Carbaryl
Analysis of Risks
to
Endangered and Threatened Salmon and Steelhead

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Summary

Carbaryl is a carbamate pesticide registered for control of a wide range of insect and other arthropod pests on more than 100 crop and noncrop use sites, including home and garden uses. It is also used for control of targeted pests such as fire ants and mosquitos and as a fruit-thinning agent for apples and pears. Carbaryl is slightly to highly toxic to fish and is very highly toxic to aquatic invertebrates. An ecological risk assessment that includes nontarget aquatic organisms has been prepared for a Reregistration Eligibility Decision (RED) to be issued in June of 2003. The assessment concludes that endangered freshwater fish are at acute risk from runoff and drift from treatment of many or most crops. Both the acute and chronic levels of concern are exceeded for populations of freshwater and estuarine invertebrates. Depletion of aquatic-invertebrate populations might adversely affect the food supply of listed steelhead and Pacific salmonids. Noncrop uses and homeowner applications to lawns, ornamentals, and gardens also may increase the estimated environmental concentrations predicted for applications to agricultural crops. The risk assessment notes that use of carbaryl in urban settings is likely to result in runoff of carbaryl into storm sewers and streams and may adversely impact some aquatic organisms. Carbaryl is frequently detected in surface waters in urban areas. However, OPP has no model scenarios to predict aquatic concentrations from homeowner uses or from noncrop uses such as rights-of-way.

We conclude that carbaryl may affect 20 Evolutionarily Significant Units (ESUs), may affect but is not likely to adversely affect two ESUs, and will have no effect on four ESUs. Our determinations are based on the known or potential use of carbaryl on various use sites in each county where there is habitat or a migration corridor for an ESU, the acute risk of carbaryl to endangered fish, and the potential for indirect effects due to acute and chronic risks to their aquatic-invertebrate food supply. We don't have data to quantify use on noncrop sites or the capability to model runoff from homeowner uses, but we presume that such uses could contribute to the exposure and risks of at least some of these ESUs.

Introduction

Problem Formulation: The purpose of this analysis is to determine whether the registration of carbaryl as an insecticide 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 carbaryl 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. We understand that any subsequent analyses, requests for consultation and resulting Biological Opinions may necessitate that Biological Opinions relative to this request be revisited, and could be modified.

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. 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, we 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. We 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. We 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. We 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.

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 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, 1991). 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 fish and aquatic invertebrates

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	>0.5	May be indirect effects on T&E fish through food supply reduction
Aquatic plant acute EC50	>0.5	May be indirect effects on aquatic vegetative cover for T&E fish

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 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.

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. 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 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 sublethal effects until there are additional data.

2. Description and use of carbaryl

Carbaryl is an N-methyl carbamate insecticide registered for control of a wide range of insect and other arthropod pests, and some diseases (e.g., mildews, rusts, blights), on more than 100 crop and noncrop use sites, including home and garden uses. It is a cholinesterase inhibitor that acts on contact on ingestion. Carbaryl also is used as a plant-growth regulator for thinning of some fruits. Major crop use sites include apples, pecans, grapes, oranges, alfalfa, and corn. Carbaryl is also used on a wide variety of noncrop sites, including lawns, gardens, ornamentals, trees, rangeland, and targeted pests (e.g., adult mosquitos, ticks, fleas, fire ants). Currently, 314 products are registered under Section 3 of FIFRA. Some products contain additional active ingredients, such as captan, rotenone, and/or copper. Twenty-six additional carbaryl products are registered to individual states under Special Local Needs (SLN) provisions in Section 24(c) of FIFRA. SLNs include control of shrimp in oyster beds in two tideland areas (Willapa Bay and Grays Harbor) in Washington and, in California, insecticidal use on fruits and nuts, pricklypear cactus, ornamental plants, and nonfood crops. Oregon and Idaho do not have SLNs for carbaryl.

Carbaryl end-use formulations include wettable powders, emulsifiable concentrates, soluble concentrates, oil-based and water-based flowables, dusts, granules, baits, suspension concentrates, and ready-to use products. Application rates, obtained from product labels, are summarized in Table 3 for individual use sites. Depending on the use site and applicator, carbaryl can be applied by aircraft, various types of ground applications, or via irrigation water (Table 4). Additional use directions, restrictions, and precautions are specified on the attached representative product labels.

Table 3. Carbaryl use sites and application information

Use site	Appl. rate (lb ai/acre)	Max. no. appl.	Appl. interval (days)	Max lb ai/year
Citrus fruits	7.5 16[a]	8 1	14 na	20
Stone fruits (peaches, apricots, cherries, nectarines, plums, prunes)	3-5	4	7	14
Pome fruits (apples, pears, etc.)	3	8	14	15[b]
Small fruits and berries (grapes, strawberries, blueberries, etc.)	2	5	7	10
Sweet corn	2	8	3	16
Field corn, pop corn	2	4	14	8
Rice	1.5	2	7	4
Wheat, flax ,millet	1.5	2	14	3
Alfalfa, clover, trefoil	1.5	8	30	12
Tree nuts (pecans, almonds, walnuts, chestnuts, filberts)	5	4	7	15

Use site	Appl. rate (lb ai/acre)	Max. no. appl.	Appl. interval (days)	Max lb ai/year
Pistachios	5	4	7	15
Olives	7.5	2	14	15
Asparagus	2-4	3-5	3-7	10
Fruiting vegetables (tomatoes, peppers, eggplant)	2	7	7	8
Leafy vegetables (broccoli, cauliflower, collards, cabbage, celery, lettuce, etc.)	1-2	4	7	6
Legume crops (beans, lentils, peas, cowpeas, etc.)	1.5	4	7	6
Cucurbits (melons, cucumbers, squash, pumpkin)	1	6	7	6
Root and tuber crops (potatoes, carrots, radishes, etc.)	2	6	7	6
Sweet potatoes	2	4	7	8
Sugar beets	1.5	2	14	4
Turfgrass (golf courses, sod farms, recreational areas, etc.)	4-8	2-4	7	16
Ornamentals	1	6	7	6
Trees (non-urban forests, Christmas trees, parks, rangeland trees, etc.)	1	2	7	2
Noncropland (rights-of-way, roadsides, ditchbanks, etc.)	1.5	2	14	3
Rangeland	1	1	n/a	1
Pasture, grasses grown for seed	1.5	2	14	3
Residential lawns	2-11	as needed	weekly	not specified
Oyster beds (WA)	1			10

[a] one application of up to 16 lb ai per acre is allowed for scale control in CA

[b] the tabulated application rate is for insect control; for fruit thinning, a single application of up to 3 lb ai per acre is made between 80% petal fall and 6 mm fruit size

