Fenamiphos
Analysis of Risks
to
Endangered and Threatened Pacific Salmon and Steelhead

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Summary

Fenamiphos is an organophosphate insecticide registered nationally for control of nematodes and insects in agricultural and commercial areas. These sites include fruit orchards, field, vegetable and fruit crops, nursery stock and commercial turf. An Interim Reregistration Eligibility Document (IRED) that includes an ecological risk assessment for fish, invertebrates and aquatic plants was issued in May 2002. Fenamiphos is very highly toxic to freshwater and estuarine fish and invertebrates, except for estuarine molluscs for which it is moderately toxic. The Estimated Environmental Concentrations (EECs) were modeled with a PRZM-EXAMS model for crops in California and the Pacific Northwest on which it is commonly used. The assessment concluded that endangered fish and invertebrates are at risk from acute and chronic exposures caused by the runoff of fenamiphos into receiving waters. The depletion of populations of aquatic invertebrates might adversely affect the food supply of listed steelhead and Pacific salmonids.

The use of fenamiphos has significantly decreased in the last few years, and based on its high risks to human health and its risks to fish and wildlife, fenamiphos is under a cancellation agreement whereby it is being phased out of production and use effective May 31, 2007.

We conclude that fenamiphos may affect two Evolutionary Significant Units (ESUs), may affect but is not likely to adversely affect nine ESUs and will have no effect on fifteen ESUs. Our determinations are based on the known use of fenamiphos on various use sites in each county where there is habitat or a migration corridor for an ESU, the acute risks of fenamiphos to fish, the potential for indirect effects due to acute and chronic risks to invertebrate food supplies, limitations currently in place for the use of fenamiphos and the documented decrease of the use of fenamiphos in California and the Pacific Northwest.

Introduction

Problem formulation: The purpose of this analysis is to determine whether the registration of fenamiphos as an insecticide and nematicide for use on various treatment sites 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 watersheds in which they occur, it is acknowledged that fenamiphos is registered for uses that may occur outside this geographic scope and that additional analyses may be required to address other T&E species in the Pacific states as well as across the United States.

Contents

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 (from 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 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, I can find no product 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. I 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. I consider this approach to be 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. I do note, however, that 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.

One area of significant weakness in modeling EECs relates to residential uses, especially by homeowners, but also to an extent by commercial applicators. There are no usage data in OPP that relate to pesticide use by homeowners on a geographic scale that would be appropriate for an assessment of risks to listed species. For example, we may know the maximum application rate for a lawn pesticide, but we do not know the size of the lawns, the proportion of the area in lawns, or the percentage of lawns that may be treated in a given geographic area. There is limited information on soil types, slopes, watering practices, and other aspects that relate to transport and fate of pesticides. We do know that some homeowners will attempt to control pests with chemicals and that others will not control pests at all or will use non-chemical methods. We would expect that in some areas, few homeowners will use pesticides, but in other areas, a high percentage could. As a result, OPP has insufficient information to develop a scenario or address the extent of pesticide use in a residential area.

It is, however, quite necessary to address the potential that home and garden pesticides may have to affect T&E species, even in the absence of reliable data. Therefore, I have developed a hypothetical scenario, by adapting an existing scenario, to address pesticide use on home lawns where it is most likely that residential pesticides will be used outdoors. It is exceedingly important to note that there is no quantitative, scientifically valid support for this modified scenario; rather it is based on my best professional judgement. I do note that the original scenario, based on golf course use, does have a sound technical basis, and the home lawn scenario is effectively the same as the golf course scenario. Three approaches will be used. First, the treatment of fairways, greens, and tees will represent situations where a high proportion of homeowners may use a pesticide. Second, I will use a 10% treatment to represent situations where only some homeowners may use a pesticide. Even if OPP cannot reliably determine the percentage of homeowners using a pesticide in a given area, this will provide two estimates. Third, where the risks from lawn use could exceed our criteria by only a modest amount, I can back-calculate the percentage of land that would need to be treated to exceed our criteria. If a smaller percentage is treated, this would then be below our criteria of concern. The percentage here would be not just of lawns, but of all of the treatable area under consideration; but in urban and highly populated suburban areas, it would be similar to a percentage of lawns. Should reliable data or other information become available, the approach will be altered appropriately.

It is also important to note that pesticides used in urban areas can be expected to transport considerable distances if they should run off on to concrete or asphalt, such as with streets (e.g., TDK Environmental, 2001). This makes any quantitative analysis very difficult to address aquatic exposure from home use. It also indicates that a no-use or no-spray buffer approach for protection, which we consider quite viable for agricultural areas, may not be particularly useful for urban areas.

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 lotic 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 lentic 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 LC50	>0.5	Potentially high acute risk
Acute LC50	>0.1	Risk that may be mitigated through restricted use classification
Acute LC50	>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 LC50[a]	>0.5	May be indirect effects on T&E fish through food supply reduction
Aquatic plant acute EC50[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 repellency, 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 and use of fenamiphos

a. Description of chemical

Fenamiphos is an organophosphate insecticide, first registered in 1972 that is used to control primarily nematodes plus some insect pests in agricultural, commercial and industrial sites. It is not registered for use on residential sites. Treatment sites include: apple, cherry, nectarine, peach and citrus orchards; asparagus, bok choy, Brussel sprouts, cabbage, eggplant, garlic, okra, peppers, peanuts, tobacco, raspberries and strawberries.; table grapes (including raisins) and wine grapes; commercial, industrial and ornamental turf including sod farms and golf courses; and ornamentals and nursery stock.

Fenamiphos is formulated as granulars (10% and 15% active ingredient, Nemacur 10G and Nemacur 15G, respectively) and an emulsifiable concentrate (35% active ingredient, Nemacur 3). It is applied by several kinds of ground application equipment including groundboom, ground sprayers, and drip and low pressure irrigation. None of the products are labeled for aerial application. Methods of application include broadcast, banded, in-furrow, soil-drench and chemigation. Following application, all formulations are to be watered in or mechanically incorporated into the soil. The fenamiphos products can be applied at various times during the growing season, depending on the crop. The timings of the applications include pre-planting, at-planting, bloom through foliage, pre-harvest and post-harvest.

Fenamiphos is classified as a Restricted Use Pesticide due to high acute toxicity and toxicity to wildlife.

b. Summary of labeled uses

Nemacur 3 and Nemacur 15G

Nemacur 3 and Nemacur 15G are registered for use on field, fruit and vegetable crops. Some of the crops grown in the Pacific Northwest (California, Oregon, Washington and Idaho) are included on both labels. These use sites are strawberries and eggplants. The application rates on both labels are generally expressed as ounces per 1000 feet of crop row or quarts or gallons per acre. As the risk assessment methods are based on exposure expressed as pounds active ingredient per acre (lb a.i./a), the rates on the labels were converted to this unit of application. For the crops that can be treated by both products, the application rates converted to the same rate expressed as lb a.i./a, regardless of the formulation.

<u>Bok choy (California only)</u> – 3.6 to 4.5 lb a.i./a. Do not make more than one application per crop season. Do not exceed 4.5 lb a.i./a per crop season.

<u>Cabbage and Brussel sprouts</u> – 1.8 to 4.5 lb a.i./a. Do not treat more than 50% of the total field area. Do not make more than one application per crop season. Do not exceed 4.5 lb a.i./a per crop season.

<u>Eggplant</u> – 2 lb a.i./a. Do not make more than one application per crop season. Do not exceed 2 lb a.i./a per crop season.

<u>Garlic</u> – 2.3 to 4.5 lb a.i./a. Do not make more than one application per crop season. Do not exceed 4.5 lb a.i./a per crop season.

<u>Non-bell peppers (California)</u> – 1.4 to 2 lb a.i./a. Do not make more than one application per crop season. Do not exceed 2 lb a.i./a per crop season.

<u>Strawberries</u> – 3 to 4.5 lb a.i./a. Do not make more than one application per crop season. Do not exceed 4.5 lb a.i./a per crop season.

<u>Non-bearing strawberry nursery stock</u> – 3.5 lb a.i./a. Do not make more than two applications per season. Do not exceed 7 pounds a.i./a per season.

<u>Raspberries (Except California)</u> – 3 to 6 lb a.i./a. Do not apply more than once per year. Apply during the period of October 1 to December 31 when adequate rainfall can be expected.

<u>Fruits – apple, cherry, nectarine, peach</u> – <u>Banded</u>: 5 to 7.5 lb a.i./a. Do not apply more than 7.5 pounds a.i./a per year. <u>Low-pressure irrigation</u>: 1.5 to 3 lb a.i./a. Do not exceed 6 pounds a.i./a per season. Apply in one to four applications at a 30-day interval.

<u>Grapes</u> – <u>Banded</u>: 3 to 6 lb a.i./a. Do not apply more than 6 lb a.i./a per season. <u>Low-pressure irrigation</u>: 1.5 to 3 lb a.i./a. Do not exceed 6 lb a.i./a per season. Apply in one to four applications at a 30-day interval.

Kiwifruit (California only) – 1.5 to 3 lb a.i./a. Do not exceed 6 lb a.i./a per season. Apply in one to four applications at a 30-day interval.

Citrus (In California do not apply to kumquat, tangelo, or citrus hybrids) – Banded: 5 to 7.5 lb a.i./a. Do not exceed two applications per season. Do not apply more than 7.5 lb a.i./a per season. Low-pressure irrigation: 1.5 to 3 lb a.i./a. Do not exceed 6 lb a.i./a per season. Apply in one to four applications at a 30-day interval.

Nemacur 10G and Nemacur 3

Nemacur 3 and Nemacur 10G are registered for use on turfgrasses, which is limited to golf courses and sod farms for the EC formulation, but also includes cemeteries and industrial grounds, in states other than California, for the granular formulation. They are both registered for use on leatherleaf fern, and the granular formulation is also applied to other ornamentals such as flower bulbs and nursery stock. There are state labels in Washington and Oregon, WA-760034 and OR-800063, respectively, for the use of Nemacur 3 on bulbs.

Turfgrasses – 10 lb a.i./a. Do not apply more than two times per year (a total of 20 lb a.i./a, maximum). No more than ten acres of turf on a golf course may be treated in a 24-hour period. There is a minimum of a three-day interval between treatments of an additional ten acres of the same golf course. It cannot be applied between noon and sunset during the heavy thunderstorm season of June through September.

Leatherleaf fern – 9 lb a.i./a. Do not make more than one application per year.

Nursery stock – 5 to 10 lb a.i./a. Do not exceed 10 lb a.i./a per season.

Iris, lily and narcissus bulbs (Except California) – 6 to 10 lb a.i./a. Do not make more than one application per crop season. Do not exceed 10 b a.i./a per season.

