuran was applied to corn in-furrow and t-banded above the seed furrow in the spring. The study notes that carbofuran moved into the tile drains, and the movement of carbofuran into the tile drains was associated with precipitation events. In the drains, the concentration of carbofuran was initially high and decreased after each subsequent precipitation event.

A third study, conducted in Hereford, United Kingdom, involved sampling a stream that collects water from an extensive tile drainage network. The researchers collected samples after granular carbofuran was broadcast on field which had previously been sown with oilseed rape (canola). Generally, the concentration of carbofuran decreased as time progressed after application of the pesticide.

The absence of contemporary targeted monitoring coupled with reductions in maximum application rates in 1998 on a subset of soils for some crops (corn and potatoes) and the temporal and spatial resolution of the monitoring complicates the interpretation of the above mentioned targeted monitoring data. Actual application rates in specific fields are not documented in most monitoring studies so it is not clear whether changes in labeled maximum rates actually resulted in a corresponding decrease in application rates used by farmers and lead to reduced concentrations.

b. Ground Water

There is substantial historical ground-water monitoring for carbofuran in a number of states, as a result of contamination associated with use of this chemical on crop land in Long Island, NY where, 20 years after use was prohibited, carbofuran is still reported in a few drinking water wells (up to 4.3 ppb). Most of the groundwater monitoring data that was targeted to areas where carbofuran was applied was collected in the 1980s and early 1990s. These include drainage canal and tile drain studies, groundwater monitoring by several state agencies and Suffolk County, New York, as well as a prospective ground water monitoring study conducted by the registrant. These studies resulted in the highest detections of carbofuran on record (e.g.176 ppb in Suffolk County).

G. Recent Changes in Carbofuran Registration

Carbofuran underwent recent changes regarding registered crop use. The changes include modification of a section 3 label for granular carbofuran (EPA Reg. No. 279-2712) eliminating the use of carbofuran on cranberries. In addition, two section 24c labels, state local need, were cancelled for use on cranberry (OR8300026) and flax (ND850006) crops. The Carbofuran Use Closure Memo, Attachment F, denotes the recent use changes.

H. Existing Protections

i. U.S. Fish and Wildlife Service Biological Opinions

Six Biological Opinions have been rendered by the FWS addressing the risk of the use of carbofuran to endangered and threatened species. Five of the six opinions addressed both the granular and flowable formulations. Only one biological opinion, the corn cluster opinion revised on September 14, 1989, addressed jeopardy to aquatic fish. The biological opinion notes jeopardy to aquatic fish and provided reasonable and prudent alternatives (RPAs) along with reasonable and prudent measures (RPMs).

ii. Protection Statements on the National Labels (section 3 labels)

The current label (EPA Reg. No. 279-2876) for flowable carbofuran with 44.0% active ingredient states in the environmental hazard section:

- "This product is toxic to fish, birds and other wildlife. Birds feeding on treated areas may be killed. For waterfowl protection, do not apply immediately before or during irrigation, or on fields in proximity of waterfowl nesting areas, or on fields where waterfowl are known to repeatedly feed. Drift and runoff from treated areas may be hazardous to fish in neighboring areas. Do not dispose of equipment washwater or rinsate in streams, lakes or other surface water bodies.

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark."

- "Notice: It is a federal offense to use any pesticide in a manner that results in the death of a member of an endangered species. The use of Furadan 4F insecticide-nematicide may pose a hazard to Federally designated endangered/threatened species. Suggested measures to protect endangered species in your county may exist in an EPA "Interim Measures" pamphlet. You may call EPA's Endangered Species Hotline (1-800-447-3818) to find out if an "Interim Measures" pamphlet exists for your county and have one sent to you. You also can consult your local county extension office or pesticide state lead agency to determine whether they have imposed any requirements in your area to protect endangered and threatened species."

- "This product is highly toxic to bees exposed to direct treatment or residues on crops. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area. Protective information may be obtained from your Cooperative Agricultural Extension Service."

- "Carbofuran is a chemical which can travel (seep or leach) through soil and can contaminate groundwater which may be used as drinking water. Carbofuran has been found in groundwater as a result of agricultural use. Users are advised not to apply carbofuran where the water table (groundwater) is close to the surface and where the soils are very permeable, i.e., well-drained soils such as loamy sands. Your local agricultural agencies can provide further information on the type of soil in your area and the location of groundwater."

The current label (EPA Reg. No. 279-2876) for flowable carbofuran with 44.0% active ingredient states in the spray drift management hazard section:

- "Sensitive Areas: Risk of exposure to adjacent areas that are known habitat for threatened or endangered species can be reduced by avoiding applications when wind direction is toward the sensitive area."

The current label (EPA Reg. No. 279-2876) for flowable carbofuran with 44.0% active ingredient states for potato and small grains (wheat, oats, barley) uses the following:

- "For waterfowl protection do not apply on fields in proximity of waterfowl nesting areas and/or on fields where waterfowl are known to repeatedly feed."

The current label (EPA Reg. No. 279-3023) for granular carbofuran with 15.0% active ingredient has a similar environmental hazard section as flowable carbofuran with 44.0% active ingredient (EPA Reg. No. 279-2876). Additionally, the granular label states the following in the environmental hazard section:

- "The use of Furadan 15G may pose a hazard to the following Federally

designated endangered/threatened species known to be found in certain areas within the named locations."
"Attwater's Greater Prairie Chicken - Texas counties including: Aransas, Austin, Brazoria, Colorado, Gollad, Harris, Refugio and Victoria"; "Aleutian Canada Goose - California counties including Colusa, Merced, Stanislaus, and Sutter"; "Kern Primrose Sphinx Moth - Walker Basin of Kern County, California"

The current label (EPA Reg. No. 279-2922) for granular carbofuran with 5.0% active ingredient has a similar environmental hazard section as the granular carbofuran label (EPA Reg. No. 279-3023) with 15.0% active ingredient. The environmental hazard section notes that carbofuran is toxic to wildlife and may contaminate ground water.

iii. Protection Statements on State and Local Need Labels (section 24c labels)

The current Washington state local need label (EPA SLN No. WA860012) for granular carbofuran with 15.0% active ingredient notes the following restrictions:

- "Furadan 15G is toxic to fish, birds and other wildlife. Birds feeding on treated areas may be killed. Birds killed by Furadan 15G pose a hazard to eagles, hawks and other birds of prey; contact the Washington Department of Fish & Wildlife or the US Fish and Wildlife Service upon finding birds or other animals that may have been poisoned. Incorporate any spills immediately to prevent birds from contacting exposed granules. Runoff from treated areas may be hazardous to fish in neighboring areas. Do not apply directly to water. Do not contaminate wells, wetlands or any body of water by cleaning of equipment or disposal of wastes."

- "Notice: It is a violation of the Federal Migratory Bird Treaty Act to use any pesticide in a manner that results in the death of a migratory bird."

iv. California Department of Pesticide Regulation Bulletins

Carbofuran is also included in bulletins for California. There, the CA DPR in the California Environmental Protection Agency creates county bulletins consistent with those developed by OPP. However, California also has a system of County Agricultural Commissioners responsible for pesticide regulation, and all agricultural and commercial applicators must get a permit for the use of any restricted use pesticide and must report all pesticide use, restricted or not. The California bulletins for protecting endangered species have been in use for approximately 5 years. Although they are currently "voluntary" in nature, the Agricultural Commissioners strongly promote their use by pesticide applicators. Carbofuran is currently included in these bulletins for the protection of aquatic organisms. The specific limitations are:

- Do not use in currently occupied habitat (see Species Descriptions table for possible exceptions)

- Provide a 20 foot minimum strip of vegetation (on which pesticides should not be applied) along rivers, creeks, streams, wetlands, vernal ponds and stock ponds or on the downhill side of fields where run-off by proper leveling, etc. Contain as much water "on-site" as possible. The planting of legumes, or other cover crops for several rows adjacent to off-target water sites is recommended. Mix pesticides in areas not prone to runoff such as concrete mixing/loading pads, disked soil in flat terrain or graveled mix pads, or use a suitable method to contain spills and/or rinsate. Properly empty and triple-rinse pesticide containers at the time of use.

- Conduct irrigations efficiently to prevent excessive loss of irrigation waters through run-off. Schedule irrigations and pesticide applications to maximize the interval of time between the pesticide application and the first subsequent irrigation. Allow at least 24 hours between the application of pesticides listed in this bulletin and any irrigation that results in surface run-off into natural waters. Time applications to allow sprays to dry prior to rain or sprinkler irrigations. Do not make aerial applications while irrigation water is on the field unless surface run-off is contained for 72 hours following the application.

- For sprayable or dust formulations: when the air is calm or moving away from the habitat, commence applications on the side nearest the habitat and proceed away from the habitat. When air currents are moving toward habitat, do not make applications within 200 yards by air or 40 yards by ground upwind from occupied habitat. The county agricultural commissioner may reduce or waive buffer zones following a site inspection, if there is an adequate hedgerow, windbreak, riparian corridor, or other physical barrier that substantially reduces the possibility of drift.

Agricultural and other commercial applicators are well sensitized to the need for protecting endangered and threatened species. CA DPR believes that the vast majority of agricultural applicators in California are following the limitations in these bulletins (Richard Marovich, 2002)

OPP currently has proposed (67 *Federal Register* 231, 71549-71561, December 2, 2002) a final implementation program that includes labeling products to require pesticide applicators to follow provisions in county bulletins. The comment period has closed, and a final *Federal Register* notice is under development and is anticipated to be published in March 2005. After this notice becomes final, it is expected that pesticide registrants will be required, as appropriate, to put on their products label statements mandating that applicators follow the label and county bulletins. It is also anticipated that these will be enforceable under FIFRA, including the California bulletins. Any measures necessary to protect T&E salmon and steelhead from carbofuran would most likely be promulgated through this system.

I. Discussion and General Risk Conclusions for Carbofuran

i. Estimated Environmental Concentrations (EECs) of Carbofuran in the Environment

In the EFED Science Chapter, carbofuran aquatic EECs were estimated using the tier 2 PRZM-EXAMS surface water models. The models consider that a 10-hectare watershed will all be treated with the minimum rate, maximum rate, maximum numbers of applications, and minimum intervals between applications. Runoff and drift from this 10-hectare watershed will go into a 1.0 hectare pond that is 2 meters deep. The fate properties of carbofuran used in the models are provided in table 22.

Table 22. Carbofuran Fate Properties Used in the PRXMS-EXAMS Models (EFED Science Chapter)

Fate Property	Value
Molecular weight	221
Aqueous solubility (mg/liter)	700[1]
Hydrolysis half-life (days), pH 7[1]	28
Aqueous photolysis half-life (days), neutral pH[1]	6
Aerobic soil metabolism half-life (days)	321
Aerobic aquatic metabolism half-life (days)	no data (642)[2]
Anaerobic (biotic) soil metabolism (days)	624
Vapor pressure (torrs)	6 x 10^{-7}
K_{oc} (ml/g)	30

1 The pH in water is 7 in the standard scenario.
2 Used aerobic soil metabolism times 2, guideline approach if there is no aerobic metabolism half-life data.