Table 4. Application methods/equipment for commercial and homeowner applications

Use site	Application method/equipment
Commercial applications	
Tree crops	airblast, aerial, chemigation
Grapes	airblast, over-the-row groundboom, power duster, aerial, chemigation
Field, forage, fiber, small fruit (i.e., berries), vegetable crops	groundboom, aerial, chemigation
Noncrop areas	groundboom, aerial, right-of-way sprayer
Ornamentals	low-pressure or high-pressure handwand, backpack, airblast/mistblower
Lawn care	hand-held power sprayer, granular spreader
Evergreens in large stands	airblast, aerial, high-pressure handwand
Poultry	compressed-air sprayer, fogger, backpack sprayer, mist blower, power sprayer
Homeowner applications	
Fruits and nuts	hose-end sprayer, hand-held pump sprayer
Vegetables	hose-end sprayer, hand-held pump sprayer, hand-held duster, shaker can
Lawns	hose-end sprayer, granular spreader, belly grinder
Ornamentals	hose-end or hand-held pump sprayer
Pets/pet bedding	pet collar/duster, sprays

Agricultural usage of carbaryl from 1992 through 2001 is presented in Table 5 for the major nationwide use sites and for those use sites for which either California, Oregon, Washington, or Idaho is a state of high usage. According to OPP/BEAD's 2002 Quantitative Usage Analysis for Carbaryl (attached), an average of 2 to 3 million pounds of active ingredient (ai) was applied to about 1.3 million acres of crop annually from 1992 through 2001. Most use was in California, Michigan, Indiana, Illinois, Ohio, Texas, Georgia, Oklahoma, Mississippi, and Arkansas. In terms of total pounds of active ingredient applied, 48% was applied to apples, pecans, grapes, oranges, alfalfa, and corn.

Table 5. Nationwide use of carbaryl from 1992 through 2001. Data on homeowner uses are not available. Tabulated values are weighted averages; the most recent years and more reliable data are weighted more heavily (source OPP/BEAD Quantitative Usage Analysis for Carbaryl, 2002)

Site	acres grown	acres treated	% crop treated	lb ai applied	states of most usage (% of total lb ai used on the crop)
Apples	587,000	139,000	23.7	242,000	WA MI NY CA CT IN (80%)
Pecans	492,000	76,000	15.5	207,000	GA TX SC (90%)
Grapes	851,000	58,000	6.8	134,000	NY CA OR PA MI AR (80%)
Oranges	874,000	21,000	2.4	130,000	CA FL (99%)
Alfalfa	22,745,000	118,000	0.5	121,000	NE SD OK MT ND IL (80%)
Field Corn	71,693,000	78,000	0.1	103,000	MO NE MS IN GA IL (50%)
Peaches	221,000	19,000	8.6	62,000	GA CA TX SC MI (70%)
Tomatoes	479,000	29,000	5.8-6.2	46,000	CA FL TX (85-97%)
Winter Wheat	44,762,000	45,000	0.1	38,000	KY NC TX WY OR MD (70%)
Snap Beans	313,000	30,000	9.6	37,000	NC FL IL OR (85%)
Asparagus	92,000	32,000	34.8	36,000	MI WA (95%)
Sweet Corn	775,000	12,000	0.9-3.0	35,000	CA MI IL (>80%)
Potatoes	1,421,000	24,000	1.7	34,000	ND WA MI ID FL NY (59%)
Sweet Cherry	49,000	11,000	22.5	30,000	WA MI CA (85%)
Sugar Beets	1,312,000	19,000	1.4	28,000	CA TX WA MN OR (80%)
Cotton	11,874,000	23,000	0.2	28,000	TN MS TX CA (85%)
Rice	3,105,000	29,000	0.9	25,000	TX CA (80%)
Strawberries	52,000	9,000	17.3	25,000	CA FL NC PA (80%)
Pistachios	53,000	7,000	13.2	23,000	CA (80%)
Olives	30,000	2,000	6.7	11,000	CA (100%)
Plums	65,000	3,000	4.6	11,000	CA (80%)
Cantaloupes	115,000	10,000	8.7	11,000	CA IL GA TX (80%)
Eggplant	120,000	7,000	5.8	10,000	FL NJ TX IL CA (65%)
Squash	54,000	7,000	13.0	9,000	NJ FL MI CA NY TX (90%)

Site	acres grown	acres treated	% crop treated	lb ai applied	states of most usage (% of total lb ai used on the crop)
Sweet Peppers	78,000	6,000	7.7	8,000	CA FL KY LA IL (80%)
Nectarines	31,000	2,000	6.5	7,000	CA (90%)
Almonds	427,000	3,000	0.7	6,000	CA (100%)
Green Peas	721,000	4,000	0.5	6,000	OR MN (>80%)
Head Lettuce	210,000	4,000	1.9	5,000	CA (80%)
Bell Pepper	57,000	3,000	5.3	4,000	FL CA MI (90%)
Dry Beans	1,825,000	10,000	0.6	4,000	CA ND CO (80%)
Dry Peas	237,000	3,000	1.3	3,000	WA ID TX (90%)
Melons and Honeydew	28,000	3,000	10.7	3,000	CA (100%)
Pears	80,000	2,000	2.5	3,000	WA OR CA PA NY OH (75%)
Blackberries	6,000	1,000	18.3	2,000	OR (100%)
Lemons	67,000	1,000	1.5	2,000	CA (90%)
Broccoli	115,000	3,000	2.6	2,000	CA OR TX (85%)
Total[a]		1,271,000		1,917,000	

[a] includes uses not tabulated; does not include home and garden uses

EPA's "Overview of Carbaryl Risk Assessment" of 08-27-2002 (EDOCKET Id: OPP-2002-0138, Document Id: OPP-2002-0138-0003) provides some additional information on the amount of carbaryl used in various market segments in 1997. Approximately 3.9 million pounds of active ingredient (59%) was used in agriculture. Homeowners used about 2.2 million pounds (34%), and the remaining 7% was used by commercial applicators in nursery, landscape, and golf course settings.

Some data from the early to mid-1990s 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 crops of highest carbaryl usage during the mid-1990s were alfalfa hay (~490,000 lb ai), corn (~427,500 lb ai), and pecans (~423,500 lb ai). Citrus, grapes, and peaches also were major crops treated with carbaryl. USGS also mapped carbaryl use on selected crops (Figure 1). This map is included here as a quick and easy visual depiction of where carbaryl 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 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.