General label directions

All formulations require that fenamiphos be incorporated immediately after application. The treatments of field, fruit and vegetable crops require immediate incorporation by mechanical cultivation following banded application methods. If fenamiphos is applied by low-pressure irrigation, the directions imply that the irrigation water is sufficient to incorporate the chemical into the soil. The turfgrass sites have very specific instructions for incorporation as bird and fish kills have been recorded on golf courses. The instructions state that "the treated area must be irrigated with a minimum of one-half inch of water immediately following the application, and must be completed within 6 hours of application." The leatherleaf fern and ornamental applications also require immediate incorporation with at least one-half inch of water.

c. Proposed label changes required by the IRED and negotiated changes with the registrant

The 2002 IRED identified high risks to human health from drinking water from shallow ground water sources associated with soils that are extremely vulnerable, based on the USDA definitions and classifications of soils. The IRED, therefore, concluded that the uses of fenamiphos in areas with extremely vulnerable soils and shallow water tables were ineligible for reregistration and are to be phased out by May 31, 2005. Based upon the high risks to aquatic and terrestrial organisms and human health risks, the Agency required extensive sets of ecological toxicology, environmental fate, human health and ground water monitoring. However, the sole registrant, Bayer Corporation, requested voluntary cancellation of all existing fenamiphos registrations. The agreement between the Agency and Bayer Corporation has the following elements:

> The registrant has agreed to cancel use, and formulation for use, of all its existing fenamiphos registrations in areas with extremely vulnerable soils and shallow water tables effective as of May 31, 2005. Cancellation for use on all other soils will be effective May 31, 2007.
>
> All sale, distribution and use of existing stocks shall be prohibited for manufacturing and end-use products, effective as of May 31, 2007.
>
> Sale and distribution of existing stocks by persons other than the registrant may continue until May 31, 2008.
>
> Revised labels for all fenamiphos products have been submitted to the Agency in accordance with the registrant's request for an amendment of all of its existing registrations. Use of stocks in the channels of trade may continue until depleted, except where prohibited by the revised labels.
>
> The registrant has also agreed to produce no more than 500,000 pounds of fenamiphos manufacturing use products for use in the United States the first year of the phase out which ends May 31, 2003. Each subsequent year of the 5 year phase out, production will be reduced by 20% of the previous year's production.

The label amendments that were enacted to mitigate environmental risks, including those to aquatic species, consist of lowering the application rates and minimizing the potential for off-site runoff of the chemical into water bodies. These measures are: cancellation of the cotton use and granular use on pineapples; reduction of the maximum seasonal application rates for several crops; requiring more rapid watering in when irrigation is used to incorporate fenamiphos; and restrictions on time of day applied during thunderstorm season to limit the potential for runoff.

The labels incorporating these changes were approved in October, 2002 and are the labels that provide the basis of this consultation.

d. Estimated usage of fenamiphos

Because of the impending cancellation and current phase out of fenamiphos, including the production caps, the use of fenamiphos is down considerably since the publication of the IRED.

The IRED provided national usage data for 1990 to 1998 indicating that approximately 780,000 pounds of fenamiphos active ingredient were used annually. Approximately 45% of the annual use was on agricultural food commodities, 30% on tobacco (230,000 pounds a.i.), 9% on turf (67,000 pounds a.i.) and 6% on ornamentals. Most agricultural use of fenamiphos was on grapes (130,000 pounds a.i.), peanuts (74,000 pounds a.i.) and citrus (90,000 pounds a.i.). Most vegetable crops ranged from 1,000 pounds a.i. to 6,000 pounds a.i. annually. The uses were not broken down regionally, but personal communication from BEAD's (Biological and Economic Analysis Division) economist for the fenamiphos review indicated that, based on data from 1996 to 1999, California was the major usage state for the agricultural uses (30% of the total national use), and it was the fourth ranking state for the total usage in turf and ornamentals (2% of the total national use). California plus several southern states accounted for more than 90% of the total usage of fenamiphos nationally.

Idaho, Washington and Oregon were not listed as significant use states in the BEAD analysis. According to BEAD's January, 2000 Quantitative Usage Analysis (QUA), based on data from 1990 to 1998, Washington and Oregon are the states with the greatest amount of use on raspberries, but only a weighted average of 9% of the crop was treated, with an estimated maximum of 21% of the crop being treated in these two states. The only other crop for which Washington was listed is pears, and that use is no longer registered. Idaho was not listed in the QUA as using significant amount of fenamiphos on any of the registered use sites. This is not surprising as the USDA Agricultural Census of 1997 indicated that very limited acreage in Idaho is planted with the crops and other use sites for which fenamiphos is registered. If there is any significant acreage for any site, the crops are not grown in the Idaho counties with salmon and steelhead ESUs.

Information for the use of fenamiphos on selected crops in Washington and Oregon is available from the USDA/NASS Washington Agricultural Statistics Service 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 2000 to 2002 indicate that fenamiphos use is very small compared to use of other insecticides and nematicides registered for the same fruit, vegetable and nursery crops as fenamiphos, and, therefore, its use in terms of amount applied per crop is not recorded.

We are not aware of any comprehensive sources of annual pesticide-use information for Oregon, Washington, or Idaho. Oregon is attempting to implement full pesticide-use reporting but has not yet done so. However, Washington State Department of Agriculture (WSDA, unpublished report, 2003) provided us with information regarding the present use of fenamiphos in that state. Although it is registered for a number of crops grown in the state, the only use of significance is the application to raspberries. WSDA reported that 9,500 acres of raspberries were planted in 2001, 10% was treated with fenamiphos, and 2850 pounds a.i. were applied. A letter from the Washington State Pest Management Resource Service to USDA (2003) indicates that 10% of the raspberry acreage was also scheduled for treatment with fenamiphos in 2003.[1] This indicates that the use of fenamiphos on raspberries as reported by Washington is consistent with the data provided in BEAD's QUA analysis. Therefore we can infer that 10% of the 4610 acres of raspberry crop in Oregon (based on 1997 USDA Agricultural Census data) is also being treated with fenamiphos in 2003. Personal communication with Deborah Bahs, WSDA, further verified the significant decrease in fenamiphos use in that state. Less than 50 acres of apples statewide were treated with fenamiphos in 2002. Additionally, very little fenamiphos is used on turfgrasses as nematodes are relatively rare pest species in the PNW. According to an article in *Grounds Maintenance Magazine*, the PNW has lighter insect pressure than other regions of the country. The European crane fly and the bluegrass billbug are troublesome at times, but these species are not controlled by fenamiphos.

The National Center for Food and Agricultural Policy (http://www.ncfap.org/database.ingredient/query.asp) provides data on pesticide use by crop and state. Their data for 1997 indicates that fenamiphos is only used on raspberries in Washington and Oregon. In 1997 9% of the raspberry acreage was treated in Oregon (415 acres, 1340 pounds a.i. applied. Their data for Washington is consistent with the information given us by WSDA. Therefore, to summarize, the only use of concern in the PNW, excepting California, are raspberries in Washington and Oregon.

Some additional data from the 1990s also are available from the U.S. 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 4-year period (1992–1995), and (2) county-level information on harvested crop acreage from the 1992 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 208 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. Their data indicate that the agricultural crops of highest fenamiphos usage during the mid-1990s were tobacco (~270,000 lb ai), grapes (~150,000 lb ai), cotton (~120,000 lb ai) and peanuts (~47,000 lb ai). These four uses comprise 88% of the total national use of fenamiphos in the mid-1990s. The remaining 12% of the uses, according to USGS were broccoli, all citrus, cauliflower, peaches, cherries and cabbage. USGS also mapped fenamiphos use on selected crops (Figure 1). This map is included here as a quick and easy visual depiction of where fenamiphos may have been used on agricultural crops. However, it should not be used for any quantitative analysis, because it is based on 1992 crop acreage data

[1]Letter from Jane M. Thomas, Washington State Pest Management Resource Service, to Burleson Smith, United States Department of Agriculture, September 5, 2003.

and was developed from 1990-1995 statewide estimates of use that were then applied to that county acreage without consideration of local practices and usage. Refer to the attached map from http://ca.water.usgs.gov/pnsp/use92/fenmiphs.html.

USGS recently updated their website and now have national crop use maps based on the 1997 Census of Agriculture and state-level information from the National Center for Food and Agricultural Policy from pesticide use information collected by state and federal agencies for 1995 to 1998. Fenamiphos is not among the 190 pesticide chemicals whose national use patterns are mapped. Based upon the information in the IRED, communications with economists, and pest and efficacy analysts in BEAD, information from the registrant, Bayer Corp, and use trend data from the California Department of Pesticide Regulation (DPR), the nationwide use of fenamiphos has significantly decreased over the last few years. The reduction in use since the publication of the 1992 map for fenamiphos may be significant enough that USGS no longer tracks its national use.

At the state and county level, more data are available for fenamiphos use in California than in Oregon, Washington, and Idaho. California requires full pesticide-use reporting by most applicators (excluding homeowners), and the California Department of Pesticide Regulation (DPR) provides the information at the county level (www.cdpr.ca.gov/docs/pur/purmain.htm).

DPR reports use trends of cholinesterase-inhibiting pesticides. Their information shows that use of fenamiphos decreased steadily in California from 232,510 pounds a.i. in 1993 to 70,939 pounds a.i. in 2002. Likewise the cumulative acres treated with fenamiphos decreased from 142,069 acres in 1993 to 38,297 acres in 2002. Table 3 presents the uses and amounts of active ingredient applied in 2000 and 2002. The amount used in 2001 is similar to that used in 2002, and is, therefore, not presented in the table. Both years each represent approximately a 30% decrease from the use in 2000. Based on the statewide acreage for each crop from the 1997 National Agricultural Census, no more than 10% of any crop is currently treated with fenamiphos, and for many crops the average is only 2 to 7% treated.

Table 3. Uses of fenamiphos in California in 2000 and 2002 (Source: California DPR Pesticide Use Report)

2000			2002		
Commodity	**lb a.i.**	**Amount treated[1]**	**Commodity**	**lb a.i.**	**Amount treated[1]**
Almond	33	37 acres			
Apple	676	465 acres	Apple	63	9 acres
Bok choy	618	275 acres	Bok choy	128	57 acres
Brussel sprout	91	39 acres			
Cabbage	222	99 acres	Cabbage	76	34 acres
Cherry	843	293 aces	Cherry	468	175 acres

Chinese cabbage (nappa)	1,527	685 acres	Chinese cabbage (nappa)	905	404 acres
Citrus	12	6 acres			
Grape	49,336	29,635 acres	Grape	35,314	20,930 acres
Grape, wine	30,191	20,414 acres	Grape, wine	23,236	11603 acres
Grapefruit	87	40 acres			
Kiwi	956	639 acres	Kiwi	730	445 acres
Landscape maintenance	1,321	NA	Landscape maintenance	743	NA
Lemon	1,897	431 acres	Lemon	1,254	288 acres
Nectarine	409	311 acres	Nectarine	514	253 acres
Orange	11,947	5,362 acres	Orange	6,849	3,904 acres
Peach	4,253	1,574 acres	Peach	520	256 acres
Plum	4	4 acres			
Soil fumigation/preplant	73	30 acres			
Structural pest control	3	NA	Structural pest control	40	NA
Walnut	7	3 acres			
			Apricot	87	30 acres
			N-outdoor plants in containers	2	< 1 acres
			Tangerine	10	11 acres
Chemical Total	104,505		**Chemical Total**	70,939	

[1]Amount treated = cumulative areas or units treated over time with the active ingredient.
[2]NA = Not available

3. General aquatic risk assessment for endangered and threatened salmon and steelhead

a. Aquatic toxicity

The acute toxicity data indicate that technical grade fenamiphos is very highly toxic to freshwater and estuarine fish and invertebrates, except for estuarine molluscs, for which it is moderately toxic. The degradate, fenamiphos sulfoxide, is moderately toxic to fish and very highly toxic to invertebrates. The sulfone degradate is moderately toxic to fish. The sulfone was not reported tested on invertebrates.