The resulting EECs are presented in table 23. These EECs are based on maximum application rates for registered uses of carbofuran. Three of the crop sites were based on climate and soils that are not likely to be representative of the western United States. Two sites, alfalfa and grapes in California, are representative of the western United States.

Table 23. Estimated Environmental Concentrations (EECs) (ppb) for Aquatic Exposure Modeled with PRZMS-EXAMS (EFED Science Chapter)

Crop Site	Maximum Application Rate & Method	EECs (ppb)		
		Acute	21-day Average	60-day Average
Alfalfa, CA	1 foliar application at 1.0 lbs a.i./A	6.0	4.6	3.0
Alfalfa, PA	1foliar application at 1.0 lbs a.i./A	7.9	6.2	4.1

Cotton, MS	1 application at planting in-furrow at 0.08 lbs a.i./1,000 feet of row (1.0 lbs a.i./A with 40 inch row spacing)	11	8.2	5.5
Grapes, CA	1 broadcast application at 10.0 lbs a.i./A to soil surface between rows	5.5	4.2	2.7
Potatoes, ME	2.0 applications at 1.0 lbs a.i./A	26	21	14

Additional efforts were made by EFED to use more recently developed sites to be more representative of the areas where Pacific salmon and steelhead occur. The additional EECs were calculated using the maximum application rate for registered uses of carbofuran. EFED provided western PRZMS-EXAMS results, presented in table 24, for artichokes, cotton, and potatoes (Attachment G).

Table 24. Estimated Environmental Concentrations (EECs) (ppb) for Aquatic Exposure Modeled with PRZMS-EXAMS (EFED Memo)

Crop Site	Maximum Application Rate (Method)	EECs (microgram / liter)		
		Acute	21-day Average	60-day Average
Artichokes, CA	2.0 lbs a.i./A (ground spray)	35	28	19
Cotton, CA	1.0 lbs a.i./A (in-furrow)	0.8	0.6	0.4
Potatoes, ID[1]	2.0 lbs a.i./A (foliar)	6.2	5.1	4.0
	3.0 lbs a.i./A (at planting in-furrow)	0.2	0.2	0.1
	6.0 lbs a.i./A (sprinkler irrigation)	10.4	8.0	6.2

1 Three application methods were modeled for use of carbofuran on potatoes in Idaho. This analysis will focus on the foliar application because most carbofuran use on potatoes in the Pacific-Northwest is to control Colorado potato beetle and the flea beetle.

A comparison of the EEC values for California and the Pacific-Northwest states indicate that the values are lower as compared to eastern states for the same crops and carbofuran treatments. This difference is primarily due to the drier weather conditions in the western United States along with differences in the soil profiles.

The PRZMS-EXAMS models are conservative for salmon and steelhead. While first order streams may be reasonably predicted for a single application, salmon and steelhead (except sockeye) occur primarily in streams and rivers where natural flow of water, and any contaminants in the water column, will move downstream precluding continued exposure from a single application. Multiple applications may provide for chronic exposure, most likely in pulsed mode.

ii. Risk Quotients for Carbofuran Uses

The risk quotients are calculated by comparing the EEC values to the toxicity values and presented in table 25. Based solely on the most sensitive species and maximum estimated environmental concentrations (EECs), the criteria of concern (RQ > 0.05) for carbofuran are exceeded for direct acute effects on fish from all modeled uses except cotton grown in California. The level of concern is not exceeded for direct chronic effects to fish. With respect to the acute and chronic indirect effects that carbofuran may have on invertebrate food sources for threatened and endangered salmon and steelhead, the level of concern is exceeded for artichokes grown in California.

Table 25. Risk Quotients (RQ) for Freshwater Fish and Invertebrates[1]

Crop	Peak EEC	Acute Fish RQ	Acute Invertebr. RQ	21-day EEC	Chronic Invertebr. RQ	60-day EEC	Chronic Fish RQ
Alfalfa, CA	6.0	0.07	0.21	4.6	0.47	3.0	0.12
Artichokes, CA	35	0.40	1.21	28	2.86	19	0.77
Cotton, CA	0.8	0.01	0.03	0.6	0.06	0.4	0.02
Grape, CA	5.5	0.06	0.19	4.2	0.43	2.7	0.11
Potatoes, ID (foliar)	6.2	0.07	0.21	5.1	0.52	4.0	0.16

1 Based on fish LC50 (bluegill sunfish) = 88 ppb; Invertebrate LC50 (waterflea) = 29 ppb; Chronic fish NOAEC (rainbow trout) = 24.8 ppb; Chronic invertebrate NOAEC (waterflea) = 9.8 ppb. Acute RQ = peak EEC / LC50; Chronic fish RQ = 60-day EEC / Chronic fish NOAEC; Chronic invertebrate RQ = 21-day EEC / invertebrate NOAEC.

Fish

With a most sensitive fish LC_{50} of 88 ppb, the Level of Concern (LOC) for direct acute effects for endangered species would be exceeded when carbofuran concentrations in water exceed 4.4 ppb [RQ for direct effects to endangered species = concentration of carbofuran / LC50 of most sensitive fish; 0.05 = concentration of carbofuran / 88 ppb]. For alfalfa, grapes, and potatoes, the LOC is slightly exceeded for direct acute effects to endangered and threatened fish. The LOC is modestly exceeded for artichokes. The level of concern for chronic risk to endangered species fish would be exceeded when carbofuran concentrations in water exceed 24.8 ppb [RQ for chronic risk to endangered species = concentration of carbofuran / NOAEC for fish; 1.0 = concentration of carbofuran / 24.8 ppb]. The chronic level of concern is not exceeded for any of the modeled scenarios.

Invertebrates

The LOCs for indirect acute effects through loss of the invertebrate food supply would be exceeded when the aquatic concentration of carbofuran exceeded 14.5 ppb for acute risk and 9.8 ppb for chronic risk. This occurs with the artichoke scenarios for both acute and chronic risks. Therefore, the use of carbofuran on artichokes presents indirect risks to listed salmon and steelhead through loss of their food supply. However, chronic risks to invertebrates are not generally expected in flowing waters, but this risk could adversely impact aquatic invertebrates inhabiting lentil waters.

Conclusions

To conclude, the use of a farm pond to model exposure to specie that inhabit fast-flowing streams and the use of carbofuran at rates less than the modeled maximum label rates indicates that the EEC values used to calculate risk are greater than would normally be expected in salmonid bearing waters. The models indicated a slight exceedance of the direct acute risks to fish when carbofuran is applied to alfalfa, grape, and potato crops. Given the slight exceedance values and conservative features of the model the acute risk to fish may be modest.

The models indicate that carbofuran use on artichokes poses a direct acute risk to fish along with an indirect acute and chronic risk to invertebrates. Despite the exceedances of the LOC, the usage data suggests that the risk to salmon and steelhead is modest. The CA DPR reported in 2002 that a total of 527 pounds of carbofuran was applied to 1,662 acres in California which grows 100% of the United States artichoke crop. Artichokes are grown in eight counties in California, whereby four counties (Monterey, San Joaquin, Santa Barbara, Ventur) are within the salmon and steelhead ESUs. Given the small reported usage amount and large geographic area where artichokes are grown it is unlikely that this carbofuran usage will affect the salmon and steelhead.

4. Description of Pacific Salmon and Steelhead Evolutionarily Significant Units (ESU) Relative to Carbofuran Use Sites

Please note that OPP will be transmitting a separate analysis of ESU locations and their critical habitat to NMFS. We have noted this in previous consultation requests, but it is taking somewhat longer then anticipated. This analysis will include what we perceive to be the most appropriate boundaries for designated critical habitat. We will be requesting comments from NMFS on the counties to be included. Depending upon NMFS comments, we will make any corrections and then will compare the results with those consultation packages previously transmitted. We do not believe that any corrections will materially change the risk assessments. However, adjustments may result in changes on where protective measures need to be taken after consultation is completed. We are not asking for comments on ESU locations as part of this particular package. All charts referenced in the following section are located in attachment H for California data and attachment I for Idaho, Oregon, and Washington states data.

(a) Chinook Salmon

Chinook salmon *(Oncorhynchus tshawytscha)* is the largest salmon species; adults weighing over 120 pounds have been caught in North American waters. Like other Pacific salmon, chinook salmon are anadromous and die after spawning.

Juvenile stream-and ocean-type chinook salmon have adapted to different ecological niches. Ocean-type chinook salmon, commonly found in coastal streams, tend to utilize estuaries and coastal areas more extensively for juvenile rearing. They typically migrate to sea within the first three months of emergence and spend their ocean life in coastal waters. Summer and fall runs predominate for ocean-type chinook. Stream-type chinook are found most commonly in headwater streams and are much more dependent on freshwater stream ecosystems because of their extended residence in these areas. They often have extensive offshore migrations before returning to their natal streams in the spring or summer months. Stream-type smolts are much larger than their younger ocean-type counterparts and are therefore able to move offshore relatively quickly.

Coast wide, chinook salmon typically remain at sea for 2 to 4 years, with the exception of a small proportion of yearling males (called jack salmon) which mature in freshwater or return after 2 or 3 months in salt water. Ocean-type chinook salmon tend to migrate along the coast, while stream-type chinook salmon are found far from the coast in the central North Pacific. They return to their natal streams with a high degree of fidelity. Seasonal “runs” (i.e., spring, summer, fall, or winter), which may be related to local temperature and water flow regimes, have been identified on the basis of when adult chinook salmon enter freshwater to begin their spawning migration. Egg deposition must occur at a time to ensure that fry emerge during the following spring when the river or estuary productivity is sufficient for juvenile survival and growth.

Adult female chinook will prepare a spawning bed, called a REDs, in a stream area with suitable gravel composition, water depth and velocity. After laying eggs in a REDs, adult chinook will guard the REDs from 4 to 25 days before dying. Chinook salmon eggs will hatch, depending upon water temperatures, between 90 to 150 days after deposition. Juvenile chinook may spend from 3 months to 2 years in freshwater after emergence and before migrating to estuarine areas as smolts, and then into the ocean to feed and mature. Historically, chinook salmon ranged as far south as the Ventura River, California, and their northern extent reaches the Russian Far East.

(1) California Coastal Chinook Salmon ESU

The California coastal chinook salmon ESU was proposed as threatened in 1998 (63FR11482-11520, March 9, 1998) and listed on September 16, 1999 (64FR50393-50415). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches and estuarine areas accessible to listed chinook salmon from Redwood Creek (Humboldt County, California) to the Russian River (Sonoma County, California), inclusive.