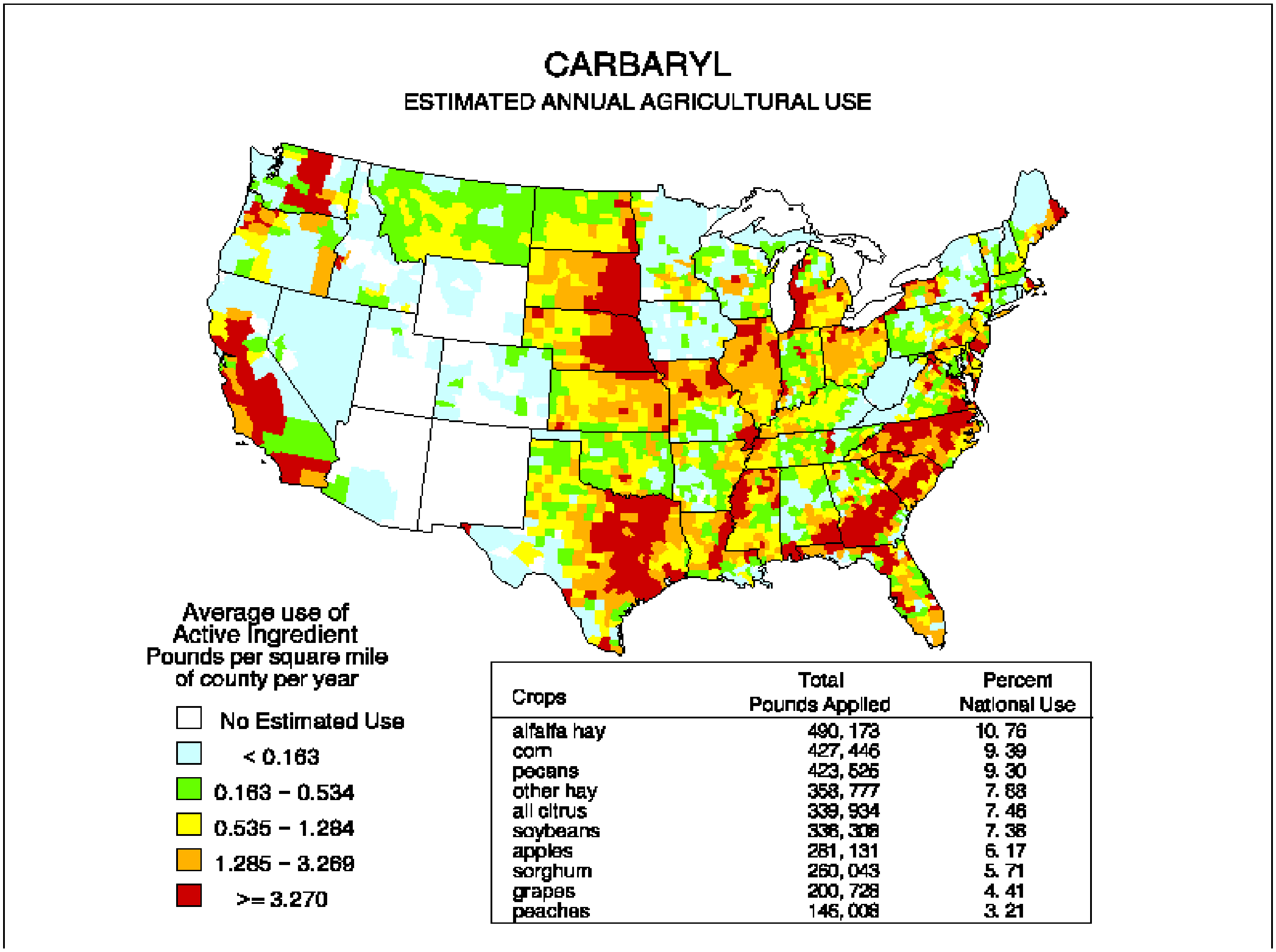

Figure 1: Carbaryl use in Agriculture (Source USGS http://water.wr.usgs.gov/pnsp/use92/mapex.html)

California requires full pesticide-use reporting by all applicators except homeowners, and the California Department of Pesticide Regulation provides the information at the county level (www.cdpr.ca.gov/docs/pur/purmain.htm). Usage by crop in 2000 and 2001 is provided in Table 7. Approximately one-quarter of the amount of carbaryl applied in 2001 was to oranges, with another 37% applied to apples, strawberries, tomatoes, grapes, and peaches. County-level usage information is not provided here but is tabulated in section "4" where we address the potential for exposure of individual salmon and steelhead ESUs.

Table 6. Reported pounds of carbaryl (active ingredient) used (excluding homeowner uses) and acreage treated in California from 1997 to 2001 (source: California DPR Summary of Pesticide Use Report Data)

Usage	1997	1998	1999	2000	2001
Lb ai applied	753,801	426,893	387,145	364,968	286,414
Acres treated	292,721	197,664	216,991	196,264	147,374

Table 7. Major uses (excluding homeowner uses) of carbaryl in California in 2000 and 2001 (source: California DPR Summary of Pesticide Use Report Data)

Use site	2000		2001	
	lb ai applied	acres treated[a]	lb ai applied	acres treated[a]
Oranges	62,823	7,656	67,832	8,865
Apples	27,326	14,131	31,743	17,909
Strawberries	20,195	13,043	20,867	11,131
Tomatoes	16,997	25,852	18,683	18,786
Grapes	17,591	12,609	18,622	12,682
Peaches	20,541	6062	16,081	4,751
Landscape maintenance	10,096	not reported	11,921	not reported
Pistachio	36,596	13,343	9,768	4,246
Rice	36,143	18,342	8,161	5,313
Melons	5,702	9266	6,959	11,430
Plums	9,232	2422	6,726	1,934
Lemons	1,304	183	6,434	2,609
Nectarine	5,807	2005	4,934	1,541

Use site	2000		2001	
	lb ai applied	acres treated[a]	lb ai applied	acres treated[a]
Peppers	6,901	4574	4,708	3,369
Olives	14,416	2095	4,580	845
Almonds	11,882	4,050	3,899	2,330
Carrots	27	18	3,546	1,264
Corn (forage-fodder)	7,240	11,931	3,486	7262
Cantaloupes	4,992	9,577	2,697	5,359
Sugarbeet	5,758	7753	1,915	2,763
Cherries	6,347	3,296	1,444	616
Tangerines	5,008	2182	1,149	554
Total all crops[b]	364,968		286,414	

[a] acreage treated is not reported for some noncrop uses
[b] including crops not tabulated

The Washington State Department of Agriculture (WSDA) recently compiled a "Carbaryl Use Profile: Crop Use Only" (WSDA 2003). According to their compilation, approximately 189,600 lb ai is used annually by agriculture in Washington, and most (120,850 lb ai) is used on apples. County-level data were not provided. Major crop uses are tabulated below.

Table 8. Agricultural Use of Carbaryl in Washington (source: Washington State Department of Agriculture's 2003 "Carbaryl Use Profile: Crop Use Only")

Crop	2001 acres planted	acres treated	% acreage treated	lb ai/acre	lb ai applied
Apples	168,000	85,700	51	1.41	120,850
Cherries	22,000	11,000	50	2.79	30,700
Oysters	9900	800	8	10.00	8000
Green beans	16,000	9000	56	0.86	7750
Asparagus	19,000	6700	35	1.09	7300
Pears	24,800	1700	7	2.11	3600

Crop	2001 acres planted	acres treated	% acreage treated	lb ai/acre	lb ai applied
Green beans[a]	7800	4400	56	0.86	3800
Peaches	2700	800	28	3.54	2850
Grapes	48,000	1900	4	1.34	2550
Cucumbers	3200	700	21	1.21	850
Cabbage[b]	1200	500	40	1.50	750
Broccoli	1000	500	46	1.25	625
Carrots	9300	500	5	1.00	500
Cranberries	1600	100	6	3.18	300
Blueberries	2000	200	10	1.75	350
Cauliflower	500	70	14	1.15	80

[a] includes snap beans and lima beans but not dry beans
[b] includes cabbage grown for seed production

We are not aware of any comprehensive sources of annual pesticide-use information for Oregon and Idaho. Oregon is attempting to implement full pesticide-use reporting but has not yet done so. Some use-report data is available from the USDA's National Agricultural Statistics Service's Agricultural Chemical Usage report (www.usda.mannlib.cornell.edu/reports/nassr/other/pcu-bb/). This report presents application rates and acres treated for selected field crops, fruit crops, and vegetable crops for the major state producers. The report includes Oregon data for use of carbaryl on apples, sweet cherries, snap beans, blackberries, squash, and strawberries (Table 9). These data indicate that much less carbaryl is used in agriculture in Oregon than in either California or Washington. No information is provided for carbaryl use in Idaho.