Tests of freshwater and estuarine fish and invertebrates with the 36% formulated end-useproduct (Nemacur 3) indicated it is very highly toxic to freshwater fish and invertebrates, highly toxic to estuarine fish and invertebrates, but only moderately toxic to estuarine molluscs. The 15% granular formulation, Nemacur 15G, is highly toxic to freshwater fish. It was not reported tested on invertebrates.

Adverse effects on reproduction or growth of freshwater fish and invertebrates occurred at exposure concentrations of 7.4 ppb of technical fenamiphos for fish and 0.24 ppb for invertebrates.

The data from EFED's Fenamiphos Environmental Risk Assessment, the IRED and the EFED database are presented in Tables 4 through 7, and the data from the AQUIRE database are presented in Table 8.

Table 4. Acute toxicity of fenamiphos technical and end-use formulations to freshwater fish and invertebrates (source: EFED Pesticide Ecotoxicity Database, EFED's Fenamiphos Environmental Risk Assessment and IRED)

Species	Scientific Name	% ai	96-h LC 50 (ppb)	Toxicity Category
Technical				
Rainbow trout	*Oncorhynchus mykiss*	81.0	72.1	Very highly toxic
Bluegill sunfish	*Lepomis macrochirus*	81.0	17.7	Very highly toxic
Bluegill sunfish	*Lepomis macrochirus*	88.0	9.5	Very highly toxic
Waterflea	*Daphnia magna*	88.7	1.9 (48-h)	Very highly toxic
Waterflea	*Daphnia magna*	88.0	1.6 (48-h)	Very highly toxic
Nemacur 3 and 15G				
Rainbow trout	*Oncorhynchus mykiss*	36.0	68.0	Very highly toxic
Rainbow trout	*Oncorhynchus mykiss*	15.0	563	Highly toxic
Bluegill sunfish	*Lepomis macrochirus*	36.0	4.5	Very highly toxic
Bluegill sunfish	*Lepomis macrochirus*	15.0	151	Highly toxic
Waterflea	*Daphnia magna*	36.0	1.3 (48-h)	Very highly toxic

Table 5. Acute toxicity of fenamiphos sulfoxide and fenamiphos sulfone to freshwater organisms (source: EFED Pesticide Ecotoxicity Database, EFED's Fenamiphos Environmental Risk Assessment and IRED)

Species	Scientific Name	% ai	96-h LC 50 (ppb)	Toxicity Category
Sulfoxide				

Bluegill sunfish	*Lepomis macrochirus*	N/A	2653	Moderately toxic
Bluegill sunfish	*Lepomis macrochirus*	99.0	2000	Moderately toxic
Waterflea	*Daphnia magna*	N/A	7.5 (48-h)	Very highly toxic
Sulfone				
Bluegill sunfish	*Lepomis macrochirus*	N/A	1173	Moderately toxic

Table 6. Acute toxicity of fenamiphos technical and end-use formulations to estuarine fish and invertebrates (source: EFED Pesticide Ecotoxicity Database, EFED's Fenamiphos Environmental Risk Assessment and IRED)

Species	Scientific Name	% ai	96-h LC 50 (ppb)	Toxicity Category
Technical				
Sheepshead minnow	*Cyprinodon variegatus*	88.7	17.0	Very highly toxic
Mysid	*Mysidopsis bahia*	88.7	6.2	Very highly toxic
Eastern oyster	*Crassostrea virginica*	88.7	1650	Moderately toxic
Nemacur 3				
Sheepshead minnow	*Cyprinodon variegatus*	36.0	320 (48-h)	Highly toxic
Eastern oyster	*Crassostrea virginica*	36.0	> 1000	Moderately toxic
Pink shrimp	*Panaeus duorarum*	36.0	150 (48-h)	Highly toxic

Table 7. Chronic toxicity of fenamiphos to fish and invertebrates (source: EFED Pesticide Ecotoxicity Database, EFED's Fenamiphos Environmental Risk Assessment and IRED)

Species	Scientific Name	% ai	Duration	Endpoints affected	NOEC (ppb)	LOEC (ppb)
Rainbow trout	*Oncorhynchus mykiss*	88.7	91 days	larval length and weight	3.8	7.4
Waterflea	*Daphnia magna*	99.6	21 days	reproduction and body length	0.12	0.24

There are some aquatic acute toxicity data for fenamiphos from EPA's AQUIRE database (http://www.epa.gov/ecotox/). We did not look at the original papers but report the toxicity values for the toxicity test periods that are analogous to the those required by OPP testing requirements as a means of comparison. The AQUIRE reference numbers for each reported value are provided. In addition to the invertebrate tests listed in the table, there were eleven fish tests in the AQUIRE database that were taken from the EFED Pesticide Toxicity Database, and they are listed in tables 4 and 6, above, and, therefore, not included in Table 8.

Most of the data in AQUIRE are reported from studies conducted with formulated products, however, the types of formulations and percents active ingredient were not reported. The AQUIRE database is not always reliable regarding the type of test material used; unless the test indicates an active ingredient, it is put into AQUIRE as formulation testing. As stated previously, AQUIRE only reported fish studies for fenamiphos that were taken from EFED's database. AQUIRE indicated that all eleven fish studies were based on "formulated product testing", whereas the EFED data indicates four were conducted with the active ingredient, three with the degradates and only five with the formulated end-use products. It is possible that some of the invertebrate tests listed in AQUIRE and conducted on species not in the EFED data, were actually conducted on the active ingredient and not the formulated product as indicated. Although a direct comparison of the AQUIRE invertebrate toxicity data with that from the OPP sources is difficult due to the possible unreliability of the test material, the ranges of the values basically corroborate the toxicity levels reported by OPP.

Table 8. Summary of acute toxicity data from the EPA AQUIRE database.

Species	Scientific Name	Test Chemical*	96-h LC 50 (ppb)	Reference
Freshwater Invertebrates				
Amphipod	*Echinogammarus tibaldii*	Form.	11.0	18621
Scud	*Gammarus italicus*	Form.	20.0	18621
Estuarine Invertebrates				
Rotifer	*Brachionus plicatilis*	Form.	3000 - 3500 (24-h)	12646
Rotifer	*Brachionus plicatilis*	Form.	10, 000 (24-h)	12646
Opossum shrimp	*Americamysis bahia*	Form.	6.8	344

* Form. = Generally, this connotes that the test was conducted with formulated products, but the product composition and percent active ingredient are not given.

b. Environmental fate and transport

(The information in this section is condensed from the 2002 IRED, page 32, and the EFED Fenamiphos Risk Assessment, 2001, pages 7, 18 to 20,

Fenamiphos readily photodegrades when exposed to natural light on the soil surface. Its photodegradation half-life is 3.23 hours. Fenamiphos dissipates in soil by microbial degradation to fenamiphos sulfoxide and fenamiphos sulfone, followed by leaching into the soil column. There is further degradation of parent fenamiphos via aerobic and anaerobic soil metabolism, with respective degradation half-lives of 15.7 and 87.9 days. The half-lives for the degradates were determined to be 62 days for fenamiphos sulfoxide and 29 days for fenamiphos sulfone.

The rate of fenamiphos degradation increase with temperature from 16C to 28C. Fenamiphos and its degradates are mobile in soils and have a high potential to leach into ground water and to contaminate runoff into surface waters due to their high solubility in water. Field dissipation studies conducted on turf in California confirmed that both degradates leach further into the soil than the parent compound. Fenamiphos and the sulfoxide and sulfone degradates exceed levels of concern for ground water quality.

Fenamiphos does not accumulate significantly in fish in laboratory studies. Average BCFs were 21X in fillets, 61X in whole fish and 98X in viscera. The highest BCF of 230 was measured in a sample of viscera. More than 95% of the accumulated fenamiphos residues were depurated during the 14-day depuration period of the study. The primary metabolite was fenamiphos sulfone, which comprised up to 51% of the residues found in the viscera.

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 such information to the states and the U. S. Fish and Wildlife Service. 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). The IRED and EFED's risk assessment listed all the terrestrial and aquatic field incidents that had occurred and been reported to the Agency up to the time of publication of the IRED. There have not been any additional reports of fish or wildlife kills submitted to the Agency since publication of the fenamiphos IRED.

d. Estimated and measured concentrations of fenamiphos in surface waters

Measured concentrations in water

At the time the IRED was written there were only limited surface water monitoring data on the concentrations of fenamiphos and its degradates available. STORET listed 37 samples from more than 20 sites in three states with no detections of fenamiphos in any sample, although the detection limits ranged from 0.04 to 0.75 ppb. The usefulness of these data are limited as it is unknown if the samples were taken from areas where fenamiphos is used. Florida also conducted monitoring at 27 sites in the South Florida Water Management District where the major use was on golf courses and other treated crops were citrus and sugarcane. No detections of fenamiphos were reported, with the detection limits ranging from 0.2 to 1.63 ppb. It is unknown if the monitoring was targeted to the times of treatment with fenamiphos.

We also found very little data on fenamiphos residues in surface waters. The USGS NAWQA database had data on parent fenamiphos and both degradates, fenamiphos sulfoxide and fenamiphos sulfone for October 2001 in Merced and Stanislaus counties in California. All three compounds were at levels below their respective limits of detection (0.029 ppb, 0.031 ppb and 0.0077 ppb, respectively). Information from the California Surface Water Database, www.cdpr.ca.gov.docs/sw, indicates that fenamiphos was monitored for from March to September in 2002 in Sutter, Merced, San Joaquin, Stanislaus and Yuba counties. The limit of detection was 0.05 ppb, and no residues were detected in any of the 107 samples.

According to EFED's risk assessment, the sampling is usually too infrequent to characterize the maximum concentrations that might have occurred with any degree of certainty. The peak concentrations of fenamiphos are expected to be of short duration, and it is unlikely that the sampling frequency of any of the reported databases would have detected it.

Estimated environmental concentrations (EECs)

The EECs calculations, based on PRZM/EXAMS scenarios, presented in the fenamiphos IRED were not adequate for this consultation as they were based on scenarios in Florida and eastern states with more rainfall than is found in the PNW and California. Therefore, EFED provided us with new EEC calculations, also based on PRZM/EXAMS, specific for this consultation. The 2002 use data from California DPR was used as the basis of selecting the scenarios to be modeled. The rationale was to choose crops with the greater amount of acreage treated, tempered by the modeling scenarios currently available. The California scenarios that were selected are peach (which also is applicable to apple, cherry and nectarine), citrus (lemons and oranges), grapes and cabbage (which is applicable to other vegetable crops). Oregon was used as the site for the raspberry scenario, as there currently are no models for Washington. However, the results are applicable to both states.