The hydrologic units and upstream barriers are Mad-Redwood, Upper Eel (upstream barrier - Scott Dam), Middle Fort Eel, Lower Eel, South Fork Eel, Mattole, Big-Navarro-Garcia, Gualala-Salmon, Russian (upstream barriers - Coyote Dam; Warm Springs Dam), and Bodega

Bay. Counties included within this ESU are Humboldt, Trinity, Mendocino, Sonoma, and Marin. A small portion of Glenn County is also included in the Critical Habitat. A small portion of Lake County contains habitat for this ESU, but is entirely within the Mendocino National Forest.

Table 1 in attachment H contains usage information for the California counties supporting the Coastal Chinook Salmon ESU. Approximately 20 pounds of carbofuran is applied to 75 acres of cotton. The small amount of carbofuran applied in this ESU leads me to conclude that the use of carbofuran will have no effect on the California Coastal Chinook Salmon ESU.

(2) Central Valley Spring-run Chinook Salmon ESU

The Central Valley Spring-run chinook salmon ESU was proposed as threatened in 1998 (63FR11482-11520, March 9, 1998) and listed on September 16, 1999 (64FR50393-50415). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches accessible to listed chinook salmon in the Sacramento River and its tributaries in California, along with the downstream river reaches into San Francisco Bay, north of the Oakland Bay Bridge, and to the Golden Gate Bridge.

Hydrologic units and upstream barriers within this ESU are the Sacramento-Lower Cow-Lower Clear, Lower Cottonwood, Sacramento-Lower Thomes (upstream barrier - Black Butte Dam), Sacramento-Stone Corral, Lower Butte (upstream barrier - Centerville Dam), Lower Feather (upstream barrier - Oroville Dam), Lower Yuba, Lower Bear (upstream barrier – Camp Far West Dam), Lower Sacramento, Sacramento-Upper Clear (upstream barriers – Keswick Dam, Whiskeytown dam), Upper Elder-Upper Thomes, Upper Cow-Battle, Mill-Big Chico, Upper Butte, Upper Yuba (upstream barrier - Englebright Dam), Suisin Bay, San Pablo Bay, and San Francisco Bay. Salmon and steelhead habitat are located in the counties of Shasta, Tehama, Butte, Glenn, Colusa, Sutter, Yolo, Yuba, Placer, Sacramento, Solano, Nevada, Contra Costa, Napa, Alameda, Marin, Sonoma, San Mateo, and San Francisco.

Table 2 in attachment H contains usage information for the California counties supporting the Central Valley spring-run chinook salmon ESU. There is a moderate amount of carbofuran usage within this ESU. Given the usage of 7,267 pounds of carbofuran on alfalfa, cotton, artichoke crops in eleven counties, the likelihood for effects from these uses seems low, especially in conjunction with the county bulletins. The predominate crop in this ESU is alfalfa which slightly exceeded the level of concern for acute risk to endangered and threatened fish. Note that models used in this assessment considered the maximum application rate for the total crop which results in a conservation valuation of risk. Therefore, I conclude that the use of carbofuran may affect, but is not likely to adversely affect, the Central Valley Spring-run Chinook Salmon ESU.

(3) Lower Columbia River Chinook Salmon ESU

The Lower Columbia River chinook salmon ESU was proposed as threatened in 1998

(63FR11482-11520, March 9, 1998) and listed a year later (64FR14308-14328, March 24, 1999). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches accessible to listed chinook salmon in Columbia River tributaries between the Grays and White Salmon Rivers in Washington and the Willamette and Hood River in Oregon, inclusive, along with the lower Columbia River reaches to the Pacific Ocean.

The hydrologic units and upstream barriers are the Middle Columbia-Hood (upstream barriers - Condit Dam, The Dalles Dam), Lower Columbia-Sandy (upstream barrier - Bull Run Dam 2), Lewis (upstream barrier - Merlin Dam), Lower Columbia-Clatskanie, Upper Cowlitz, Lower Cowlitz, Lower Columbia, Clackamas, and the Lower Willamette. Salmon habitat is located in the counties of Hood River, Wasco, Clatsop, Columbia, Clackamas, Marion, Multnomah, and Washington in Oregon, and Klickitat, Skamania, Clark, Cowlitz, Lewis, Wahkiakum, Pierce, and Pacific in Washington.

Table 3 in attachment I shows the cropping information for Oregon and Washington counties where the Lower Columbia River chinook salmon ESU occurs. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

There is a modest amount of carbofuran, 71,469 pounds, applied to approximately 46,000 acres within this ESU to treat alfalfa, grape, and potato crops. Because the level of concern for direct acute risks was slightly exceeded for the alfalfa, grape, and potato models, I conclude that use of carbofuran may affect, but is not likely to affect the Lower Columbia River Chinook Salmon ESU.

(4) Puget Sound Chinook Salmon ESU

The Puget Sound chinook salmon ESU was proposed as threatened in 1998 (63FR11482-11520, March 9, 1998) and listed a year later (64FR14308-14328, March 24, 1999). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all marine, estuarine, and river reaches accessible to listed chinook salmon in Puget Sound and its tributaries, extending out to the Pacific Ocean.

The hydrologic units and upstream barriers are the Strait of Georgia, San Juan Islands, Nooksack, Upper Skagit, Sauk, Lower Skagit, Stillaguamish, Skykomish, Snoqualmie (upstream barrier - Tolt Dam), Snohomish, Lake Washington (upstream barrier – Landsburg Diversion), Duwamish, Puyallup, Nisqually (upstream barrier - Alder Dam), Deschutes, Skokomish, Hood Canal, Puget Sound, Dungeness-Elwha (upstream barrier - Elwha Dam). Affected counties in Washington are Skagit, Whatcom, San Juan, Island, Snohomish, King, Pierce, Thurston, Lewis, Grays Harbor, Mason, Clallam, Jefferson, and Kitsap.

Table 4 in attachment I shows the acreage information for Washington counties where the Puget Sound chinook salmon ESU is located. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

There is a modest amount of acreage that could potentially be treated with carbofuran within this ESU. The level of risk exceeded the level of concern for the following crops grown in this ESU: alfalfa, artichokes, grapes, and potatoes. Using the 1997 USDA Agricultural Census data it is estimated that 59,773 pounds of carbofuran will be applied to approximately 0.12% of the total acres in this ESU. Though the modest amount of carbofuran is applied to a small portion of the total ESU acreage, the likelihood for effects from these uses seems low, but cannot be precluded. Therefore, I concluded that the use of carbofuran may affect, but is not likely to adversely affect the Puget Sound Chinook Salmon ESU.

(5) Sacramento River Winter-run Chinook Salmon ESU

The Sacramento River Winter-run chinook was emergency listed as threatened with critical habitat designated in 1989 (54FR32085-32088, August 4, 1989). This emergency listing provided interim protection and was followed by (1) a proposed rule to list the winter-run on March 20, 1990, (2) a second emergency rule on April 20, 1990, and (3) a formal listing on November 20, 1990 (59FR440-441, January 4, 1994). A somewhat expanded critical habitat was proposed in 1992 (57FR36626-36632, August 14, 1992) and made final in 1993 (58FR33212-33219, June 16, 1993). In 1994, the winter-run was reclassified as endangered because of significant declines and continued threats (59FR440-441, January 4, 1994).

Critical Habitat has been designated to include the Sacramento River from Keswick Dam, Shasta County (river mile 302) to Chipps Island (river mile 0) at the west end of the Sacramento-San Joaquin delta, and then westward through most of the fresh or estuarine waters, north of the Oakland Bay Bridge, to the ocean. Estuarine sloughs in San Pablo and San Francisco bays (including Santa Clara County) are excluded (58FR33212-33219, June 16, 1993). Counties containing habitat include Alameda, Butte, Colusa, Contra Costa, Glenn, Marin, Sacramento, San Francisco, San Mateo, Shasta, Solano, Sonoma, Sutter, Tehama, and Yolo. Spawning and growth habitat are also located in Shasta and Tehama counties.

Table 5 in attachment H shows the cropping information for California counties where the Sacramento River winter-run chinook salmon ESU is located. There is a moderate amount of carbofuran usage within this ESU mostly on alfalfa with 7,051 total pounds applied to approximately 11,130 acres in the entire ESU. The breeding area of the Sacramento River Winter-run chinook salmon is in the Sacramento River rather than tributaries. Given that the level of concern for alfalfa was only slightly exceeded for acute risk to endangered and threatened fish species and that approximately 7,171 pounds of carbofuran are applied to this entire ESU, I believe that the likelihood for effects is low. In addition, consideration must be given to the county bulletins issued by the California Department of Pesticide Regulation. I conclude that the use of carbofuran may affect, but is not likely to adversely affect the Sacramento River Winter-run Chinook Salmon ESU.

(6) Snake River Fall-Run Chinook Salmon ESU

The Snake River fall-run chinook salmon ESU was proposed as threatened in 1991 (56FR29547-29552, June 27, 1991) and listed about a year later (57FR14653-14663, April 22, 1992). Critical habitat was designated on December 28, 1993 (58FR68543-68554) to include all tributaries of the Snake and Salmon Rivers accessible to Snake River fall-run chinook salmon, except reaches above impassable natural falls and Dworshak and Hells Canyon Dams. The Clearwater River and Palouse River watersheds are included for the fall-run ESU, but not for the spring/summer run.

This chinook ESU was proposed for reclassification on December 28, 1994 (59FR66784-57403) as endangered because of critically low levels, based on very sparse runs. However, because of increased runs in subsequent years, this proposed reclassification was withdrawn (63FR1807-1811, January 12, 1998).

In 1998, NMFS proposed to revise the Snake River fall-run chinook to include those stocks using the Deschutes River (63FR11482-11520, March 9, 1998). The John Day, Umatilla, and Walla Walla Rivers would be included; however, fall-run chinook in these rivers are believed to have been extirpated. It appears that this proposal has yet to be finalized.

Hydrologic units with spawning and rearing habitat for this fall-run chinook are the Clearwater, Hells Canyon, Imnaha, Lower Grande Ronde, Lower North Fork Clearwater, Lower Salmon, Lower Snake-Asotin, Lower Snake-Tucannon, and Palouse. The proposed revision of the ESU adds the Lower Deschutes, Trout, Lower John Day, Upper John Day, North Fork - John Day, Middle Fork - John Day, Willow, Umatilla, and Walla Walla hydrologic units. It appears that no additions have been proposed for Washington tributaries to the Columbia River. In this ESU, spawning and growth habitat are located in Idaho in Adams, Benewah, Clearwater, Idaho, Latah, Lewis, Nez Perce, Shoshone, and Valley counties; in Washington state in Adams, Asotin, Columbia, Franklin, Garfield, Lincoln, Spokane, Walla Walla, and Whitman counties; and in Oregon in Union and Wallowa counties. Migration corridors are located in Washington in Benton, Clark, Cowlitz, Klickitat, Pacific, Skamania, Wahkiakum, and Walla Walla counties; and in Oregon in Clatsop, Columbia, Gilliam, Hood River, Morrow, Multnomah, Sherman, Umatilla, and Wasco counties.