Table 9. Reported crop uses of carbaryl in Oregon in 2000 or 2001 (source: USDA/NASS Agricultural Chemical Usage)

Crop	acreage grown	% acreage treated	lb ai/acre/ application	lb ai per acre per year	lb ai applied annually
Apples	10,254	43	0.82	1.28	4,800
Snap beans	24,187	20	0.92	1.05	4,700
Blackberries	6,160	32	1.25	1.41	2,800

Crop	acreage grown	% acreage treated	lb ai/acre/ application	lb ai per acre per year	lb ai applied annually
Sweet cherries	14,013	10	1.81	2.58	3,000
Squash	3464	10	0.69	0.69	100
Strawberries	4413	2	0.80	0.80	0.1

Bayer CropScience LP has recently provided 2001 data on the amount of carbaryl active ingredient used in agriculture and by homeowners in California and the Pacific Northwest states. The amount used by commercial turf and ornamental operators was not included. Agricultural usage is reported only as the total amount of active ingredient used per county; use on individual crops was not reported. These data are Confidential Business Information (CBI). Because they are CBI, we cannot present them here but will discuss them in more detail with NMFS as necessary. Although we cannot list the amount of active ingredient used in each of these counties, we do consider it in our determination for each ESU. Bayer provided homeowner usage data (CBI) as the amount of active ingredient sold state-wide by Bayer to homeowners in California, Washington, and Oregon, but not Idaho. The homeowner data were provided only for Bayer products and do not include those of other registrants.

OPP has some additional information on homeowner uses of carbaryl provided by the 1990 EPA National Home and Garden Pesticide Use Survey (NHGPUS). According to NHGPUS, about 10.9% of all households surveyed in 1990 reported using carbaryl on one or more indoor and/or outdoor sites. Carbaryl use on outdoor sites is presented in Table 10. As previously noted, homeowners used about 2.2 million pounds of carbaryl ai in 1997. We have additional information at the state level which we can discuss with NMFS as necessary; however, these data are CBI and cannot be presented here.

Table 10. Outdoor use of carbaryl by homeowners (source: National Home and Garden Pesticide Use Survey, 1990)

Site	percent of households applying	avg. no. applications per household
Roses and other ornamentals	4.7	5.0
Pet/pet bedding/kennel area	3.2	9.3
Vegetables	3.0	4.2
Lawns	1.5	3.7
Fruit/nut trees or vines	0.9	3.5

As noted in EPA's "Overview of Carbaryl Risk Assessment" of 08-27-2002 (EDOCKET Id: OPP-2002-0138, Document Id: OPP-2002-0138-0003), about 7% of carbaryl is used by the commercial turf and ornamental market. Slightly more than half of this use is on golf courses, about a third or more is used for lawn and landscape services, and the remainder is used in commercial nurseries and greenhouses.

a. Aquatic toxicity of carbaryl

The acute toxicity data for freshwater fish indicate that technical-grade carbaryl is slightly to highly toxic to a variety of fish species but is very highly toxic to aquatic invertebrates (Table 11). Additional testing with rainbow trout and bluegill demonstrate that the various formulations tested are moderately to practically nontoxic, indicating that the various inert ingredients do not enhance the toxicity of the active ingredient. Formulations tested with the water flea provided toxicity values comparable to that for the technical-grade material.

Table 11. Acute toxicity of carbaryl to freshwater fish and invertebrates (source: EFED environmental risk assessment)

Species	Scientific name	% ai	96-h LC50 (ppb)	Toxicity Category
Fish				
Atlantic salmon	*Salmo salar*	99.5	250	highly toxic
Yellow Pearch	*Perca flavescens*	99.5	350	highly toxic
Lake Trout	*Salvelinus namaycush*	99.5	690	highly toxic
Cutthroat Trout	*Oncorhynchus clarki*	99.5	970	highly toxic
Rainbow trout	*Oncorhynchus mykiss*	99.5	1,200	moderately toxic
		81.5	3,300	moderately toxic
		50	3,450	moderately toxic
		50	4,500	moderately toxic
		44	1,400	moderately toxic
Coho Salmon	*Oncorhynchus kisutch*	99.5	2,400	moderately toxic
Chinook Salmon	*Oncorhynchus tshawytacha*	99.5	2,400	moderately toxic
Black Crappie	*Pomoxis nigromaculatus*	99.5	2,600	moderately toxic
Brook Trout	*Salvelinus fontinalis*	99.5	3,000	moderately toxic

Species	Scientific name	% ai	96-h LC50 (ppb)	Toxicity Category
Bluegill sunfish	*Lepomis macrochirus*	99.9	5,040	moderately toxic
		99.9	14,000	slightly toxic
		50	22,000	slightly toxic
		44	9,800	moderately toxic
		30	49,000	slightly toxic
		5	290,000	practically nontoxic
Carp	*Cyprinus carpio*	99.5	5,300	moderately toxic
Largemouth Bass	*Micropterus salmoides*	99.5	6,400	moderately toxic
Fathead minnow	*Pimephales promelas*	99.5	7,700	moderately toxic
Channel catfish	*Ictalarus punctatus*	99.9	7,790	moderately toxic
Green Sunfish	*Lepomis cyanellus*	99.5	9,500	moderately toxic
Black Bullhead	*Ictalurus melas*	99.5	20,000	slightly toxic
Invertebrates				
Water flea	*Daphnia magna*	99.5	5.6 (48-h EC50)	very highly toxic
		81.5	7.2 (48-h EC50)	very highly toxic
		49	7.1 (48-h EC50)	very highly toxic
		47.3	4.3 (48-h EC50)	very highly toxic
		43.9	13.0 (48-h EC50)	very highly toxic
		43.7	6.7 (48-h EC50)	very highly toxic
Stonefly	*Classenia sabulosa*	99.5	5.6	very highly toxic
Stonefly	*Isogenus sp.*	99.5	3.6	very highly toxic
Stonefly	*Pteronarcella badia*	99.5	1.7	very highly toxic
Scud	*Gammarus fasciatus*	99.5	26	very highly toxic

Adverse chronic effects on reproduction or growth of freshwater fish and invertebrates occurred at exposure concentrations of 3.3 to 680 ppb (Table 12). Test organisms in these studies were exposed to the test material for extended periods. A supplemental study with midge larvae displayed reduced emergence and development rates at 1000 ppb.