All EECs are based on one application of fenamiphos on January 5 at the maximum label rate for each crop with an incorporation depth of one inch. A spray drift component was not included in the EEC calculations as the chemical is applied in a band or through irrigation, followed immediately by incorporation. There are two EECs for raspberry, one with the standard one-inch incorporation and another with a two-inch incorporation to determine if a greater depth of incorporation significantly affects the amount of fenamiphos getting into waterways. The EECs are presented in Table 9 below.

Table 9. Estimated Environmental Concentrations (EECs) for Aquatic Exposure Modeled With PRZM/EXAMS

Use site	Appl. rate (lb ai/acre)	Peak EEC (ppb)	21-day-avg. EEC (ppb)	60-day-avg. EEC (ppb)	90-day-avg EEC (ppb)
Peaches[a]	7.5	17.36	15.19	11.87	9.83
Citrus	7.5	0.25	0.22	0.16	0.13
Grapes	6.0	14.35	12.58	9.87	8.17
Cabbage[b]	4.5	35.36	30.23	23.51	19.31

Raspberries (1-inch incorp.)	6.0	32.80	24.09	19.39	16.69
Raspberries (2-inch incorp.)	6.0	16.39	12.04	9.69	8.34

[a]The scenario and EECs for peaches also apply to apples, cherries and nectarines.
[b]The scenario and EECs for cabbage also apply to other vegetable crops.

The EEC values for citrus are significantly lower than those for the other crops as citrus is grown in the drier southern counties of California, where the climate is almost desert-like. The other California crops are grown in the northern counties where there is more rainfall than in southern California, and therefore, a less arid climate.

We note that these EECs are likely to be higher than we would actually expect in California and the PNW because the application information used in the modeling is based on nationwide maximum application rates for each crop. However, the usage information from California (Table 3) indicates that the amounts used in 2002 on the modeled crops were 2 pounds a.i./a on peach, 2 to 3 pounds a.i./a on grape, 1.8 to 4.4 pounds a.i./a on citrus and 2.2 pounds a.i./a on cabbage. WSDA reported that 3 pounds a.i./a of Nemacur 3 are applied to raspberries. Furthermore, the PRZM-EXAMS models are based on runoff into a one-acre farm pond, which is very different than the flowing rivers habitats of endangered and threatened salmon and steelhead. If a validated model for flowing rivers were available, the EEC values would be significantly lower than those reported here, but currently the difference cannot be quantified.

e. General risk conclusions

Our risk conclusions are based on risk quotients (RQS) derived from the available toxicity data (Tables 4 to 8) and EECs from the PRZM-EXAMS model for currently maximum labeled rates of 4.5 pounds a.i./a to 7.5 pounds a.i./a. The RQS are presented in Table 10.

Table 10. Acute and Chronic Risk Quotients for Freshwater and Estuarine Fish and Aquatic Invertebrates, Based on Toxicity for the Most Sensitive Species (Tables 4 to 8) and EECs Modeled from PRZM/EXAMS (Table 9)

Use Site	Acute Risk Quotients[g]				Chronic Risk Quotients[h]	
	freshwater fish[a]	freshwater invertebrate[b]	estuarine fish[c]	estuarine invertebrate[d]	freshwater fish[e]	freshwater invertebrate[f]
peaches	1.83	10.85	1.02	2.80	2.59	126.6
citrus	0.03	0.16	0.01	0.04	0.03	1.83
grapes	1.51	8.97	0.84	2.31	2.15	104.8
cabbage	3.72	22.10	2.08	5.70	5.08	251.9

Use Site	Acute Risk Quotients[g]				Chronic Risk Quotients[h]	
	freshwater fish[a]	freshwater invertebrate[b]	estuarine fish[c]	estuarine invertebrate[d]	freshwater fish[e]	freshwater invertebrate[f]
raspberries (1-inch)	3.45	20.50	1.93	5.29	4.39	200.8
raspberries (2-inch)	1.73	10.24	0.96	2.64	2.19	100.3

[a] bluegill acute LC50 = 9.5 ppb.
[b] Daphnia acute LC50 = 1.6 ppb. The RED used the LC50 of 1.9 ppb, but we selected the equally valid, but lower, and therefore, more sensitive, toxicity value for our analysis.
[c] sheepshead minnow LC50 = 17 ppb.
[d]mysid LC50 = 6.2 ppb.
[e] rainbow trout chronic NOEC = 3.8 ppb.
[f] Daphnia chronic NOEC = 0.12 ppb.
[g] Peak EEC/LC50; the acute LOC is >0.05 for endangered fish and >0.5 for aquatic invertebrate populations.
[h]21-day-avg EEC/NOEC for invertebrates and the 90-day-avg EEC/NOEC for rainbow trout; the chronic LOC is 1 for fish and invertebrates.

OPP uses an RQ > 0.05 (LOC > 0.05) to indicate there is a potential direct acute risk to endangered aquatic species. The LOC for determining indirect effects to endangered salmonids through loss of their food supply is RQ > 0.5 for acute effects on freshwater and estuarine invertebrates. The acute risk LOCs are exceeded for freshwater and estuarine fish and invertebrates from all uses except applications to citrus. The chronic LOC (RQ > 1) is exceeded for invertebrates from all uses and for fish from all uses but citrus. Therefore, we conclude that all current uses except citrus present direct acute and chronic risks to listed salmon and steelhead and an indirect effect from loss of their food supply through acute and chronic exposures of their invertebrate food supply. The use on citrus only presents an indirect risk to listed salmonids from chronic risks to their food source of aquatic invertebrates. Chronic risk to invertebrates is not likely in flowing waters where fenamiphos should be rapidly dissipated, but this risk could adversely impact aquatic invertebrates inhabiting lentic waters.

The acute freshwater RQS are based on the sensitive species tested with fenamiphos, the bluegill. However, the rainbow trout is a better model for the listed salmonids and more accurately represents the risks of fenamiphos to these listed species. The toxicity data indicate that the acute LC50 for the rainbow trout, based on the technical grade of the active ingredient is 72.1 ppb, compared to the bluegill value of 9.5 ppb, which was used in the calculations in table 10. Recalculation of the acute RQS are in Table 10a.

Table 10a. Comparison of the acute risk quotients with the rainbow trout and bluegill.

Use Site	Bluegill RQ	Rainbow trout RQ
peaches	1.83	0.24
citrus	0.03	0.003
grapes	1.51	0.20
cabbage	3.72	0.49
raspberries (1-inch)	3.45	0.45
raspberries (2-inch)	1.73	0.23

As discussed above, the EECs were based on maximum label rates, whereas the state data indicates fenamiphos is used at lower rates. However, the EECs would have to be lower than 0.475 ppb to not have a concern for direct effects on endangered fish species (0.475 ppb/9.5 ppb = 0.05). The application rates would have to be significantly reduced, even lower than those commonly used in California and the PNW, to be below the level of concern.

Another mitigating factor in the exposure and risks of salmon and steelhead relates to the label statements requiring a buffer zone of 100 feet from bodies of water such as rivers and streams and a vegetative filter strip of 10 feet to reduce the amount of fenamiphos entering the water from runoff following rainfalls. Fenamiphos is highly soluble in water, hence its propensity to readily runoff from treated fields. The 1989 Biological Opinion from the U.S. Fish and Wildlife Service (FWS) requires a use limitation (buffer zone) of 40 yards (120 feet) from the edge of water for ground applications. The label statement approaches the buffer zone size provided by the FWS in the Opinion. The incidental take number for fenamiphos was set at zero. At the time the Opinion was written by the FWS the use of fenamiphos was significantly more widespread than current use, and the labels at that time did not have the protective measures developed during the IRED process since the mid-1990s. Even without the relatively recent protective measures and with a greater volume of use of the chemical in the PNW and California at the time the Opinion was written, the FWS considered the 40 yard limitation sufficient protection for endangered and threatened aquatic species. Although it cannot be quantified, the use of a 100 foot buffer zone plus the significant decrease in use of fenamiphos may be equivalent in protection to the FWS buffer zone of 40 yards.

To conclude, the use of a farm pond to model exposure to species that inhabit fast-slowing streams, the use of the rainbow trout toxicity data to characterize risk to endangered and threatened salmonids, the use of fenamiphos at rates less than the modeled maximum label rates, the requirement for a 100 foot buffer zone near water bodies, that is analagous to the limitation set by the FWS, will reduce risk. Therefore, it is my best professional judgement that in most cases fenamiphos would be very unlikely to adversely affect listed salmon and steelhead in ESUs where much is used. In some individual ESUs there may be no effect based on the very limited amount of fenamiphos used throughout the ESU. In a few ESUs the extent of use precludes a determination of "not likely to adversely affect."

f. Existing protective measures

Nationally, there are no specific protective measures for endangered and threatened species beyond the generic statements on the current fenamiphos labels. As stated on product labels, it is a violation of federal law to use a product in a manner inconsistent with its labeling. FIFRA section 3 labels for nongranular formulations of fenamiphos warn that "This pesticide is toxic to fish and wildlife. Drift and runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Do not use mist sprayers. Use only coarse sprays directed at soil to eliminate spray drift. Aerial application of this product is prohibited." The granular formulations include a warning about risks to birds, "Birds feeding on treated areas may be killed. Cover, incorporate or pick up spilled granules at row ends or turn areas." All formulations require that applicators adhere to the following or similar labeling:

> "Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters."
>
> All formulations have a ground water advisory statement:
>
> "Fenamiphos is known to leach through soil and has been found in ground water as a result of agricultural use. Users are advised not to apply in areas where soils are permeable, particularly where ground water is used for drinking water. Consult with the pesticide state lead agency for information regarding soil permeability and aquifer vulnerability in your area."

The risks to human health from drinking water contaminated with fenamiphos residues also prompted additional restrictions on the labels for field, fruit and vegetable crops:

> "When used on erodible soils, best management practices for minimizing runoff should be employed. Consult your local Soil Conservation Service for recommendations in your use area.
>
> Do not apply within 100 feet of the following aquatic areas: lakes, reservoirs, rivers, permanent streams, marshes, natural ponds and estuaries.
>
> Do not cultivate within 10 feet of an aquatic area to allow growth of a vegetative filter strip.
>
> After May 31, 2005, do not apply to hydrologic soil group A soils that are excessively drained and predominately sand or loamy sand such as soils in the suborder psamments with shallow water tables (less than 50 feet deep). These classifications and soil taxonomy refer to USDA definitions. If you are unsure of the type of soil you are treating, please consult with your county's extension agent or the product manufacturer."