Table 6 in attachment I shows the cropping information for Pacific Northwest counties where the Snake River fall-run chinook salmon ESU is located and for the Oregon and Washington counties where this ESU migrates. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

A substantial amount of acreage could potentially be treated with carbofuran within this ESU. Alfalfa, grapes, and potatoes crops are grown within the Snake River Fall-Run for Chinook salmon. Approximately 1.3 million pounds of carbofuran could be applied to the abovementioned crops in this ESU. It is estimated that approximately 680,000 pounds of carbofuran could be applied in the migration residency for chinook salmon. In addition, 740,000 pounds could be applied in the spawning and growth residency area. Given that there is substantial agricultural usage in most counties within this ESU, the likelihood for effects from these uses cannot be precluded. Therefore, I conclude that the use of carbofuran may affect the Snake River Fall-run Chinook Salmon ESU.

(7) Snake River Spring / Summer-Run Chinook Salmon

The Snake River Spring/Summer-run chinook salmon ESU was proposed as threatened in 1991 (56FR29542-29547, June 27, 1991) and listed about a year later (57FR14653-14663, April 22, 1992). Critical habitat was designated on December 28, 1993 (58FR68543-68554) to include all tributaries of the Snake and Salmon Rivers (except the Clearwater River) accessible to Snake River spring/summer chinook salmon. Like the fall-run chinook, the spring/summer-run chinook ESU was proposed for reclassification on December 28, 1994 (59FR66784-57403) as endangered because of critically low levels, based on very sparse runs. However, because of increased runs in subsequent years, this proposed reclassification was withdrawn (63FR1807-1811, January 12, 1998).

Hydrologic units in the potential spawning and rearing areas include Hells Canyon, Imnaha, Lemhi, Little Salmon, Lower Grande Ronde, Lower Middle Fork Salmon, Lower Salmon, Lower Snake-Asotin, Lower Snake-Tucannon, Middle Salmon-Chamberlain, Middle Salmon-Panther, Pashimerol, South Fork Salmon, Upper Middle Fork Salmon, Upper Grande Ronde, Upper Salmon, and Wallowa. Areas above Hells Canyon Dam are excluded, along with unnamed “impassable natural falls.” Napias Creek Falls, near Salmon, Idaho, was later named an upstream barrier (64FR57399-57403, October 25, 1999). The Grande Ronde, Imnaha, Salmon, and Tucannon subbasins, and Asotin, Granite, and Sheep Creeks were specifically named in the Critical Habitat Notice.

Spawning and rearing counties include Union, Wallowa, and Baker counties in Oregon; Adams, Custer, Idaho, Lemhi, Lewis, Nez Perce, and Valley counties in Idaho; and Asotin, Columbia, Franklin, Garfield, and Whitman counties in Washington. Other counties within migratory corridors are all of those down stream from the confluence of the Snake and Columbia Rivers: Umatilla, Morrow, Gilliam, Sherman, Wasco, Hood River, Multnomah, Columbia, and Clatsop Counties in Oregon; and Klickitat, Skamania, Clark, Cowlitz, Wahkiakum, Benton, and Walla Walla Counties in Washington. Salmon habitat is also located in Blaine County in Idaho.

Table 7 in attachment I show the crop-acreage information for Oregon and Washington counties where the Snake River spring/summer-run chinook salmon ESU occurs. If there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

There is a substantial amount of alfalfa, grape, and potato crop acreage that could potentially be treated with carbofuran in this ESU. In the habitat residency approximately 74,000 pounds could be applied to 53,682 acres. In the migration residency area approximately 680,000 pounds of carbofuran could be applied to approximately 200,000 acres. Also, 471,812 pounds could be applied to approximately 260,000 acres in the spawning and growth areas. Given that over 1 million pounds of carbofuran may be applied in this ESU, the likelihood for effects from these uses cannot be precluded. Therefore, I conclude that the use of carbofuran may affect the Snake River Spring / summer-run Chinook Salmon ESU.

(8) Upper Columbia River Spring-Run Chinook Salmon ESU

The Upper Columbia River Spring-run Chinook Salmon ESU was proposed as endangered in 1998 (63FR11482-11520,March 9,1998) and listed a year later (64FR14308-14328, March 24, 1999). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches accessible to listed chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River, as well as all down stream migratory corridors to the Pacific Ocean. Hydrologic units and their upstream barriers are Chief Joseph (Chief Joseph Dam), Similkameen, Methow, Upper Columbia-Entiat, Wenatchee, Upper Columbia-Priest Rapids, Middle Columbia-Lake Wallula, Middle Columbia-Hood, Lower Columbia-Sandy, Lower Columbia-Clatskanie, Lower Columbia, and Lower Willamette. Counties in which spawning and rearing occur are Chelan, Douglas, Okanogan, Grant, Benton, and Kittitas Counties in Washington.. Migratory corridors include Clatsop, Columbia, Gilliam, Hood River, Morrow, Multnomah, Sherman, Umatilla, and Wasco Counties in Oregon; and Clark, Cowlitz, Franklin, Klickitat, Pacific, Skamania, Wahkiakum, Walla Walla, and Yakima Counties in Washington.

Table 8 in attachment I shows the cropping information for Washington counties that support the Upper Columbia River spring-run chinook salmon ESU and for the Oregon and Washington counties where this ESU migrates. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

There is a substantial amount of acreage that could potentially be treated with carbofuran within this ESU. Though grapes and potatoes are grown in this ESU, the predominate crop treated with carbofuran and grown in this ESU is alfalfa. The models indicate that alfalfa treated with carbofuran slightly exceeded the level of concern for acute risk to endangered and threatened fish. Given the total potential amounts of carbofuran applied to alfalfa, grapes, and potatoes in migratory area is over 870,000 pounds and over 770,000 pounds in spawning and growth areas, the likelihood for effects from these uses cannot be precluded. In the migratory area, only 1.13% of the total ESU would be potentially treated with carbofuran if 100% of the crop acres are treated. In the spawning and growth area, only 0.93 % of the total ESU would be treated with carbofuran if 100 % of the crops were treated. Considering that over 1.5 million pounds of carbofuran potentially could be applied to this ESU, I conclude that use of carbofuran may affect the Upper Colombia River Spring-run Chinook Salmon ESU.

(9) Upper Willamette River Chinook Salmon ESU

The Upper Willamette River Chinook Salmon ESU was proposed as threatened in 1998

(63FR11482-11520, March 9, 1998) and listed a year later (64FR14308-14328, March 24, 1999). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches accessible to listed chinook salmon in the Clackamas River and the Willamette River and its tributaries above Willamette Falls, in addition to all down stream river reaches of the Willamette and Columbia Rivers to the Pacific Ocean.

The hydrologic units included are the Lower Columbia-Sandy, Lower Columbia-Clatskanie, Lower Columbia, Middle Fork Willamette, Coast Fork Willamette (upstream barriers - Cottage Grove Dam, Dorena Dam), Upper Willamette (upstream barrier - Fern Ridge Dam), McKenzie (upstream barrier - Blue River Dam), North Santiam (upstream barrier – Big Cliff Dam), South Santiam (upstream barrier - Green Peter Dam), Middle Willamette, Yamhill, Molalla-Pudding, Tualatin, Clackamas, and Lower Willamette. Spawning and rearing habitat is in the Oregon counties of Clackamas, Douglas, Lane, Benton, Linn, Polk, Marion, Yamhill, and Washington. Migration corridors include Multnomah, Columbia, and Clatsop Counties in Oregon, and Clark, Cowlitz, Wahkiakum, and Pacific Counties in Washington. Other habitat is located in Lincoln and Tillamook Counties in Oregon.

Table 9 in attachment I shows the cropping information for Oregon counties where the Upper Willamette River chinook salmon ESU occurs and for the Oregon and Washington counties where this ESU migrates. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

In the habitat residency portion of this ESU, only 10 pounds of carbofuran is applied to approximately 1 acre of grapes. Approximately 4,500 pounds of carbofuran is applied to alfalfa, grape, and potato crops in the migration area. In addition, an estimated 88,200 pounds of carbofuran is applied to 5,100 acres in the spawning and growth residency portion of this ESU. In total, approximately 92,000 pounds of carbofuran could be applied to 7,446 acres within this ESU with the 75,810 pounds being applied to 7,581 acres of grape crops. For alfalfa, grapes, and potato crops the models indicated a potential direct acute risk to fish. Given the modest amount of carbofuran applied to this ESU and the low potential acute risk to fish, I conclude that carbofuran use may affect, but is not likely to affect the Upper Willamette River Chinook Salmon ESU.

(b) Chum Salmon

Chum salmon, *Oncorhynchus keta*, have the widest natural geographic and spawning distribution of any Pacific salmonid, primarily because its range extends farther along the shores of the Arctic Ocean. Chum salmon have been documented to spawn from Asia around the rim of the North Pacific Ocean to Monterey Bay in central California. Presently, major spawning populations are found only as far south as Tillamook Bay on the northern Oregon coast.

Most chum salmon mature between 3 and 5 years of age, usually 4 years, with younger fish being more predominant in southern parts of their range. Chum salmon usually spawn in coastal areas, typically within 100 km of the ocean where they do not have surmount river blockages and falls. However, in the Skagit River, Washington, they migrate at least 170 km. During the spawning migration, adult chum salmon enter natal river systems from June to March, depending on characteristics of the population or geographic location. In Washington, a variety of seasonal runs are recognized, including summer, fall, and winter populations. Fall-run fish predominate, but summer runs are found in Hood Canal, the Strait of Juan de Fuca, and in southern Puget Sound, and two rivers in southern Puget Sound have winter-run fish.

Reeds are usually dug in the mainstream or in side channels of rivers. Juveniles migrate out to seawater almost immediately after emerging from the gravel that covers their reeds. This means that survival and growth in juvenile chum salmon depend less on freshwater conditions than on favorable estuarine and marine conditions.

(1) Columbia River Chum Salmon ESU

The Columbia River chum salmon ESU was proposed for listing as threatened, and critical habitat was proposed, in 1998 (63FR11774-11795, March 10, 1998). The final listing was published a year later (63FR14508-14517, March 25, 1999), and critical habitat was designated in 2000 (65FR7764-7787).

Critical habitat for the Columbia River chum salmon ESU encompasses all accessible reaches and adjacent riparian zones of the Columbia River (including estuarine areas and tributaries) downstream from Bonneville Dam, excluding Oregon tributaries upstream of Milton Creek at river km 144 near the town of St. Helens. These areas are the hydrologic units of Lower Columbia-Sandy (upstream barrier - Bonneville Dam), Lewis (upstream barrier – Merlin Dam), Lower Columbia-Clatskanie, Lower Cowlitz, Lower Columbia, and Lower Willamette in the counties of Clark, Skamania, Cowlitz, Wahkiakum, Pacific, and Lewis in Washington; and Multnomah, Clatsop, Columbia, and Washington in Oregon. It appears that there are three extant populations in Grays River, Hardy Creek, and Hamilton Creek.