Table 12. Chronic toxicity of carbaryl to freshwater fish and invertebrates (source: EFED environmental risk assessment)

Species	Scientific name	test duration (days)	% ai	Endpoints affected	NOEC (ppb)	LOEC (ppb)
Water flea	*Daphnia magna*	21	99	reproduction	1.5	3.3
Midge	*Chironomous riparius*	28	99.1	Emergence/ developmental rate	500	1000
Fathead minnow	*Pimephales promelas*	[not reported in assessment]	99	no. eggs per ♀/ eggs spawned/ larval survival	210	680

The available acute toxicity categorize technical-grade carbaryl as moderately toxic to estuarine fish and moderately to very highly toxic to estuarine invertebrates (Table 13). These toxicity values are comparable to those for freshwater organisms. Formulations tested with the mysid shrimp and Eastern oyster provided toxicity values comparable to that for the technical-grade material, indicating that inert ingredients did not enhance the toxicity of the active ingredient.

Table 13. Aquatic organisms: acute toxicity of carbaryl to estuarine fish and invertebrates (source: EFED environmental risk assessment)

Species	Scientific name	% ai	96-h LC50 (ppb)	Toxicity Category
Fish				
Sheepshead minnow	*Cyprinodon variegatus*	99	2,200	moderately toxic
Sheepshead minnow		99.7	2,600	moderately toxic
Invertebrates				
Brown Shrimp	*Penaeus aztecus*	99.7	1.5 (48-h EC50)	very highly toxic

Species	Scientific name	% ai	96-h LC50 (ppb)	Toxicity Category
Mysid	*Mysidopsis bahia*	99.7	5.7	very highly toxic
		99	6.7	very highly toxic
		81.5	9.3 (48-h LC50)	very highly toxic
		81.5	9.6 (48-h LC50)	very highly toxic
		43.7	20.2	very highly toxic
Glass Shrimp	*Palaemonetes kadiakensis*	99.5	5.6 (48-h LC50)	very highly toxic
Grass Shrimp	*Palaemonetes pugio*	99.7	28 (48-h LC50)	very highly toxic
Pink Shrimp	*Penaeus duorarum*	99.7	32 (48-h LC50)	very highly toxic
Fairy Shrimp		95.3	170 (48-h LC50)	highly toxic
Blue Crab	*Callinectes sapidus*	99.7	320 (48-h LC50)	highly toxic
Eastern Oyster	*Crassostrea virginica*	99.7	>2	not determined
		99	2,700	moderately toxic
		95	>1,000	not determined
		43.3	23,600	slightly toxic

There are no available chronic toxicity data for estuarine invertebrates. An estuarine/marine fish early life-stage toxicity test using the technical grade of the active ingredient is being required for reregistration of carbaryl.

Because some aquatic invertebrates are an important food source for salmonids, we searched the USEPA/ORD/NHEERL Ecotoxicity database (www.epa.gov/ecotox) for additional data to characterize acute toxicity of carbaryl to aquatic insects and other aquatic invertebrates. These data indicate that carbaryl is highly to very highly toxic to many aquatic invertebrates that salmonids might utilize as food (Table 14). However, there is variability in toxicity even among the arthropods. Toxicity to daphnids, amphipods, shrimps, prawns, and crabs is less than 10 ppb in at least one test for each of these groups. Crayfish, freshwater crabs, isopods, and especially mollusks, are less sensitive.

Table 14. Additional data to characterize the acute toxicity of carbaryl to aquatic insects and other aquatic invertebrates (source: USEPA/ORD/NHEERL Ecotoxicity Database)

Taxon	no. data points	test duration (h)	LC50 or EC50 (ppb)	formulation or active ingredient
Insects				
Stoneflies	2	96	1.7 to 4.8	A
	19	96	1.7 to 29	F
Midges	1 1	24 48	127 290	F
Mayflies	1	72	390	F
Dragonflies	1 1	48 96	430 72	F
Alder fly	1	72	200	F
Mosquitoes	3	96	50 to 336	A
	12	24	145 to 4790	F
Beetles	1 1	48 96	890 3300	F
Other invertebrates				
Daphnids	1	18	>1<10	A
	2 1 2	48 96 168	6 to 6.4 3280 8.6 to 10.6	F
Amphipods	3	96	16 to 26	A
	11 1	96 96	6.5 to 28 250	F
Isopods	2	96	240 to 280	A
	1	96	280	F
Shrimps (saltwater)	3	96	7 to 24.8	A
	4 1 11	24 53 96	1.7 to 137 20 5.7 to 210	F
Prawns	2	96	5.6 to 19	A
	3	96	32.6 to 120	F

Taxon	no. data points	test duration (h)	LC50 or EC50 (ppb)	formulation or active ingredient
Crayfish	2	96	1000 to 1900	A
	3	96	500 to 2870	F
Crabs (saltwater)	2 1 2	96 120 20 to 25 days	9 to 10 401 2 to 5	F
Crabs (freshwater)	1	96	1006	A
	1	96	4161	F
Snails	1 2 1	72 96 240	10,700 4400 to 4500 440	A
	7 4	48 96	3500 to 30,000 10,100 to >27,000	F
Clams	3	96	5100 to 125,000	F
Scallops	1	96	5600	F
Mussels	2	96	10,300 to 22,700	F
Rotifers	1	48	112	F

Toxicity of 1-naphthol

Carbaryl degrades by abiotic and microbially mediated processes to 1-naphthol. The available acute toxicity data indicate that 1-naphthol is moderately to highly toxic to freshwater and estuarine fish and invertebrates (Table 15). Bluegill appear to be more sensitive to 1-naphthol than to carbaryl, but sensitivity is approximately the same for the rainbow trout and sheepshead minnow. Aquatic arthropods seem to be much less sensitive to 1-naphthol.

Table 15. Acute toxicity of 1-naphthol to freshwater and estuarine fish and invertebrates (source: EFED environmental risk assessment)

Species	Scientific name	96-h LC50 (ppb)	Toxicity Category
Fish			
Rainbow Trout	*Oncorhynchus mykiss*	1,400	moderately toxic
		1,600	moderately toxic

Species	Scientific name	96-h LC50 (ppb)	Toxicity Category
Bluegill Sunfish	*Lepomis macrochirus*	750	highly toxic
		760	highly toxic
Sheepshead Minnow	*Cyprinodon variegatus*	1,200	moderately toxic
		1,800	moderately toxic
Invertebrates			
Water flea	*Daphnia magna*	700 (48-h LC50)	highly toxic
		730 (48-h LC50)	highly toxic
Mysid	*Mysidopsis bahia*	200	highly toxic
		210	highly toxic
Eastern Oyster	*Crassostrea virginica*	2,100 (48-h LC50)	moderately toxic

The available OPP toxicity data for aquatic plants is presented in Table 16. Testing is required with one vascular species (duckweed) and four nonvascular species (algae and diatoms), but testing is incomplete except for green algae. Studies were submitted for all five test species, but all except the green algae study are invalid and thus not acceptable for use in risk assessments. We also queried the USEPA/ORD/NHEERL Ecotoxicity database for any toxicity data for aquatic plants. Several records are available for green algae but none for any aquatic vascular species. We consider algae to be only remotely representative of aquatic vascular plants.