The labels for the turf and ornamental uses do not have restrictions pertaining to the use of best management practices to minimize runoff or statements regarding lay-off distances from aquatic areas. Instead they have statements pertaining to irrigation practices:

> "For all applications that require overhead irrigation for incorporation, do not apply between noon and sunset during the heavy rainstorm season (June through September).
>
> For all applications that require sprinkler irrigation for incorporation, irrigation must occur withing 6 hours of the application."

Fenamiphos products are labeled as Restricted Use Pesticides based on its high acute toxicity and toxicity to wildlife, and therefore, can only be applied by certified applicators.

OPP's endangered species program has developed a series of county bulletins which provide information to pesticide users on steps that would be appropriate for protecting endangered or threatened species. Bulletin development is on ongoing process, and there are no bulletins yet developed that would address fish in the Pacific Northwest. OPP is preparing such bulletins. OPP's county bulletins have limitations on the use of fenamiphos in the habitats of endangered aquatic species which state that it cannot be applied within 40 yards from the edge of the water for ground applications, nor within 200 yards for aerial applications. These limitations, taken from Biological Opinions written by the FWS, are only in the bulletins and not currently on product labels. The intent is to have the use limitations listed in the county bulletins on product labels when the Endangered Species Protection Program becomes final. In California, DPR creates county bulletins consistent with those developed by OPP. Fenamiphos is not listed in the California bulletins but should be as there is a Biological Opinion from the FWS (1989) indicating that one amphibian species, 17 freshwater fish species, 22 freshwater clam species, two crustaceans and four avian species were determined to be in jeopardy from this pesticide.

4. Listed salmon and steelhead ESUs and comparison with fenamiphos use areas

In this section we present available information on the listed Pacific salmon and steelhead ESUs and evaluate potential exposure and risk based on known use of fenamiphos in each ESU. Our information on the various ESUs is taken almost entirely from various Federal Register Notices relating to listing, critical habitat, or status reviews. Usage data in California was obtained from the California Department of Pesticide Regulation's Summary of Pesticide Use Report Data for 2002 (Table 3) which provides county-level data for individual use sites. Statewide data for crops treated with fenamiphos in Washington and Oregon are taken from WSDA from their records for current use of fenamiphos and the Oregon data from USDA/NASS, respectively. Although several crops that are registered for treatment with fenamiphos are listed for Oregon, raspberries are the only crop being treated with fenamiphos in Oregon, and the only crop being considered in the decision for the ESUs located in Oregon.

A. Steelhead

Steelhead, *Oncorhyncus mykiss*, exhibit one of the most complex suite 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 redds 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 nonanadromous 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. 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. There is a potential for steelhead waters to drain agricultural areas in Ventura, Santa Barbara, and San Luis Obispo counties.

Usage of fenamiphos in counties where this ESU occurs is presented in Table 11.

Table 11. Use of fenamiphos in 2002 in counties within the Southern California steelhead ESU

County	use site	fenamiphos usage (lb ai)	acres treated
San Diego	not used		
Los Angeles	peach	107	48
Ventura	lemon	1233	278
San Luis Obispo	not used		
Santa Barbara	bok choy Chinese cabbage grape, wine **total**	52 114 429 **594**	23 51 147

The use of fenamiphos within the Southern California steelhead ESU is relatively low (3.4% of the statewide use), and over half the fenamiphos use in this ESU is on citrus, which presents a no effect to the steelhead. Also the total acreage in this ESU treated with fenamiphos is low. Indirect effects from chronic effects on their invertebrate food source are not likely, due to the flowing water habitat, but there is additional acreage beyond citrus. Therefore, we conclude that use of fenamiphos on crops other than citrus may affect but is not likely to adversely affect the Southern California steelhead ESU.

2. 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, San Benito, Monterey, and San Luis Obispo. There are agricultural areas in these counties, and these areas would be drained by waters where steelhead critical habitat occurs.

Table 12 shows fenamiphos usage in 2002 in those counties where this ESU occurs.

Table 12. Use of fenamiphos in 2002 in counties with the South Central California steelhead ESU.

County	use site	fenamiphos usage (lb ai)	acres treated
Santa Cruz	apple	63	9
Santa Clara	apricot landscape maintenance **total**	87 87 **175**	30
San Benito	grape, wine	87	13
Monterey	grape, wine landscape maintenance **total**	7390 132 **7523**	2688
San Luis Obispo	bok choy cabbage Chinese cabbage grape, wine **total**	76 76 792 313 **1257**	34 34 354 122

The use of fenamiphos in the South Central California steelhead ESU is moderate (12.6% of the statewide use), although the use on grapes is relatively high, even with the overall decrease in use of this pesticide. Based on the high localized use on grapes we conclude that use of fenamiphos may affect the South Central California steelhead ESU through direct effects and indirect effects through acute loss of its food supply.

3. 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).

Counties of occurrence for this ESU are Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Medocino, Napa, Alameda, Contra Costa, Solano and Santa Clara counties. This ESU is associated with significantly large urban and suburban areas.

Usage of fenamiphos in 2002 in the counties in the Central California coast steelhead ESU is presented in Table 13.

Table 13. Use of fenamiphos in 2002 in counties in the Central California Coast steelhead ESU.

County	use site	fenamiphos usage (lb ai)	acres treated
Santa Cruz	apple	63	9
San Mateo	landscape maintenance	159	
San Francisco	landscape maintenance structural pest control **total**	150 40 **190**	
Marin	not used		
Sonoma	grape, wine	32	11
Mendocino	grape, wine	594	203
Napa	grape, wine	369	152
Alameda	grape, wine	1180	405
Contra Costa	landscape maintenance	4	
Solano	not used		
Santa Clara	apricot landscape maintenance **total**	87 87 **175**	30

The use of fenamiphos is relatively low (3.9% of the statewide use), as is the total acreage treated with fenamiphos in this ESU. We conclude that use of fenamiphos may affect but is not likely to adversely affect the Central California Coast steelhead ESU.

4. 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, 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 fenamiphos in this ESU is provided in Table 14.

Table 14. Use of fenamiphos in 2002 in counties with the California Central Valley steelhead ESU.

County	use site	fenamiphos usage (lb ai)	acres treated
Alameda	grape, wine	1180	405
Amador	not used		
Butte	not used		
Calaveras	not used		
Colusa	not used		
Contra Costa	landscape maintenance	4	
Glenn	not used		
Marin	not used		
Merced	peach	128	49
Nevada	not used		
Placer	not used		
Sacramento	grape, wine	208	143
San Joaquin	cherry grape **total**	401 4586 **4987**	150 2114
San Mateo	landscape maintenance	159	
San Francisco	landscape maintenance structural pest control **total**	150 40 **190**	

County	use site	fenamiphos usage (lb ai)	acres treated
Shasta	cherry	15	7
Solano	not used		
Sonoma	grape, wine	32	11
Stanislaus	grape, wine peach **total**	813 61 **874**	291 40
Sutter	not used		
Tehama	not used		
Tuloumne	not used		
Yolo	grape, wine	321	cherry
Yuba	not used		

The use of fenamiphos in the California Central Valley steelhead ESU is relatively moderate (11.4% of the statewide use), although the use on grapes is high, even with the overall decrease in use of this pesticide. Based on this high localized use on grapes we conclude that fenamiphos may affect the California Central Valley steelhead ESU through direct effects and indirect effects through acute loss of its food supply.

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.

Fenamiphos use in this ESU is presented in Table 15.

Table 15. Use of fenamiphos in 2002 in counties with the Northern California steelhead ESU.

County	use site	fenamiphos usage (lb ai)	acres treated
Humboldt	not used		
Mendocino	grape, wine	594	203
Trinity	not used		
Lake	not used		

We conclude that fenamiphos will have no effect on the Northern California steelhead ESU. The only use of fenamiphos is on grapes in Mendocino County, and that total amount is minimal.

6. 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), Okanogan, 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.

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

Crop acreage in the counties within this ESU is provided in Tables 16 and 17.

Table 16. Crop acreage in Washington counties where there is spawning and growth of the Upper Columbia River steelhead ESU. Acreage is only given for raspberries as that is the only crop being treated with fenamiphos according to the Washington State Department of Agriculture. The acreage treated is based on their data that only 10% of the state's total crop is treated with fenamiphos.

State	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Benton	none	not used
WA	Franklin	none	not used
WA	Kittitas	none	not used
WA	Yakima	none	not used
WA	Chelan	none	not used
WA	Douglas	none	not used
WA	Okanogan	none	not used
WA	Grant	none	not used

Table 17. Crop acreage in Oregon and Washington counties that are migration corridors for the Upper Columbia River steelhead ESU. The information for Oregon is taken from USDA/NASS and the Agricultural Census.

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Walla Walla	none	not used
WA	Klickitat	none	not used
WA	Skamania	none	not used
WA	Clark	860	86
WA	Cowlitz	600	60
WA	Wahkiakum	none	not used
WA	Pacific	none	not used

Table 17a. Crop acreage in Oregon. Only crops labeled for fenamiphos are listed for Oregon, but only raspberries are currently treated with fenamiphos.

OR	county	crop	acreage grown in county
OR	Gilliam	none	
OR	Umatilla	grape strawberry raspberry	163 9 7
OR	Sherman	none	
OR	Morrow	none	
OR	Wasco	grape	110
OR	Hood River	grape raspberry	62 1
OR	Multnomah	grape strawberry raspberry cherry	28 171 741 4
OR	Columbia	grape strawberry raspberry	6 6 1
OR	Clatsop	none	

Very little fenamiphos is used in Washington. The total raspberry acreage that potentially can be treated in the counties in Oregon in this ESU is approximately 750 acres. If, as discussed earlier, no more than 10% of the planted acreage is currently treated with fenamiphos, then only 75 acres total are likely treated. The total acreage treated with fenamiphos is very limited and decreasing in these two states. Therefore, we conclude that fenamiphos will have no effect on the Upper Columbia River steelhead ESU.

7. 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, Baker, Union, and Umatilla (northeastern part) in Oregon; Asotin, Garfield, Columbia, Whitman, Franklin, and Walla Walla in Washington; and Adams, Idaho, Nez Perce, Blaine, Custer, Lemhi, Boise, Valley, Lewis, Clearwater, and Latah in Idaho. We have excluded Baker County, Oregon, which has a tiny fragment of the Imnaha River watershed. While a small part of Rock Creek that extends into Baker County, this occurs at 7200 feet in the mountains (partly in a wilderness area) and is of no significance with respect to fenamiphos use in agricultural areas. We have similarly excluded the Upper Grande Ronde watershed tributaries (e.g., Looking Glass and Cabin Creeks) that are barely into higher elevation forested areas of Umatilla County. However, crop areas of Umatilla County are considered in the migratory routes. In Idaho, Blaine and Boise counties technically have waters that are part of the steelhead ESU, but again, these are tiny areas which occur in the Sawtooth National Recreation Area and/or National Forest lands. We have excluded these areas because they are not relevant to use of fenamiphos. The agricultural areas of Valley County, Idaho, appear to be primarily associated with the Payette River watershed, but there is enough of the Salmon River watershed in this county that we were not able to exclude it.