Table 10 attachment I shows the cropping information for Oregon and Washington counties where the Columbia River chum salmon ESU occurs. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Approximately 17,000 pounds of carbofuran could be applied in habitat areas for chum salmon. In this ESU, 1,059 acres of grapes could be treated with 10,590 pounds of carbofuran. Other crops grown in this ESU include 4,642 acres of alfalfa and 336 acres of potatoes. There is a modest amount of carbofuran applied, therefore I conclude that use of carbofuran may affect, but is not likely to adversely affect the Columbia River Chum Salmon ESU.

(2) Hood Canal Summer-Run Chum Salmon ESU

The Hood Canal summer-run chum salmon ESU was proposed for listing as threatened, and critical habitat was proposed, in 1998 (63FR11774-11795, March 10, 1998). The final listing was published a year later (63FR14508-14517, March 25, 1999), and critical habitat was designated in 2000 (65FR7764-7787).

Critical habitat for the Hood Canal ESU includes Hood Canal, Admiralty Inlet, and the straits of Juan de Fuca, along with all river reaches accessible to listed chum salmon draining into Hood Canal as well as Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington. The hydrologic units are Skokomish (upstream boundary - Cushman Dam), Hood Canal, Puget Sound, Dungeness-Elwha, in the counties of Mason, Clallam, Jefferson, Kitsap, Island, and Grays Harbor. Grays Harbor County was excluded because the very small amount of habitat is within the Olympic National Forest.

Streams specifically mentioned, in addition to Hood Canal, in the proposed critical habitat Notice include Union River, Tahuya River, Big Quilcene River, Big Beef Creek, Anderson Creek, Dewatto River, Snow Creek, Salmon Creek, Jimmy Comelately Creek, Duckabush 'stream,' Hamma Hamma 'stream,' and Dosewallips 'stream.'

Table 11 in attachment I shows the acreage of crops in these counties on which carbofuran can be used. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

There is a modest amount of acreage that could potentially be treated with carbofuran within this ESU. Therefore, along with the amount of potential use of only 4,287 pounds, I conclude that the use of carbofuran may affect, but is not likely to adversely affect Hood Canal Summer-run Chum Salmon ESU.

(c) Coho Salmon

Coho salmon, *Oncorhynchus kisutch*, were historically distributed throughout the North Pacific Ocean from central California to Point Hope, AK, through the Aleutian Islands into Asia. Historically, this species probably inhabited most coastal streams in Washington, Oregon, and central and northern California. Some populations may once have migrated hundreds of miles inland to spawn in tributaries of the upper Columbia River in Washington and the Snake River in Idaho.

Coho salmon generally exhibit a relatively simple, 3-year life cycle. Adults typically begin their freshwater spawning migration in the late summer and fall, spawn by mid-winter, then die. Southern populations are somewhat later and spend much less time in the river prior to spawning than do northern coho. Homing fidelity in coho salmon is generally strong; however their small tributary habitats experience relatively frequent, temporary blockages, and there are a number of examples in which coho salmon have rapidly recolonized vacant habitat that had only recently become accessible to anadromous fish.

After spawning in late fall and early winter, eggs incubate in reeds for 1.5 to 4 months, depending upon the temperature, before hatching as alevins. Following yolk sac absorption, alevins emerge and begin actively feeding as fry. Juveniles rear in fresh water for up to 15 months, then migrate to the ocean as “smolts” in the spring. Coho salmon typically spend two growing seasons in the ocean before returning to their natal stream. They are most frequently recovered from ocean waters in the vicinity of their spawning streams, with a minority being recovered at adjacent coastal areas, decreasing in number with distance from the natal streams. However, those coho released from Puget Sound, Hood Canal, and the Strait of Juan de Fuca are caught at high levels in Puget Sound, an area not entered by coho salmon from other areas.

(1) Central California Coast Coho Salmon ESU

The Central California Coast Coho Salmon ESU includes all coho naturally reproduced in streams between Punta Gorda, Humboldt County, CA and San Lorenzo River, Santa Cruz County, CA, inclusive. This ESU was proposed in 1995 (60FR38011-38030, July 25, 1995) and listed as threatened, with critical habitat designated, on May 5, 1999 (64FR24049-24062). Critical habitat consists of accessible reaches along the coast, including Arroyo Corte Madera Del Presidio and Corte Madera Creek, tributaries to San Francisco Bay.

Hydrologic units within the boundaries of this ESU are: San Lorenzo-Soquel (upstream barrier - Newell Dam), San Francisco Coastal South, San Pablo Bay (upstream barrier – Phoenix Dam-Phoenix Lake), Tomales-Drake Bays (upstream barriers - Peters Dam-Kent Lake; Seeger Dam-Nicasio Reservoir), Bodega Bay, Russian (upstream barriers - Warm springs dam-Lake Sonoma; Coyote Dam-Lake Mendocino), Gualala-Salmon, and Big-Navarro-Garcia. California counties included are Santa Cruz, San Mateo, Marin, Napa, Sonoma, and Mendocino. San Francisco County lies within the north-south boundaries of this ESU, but was not named in the Critical Habitat FR Notice, presumably because there are no coho salmon streams in the county, therefore it is excluded.

Reportable usage of carbofuran in counties where this ESU occurs are presented in table 12 of attachment H.

There is negligible usage of carbofuran on crops in this ESU. Given that usage of carbofuran on artichokes is reported for 10 pounds applied to 37 acres within the 4.6 million acres comprising this ESU, I conclude that the use of carbofuran will have no effect on the Central California Coast Coho Salmon ESU.

(2) Oregon Coast Coho Salmon ESU

The Oregon coast coho salmon ESU was first proposed for listing as threatened in 1995 (60FR38011-38030, July 25, 1995), and listed several years later (63FR42587-42591, August 10,
1998). Critical habitat was proposed in 1999 (64FR24998-25007, May 10, 1999) and designated on February 16, 2000 (65FR7764-7787).

This ESU includes coastal populations of coho salmon from Cape Blanco, Curry County, Oregon to the Columbia River. Spawning is spread over many basins, large and small, with higher numbers further south where the coastal lake systems (e.g., the Tenmile, Tahkenitch, and Siltcoos basins) and the Coos and Coquille Rivers have been particularly productive. Critical Habitat includes all accessible reaches in the coastal hydrologic reaches Necanicum, Nehalem, Wilson-Trask-Nestucca (upstream barrier - McGuire Dam), Siletz-Yaquina, Alsea, Siuslaw, Siltcoos, North Umpqua (upstream barriers - Cooper Creek Dam, Soda Springs Dam), South Umpqua (upstream barrier - Ben Irving Dam, Galesville Dam, Win Walker Reservoir), Umpqua, Coos (upstream barrier - Lower Pony Creek Dam), Coquille, Sixes. Related Oregon counties are Josephine, Douglas, Lane, Coos, Curry, Benton, Lincoln, Polk, Tillamook, Yamhill, Washington, Columbia, and Clatsop.

Table 13 in attachment I shows the acreage where carbofuran can be used for Oregon counties where the Oregon coast coho salmon ESU occurs. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Alfalfa, grapes, and potato crops are grown in this ESU and could potentially be treated with a total of 78,132 pounds of carbofuran. With a modest amount of carbofuran treating 0.1 % of the total ESU acres, I conclude that while the likelihood is low the use of carbofuran may affect, but is not likely to adversely affect the Oregon Coast Coho Salmon ESU.

(3) Southern Oregon / Northern California Coast Coho Salmon ESU

The Southern Oregon/Northern California coastal coho salmon ESU was proposed as threatened in 1995 (60FR38011-38030, July 25, 1995) and listed on May 6, 1997 (62FR24588-24609). Critical habitat was proposed later that year (62FR62741-62751, November 25, 1997) and finally designated on May 5, 1999 (64FR24049-24062) to encompass accessible reaches of all rivers (including estuarine areas and tributaries) between the Mattole River in California and the Elk River in Oregon, inclusive.

The Southern Oregon/Northern California Coast coho salmon ESU occurs between Punta Gorda, Humboldt County, California and Cape Blanco, Curry County, Oregon. Major basins with this salmon ESU are the Rogue, Klamath, Trinity, and Eel river basins, while the Elk River, Oregon, and the Smith and Mad Rivers, and Redwood Creek, California are smaller basins within the range. Hydrologic units and the upstream barriers are Mattole, South Fork Eel, Lower Eel, Middle Fork Eel, Upper Eel (upstream barrier - Scott Dam-Lake Pillsbury), Mad-Redwood, Smith, South Fork Trinity, Trinity (upstream barrier - Lewiston Dam-Lewiston Reservoir), Salmon, Lower Klamath, Scott, Shasta (upstream barrier - Dwinnell Dam-Dwinnell Reservoir), Upper Klamath (upstream barrier - Irongate Dam-Irongate Reservoir), Chetco, Illinois (upstream barrier - Selmac Dam-Lake Selmac), Lower Rogue, Applegate (upstream barrier – Applegate Dam-Applegate Reservoir), Middle Rogue (upstream barrier - Emigrant Lake Dam-Emigrant Lake), Upper Rogue (upstream barriers - Agate Lake Dam-Agate Lake; Fish Lake Dam-Fish Lake; Willow Lake Dam-Willow Lake; Lost Creek Dam-Lost Creek Reservoir), and Sixes.

Related counties are Humboldt, Mendocino, Trinity, Lake, and Del Norte in California and Curry, Jackson, Josephine, Klamath, and Douglas in Oregon.

Note: We previously included Klamath County, OR in this ESU, but have now omitted it because it appears to be entirely upstream of various named barriers. Again we will submit more details in a separate transmittal to NMFS.

Reportable carbofuran usage in the California counties supporting the Southern Oregon / Northern California coastal coho salmon ESU are presented in table 14 of attachment H. Approximately 1,524 pounds of carbofuran could potentially be applied to 880 acres of outdoor transplants in California. In addition, table 14 of attachment I presents the acreage where carbofuran may be used on crops in the Oregon counties where the Southern Oregon / Northern California coastal coho salmon ESU occurs. In Table 14, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available. In the Oregon counties, approximately 135,000 pounds of carbofuran could be applied to alfalfa, grape, and potato crops in this ESU. Given that there is over 100,000 pounds of carbofuran usage in this ESU, I conclude that while the likelihood is low the usage of carbofuran may affect, but is not likely to adversely affect the Southern Oregon / Northern California Coastal Coho Salmon ESU.