Table 16. Toxicity of carbaryl to algae and aquatic plants (source: EFED toxicity database)

Species	Scientific name	120-h EC50 (ppb)
Green algae	*Selanastrum capricornutum*	1100
Duckweed	*Lemna gibba*	no data
Blue-green algae	*Anabaena flos-aquae*	no data
Diatom	*Navicula pelliculosa*	no data
Diatom	*Skeletonema costatum*	no data

Toxicity summary and literature information

The available OPP toxicity data for carbaryl indicate that carbaryl is slightly to highly toxic to fish but is highly to very highly toxic to most freshwater and estuarine invertebrate species tested. Formulations tested with fish and invertebrates yielded toxicity values comparable to that for the technical-grade material, indicating that the inert ingredients did not enhance the toxicity of the active ingredient. Chronic testing indicated that carbaryl has adversely affected reproduction at levels of 3.3 ppb for freshwater invertebrates and 680 ppb for freshwater fish. Additional testing indicate that 1-naphthol, the primary degradate, is moderately to highly toxic to fish and aquatic invertebrates. Acceptable toxicity data for vascular aquatic plants are not available.

The pesticide literature indicates that carbaryl also may adversely affects some aquatic organisms, especially fish, but effects may depend on the level and duration of exposure. The information below is summarized from the draft environmental risk assessment.

Exposure to sublethal carbaryl concentrations has been shown to have deleterious effects in freshwater fish. Freshwater murrell (*Channa punctatus*) exposed to concentrations from 1700 to 3700 ppb displayed thyroid and gonadal dysfunction resulting from inhibition of acetylcholinesterase (Ghosh et al. 1990). However, this study tested concentrations well above the highest peak concentration modeled for registered carbaryl uses and does not provide an indication as to potential effects under field conditions. Exposure of fathead minnows (*Primephales promelas*) to carbaryl at 680 ppb inhibited reproduction and decreased survival (Carlson 1972), but no adverse effects were reported at 210 ppb.

Information from the literature indicates that exposure to sublethal levels of carbaryl can produce certain adverse effects in some estuarine fish. According to Weis and Weis (1974), laboratory exposure of the silverside (*Menidia menidia*) to a single dose of 100 ppb carbaryl resulted in the temporary disruption of schooling behavior, consisting mainly of a spreading out of the school over a larger area. This change in behavior was observed after 24 hours of exposure. Returning the fish to carbaryl-free water did not bring about a return of normal schooling patterns until 72 hours later. This effect was attributed to the accumulation of 1-naphthol. Exposure to carbaryl at 10 ppb caused retardation of fin regeneration during the first week of the study in the killifish (*Fundulus heteroclitus*) (Weis and Weis 1975). Field exposure to a maximum carbaryl aquatic concentration of 1200 ppb affected burying behavior in caged English sole young (Pozorycki 1999).

Other data indicate that carbaryl has a potential for endocrine-disruption effects in fish. Serum and pituitary levels of gonadotropic hormone and gonadotropin-releasing hormone (GnRH) in the freshwater murrell (*Channa punctatus*) were reduced from exposure to 1660 to 3730 ppb of carbaryl in laboratory and paddy field tests (Ghosh et al. 1990). The decrease in GnRH levels could be explained by exposure to high estrogen levels, acting through a negative feedback pathway to inhibit GnRH release, and thus the release of gonadotropins (Klotz et al. 1997). Plasma and ovarian estrogen levels in freshwater perch (*Anabas testudineus*) exposed to 1660 ppb of carbaryl for 90 days increased until day 15 and then declined relative to control fish, indicating that long-term exposure to this chemical may cause an inhibitory effect on fish reproduction (Choudhury et al. 1993). However, both the murrell and perch studies were performed at concentrations well above the highest peak concentration modeled for registered carbaryl uses and, therefore, may not reflect risk under actual use conditions.

Carbaryl also has been shown to have the potential to adversely affect amphibians. Nearly 18% of the tadpoles of the southern leopard frog (*Rana sphenocephala*) exhibited visceral and limb malformations after being exposed to carbaryl during development (Bridges 2000). In contrast, only a single control tadpole was deformed. Tadpoles exposed throughout the egg stage also were smaller than the control tadpoles. A single acute exposure of carbaryl (concentrations from 3500 to 7200 ppb) to plains leopard frog tadpoles (*Rana blairi*) led to a 90% reduction in swimming activity, including sprint speed and sprint distance, and all activity ceased at the highest concentration (Bridges 1997).

Some additional information also exists for invertebrates. Populations of damselflies (*Xanthocnemis zealandica*) showed a 90% reduction in emergence success 10 to12 days after exposure to 100 ppb carbaryl (Hardersen and Wratten 1998). Hanazato (1995) exposed *Daphnia ambigua* to carbaryl and a kairomone released by a predator, the phantom midge(*Chaoborus*). Results suggest that carbaryl at low concentrations (1 to 3 ppb) can alter predator-prey interactions by inducing helmet formation and daphnid vulnerability to predators.

Mora et al. (2000) studied the relationship between toxicokinetics of carbaryl and effects on acetylcholinesterase (ACHase) activity in a snail (*Pomaca patula*) and observed increased enzyme inhibition, along with the bioconcentration of carbaryl, after 72 hours of exposure to sublethal levels (3.2 ppb). The transfer of snails to carbaryl-free water was followed by rapid monophasic elimination with a half-life of 1 hour, although ACHase activity levels never returned to control values.

Havens (1995) reports a decline in total zooplankton biomass and individuals across the range of carbaryl treatments (0 to 100 ppb) in enclosed mesocosms. *Daphnia* were no longer found at concentrations greater than 20 ppb, and all cladocerans were eliminated above 50 ppb. The result was an increase in algal biomass and repartitioning of biomass from zooplankton to phytoplankton. In other mesocosms studies, exposure to carbaryl at 1000 ppb killed all plankton species, including *Chaoborus* larvae (Hanazato 1989). However, this concentration is well above the maximum EECs modeled for carbaryl, and is unlikely that such high levels of this chemical would be found under field conditions.

b. Environmental fate and transport

Carbaryl is a widely used pesticide that is commonly detected in the environment from its application in agricultural and non-agricultural settings. Carbaryl and its primary degradate, 1-naphthol, are fairly mobile and slightly persistent in the environment. Although they are not likely to persist or accumulate under most conditions, they may do so under acidic conditions with limited microbial activity. Carbaryl dissipates in the environment by abiotic and microbially mediated degradation. The environmental fate characteristics for carbaryl are listed below.

Parameter	Value
Molecular weight	201.22
Water solubility	32 mg/L (ppm) at 20º C
Vapor pressure	1.36 10^{-7} mm Hg (25º C)
Henry's law constant	1.28 x 10^{-8} atm m^3 mol^{-1}
Octanol/Water partition	K_{ow} = 229
Hydrolysis ($t_{1/2}$) pH 5	stable
pH 7	12 days
pH 9	3.2 hours
Aqueous photolysis ($_{t½}$)	21 days
Soil photolysis	assumed stable
Aerobic soil metabolism ($_{t½}$)	4 days - sandy loam soil
Anaerobic soil metabolism ($_{t½}$)	72 days
Aerobic aquatic metabolism ($_{t½}$)	4.9 days
Anaerobic aquatic metabolism ($_{t½}$)	72 days
K_{oc}	207 - sandy loam 249 - clay loam sediment 211 - silt loam 177 - silty clay loam

The major degradation products are CO_2 and 1-naphthol, which is further degraded to CO_2. Carbaryl is stable to hydrolysis in acidic conditions but hydrolyzes in neutral and especially alkaline environments. Carbaryl is degraded by photolysis in water with a half-life of 21 days. Under aerobic conditions, it degrades rapidly by microbial metabolism in soil and aquatic environments. Metabolism is much slower in anaerobic environments, with half-lives on the order of 2 to3 months. Carbaryl is mobile in the environment. Sorption onto soils is positively correlated with increasing soil organic content. Because of its low octanol/water partition coefficient (K_{ow} values range from 65 to 229), carbaryl is not expected to significantly bioaccumulate.