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 Benton, Klickitat, Skamania, Clark, Cowlitz, Wahkiakum, and Pacific in Washington.

Tables 18 and 19 show the cropping information for the Pacific Northwest counties encompassing spawning and rearing habitat of the Snake River Basin steelhead ESU and for the Oregon and Washington counties where this ESU migrates.

Table 18. Crop acreage in Pacific Northwest counties which provide spawning and rearing habitat for the Snake River Basin steelhead ESU. Information is from USDA/NASS and the WSDA.

State	county	crop	crop acreage
ID	Adams	no use	
ID	Idaho	no use	
ID	Nez Perce	no use	
ID	Custer	no use	
ID	Lemhi	no use	
ID	Valley	no use	

State	county	crop	crop acreage
ID	Lewis	no use	
ID	Clearwater	no use	
ID	Latah	no use	
WA	Adams	no use	
WA	Asotin	no use	
WA	Garfield	no use	
WA	Columbia	no use	
WA	Whitman	no use	
WA	Franklin	no use	
WA	Walla Walla	no use	
WA	Lincoln	no use	
WA	Spokane	no use	
OR	Wallowa	no use	
OR	Union	no use	

Table 19. Crop acreage in Washington and Oregon counties through which the Snake River Basin steelhead ESU migrates. Information is from USDA/NASS and the WSDA

Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Benton	none	
WA	Klickitat	none	
WA	Skamania	none	
WA	Clark	860	86
WA	Cowlitz	600	60
WA	Wahkiakum	none	
WA	Pacific	none	

Table 19a. Crop acreage in Oregon

OR	county	crop	acreage grown in county
OR	Gilliam	none	
OR	Umatilla	grape strawberry raspberry	163 9 7
OR	Sherman	none	
OR	Morrow	none	
OR	Wasco	grape	110
OR	Hood River	grape raspberry	62 1
OR	Multnomah	grape strawberry raspberry cherry	28 171 741 4
OR	Columbia	grape strawberry raspberry	6 6 1
OR	Clatsop	none	

Very little fenamiphos is used, or can potentially be used, in the Snake River Basin steelhead ESU. Therefore, we conclude that fenamiphos will have no effect on the Snake River Basin steelhead ESU.

8 Upper Willamette 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, and small parts of Lincoln and Tillamook counties. However, the latter two counties are small portions in forested areas where fenamiphos would not be used, and these counties are excluded from my analysis. While the Willamette River extends upstream into Lane County, the final Critical Habitat Notice does not include the Willamette River (mainstem, Coastal and Middle forks) in Lane County or the MacKenzie River and other tributaries in this county that were in the proposed Critical Habitat.

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, Oregon, and Clark, Cowlitz, Wahkiakum, and Pacific counties, Washington.

Tables 20 and 21 show the crop acreage for this ESU.

Table 20. Crop acreage in the spawning and rearing habitat of the Upper Willamette River steelhead ESU.

OR	county	crop	crop acreage
OR	Benton	grape strawberry bulbs raspberry cherry	242 17 13 2 14
OR	Linn	grape strawberry bulbs raspberry	93 52 3 387
OR	Polk	grape strawberry cherry	1123 22 1484
OR	Clackamas	grape strawberry raspberry cherry	207 608 1435 23

OR	county	crop	crop acreage
OR	Marion	grape strawberry bulbs raspberry cherry	761 1858 536 546 1459
OR	Yamhill	grape strawberry cherry	2887 265 1140
OR	Washington	raspberry cherry	1150 141

Table 21. Crop acreage in Oregon and Washington counties that are part of the migration corridors of the Upper Willamette River steelhead ESU.

Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Clark	860	86
WA	Cowlitz	600	60
WA	Wahkiakum	none	
WA	Pacific	none	

Table 21a. Crop acreage in Oregon

OR	county	crop	acreage grown in county
OR	Multnomah	grape strawberry raspberry cherry	28 171 741 4
OR	Columbia	grape strawberry raspberry	6 6 1
OR	Clatsop	none	

Very little fenamiphos is used in Washington. The total raspberry acreage that potentially can be treated in the counties in Oregon in this ESU is approximately 4300 acres. If, as discussed earlier, no more than 10% of the planted acreage is currently treated with fenamiphos, then only about 430 acres total are likely treated. Based on the extent of the raspberry use in Oregon we conclude that use of fenamiphos may affect but is not likely to adversely affect the Upper Willamette River steelhead ESU.

9. 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 the counties of 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.

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.

Tables 22 and 23 show the crop acreage 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.

Table 22. Crop acreage in counties that provide spawning and rearing habitat for the Lower Columbia River Steelhead ESU.

Oregon

OR	county	crop	acreage grown in county
OR	Hood River	grape raspberry	62 1
OR	Multnomah	grape strawberry raspberry cherry	28 171 741 4
OR	Clackamas	grape strawberry raspberry cherry	207 608 1435 35

Table 22a. Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Clark	860	86
WA	Lewis	none used	
WA	Cowlitz	600	60
WA	Skamania	none	

Table 23. Crop acreage in counties that are migratory corridors for the Lower Columbia River Steelhead ESU.

Oregon

OR	county	crop	acreage grown in county
OR	Columbia	grape strawberry raspberry	6 6 1
OR	Clatsop	none used	

Table 23a. Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Pacific	none used	
WA	Wahkiakum	none used	

Virtually no fenamiphos is used along the migratory corridors of the Lower Columbia River steelhead. Fenamiphos can potentially be used on 2200 acres of raspberries in Oregon and 1500 acres in Washington, in the spawning and rearing habitat. As the use data indicate that only about 10% of this acreage is likely treated with fenamiphos (less than 400 acres), the presence of fenamiphos in the habitat is somewhat limited. Therefore we conclude that fenamiphos may affect but is not likely to adversely affect the Lower Columbia River steelhead ESU.

10. 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. We are unsure of the status of these Dog and Collins creeks.

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.

In the John Day River watershed, we have excluded Harney County, Oregon because there is only a tiny amount of the John Day River and several tributary creeks (e.g., Utley, Bear Cougar creeks) which get into high elevation areas (approximately 1700M and higher) of northern Harney County where there are no crops grown. Similarly, the Umatilla River and Walla Walla River get barely into Union County OR, and the Walla Walla River even gets into a tiny piece of Wallowa County, Oregon. But again, these are high elevation areas where crops are not grown, and we have excluded these counties for this analysis.

The Oregon counties then that appear to have spawning and rearing habitat are Gilliam, Morrow, Umatilla, Sherman, Wasco, Crook, Grant, Wheeler, and Jefferson counties. Hood River, Multnomah, Columbia, and Clatsop counties in Oregon provide migratory habitat. Washington counties providing spawning and rearing habitat would be Benton, Columbia, Franklin, Kittitas, Klickitat, Skamania, Walla Walla, and Yakima, although only a small portion of Franklin County between the Snake River and the Yakima River is included in this ESU. Skamania, Clark, Cowlitz, Wahkiakum, and Pacific Counties in Washington provide migratory corridors.

Tables 24 and 25 show the crop acreage 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.

Table 24. Crop acreage in counties that provide spawning and rearing habitat for the Middle Columbia River Steelhead ESU.

Oregon

OR	county	crop	acreage grown in county
OR	Gilliam	none	
OR	Umatilla	grape strawberry raspberry	163 9 7
OR	Sherman	none	
OR	Morrow	none	
OR	Wasco	grape	110
OR	Crook	none	
OR	Grant	none	
OR	Wheeler	strawberry	1257
OR	Jefferson	none	

Table 24a. Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Benton	none	
WA	Klickitat	none	
WA	Skamania	none	
WA	Columbia	none	
WA	Franklin	none	
WA	Kittitas	none	
WA	Walla Walla	none	
WA	Yakima	none	

Table 25. Crop acreage in Washington and Oregon counties through which the Middle Columbia River steelhead ESU migrates.

Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Skamania	none	
WA	Clark	860	86
WA	Cowlitz	600	60
WA	Wahkiakum	none	
WA	Pacific	none	

Table 25a. Oregon

OR	county	crop	acreage grown in county
OR	Hood River	grape raspberry	62 1
OR	Multnomah	grape strawberry raspberry cherry	28 171 741 4
OR	Columbia	grape strawberry raspberry	6 6 1
OR	Clatsop	none	

The potential and actual use of fenamiphos is very limited in the spawning and rearing habitat and the migration corridors of the Middle Columbia River steelhead. Therefore we conclude that fenamiphos will have no effect on the Middle Columbia River steelhead ESU.

B. 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.

Coastwide, 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 redd, in a stream area with suitable gravel composition, water depth and velocity. After laying eggs in a redd, adult chinook will guard the redd 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. 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 are excluded (58FR33212-33219, June 16, 1993).

Use of fenamiphos in this ESU in 2002 is presented in Table 26.

Table 26. Use of fenamiphos in 2002 in counties with the Sacramento River winter-run chinook salmon ESU. Spawning areas are primarily in Shasta and Tehama counties above the Red Bluff diversion dam.

County	crop	fenamiphos usage (lb ai)	acres treated
Alameda	grape, wine	1180	405
Butte		none used	

County	crop	fenamiphos usage (lb ai)	acres treated
Colusa		none used	
Contra Costa	landscape maintenance	4	
Glenn		none used	
Marin		none used	
Sacramento	grape, wine	208	143
San Mateo	landscape maintenance	159	
San Francisco	landscape maintenance structural pest control **total**	150 40 **190**	
Shasta	cherry	15	7
Solano		none used	
Sonoma	grape, wine	32	11
Sutter		none used	
Tehama		none used	
Yolo	grape, wine	321	110

The use of fenamiphos is relatively low (3% of the statewide use), as is the total acreage treated with fenamiphos in this ESU. We conclude that use of fenamiphos may affect but is not likely to adversely affect the Sacramento River winter-run chinook salmon ESU.

2. 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 year, 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. We have not included these counties here; however, we would note that the Middle Columbia River steelhead ESU encompasses these basins, and crop information is presented in that section of this analysis.

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. These units are in Baker, Umatilla, Wallowa, and Union counties in Oregon; Adams, Asotin, Columbia, Franklin, Garfield, Lincoln, Spokane, Walla Walla, and Whitman counties in Washington; and Adams, Benewah, Clearwater, Idaho, Latah, Lewis, Nez Perce, Shoshone, and Valley counties in Idaho. I note that Custer and Lemhi counties in Idaho are not listed as part of the fall-run ESU, although they are included for the spring/summer-run ESU. Because only high elevation forested areas of Baker and Umatilla counties in Oregon are in the spawning and rearing areas for this fall-run chinook, we have excluded them from consideration because fenamiphos would not be used in these areas. We have, however, kept Umatilla County as part of the migratory corridor.

Tables 27 and 28 show the crop acreage 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.

Table 27. Crop acreage in Pacific Northwest counties which provide spawning and rearing habitat for the Snake River fall-run chinook ESU.