(d) Sockeye Salmon

Sockeye salmon, *Oncorhynchus nerka*, are the third most abundant species of Pacific salmon, after pink and chum salmon. Sockeye salmon exhibit a wide variety of life history patterns that reflect varying dependency on the fresh water environment. The vast majority of sockeye salmon typically spawn in inlet or outlet tributaries of lakes or along the shoreline of lakes, where their distribution and abundance is closely related to the location of rivers that provide access to the lakes. Some sockeye, known as kokanee, are non-anadromous and have been observed on the spawning grounds together with their anadromous counterparts. Some sockeye, particularly the more northern populations, spawn in mainstream rivers. Growth is influenced by competition, food supply, water temperature, thermal stratification, and other factors, with lake residence time usually increasing the farther north a nursery lake is located. In Washington and British Columbia, lake residence is normally 1 or 2 years. Incubation, fry emergence, spawning, and adult lake entry often involve intricate patterns of adult and juvenile migration and orientation not seen in other *Oncorhynchus* species.

Upon emergence from the substrate, lake-type sockeye salmon juveniles move either downstream or upstream to rearing lakes, where the juveniles rear for 1 to 3 years prior to migrating to sea. Smolt migration typically occurs beginning in late April and extending through early July.

Once in the ocean, sockeye salmon feed on copepods, euphausiids, amphipods, crustacean larvae, fish larvae, squid, and pteropods. They will spend from 1 to 4 years in the ocean before returning to freshwater to spawn. Adult sockeye salmon home precisely to their natal stream or lake. River-and sea-type sockeye salmon have higher straying rates within river systems than lake-type sockeye salmon.

(1) Ozette Lake Sockeye Salmon ESU

The Ozette Lake sockeye salmon ESU was proposed for listing, along with proposed critical habitat, in 1998 (63FR11750-11771, March 10, 1998). It was listed as threatened on March 25, 1999 (64FR14528-14536), and critical habitat was designated on February 16, 2000 (65FR7764-7787). This ESU spawns in Lake Ozette, Clallam County, Washington, as well as in its outlet stream and the tributaries to the lake. It has the smallest distribution of any listed Pacific salmon.

While Lake Ozette itself is part of Olympic National Park, its tributaries extend outside park boundaries, much of which is private land. There is limited agriculture in Clallam County. Table 15 of attachment I shows that 1,830 pounds of carbofuran may be used to treat 1,790 acres and 4 acres of alfalfa and grape crops, respectively, in Clallam county Washington. There is a modest amount of carbofuran applied, therefore I conclude that the likelihood is low the use of carbofuran may affect, but is not likely to adversely affect Ozette Lack Sockeye Salmon ESU.

(2) Snake River Sockeye Salmon ESU

The Snake River sockeye salmon was the first salmon ESU in the Pacific Northwest to be listed. It was proposed and listed in 1991 (56FR14055-14066, April 5, 1991 & 56FR58619-58624, November 20, 1991). Critical habitat was proposed in 1992 (57FR57051-57056, December 2, 1992) and designated a year later (58FR68543-68554, December 28, 1993) to include river reaches of the mainstream Columbia River, Snake River, and Salmon River from its confluence with the outlet of Stanley Lake down stream, along with Alturas Lake Creek, Valley Creek, and Stanley, Redfish, Yellow Belly, Pettit, and Alturas lakes (including their inlet and outlet creeks).

Spawning and rearing habitats are considered to be all of the above-named lakes and creeks, even though at the time of the critical habitat Notice, spawning only still occurred in Redfish Lake. These habitats are in Custer and Blaine counties in Idaho. Migration corridors occur in the counties of Asotin, Benton, Clark, Columbia, Cowlitz, Franklin, Farfield, Klickitat, Pacific, Skamania, Wahkiakum, Walla, Walla, and Whitman in Washington; Clatsop, Columbia, Gilliam, Hood River, Morrow, Multnomah, Sherman, Umatilla, Wallowa, and Wasco in Oregon; and Lewis, Idaho, Lemhi, and Nez Perce in Idaho.

Table 16 in attachment I shows the acreage of crops (alfalfa, grapes, and potatoes) in counties containing habitat for this ESU. In the migratory area approximately 400,000 crop acres could potentially be treated with 1.0 million pounds of carbofuran. In the spawning and growth areas, approximately 43,000 crop acres could be treated with 50,022 pounds of carbofuran. Alfalfa, grape, and potato crops treated with carbofuran may have a direct acute impact to fish, although the level of concern was only slightly exceeded for each of the abovementioned crops. Given that over 400,000 pounds of carbofuran would treat approximately 1.0% of the total ESU, the likelihood for effects from these uses seems low. Therefore, I conclude that the use of carbofuran may affect, but is not likely to adversely affect the Snake River Sockeye Salmon ESU.

(e) Steelhead

Steelhead, *Oncorhynchus mykiss*, exhibit one of the most complex suites of life history traits of any salmonid species. Steelhead may exhibit anadromy or freshwater residency. Resident forms are usually referred to as “rainbow” or “redband” trout, while anadromous life forms are termed “steelhead.” The relationship between these two life forms is poorly understood; however, the scientific name was recently changed to represent that both forms are a single species.

Steelhead typically migrate to marine waters after spending 2 years in fresh water. They then reside in marine waters for typically 2 or 3 years prior to returning to their natal stream to spawn as 4-or 5-year-olds. Unlike Pacific salmon, they are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying; most that do so are females. Steelhead adults typically spawn between December and June.

Depending on water temperature, steelhead eggs may incubate in reeds (spawning beds) for 1.5 to 4 months before hatching as alevins. Following yolk sac absorption, alevins emerge as fry and begin actively feeding. Juveniles rear in fresh water from 1 to 4 years, then migrate to the ocean as “smolts.”

Biologically, steelhead can be divided into two reproductive ecotypes. “Stream maturing” or “summer steelhead” enter fresh water in a sexually immature condition and require several months to mature and spawn. “Ocean maturing” or “winter steelhead” enter fresh water with well-developed gonads and spawn shortly after river entry. There are also two major genetic groups, applying to both anadromous and non-anadromous forms: a coastal group and an inland group, separated approximately by the Cascade crest in Oregon and Washington. California is thought to have only coastal steelhead while Idaho has only inland steelhead.

Historically, steelhead were distributed throughout the North Pacific Ocean from the Kamchatka Peninsula in Asia to the northern Baja Peninsula, but they are now known only as far south as the Santa Margarita River in San Diego County. Many populations have been extirpated.

(1) Central California Coast Steelhead ESU

The Central California coast steelhead ESU was proposed for listing as endangered on August 9, 1996 (61FR41541-41561) and the listing was made final, as threatened, a year later (62FR43937-43954, August 18, 1997). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787). This coastal steelhead ESU occupies California river basins from the Russian River, Sonoma County, to

Aptos Creek, Santa Cruz County, (inclusive), and the drainages of San Francisco and San Pablo Bays eastward to the Napa River (inclusive), Napa County. The Sacramento-San Joaquin River Basin of the Central Valley of California is excluded. Steelhead in most tributary streams in San Francisco and San Pablo Bays appear to have been extirpated, whereas most coastal streams sampled in the central California coast region do contain steelhead.

Only winter steelhead are found in this ESU and those to the south. River entry ranges from October in the larger basins, late November in the smaller coastal basins, and continues through June. Steelhead spawning begins in November in the larger basins, December in the smaller coastal basins, and can continue through April with peak spawning generally in February and March. Hydrologic units in this ESU include Russian (upstream barriers - Coyote Dam, Warm Springs Dam), Bodega Bay, Suisun Bay, San Pablo Bay (upstream barriers – Phoenix Dam, San Pablo Dam), Coyote (upstream barriers - Almaden, Anderson, Calero, Guadelupe, Stevens Creek, and Vasona Reservoirs, Searsville Lake), San Francisco Bay (upstream barriers - Calveras Reservoir, Chabot Dam, Crystal Springs Reservoir, Del Valle Reservoir, San Antonio Reservoir), San Francisco Coastal South (upstream barrier - Pilarcitos Dam), and San Lorenzo-Soquel (upstream barrier - Newell Dam). Affected counties include Alameda, Contra Costa, Marin, Mendocino, Napa, San Francisco, San Mateo, Santa Clara, Santa Cruz, Solano, and Sonoma.

Counties of occurrence for this ESU are Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Mendocino, Napa, Alameda, Contra Costa, Solano, and Santa Clara counties Attachment H, Table 17.

There is modest use of carbofuran within this ESU. Alfalfa, artichokes, and outdoor plants in containers are grown in the Central California coast ESU. Approximately 3,026 acres are treated in this ESU, with 2,125 pounds applied to alfalfa, 31 pounds to artichokes, and 2 pounds treating outdoor plants in containers. The level of concern for alfalfa was slightly exceeded for acute endangered and threatened fish, although only 2,900 acres of alfalfa are grown in this ESU. The level of concerns for acute fish, acute invertebrates, and chronic invertebrates was exceeded for artichokes, but only 64 acres are treated with carbofuran in the ESU. As for outdoor plants grown in containers only 13 acres are treated in this ESU. Thus, given that 3,026 acres within the ESU are treated with carbofuran, the likelihood for effects seems low, especially in conjunction with the county bulletins. Therefore, I conclude that the use of carbofuran may affect, but is not likely to adversely affect, the Central California Coast Steelhead ESU.

(2) California Central Valley Steelhead ESU

The California Central Valley steelhead ESU was proposed for listing as endangered on August 9, 1996 (61FR41541-41561) and the listing was made final in 1998 (63FR 13347-13371, March 18, 1998). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787).

This ESU includes populations ranging from Shasta, Trinity, and Whiskeytown areas, along with other Sacramento River tributaries in the North, down the Central Valley along the San Joaquin River to and including the Merced River in the South, and then into San Pablo and San Francisco Bays. Counties at least partly within this area are Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Glenn, Marin, Merced, Nevada, Placer, Sacramento, San Francisco, San Joaquin, San Mateo, San Francisco, Shasta, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tuloumne, Yolo, and Yuba. A large proportion of this area is heavily agricultural, but there are also large amounts of urban and suburban areas.

Usage of carbofuran in counties where the California Central Valley steelhead ESU occurs is presented in attachment H, table 18. There is a modest amount of carbofuran usage within this ESU, primarily on alfalfa, but also on other crops including cotton, grapes, potatoes, and corn. The level of concern for acute effects to endangered species (RQ > 0.05) was slightly exceeded (RQ = 0.07) from the PRZMS-EXAMS modeling of alfalfa grown in California. Approximately 41,178 acres of the 19.5 million acres in the entire ESU are treated with carbofuran. Given that the ratio of usage acres to total acres in the ESU is small, the likelihood for effects from these uses seems low, especially in conjunction with the county bulletins. Therefore, I conclude that the use of carbofuran may affect, but is not likely to adversely affect, the California Central Valley Steelhead ESU.