The major metabolite of carbaryl degradation by both abiotic and microbially mediated processes is 1-naphthol. This degradate represented up to 67% of the applied carbaryl in degradation studies. It is also formed in the environment by degradation of naphthalene and other polyaeromatic hydrocarbon compounds. OPP has only limited information on the environmental transport and fate of 1-naphthol, but literature information suggests that it is less persistent and less mobile than parent carbaryl.

In a field dissipation study, carbaryl was applied on 3- to 8- foot tall pine trees in an Oregon forest. Maximum measured concentrations were 264 ppm on foliage at 2 days post-treatment, 28.7 ppm in leaf litter after 92 days, 0.16 ppm in the upper 15 cm of litter-covered soil at 62 days, and 1.14 ppm in the upper 15 cm of exposed soil at 2 days. Carbaryl was detected in the leaf litter up to 365 days after treatment and in litter-covered soil up to 302 days after treatment. Half-lives were 21 days on foliage, 75 days in leaf litter, and 65 days in soil. Carbaryl was detected at $\leq$0.003 ppm in water and sediment from a pond and stream located approximately 50 feet from the treated area. No information was provided on 1-naphthol.

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). OPP is aware of several incident reports for carbaryl. Several reports involved either fish, birds, mammals, or vegetables crops, and numerous bee kill incidents also have been reported in several states. The three incident reports for fish are discussed below, but uncertainty exists as to whether or not carbaryl can be implicated in the fish kills.

One incident involved a fish kill in New Jersey (1980) following a carbaryl application to control gypsy moth. No residue data were provided.

In an incident in Louisiana, a fish kill was reported in early June 1992. A number of pesticides (carbaryl, MSMA, atrazine, iprodione, dimethylamine, dicamba with 2,4-D, and chlorpyrifos) had been applied to area lawns and golf courses prior to the incident, which followed a high rain event. No chemical residues were reported. However, carbaryl had not been applied in the area since late April, and it is unlikely that residues would have been sufficiently high to result in a fish kill after two months. Both chlorpyrifos and iprodione had been applied less than a week before the incident and are more likely to have caused the fish kill.

In a third incident in Oklahoma where approximately 22,000 catfish died, several pesticides (toxaphene, carbaryl, endrin, methyl parathion and DDT) had been applied. No residue data were provided. Because both toxaphene and endrin are very highly toxic to catfish, they seem more likely than carbaryl to have caused the fish kill.

d. Estimated and actual concentrations of carbaryl in surface waters

Estimated environmental concentrations (EECs)

In the environmental risk assessment, aquatic EECs are modeled for several sites using PRZM/EXAMS scenarios. The sites include sweet corn and field corn in Ohio, apples in Pennsylvania, sugar beets in Minnesota, and Florida citrus. These scenarios and the input values used to model them are discussed in more detail in the attached EFED memorandum "Revised Estimate of Carbaryl Concentrations in Aquatic Environments" dated March 10, 2003. EECs are presented for both the maximum and average application rates (Table 17). The average application rate for each crop, obtained from the OPP/BEAD Usage Report (attached), was derived by dividing the total pounds applied by the extent of acreage treated. Some uncertainty exists as to how well average rates might represent actual use rates. Exposure to 1-naphthol also is expected, especially in alkaline waters, but aquatic EECs can't be calculated due to lack of environmental-fate and transport data for this degradate. We also asked EFED to provide PRZM/EXAMS EECs for several scenarios more appropriate to the conditions relevant to listed salmonids in California and the Pacific Northwest. These scenarios include apples, snap beans, and blackberries in Oregon and citrus, peaches, and tomatoes in California. The acute (i.e., peak) EECs, 21-day-average and 60-day-average EECs for these uses also are provided in Table 17.

Table 17. Surface water EECs derived from PRZM/EXAMS modeling. EECs are provided for both maximum and average application rates for national scenarios

Use site	appl. method	no. appl. per year	appl. rate (lb ai/appl.)	1 in 10 year EEC (ppb)		
				peak (single day)	21-day-avg.	60-day-avg.
National scenarios						
Sweet Corn (OH)	aerial aerial	8 2	2 3.4	53 46	30 25	19 13
Field Corn (OH)	aerial aerial	4 2	2 1	47 13	25 7	14 4
Apples (PA)	aerial spray blast	5 2	2 1.2	31 12	15 5	7 2
Sugar beets (MN)	aerial aerial	2 1	1.5 1.5	23 7	13 3	6 2
Citrus (FL)	aerial aerial	4 2	5 3.4	153 100	82 51	41 23
California and Pacific Northwest scenarios						
Peaches (CA)	aerial spray blast	2 1	7 3.5	57 14	33 7	12 3

Citrus (CA)	aerial aerial	4 2	5 3.4	20 7	13 4	11 2
Tomatoes (CA)	aerial spray blast	4 1	2 0.66	17 2	13 1	7 1
Apples (OR)	aerial aerial	5 2	2 1.2	19 3	13 2	6 1
Blackberries (OR)	aerial spray blast	5 1	2 1.9	12 8	10 6	6 3
Snap beans (OR)	aerial ground	4 1	1.5 0.8	10 1.2	1 0.7	<1 0.3

EFED also modeled EECs for rangeland, using a wheat scenario for North Dakota as a surrogate for rangeland. We have not included those EECs here. Carbaryl is used under USDA/APHIS management to control outbreaks of grasshoppers and Mormon crickets in some states, but that use does not apply to California or the Pacific Northwest.

Scenarios are not available for predicting aquatic EECs from pesticide use in urban and suburban settings, and more information would be needed to adequately assess the environmental impacts from such uses of carbaryl. However, carbaryl is used in residential settings, and monitoring data indicate surface-water contamination. In urban and suburban areas, small streams are generally greatly affected by surface runoff and water deposition into storm sewers. These small streams provide habitat for aquatic animals, and this habitat can be severely degraded by pesticide runoff. Applications of garden, lawn-care, and ornamental products can result in carbaryl movement into storm sewers and streams.

Measured Concentrations in Surface Water

Carbaryl is second most widely detected insecticide in the USGS NAWQA program (http://water.usgs.gov/nawqa/nawqa_home.html). Carbaryl was detected in 46% of 36 NAWQA study units between 1991 and 1998. Out of 5220 surface water samples analyzed, 1082, or about 21 percent, detected carbaryl. The mean concentration was 0.11 ppb (standard deviation of 0.43 ppb), with a maximum reported concentration of 5.5 ppb. In areas with high agricultural use the load measured in surface waters was relatively consistent across the country at about 0.1 percent of the amount used in the basins (Larson et al. 1999) http://water.wr.usgs.gov/pnsp/rep/wrir984222/load.html.