Idaho

State	county	crop	crop acreage
ID	Adams	no use	
ID	Idaho	no use	
ID	Nez Perce	no use	
ID	Valley	no use	
ID	Lewis	no use	
ID	Benewah	no use	
ID	Shoshone	no use	
ID	Clearwater	no use	
ID	Latah	no use	

Table 27a. Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Adams	none	
WA	Lincoln	none	
WA	Spokane	none	
WA	Asotin	none	
WA	Garfield	none	
WA	Columbia	none	
WA	Whitman	none	
WA	Franklin	none	
WA	Walla Walla	none	

Table 27b. Oregon

OR	county	crop	acreage grown in county
OR	Gilliam	none	
OR	Wallowa	none	
OR	Sherman	none	
OR	Morrow	none	
OR	Wasco	grape	110
OR	Jefferson	none	
OR	Union	none	
OR	Wheeler	strawberry	1257
OR	Morrow	none	
OR	Grant	none	

Table 28. Crop acreage in Washington and Oregon counties through which the Snake River fall-run chinook and the Snake River spring/summer-run chinook ESUs migrate.

Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Benton	none	
WA	Klickitat	none	
WA	Skamania	none	
WA	Clark	860	86
WA	Cowlitz	600	60
WA	Wahkiakum	none	
WA	Pacific	none	

Table 28a. Oregon

OR	county	crop	acreage grown in county
OR	Gilliam	none	
OR	Umatilla	grape strawberry raspberry	163 9 7
OR	Sherman	none	
OR	Morrow	none	
OR	Wasco	grape	110
OR	Hood River	grape raspberry	62 1
OR	Multnomah	grape strawberry raspberry cherry	28 171 741 4
OR	Columbia	grape strawberry raspberry	6 6 1
OR	Clatsop	none	

We conclude that there is no effect on the Snake River fall-run chinook salmon ESUs as very little fenamiphos is used, or can potentially be used in the spawning and rearing habitat and the migration corridors.

3. 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 year, 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, Pahsimerol, 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 mentioned in the Critical Habitat Notice include Union, Umatilla, Wallowa, and Baker counties in Oregon; Adams, Blaine, Custer, Idaho, Lemhi, Lewis, Nez Perce, and Valley counties in Idaho; and Asotin, Columbia, Franklin, Garfield, Walla Walla, and Whitman counties in Washington. However, we have excluded Umatilla and Baker counties in Oregon and Blaine County in Idaho because accessible river reaches are all well above areas where fenamiphos can be used. Counties with migratory corridors are all of those down stream from the confluence of the Snake and Columbia Rivers.

Table 29 shows the crop acreage for Oregon and Washington counties where the Snake River spring/summer-run chinook salmon ESU occurs. The crop acreage for the migratory corridors is the same as for the Snake River fall-run chinook salmon (Table 27).

Table 29. Crop acreage in counties which provide spawning and rearing habitat for the Snake River spring/summer run chinook ESU.

Idaho

State	county	crop	crop acreage
ID	Adams	no use	
ID	Idaho	no use	
ID	Nez Perce	no use	

State	county	crop	crop acreage
ID	Valley	no use	
ID	Lewis	no use	
ID	Shoshone	no use	
ID	Lemhi	no use	
ID	Latah	no use	

Table 29a. Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Asotin	none	
WA	Garfield	none	
WA	Columbia	none	
WA	Whitman	none	
WA	Franklin	none	

Table 29b. Oregon

OR	county	crop	crop acreage in county
OR	Gilliam	none	
OR	Wallowa	none	

Based on the lack of use of fenamiphos we conclude that there is no effect on the Snake River spring/summer run chinook salmon ESU.

4. 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 down stream 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. These areas are said to be 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. However, with San Mateo County being well south of the Oakland Bay Bridge, it is difficult to see why this county was included.

Table 34 contains usage information for the California counties supporting the Central Valley spring-run chinook salmon ESU.

Table 30. Use of fenamiphos in 2002 in counties with the Central Valley spring run chinook salmon ESU

County	use site	fenamiphos usage (lb ai)	acres treated
Alameda	grape, wine	1180	405
Butte		none	
Colusa		none	
Contra Costa	landscape maintenance	4	
Glenn		none	
Marin		none	
Napa	grape, wine	369	152
Nevada		none	
Placer		none	
Sacramento	grape, wine	208	143
San Mateo	landscape maintenance	159	
San Francisco	landscape maintenance structural pest control **total**	150 40 **190**	
Shasta	cherry	15	7

County	use site	fenamiphos usage (lb ai)	acres treated
Solano		none	
Sonoma	grape, wine	32	11
Sutter		none	
Tehama		none	
Yolo	grape, wine	321	110
Yuba		none	

The use of fenamiphos is relatively low (3.5% of the statewide use), as is the total acreage treated with fenamiphos in this ESU. We conclude that use of fenamiphos may affect but is not likely to adversely affect the Central Valley spring run chinook salmon ESU.

5. 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 with agricultural areas where fenamiphos is used minimally are Humboldt, Trinity, Mendocino, Lake, Sonoma, and Marin. A small portion of Glenn County is also included in the Critical Habitat, but fenamiphos would not likely be used in the forested upper elevation areas.

Table 31 contains usage information for the California counties supporting the California Coastal chinook salmon ESU.

Table 31. Use of fenamiphos in 2002 in counties within the California Coastal chinook salmon ESU

County	use site	fenamiphos usage (lb ai)	acres treated
Humboldt		none	

County	use site	fenamiphos usage (lb ai)	acres treated
Mendocino	grape, wine	594	203
Sonoma	grape, wine	32	11
Marin		none	
Trinity		none	
Lake		none	

We conclude that fenamiphos will have no effect on the California Coastal chinook salmon ESU. The only use of fenamiphos is on grapes in Mendocino County and Sonoma County, and that total amount is minimal, less than 1% of statewide use of fenamiphos.

6. 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, apparently all of which could have spawning and rearing habitat, are Skagit, Whatcom, San Juan, Island, Snohomish, King, Pierce, Thurston, Lewis, Grays Harbor, Mason, Clallam, Jefferson, and Kitsap.

Table 32 shows the crop acreage for Washington counties where the Puget Sound chinook salmon ESU is located.

Table 32. Crop acreage in counties within the Critical Habitat of the Puget Sound chinook salmon ESU.

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Skagit	1330	33
WA	Whatcom	6400	640
WA	San Juan	none	
WA	Island	none	
WA	Snohomish	none	
WA	King	none	
WA	Pierce	110	11
WA	Thurston	none	
WA	Lewis	none	
WA	Grays Harbor	none	
WA	Mason	none	
WA	Clallam	none	
WA	Jefferson	none	
WA	Kitsap	none	

We conclude that fenamiphos will have no effect on the Puget Sound chinook salmon ESU. Our determination is made based on the relative lack of use of fenamiphos in this ESU.

7. 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 Rivers 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. Spawning and rearing habitat would be in the counties of Hood River, Wasco, Columbia, Clackamas, Marion, Multnomah, and Washington in Oregon, and Klickitat, Skamania, Clark, Cowlitz, Lewis, Wahkiakum, Pacific, Yakima, and Pierce in Washington. Clatsop County appears to be the only county in the critical habitat that does not contain spawning and rearing habitat, although there is only a small part of Marion County that is included as critical habitat. We have excluded Pierce County, Washington because the very small part of the Cowlitz River watershed in this county is at a high elevation where fenamiphos would not likely be used.

Table 33 shows the crop acreage for Oregon and Washington counties where the Lower Columbia River chinook salmon ESU occurs.

Table 33. Crop acreage in counties that are in the Critical Habitat of the Lower Columbia River chinook salmon ESU.

Oregon

OR	county	crop	crop acreage
OR	Wasco	grape	110
OR	Hood River	grape raspberry	62 1
OR	Marion	grape strawberry bulbs raspberry cherry	761 1858 536 546 1459
OR	Clackamas	grape strawberry raspberry cherry	207 608 1435 23
OR	Multnomah	grape strawberry raspberry cherry	28 171 741 4
OR	Washington	raspberry cherry	1150 141
OR	Columbia	grape strawberry raspberry	6 6 1
OR	Clatsop	none	

Table 33a. Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Lewis	none	
WA	Klickitat	none	
WA	Skamania	none	
WA	Clark	860	86
WA	Cowlitz	600	60
WA	Wahkiakum	none	
WA	Pacific	none	

Very little fenamiphos is used in Washington. The total raspberry acreage that potentially can be treated in the counties in Oregon in this ESU is approximately 3900 acres. If, as discussed earlier, no more than 10% of the planted acreage is currently treated with fenamiphos, then only about 390 acres total are likely treated. As this is still a moderate amount of acreage that can be treated with fenamiphos we conclude that fenamiphos may affect but is not likely to adversely affect the Lower Columbia Rive chinook salmon ESU.

8. 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, Lincoln, Linn, Polk, Marion, Yamhill, Washington, and Tillamook. However, Lincoln and Tillamook counties include salmon habitat only in the forested parts of the coast range where fenamiphos would not be used. Salmon habitat for this ESU is exceedingly limited in Douglas County also.

Tables 34 and 35 show the crop acreage for Oregon counties where the Upper Willamette

River chinook salmon ESU occurs and for the Oregon and Washington counties where this ESU migrates.

Table 34. Crop acreage in the spawning and rearing habitat of the Upper Willamette River chinook salmon ESU.

OR	county	crop	crop acreage
OR	Douglas	grape strawberry bulbs raspberry	581 24 4 14
OR	Lane	grape strawberry bulbs raspberry	631 74 43 20
OR	Benton	grape strawberry bulbs raspberry cherry	242 17 13 2 14
OR	Linn	grape strawberry bulbs raspberry	93 52 3 387
OR	Polk	grape strawberry cherry	1123 22 1484
OR	Clackamas	grape strawberry raspberry cherry	207 608 1435 23
OR	Marion	grape strawberry bulbs raspberry cherry	761 1858 536 546 1459

OR	county	crop	crop acreage
OR	Yamhill	grape strawberry cherry	2887 265 140
OR	Washington	raspberry cherry	1150 141

Table 35. Crop acreage in the migration corridors of the Upper Willamette River chinook salmon ESU.

Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Clark	860	86
WA	Cowlitz	600	60
WA	Wahkiakum	none	
WA	Pacific	none	

Table 35a. Oregon

OR	county	crop	acreage grown in county
OR	Multnomah	grape strawberry raspberry cherry	28 171 741 4
OR	Columbia	grape strawberry raspberry	6 6 1
OR	Clatsop	none	

The total raspberry acreage that potentially can be treated in Oregon in this ESU is approximately 4300 acres. If, as discussed earlier, no more than 10% of the planted acreage is currently treated with fenamiphos, then about 430 acres total are likely treated. The use of fenamiphos in the Upper Willamette River chinook salmon ESU is moderate. We conclude that use of fenamiphos may affect but is not likely to adversely affect the Upper Willamette River chinook salmon ESU.

9. 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, Kittitas, and Benton with the lower river reaches being migratory corridor.

Tables 36 and 37 present crop acreage for those Washington counties that support the Upper Columbia River chinook salmon ESU and for Oregon and Washington counties where this ESU migrates.