(3) Lower Columbia River Steelhead ESU

The Lower Columbia River steelhead ESU was proposed for listing as endangered on August 9, 1996 (61FR41541-41561) and the listing was made final a year later (62FR43937-43954, August 18, 1997). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787).

This ESU includes all tributaries from the lower Willamette River (below Willamette Falls) to Hood River in Oregon, and from the Cowlitz River up to the Wind River in Washington. These tributaries would provide the spawning and presumably the growth areas for the young steelhead. It is not clear if the young and growing steelhead in the tributaries would use the nearby mainstem of the Columbia prior to downstream migration. If not, the spawning and rearing habitat would occur in Hood River, Clackamas, and Multnomah counties in Oregon, and Skamania, Clark, and Cowlitz counties in Washington. Tributaries of the extreme lower Columbia River, e.g., Grays River in Pacific and Wahkiakum counties, Washington and John Day River in Clatsop county, Oregon, are not discussed in the Critical Habitat FRNs; because they are not “between” the specified tributaries, they do not appear part of the spawning and rearing habitat for this steelhead ESU. The mainstem of the Columbia River from the mouth to Hood River constitutes the migration corridor. This would additionally include Columbia and Clatsop counties, Oregon, and Pacific and Wahkiakum counties, Washington. Other habitat is located in Lewis County, Washington and in Marion and Washington Counties in Oregon.

Hydrologic units for this ESU are Middle Columbia-Hood, Lower Columbia-Sandy (upstream barrier - Bull Run Dam 2), Lewis (upstream barrier - Merlin Dam), Lower Columbia-Clatskanie, Lower Cowlitz, Lower Columbia, Clackamas, and Lower Willamette.

Table 19 in attachment I shows the cropping information for Oregon and Washington counties where the Lower Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

There is a modest amount, 30,394 pounds, of carbofuran applied to 9,899 acres of alfalfa, grape, and potato crops within this ESU. Approximately 8.6 million acres comprise the ESU, therefore carbofuran could potentially be applied to a very small portion of the ESU. Therefore, I conclude that the use of carbofuran, may affect, but is not likely to adversely affect the Lower Columbia River Steelhead ESU.

(4) Middle Columbia River Steelhead ESU

The Middle Columbia River steelhead ESU was proposed for listing as threatened on March 10, 1998 (63FR11798-11809) and the listing was made final a year later (64FR14517-14528, March 25, 1999). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787).

This steelhead ESU occupies "the Columbia River Basin and tributaries from above the Wind River in Washington and the Hood River in Oregon (exclusive), upstream to, and including, the Yakima River, in Washington." The Critical Habitat designation indicates the downstream boundary of the ESU to be Mosier Creek in Wasco County, Oregon; this is consistent with Hood River being "excluded " in the listing notice. No downstream boundary is listed for the Washington side of the Columbia River, but if Wind River is part of the Lower Columbia steelhead ESU, it appears that Collins Creek, Skamania County, Washington would be the last stream down river in the Middle Columbia River ESU. Dog Creek may also be part of the ESU, but White Salmon River certainly is, since the Condit Dam is mentioned as an upstream barrier.

The only other upstream barrier, in addition to Condit Dam on the White Salmon River, is the Pelton Dam on the Deschutes River. As an upstream barrier, this dam would preclude steelhead from reaching the Metolius and Crooked Rivers as well the upper Deschutes River and its tributaries.

The Oregon counties then that appear to have spawning and rearing habitat are Gilliam, Morrow, Umatilla, Sherman, Wasco, Crook, Grant, Wheeler, and Jefferson counties in Oregon. Washington counties providing spawning and rearing habitat include Columbia, Benton, Franklin, Kittitas, Klickitat, Skamania, Walla Walla, and Yakima. Only small portions of Franklin and Skamania Counties intersect with the spawning and rearing habitat of this ESU.

Migratory corridors include Hood River, Multnomah, Columbia, and Clatsop counties in Oregon, and Skamania, Clark, Cowlitz, Wahkiakum, and Pacific Counties in Washington.

Additional habitat is located in Wallowa, Harney, and Union Counties in Oregon.

Table 20 in attachment I shows the cropping information for Oregon and Washington counties where the Middle Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

There is a considerable amount of acreage that could potentially be treated with carbofuran within this ESU. Alfalfa, grape, and potato crops are grown in the spawning and migration, habitat, and migration areas for steelhead. Given the total potential use is over 1.2 million pounds being applied to over 500,000 acres, the likelihood effects from these uses cannot be precluded. Therefore, I conclude that the use of carbofuran may affect the Middle Columbia River Steelhead ESU.

(5) Northern California Steelhead ESU

The Northern California steelhead ESU was proposed for listing as threatened on February 11, 2000 (65FR6960-6975) and the listing was made final on June 7, 2000 (65FR36074-36094). Critical Habitat has not yet been officially established. This Northern California coastal steelhead ESU occupies river basins from Redwood Creek in Humboldt County, CA to the Gualala River, inclusive, in Mendocino County, CA. River entry ranges from August through June and spawning from December through April, with peak spawning in January in the larger basins and in late February and March in the smaller coastal basins. The Northern California ESU has both winter and summer steelhead, including what is presently considered to be the southernmost population of summer steelhead, in the Middle Fork Eel River. Counties included appear to be Humboldt, Mendocino, Trinity, and Lake.

There is no reported usage of carbofuran within this ESU. I conclude that the use of carbofuran will have no effect on the Northern California Steelhead ESU.

(6) Snake River Basin Steelhead ESU

The Snake River Basin steelhead ESU was proposed for listing as endangered on August 9, 1996 (61FR41541-41561) and the listing was made final a year later (62FR43937-43954, August 18, 1997). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787).

Spawning and early growth areas of this ESU consist of all areas upstream from the confluence of the Snake River and the Columbia River as far as fish passage is possible. Hells Canyon Dam on the Snake River and Dworshak Dam on the Clearwater River, along with Napias Creek Falls near Salmon, Idaho, are named as impassable barriers. These areas include the counties of Wallowa and Union; Asotin, Garfield, Columbia, Whitman, Franklin, Adams, and Walla Walla in Washington; and Adams, Idaho, Nez Perce, Custer, Lemhi, Valley, Lewis, Clearwater, and Latah in Idaho.

Note: We are uncertain about the inclusion of Adams, Lincoln and Spokane counties in Washington in this ESU. They are not named in the Critical Habitat FR Notice, but they appear to include waters in the listed hydrologic unit. We have included them below, but will be seeking NMFS guidance in a separate request.

Critical Habitat also includes the migratory corridors of the Columbia River from the confluence of the Snake River to the Pacific Ocean. Additional counties in the migratory corridors are Umatilla, Gilliam, Morrow, Sherman, Wasco, Hood River, Multnomah, Columbia, and Clatsop in Oregon; and Walla Walla, Benton, Klickitat, Skamania, Clark, Cowlitz, Wahkiakum, and Pacific in Washington. Other habitat is included in Blaine and Boise Counties in Idaho, and Baker County, Oregon.

Table 22 in attachment I shows the cropping information for the Pacific Northwest counties where the Snake River Basin steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

There is considerable acreage of alfalfa, grape, and potato crops that could be treated with carbofuran. If 100% of the abovementioned crop acres were treated, then over 1 million pounds of carbofuran would be applied to this ESU. Treating these crops with carbofuran has the potential for direct acute effects to fish, although the crop acres treated would account for less than 1.0% of the total ESU acres. The likelihood for effects from carbofuran uses seems low, especially in conjunction with the county bulletins, therefore I conclude that carbofuran use may affect, but is not likely to adversely affect the Snake River Basin Steelhead ESU.

(7) South Central California Steelhead ESU

The South Central California steelhead ESU was proposed for listing as endangered on August 9, 1996 (61FR41541-41561) and the listing was made final, as threatened, a year later (62FR43937-43954, August 18, 1997). Critical Habitat was proposed February 5,1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787). This coastal steelhead ESU occupies rivers from the Pajaro River, Santa Cruz County, to (but not including) the Santa Maria River, San Luis Obispo County. Most rivers in this ESU drain the Santa Lucia Mountain Range, the southernmost unit of the California Coast Ranges (62FR43937-43954, August 18, 1997). River entry ranges from late November through March, with spawning occurring from January through April.

This ESU includes the hydrologic units of Pajaro (upstream barriers - Chesbro Reservoir, North Fork Pachero Reservoir), Estrella, Salinas (upstream barriers - Nacimiento Reservoir, Salinas Dam, San Antonio Reservoir), Central Coastal (upstream barriers - Lopez Dam, Whale Rock Reservoir), Alisal-Elkhorn Sloughs, and Carmel. Counties of occurrence include Santa

Cruz, Santa Clara, San Benito, Monterey, and San Luis Obispo.

Reportable usage of carbofuran in counties where this ESU occurs are presented in attachment H, table 23. There is modest use of carbofuran, 15, 856 total pounds of carbofuran, applied to alfalfa, artichokes, grapes and outdoor plants in containers within this ESU. Given that a total of 8,749 acres within this ESU are treated with carbofuran, the likelihood for effects from these uses seems. Therefore, I concluded that the use of carbofuran may affect, but is not likely to adversely affect, the South Central California Steelhead ESU.

(8) Southern California Steelhead ESU

The Southern California steelhead ESU was proposed for listing as endangered on August 9, 1996 (61FR41541-41561) and the listing was made final a year later (62FR43937-43954, August 18, 1997). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787). This ESU ranges from the Santa Maria River in San Luis Obispo County south to San Mateo Creek in San Diego County. Steelhead from this ESU may also occur in Santa Barbara, Ventura and Los Angeles counties, but this ESU apparently is no longer considered to be extant in Orange County (65FR79328-79336, December 19, 2000). Hydrologic units in this ESU are Cuyama (upstream barrier - Vaquero Dam), Santa Maria, San Antonio, Santa Ynez (upstream barrier - Bradbury Dam), Santa Barbara Coastal, Ventura (upstream barriers - Casitas Dam, Robles Dam, Matilja Dam, Vern Freeman Diversion Dam), Santa Clara (upstream barrier - Santa Felicia Dam), Calleguas, and Santa Monica Bay (upstream barrier - Rindge Dam). Counties comprising this ESU show a very high percentage of declining and extinct populations.

River entry ranges from early November through June, with peaks in January and February. Spawning primarily begins in January and continues through early June, with peak spawning in February and March.

Within San Diego County, the San Mateo Creek runs through Camp Pendleton Marine Base and into the Cleveland National Forest. While there are agricultural uses of pesticides in other parts of California within the range of this ESU, it would appear that there are no such uses in the vicinity of San Mateo Creek. Within Los Angeles County, this steelhead occurs in Malibu Creek and possibly Topanga Creek. Neither of these creeks drain agricultural areas.