Table 36. Crop acreage in Washington counties where there is spawning and rearing habitat for the Upper Columbia River chinook salmon ESU.

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Benton		
WA	Kittitas	none	
WA	Chelan	none	
WA	Douglas	none	
WA	Okanogan	none	
WA	Grant	none	

Table 37. Crop acreage in counties that are migration corridors for the Upper Columbia River chinook salmon ESU.

Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Franklin	none	
WA	Yakima	none	

WA	Walla Walla	none	
WA	Klickitat	none	
WA	Skamania	none	
WA	Clark	860	86
WA	Cowlitz	600	60
WA	Wahkiakum	none	
WA	Pacific	none	

Table 37a. Oregon

OR	county	crop	acreage grown in county
OR	Gilliam	none	
OR	Umatilla	grape strawberry raspberry	163 9 7
OR	Sherman	none	
OR	Morrow	none	
OR	Wasco	grape	110
OR	Hood River	grape raspberry	62 1
OR	Multnomah	grape strawberry raspberry cherry	28 171 741 4
OR	Columbia	grape strawberry raspberry	6 6 1
OR	Clatsop	none	

Fenamiphos is not used in the spawning and rearing habitat for the Upper Columbia River chinook salmon, and with relatively low use in the migration corridors. Therefore, we conclude that there is no effect on the Upper Columbia River chinook 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 redds 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.

Table38 contains fenamiphos usage information for the California counties supporting the Central California coast coho salmon ESU.

Table 38. Use of fenamiphos in 2002 in counties with the Central California Coast coho ESU

County	use site	fenamiphos usage (lb ai)	acres treated
Santa Cruz	apple	63	9
San Mateo	landscape maintenance	159	
Marin		none	
Sonoma	grape, wine	32	11
Mendocino	grape, wine	594	203
Napa	grape, wine	369	152

The use of fenamiphos is relatively low (less than 2% of the statewide use), as is the total acreage treated with fenamiphos in this ESU. We conclude that use of fenamiphos may affect but is not likely to adversely affect the Central California Coast coho salmon ESU.

2. 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 Klam (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, Glenn, Lake, Del Norte, Siskiyou in California and Curry, Jackson, Josephine, Klamath, and Douglas, in Oregon. However, we have excluded Glenn County, California from this analysis because the salmon habitat in this county is not near the agricultural areas.

Fenamiphos use in counties occupied by this ESU is presented in Tables 39 and 40.

Table 39. Fenamiphos usage in 2002 in California counties within the Southern Oregon/Northern California coastal coho salmon ESU.

County	crop	fenamiphos usage (lb ai)	acres treated
Humboldt		none	
Mendocino	grape, wine	594	203
Del Norte		none	
Siskiyou		none	
Trinity		none	
Lake		none	

Table 40. Crop acreage in Oregon counties where there is habitat for the Southern Oregon/Northern California coastal coho salmon ESU.

State	county	crop	crop acreage
OR	Curry	strawberry bulbs	1 91
OR	Jackson	grape strawberry raspberry	76 18 5
OR	Josephine	grape strawberry raspberry	355 3 2
OR	Douglas	grape strawberry bulbs raspberry	581 24 4 14

Fenamiphos is not used to any extent in the California counties and can potentially be used on 26 acres in Oregon in the Southern Oregon/Northern California coho salmon habitat. Based on the limited use we conclude that fenamiphos will have no effect on the Southern Oregon/Northern California coho salmon ESU.

3. 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 Douglas, Lane, Coos, Curry, Benton, Lincoln, Polk, Tillamook, Yamhill, Washington, Columbia, Clatsop. However, the portions of Yamhill, Washington, and Columbia counties that are within the ESU do not include agricultural areas, and we have eliminated them in this analysis.

Table 41 shows the crop acreage for Oregon counties where the Oregon coast coho salmon ESU occurs.

Table 41. Crop acreage in counties where there is habitat for the Oregon coast coho salmon ESU.

State	county	crop	crop acreage
OR	Curry	strawberry bulbs	1 91
OR	Coos	grape	12
OR	Douglas	grape strawberry bulbs raspberry	581 24 4 14
OR	Lane	grape strawberry bulbs raspberry	631 74 43 20

State	county	crop	crop acreage
OR	Lincoln	grape raspberry	1 3
OR	Benton	grape strawberry bulbs raspberry cherry	242 17 13 2 14
OR	Polk	grape strawberry cherry	1123 22 1484
OR	Tillamook	none	
OR	Clatsop	none	

Fenamiphos can potentially be used on 39 acres of raspberries in Oregon in the Oregon Coast coho salmon habitat. The presence of fenamiphos in the habitat is very limited. Therefore we conclude that fenamiphos will have no effect on the Oregon Coast coho salmon ESU.

D. 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 to 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.

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

1. 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, and Island.

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, Jimmycomelately Creek, Duckabush 'stream', Hamma Hamma 'stream', and Dosewallips 'stream'.

Table 42 shows the crop acreage for Washington counties where the Hood Canal summer-run chum salmon ESU occurs.

Table 42. Crop acreage in counties where there is habitat for the Hood Canal Summer-run chum salmon ESU.

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Mason	none	
WA	Clallam	none	
WA	Jefferson	none	
WA	Kitsap	none	
WA	Island	none	
WA	Grays Harbor	none	

We conclude that oryzalin will have no effect on the Hood Canal Summer-run chum salmon ESU. Our determination is based on the lack of use in this ESU as reported by WSDA.

2. 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, Lower Willamette in the counties of Clark, Skamania, Cowlitz, Wahkiakum, Pacific, Lewis, Washington and Multnomah, Clatsop, Columbia, and Washington, Oregon. It appears that there are three extant populations in Grays River, Hardy Creek, and Hamilton Creek.

Table 43 shows the crop acreage information for Oregon and Washington counties where the Columbia River chum salmon ESU occurs.

Table 43. Crop acreage in counties where there is habitat for the Columbia River chum salmon ESU.

Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Lewis	none	
WA	Skamania	none	
WA	Clark	860	86
WA	Cowlitz	600	60
WA	Wahkiakum	none	
WA	Pacific	none	

Table 43a. Oregon

OR	county	crop	acreage grown in county
OR	Multnomah	grape strawberry raspberry cherry	28 171 741 4
OR	Columbia	grape strawberry raspberry	6 6 1

OR	Washington	raspberry cherry	1150 141
OR	Clatsop	none	

Fenamiphos is used on a very limited amount of acreage in Washington. It can potentially be used on approximately 2000 acres of raspberries but the use information indicates that, at most, 200 acres would be treated with fenamiphos. As the total acreage is very low, we conclude that fenamiphos will have no effect on the Columbia River chum salmon ESU.

E. 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 mainstem 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 the whole of Clallam County (Table 44).

Table 44. Crop acreage in Clallam County where there is habitat for the Ozette Lake sockeye salmon ESU

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Clallam	none	

We conclude that of fenamiphos will have no effect on the Ozette Lake sockeye salmon ESU. Our determination is based on the lack of use in the habitat.

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 mainstem 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. However, the habitat area for the salmon is high elevation areas in a National Wilderness area and National Forest. Fenamiphos cannot be used in this area. It is possible that this salmon ESU could be exposed to fenamiphos in the lower and larger river reaches during its juvenile or adult migration.

Crop acreage in counties encompassing spawning and rearing habitat and migratory corridors for the Snake River sockeye salmon ESU is provided in Tables 45 and 46.

Table 45. Crop acreage in Idaho counties where there is spawning and rearing habitat for the Snake River sockeye salmon ESU

State	county	crop	crop acreage
ID	Custer	none	
ID	Blaine	none	

Table 46. Crop acreage in counties within the migratory corridors for the Snake River sockeye salmon ESU.

Idaho

State	county	crop	crop acreage
ID	Idaho	none	
ID	Lemhi	none	
ID	Lewis	none	
ID	Nez Perce	none	
ID	Valley	none	

Table 46a. Washington

WA	county	acreage of raspberry crop in county	acreage treated with fenamiphos
WA	Asotin	none	
WA	Garfield	none	
WA	Whitman	none	
WA	Columbia	none	
WA	Walla Walla	none	
WA	Franklin	none	
WA	Benton	none	
WA	Klickitat	none	
WA	Skamania	none	
WA	Clark	860	86

WA	Cowlitz	600	60
WA	Wahkiakum	none	
WA	Pacific	none	

Table 46a. Oregon

OR	county	crop	acreage grown in county
OR	Wallowa	none	
OR	Gilliam	none	
OR	Umatilla	grape strawberry raspberry	163 9 7
OR	Sherman	none	
OR	Morrow	none	
OR	Wasco	grape	110
OR	Hood River	grape raspberry	62 1
OR	Multnomah	grape strawberry raspberry cherry	28 171 741 4
OR	Columbia	grape strawberry raspberry	6 6 1
OR	Clatsop	none	

There is no usage of fenamiphos in Idaho, very low usage in Washington, and only, at most, 100 treated acres in Oregon.We conclude there is no effect on the Snake River sockeye salmon ESU.

5. Summary conclusions for listed Pacific salmon and steelhead

Based on the available information and best professional judgement, our conclusions on potential adverse effects on listed Pacific salmon and steelhead are provided in Table 47. We conclude that oryzalin may affect but will not adversely affect 17 ESUs from possible indirect effects on aquatic-plant cover and will have no effect on nine ESUs.

Table 47. Summary conclusions on specific ESUs of listed Pacific salmon and steelhead for fenamiphos

Species	ESU	Finding
Steelhead	Southern California	may affect but not likely to adversely affect
Steelhead	South-Central California Coast	may affect
Steelhead	Central California Coast	may affect but not likely to adversely affect
Steelhead	Central Valley, California	may affect
Steelhead	Northern California	no effect
Steelhead	Upper Columbia River	no effect
Steelhead	Snake River Basin	no effect
Steelhead	Upper Willamette River	may affect but not likely to adversely affect
Steelhead	Lower Columbia River	may affect but not likely to adversely affect
Steelhead	Middle Columbia River	no effect
Chinook Salmon	Sacramento River winter-run	may affect but not likely to adversely affect
Chinook Salmon	Snake River fall-run	no effect
Chinook Salmon	Snake River spring/summer-run	no effect
Chinook Salmon	Central Valley spring-run	may affect but not likely to adversely affect
Chinook Salmon	California Coastal	no effect
Chinook Salmon	Puget Sound	no effect
Chinook Salmon	Lower Columbia	may affect but not likely to adversely affect
Chinook Salmon	Upper Willamette	may affect but not likely to adversely affect
Chinook Salmon	Upper Columbia	no effect

Species	ESU	Finding
Coho salmon	Central California	may affect but not likely to adversely affect
Coho salmon	Southern Oregon/Northern California Coasts	no effect
Coho salmon	Oregon Coast	no effect
Chum salmon	Hood Canal summer-run	no effect
Chum salmon	Columbia River	no effect
Sockeye salmon	Ozette Lake	no effect
Sockeye salmon	Snake River	no effect

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