Reportable usage of carbofuran in counties where this ESU occurs are presented in attachment H, table 23. There is modest use of carbofuran, 1,068 total pounds of carbofuran, applied within this ESU. Carbofuran is used in this ESU to treat a total of 1,562 acres of alfalfa and grape crops. Given that the usage comprises approximately only 0.6% acres of San Luis Obispo County in this ESU, the likelihood for effects from these uses seems low, especially in conjunction with the county bulletins. Therefore, I conclude that the use of carbofuran may affect, but is not likely to adversely affect, the Southern California Steelhead ESU.

(9) Upper Columbia River Steelhead ESU

The Upper Columbia River steelhead ESU was proposed for listing as endangered on August 9, 1996 (61FR41541-41561) and the listing was made final a year later (62FR43937-43954, August 18, 1997). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787).

The Upper Columbia River steelhead ESU ranges from several northern rivers close to the Canadian border in central Washington (Okanogan and Chelan counties) to the mouth of the Columbia River. The primary area for spawning and growth through the smolt stage of this ESU is from the Yakima River in south Central Washington upstream. Hydrologic units within the spawning and rearing habitat of the Upper Columbia River steelhead ESU and their upstream barriers are Chief Joseph (upstream barrier - Chief Joseph Dam), Oanogan, Similkameen, Methow, Upper Columbia-Entiat, Wenatchee, Moses-Coulee, and Upper Columbia-Priest Rapids. Within the spawning and rearing areas, counties are Chelan, Douglas, Okanogan, Grant, Benton, Franklin, Kittitas, and Yakima, all in Washington.

Note: Adams County, WA was not one of the counties named in the critical habitat FR Notice, but appears to be included in a hydrologic unit named in that notice. We have included it here, but seek NMFS guidance for future efforts.

Areas downstream from the Yakima River are used for migration. Additional counties through which the ESU migrates are Walla Walla, Klickitat, Skamania, Clark, Cowlitz, Wahkiakum, and Pacific in Washington; and Gilliam, Morrow, Sherman, Umatilla, Wasco, Hood River, Multnomah, Columbia, and Clatsop in Oregon. Other habitat is located in Columbia County in Washington.

Table 25 in attachment I shows the cropping information where carbofuran can be used in Washington counties where the Upper Columbia River steelhead ESU is located. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

There is a considerable amount of carbofuran applied to alfalfa, grape, and potato crop acres within this ESU. Over 1.3 million pounds of carbofuran could potentially be applied to this ESU if 100% of the alfalfa, grape, and potato crops were treated with carbofuran. Given that approximately 560,000 acres could be treated, there is a likelihood of direct acute effects to fish from carbofuran use on alfalfa, grapes, and potato crops. Therefore, I conclude that the use of carbofuran, may affect the Upper Columbia River Steelhead ESU.

(10) UpperWillamette River Steelhead ESU

The Upper Willamette River steelhead ESU was proposed for listing as threatened on March 10, 1998 (63FR11798-11809) and the listing was made final a year later (64FR14517-14528, March 25, 1999). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787). Only naturally spawned, winter steelhead trout are included as part of this ESU; where distinguishable, summer-run steelhead trout are not included.

Spawning and rearing areas are river reaches accessible to listed steelhead in the Willamette River and its tributaries above Willamette Falls up through the Calapooia River. This includes most of Benton, Linn, Polk, Clackamas, Marion, Yamhill, and Washington counties.

Hydrologic units where spawning and rearing occur are Upper Willamette, North Santiam (upstream barrier - Big Cliff Dam), South Santiam (upstream barrier - Green Peter Dam), Middle Willamette, Yamhill, Molalla-Pudding, and Tualatin. The areas below Willamette Falls and downstream in the Columbia River are considered migration corridors, and include Multnomah, Columbia, and Clatsop counties in Oregon and Clark, Cowlitz, Wahkiakum, and Pacific counties in Washington. Other habitat is located in Columbia County in Washington and in Lincoln and Tillamook Counties in Oregon.

Table 26 in attachment I shows the cropping information for Oregon counties where the Upper Willamette River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

There is a modest amount, approximately 79,589 pounds, of carbofuran applied to 20,563 acres in this ESU. These values reflect 100% treatment of alfalfa, grape, and potato crops grown in the counties supporting this ESU. Given the modest amount of potential carbofuran usage, I conclude that the use of carbofuran may affect, but is not likely to adversely affect, the Upper Willamette River Steelhead ESU.

5. Specific Conclusions for Pacific Salmon and Steelhead

Table 26 depicts the summary conclusion on specific ESUs of salmon and steelhead for carbofuran use in the Pacific-Northwest and California. Based on this analysis, it is my professional judgment that for 3 of the 26 salmon and steelhead ESUs carbofuran has no effect on the ESUs. For 18 of the ESUs legal carbofuran use may affect, but is not likely to adversely affect these T&E species. Legal use of carbofuran may affect salmon and steelhead species in the remaining 5 ESUs located in the Pacific-Northwest and California.

Table 26. Summary Conclusions on Specific ESUs of Salmon and Steelhead for Carbofuran

ESU	Finding
Chinook Salmon	
California Coastal	no effect
Central Valley Spring-Run	may affect, but not likely to adversely affect
Lower Columbia	may affect, but not likely to adversely affect

Puget Sound	may affect, but not likely to adversely affect
Sacramento River Winter-Run	may affect, but not likely to adversely affect
Snake River Fall-Run	may effect
Snake River Spring / Summer-Run	may effect
Upper Columbia Spring-Run	may effect
Upper Willamette	may affect, but not likely to adversely affect
Chum Salmon	
Columbia River	may affect, but not likely to adversely affect
Hood Canal Summer-Run	may affect, but not likely to adversely affect
Coho Salmon	
Central California	no effect
Oregon Coast	may affect, but not likely to adversely affect
Southern Oregon / Northern California Coast	may affect, but not likely to adversely affect
Sockeye Salmon	
Ozette Lake	may affect, but not likely to adversely affect
Snake River	may affect, but not likely to adversely affect
Steelhead	
Central California Coast	may affect, but not likely to adversely affect
Central Valley California	may affect, but not likely to adversely affect
Lower Columbia River	may affect, but not likely to adversely affect
Middle Columbia River	may effect
Northern California	no effect
Snake River Basin	may affect, but not likely to adversely affect
South-Central California	may affect, but not likely to adversely affect
Southern California	may affect, but not likely to adversely affect
Upper Columbia River	may effect
Upper Willamette River	may affect, but not likely to adversely affect

6. References

Beyers, D.W., T.J. Keefe, and C.A. Carlson. 1994. Toxicity of Carbaryl and Malathion to Two Federally Endangered Fishes, as Estimated by Regression and ANOVA. Environ. Toxicol. Chem. 13:101-107.

Dwyer, F.J., Hardesty, D.K., Henke, C.E., Ingersoll, C.G., Whites, G.W., Mout, D.R., Bridges, C.M. 1999. Assessing contaminant sensitivity of endangered and threatened species: Toxicant classes. U.S. Environmental Protection Agency Report No. EPA/600/R-99/098, Washington, D.C. 15p.

Effland, W.R., N.C. Thurman, and I. Kennedy. Proposed Methods for Determining Watershed - Derived Percent Cropped Areas and Considerations for Applying Crop Area Adjustments to Surface Water Screening Models: U.S. Environmental Protection Agency Office of Pesticide Programs; Presentation to FIFRA Science Advisory Panel, May 27, 1999.

Hamilton, D.J., Ambrus, A., Dieterle, R.M., Felsot, A.S., Harris, C.A., Holland, P.T., Katayama, A., Kurihara, N., Linders, J., Unsworth, J., Wong, S.S. 2003. Regulatory limits for pesticide residues in water (IUPAC Technical Report). Pure Appl. Chem., 75(8): 1123-1155.

Hashimoto, Y., Nishiuchi, Y. 1981. Establishment of bioassay methods for the evaluation of acute toxicity of pesticides to Aquatic organisms. J. Pesticide Science 6(2): 257-264.

Hasler, A.D., and A.T. Scholz. 1983. Olfactory Imprinting and Homing in Salmon. New York: Springer-Verlag. 134 p.

Johnson, W.W., and M.T. Finley. 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. U.S. Fish and Wildlife Service Publication No. 137.

Matthiessen, P., D. Sheahan, R. Harrison, M. Kirby, R. Rycroft, A. Turnbull, C. Volkner, and R. Williams. 1995. Use of *Gammarus pulex* bioassay to measure the effects of transient carbofuran runoff from farmland. Exotoxicology and Environmental Safety 30:111-119.

Marovich, Richard. 2002. CDPR - Endangered Species Project, telephone communication on July 19, 2002.

Moore, A., and C.P. Waring. 1996. Sublethal Effects of the Pesticide Diazinon on the Olfactory Function in Mature Male Atlantic Salmon Parr. J. Fish. Biol. 48:758-775.

Nicosia, S., N. Carr, D.A. Gonzales and M.K. Orr. 1991. Off-field movement and dissipation of soil-incorporated carbofuran from three commercial rice fields. J. Environ. Qual. 20:532-539.

Paris, D.F., W.C. Steen, G.L. Baughman, and J.T. Barrnett Jr. 1981. Second-Order Model to Predict Microbial Degradation of Organic Compounds in Natural Waters. Applied and Environmental Microbiology. Vol. 41, No. 3. p.603-609.

Sappington, L.C., F.L. Mayer, F.J Dwyer, D.R. Buckler, J.R. Jones, and M.R. Ellersieck. 2001. Contaminant Sensitivity of Threatened and Endangered Fishes Compared to Standard Surrogate Species. Environ. Toxicol. Chem. 20:2869-2876.

Scholz, N.T., N.K. Truelove, B.L. French, B.A. Berejikian, T.P. Quinn, E. Casillas, and T.K. Collier. 2000. Diazinon Disrupts Antipredator and Homing Behaviors in Chinook Salmon (*Oncohynchus tshawytscha*). Can. J. Fish. Aquat. Scie., 57:1911-1918.

State of Washington Department of Agriculture. 2004. Washington State Carbofuran Use Summary.

TDK Environmental. 2001. Diazinon & Chlorpyrifos Products: Screening for Water Quality. Contract Report Prepared for California Department of Pesticide Regulation. San Mateo, California.

Tucker, R.K. and J.S. Leitzke. 1979. Comparative Toxicology of Insecticides for Vertebrate Wildlife and Fish. Pharmacol. Ther., 6, 167-220.

Urban, D.J. and N.J. Cook. 1986. Hazard Evaluation Division - Standard Evaluation Procedure - Ecological Risk Assessment, U.S. Environmental Protection Agency Publication 540/9-86-001.

US EPA, Office of Water, Ground Water and Drinking Water, Consumer Factsheet On: Carbofuran, Updated April 27, 2004, available at http://www.epa.gov/safewater/dwh/c-soc/carbofur.html

Zucker, E. 1984. Hazard Evaluation Division - Standard Evaluation Procedure - Acute Toxicity Test for Freshwater Fish. U.S. EPA Publication 540/9-85-006.