Streams draining urban areas showed more frequent detections and higher concentrations than streams draining agricultural or mixed land use areas. Monitoring data indicate that about 50% of urban streams have measurable concentrations (>0.01 ppb) of carbaryl compared to less than 10% of agricultural sites (Larson et al. 1999). In the South Platte River Basin Study Unit, between April and December of 1993, Kimbrough and Litke (1996) reported carbaryl was detected in 14 urban drainage samples and 6 agricultural drainage samples. Carbaryl had the highest concentration of the four insecticides analyzed with a maximum concentration of 2.5 ppb in the urban basin and 1.5 ppb in the agricultural basin (http://webserver.cr.usgs.gov/nawqa/splt/meetings/KIMB1.html). In a South-Central Texas Study Unit, carbaryl was detected in 12% of streams draining agricultural areas and 52 % draining urban areas (Bush et al. 2000) http://water.usgs.gov/pubs/circ/circ1212/.

In the EPA STORET database, reported detections of carbaryl suggest that it is infrequently detected in surface water and usually only at low levels. Of 8048 carbaryl records, 432 reported concentrations above the detection limits. However, only 18 detections were greater than 1 ppb, with 5.5 ppb being the maximum value reported. The data is the STORET database should only be used to give a general indication of the occurrence pattern.

e. Changes in registration status

Carbaryl is currently undergoing reregistration, and a Reregistration Eligibility Decision (RED) is scheduled to be issued by June 30, 2003. A draft environmental risk assessment for the RED was issued for public comments, and a revised assessment was completed in March of 2003 (copy attached). However, any changes in registration status of carbaryl products will not be known until the RED is issued.

f. General risk conclusions

According to EFED's revised environmental risk assessment for the RED, carbaryl poses direct risks to endangered fish and especially to aquatic invertebrates. The acute LOC for endangered freshwater fish is exceeded 1- to 12-fold for those eastern and midwestern scenarios (citrus, sweet corn, field corn, apples, and sugar beets) modeled for the RED, except for an average application in sugar beets (Table 18). For endangered estuarine fish, the LOC is exceeded only for a maximum application in citrus. LOC exceedances for acute risk are much higher for aquatic invertebrates than for fish and range from 2.5- to 60-fold across sites for both freshwater and estuarine species. Depletion of aquatic-invertebrate populations, especially insects and crustaceans, could have severe indirect effects on endangered fish if foods become scarce. Chronic risk is not a concern for fish, but the chronic LOC for invertebrates is exceeded at all use sites. Chronic risk is not likely in flowing waters where carbaryl should be rapidly dissipated but could adversely impact aquatic invertebrates inhabiting stagnant waters.

Table 18. Acute and Chronic Risk Quotients for Freshwater and Estuarine Fish and Aqautic Invertebrates, Based on Toxicity for the Most Sensitive Test Species and EECs Modeled from PRZM/EXAMS for national scenarios

Use site	application[a]	freshwater fish[b]	freshwater invertebrates[c]	estuarine fish[d]	estuarine invertebrates[e]
Acute RQs[f]					

Use site	application[a]	freshwater fish[b]	freshwater invertebrates[c]	estuarine fish[d]	estuarine invertebrates[e]
Citrus (FL)	maximum	0.6	30	0.06	27
	average	0.4	20	0.04	18
Sweet corn (OH)	maximum	0.2	10	0.02	9
	average	0.2	9	0.02	8
Field corn (OH)	maximum	0.2	9	0.02	8
	average	0.05	3	0.01	2
Apples (PA)	maximum	0.1	6	0.01	5
	average	0.05	2	<0.01	2
Sugar beets (MN)	maximum	0.1	5	0.01	4
	average	0.03	1	<0.01	1.2
Chronic RQs[g]					
Citrus (FL)	maximum	0.2	55	no data	
	average	0.1	34		
Sweet corn (OH)	maximum	0.1	20		
	average	0.1	17		
Field corn (OH)	maximum	0.1	17		
	average	<0.1	5		
Apples (PA)	maximum	<0.1	10		
	average	<0.1	3		
Sugar beets (MN)	maximum	<0.1	9		
	average	<0.1	2		

[a] see Table 17 for application rates used to model EECs
[b] Atlantic salmon LC50 = 250 ppb and fathead minnow NOEC = 210 ppb
[c] stonefly EC50 = 5.1 ppb and water flea NOEC = 1.5 ppb
[d] sheepshead minnow LC50 = 2600 ppb
[e] mysid LC50 = 5.7 ppb
[f] peak EEC/LC50 or EC50; acute LOC is 0.05 for endangered fish and 0.5 for aquatic-invertebrate populations
[g] 60-day-average EEC for fish and 21-day-average EEC for invertebrates; chronic LOC is 1 for endangered fish and aquatic-invertebrate populations

Because some uncertainty exists in extrapolating from these eastern scenarios to the conditions in California and the Pacific Northwest, we calculated RQs based on the EECs derived from the California and Oregon scenarios in Table 17. RQs are somewhat lower than those for the scenarios in Table 18, but the acute LOC for endangered freshwater fish is exceeded for the maximum application rate to peaches, citrus, tomatoes, apples, and blackberries (Table 19). The acute LOC for freshwater and estuarine invertebrates is exceeded at all use sites for the maximum application rate and at all sites except tomatoes and snap beans for the average application rate. The chronic LOC for aquatic invertebrates is exceeded for all use sites except snap beans. Based on the RQs and LOCs, we presume an acute risk to listed steelhead and Pacific salmon from many or most agricultural uses of carbaryl. We also presume an indirect risk to salmonids, because the acute and chronic LOCs for both freshwater and estuarine invertebrates are exceeded for most sites, even when the RQ is based on the average application rate.

Table 19. Acute and Chronic Risk Quotients for Freshwater and Estuarine Fish and Aqautic Invertebrates, Based on Toxicity for the Most Sensitive Test Species and EECs Modeled from PRZM/EXAMS for scenarios in California and the Pacific Northwest

Use site[a]	application[a]	freshwater fish[b]	freshwater invertebrates[c]	estuarine fish[d]	estuarine invertebrates[e]
Acute RQs[f]					
Peaches (CA)	maximum	0.23	11	0.02	10
	average	0.06	3	<0.01	3
Citrus (CA)	maximum	0.08	4	<0.01	4
	average	0.03	1.4	<0.01	1.2
Tomatoes (CA)	maximum	0.07	3	<0.01	3
	average	<0.01	0.4	<0.01	0.4
Apples (OR)	maximum	0.08	4	<0.01	3
	average	0.01	0.6	<0.01	0.5
Blackberries (OR)	maximum	0.05	2	<0.01	2
	average	0.03	1.6	<0.01	1.4
Snap beans (OR)	maximum	0.04	2	<0.01	2
	average	<0.01	0.2	<0.01	0.2
Chronic RQs[g]					
Peaches (CA)	maximum	<0.1	22	no data	
	average	<0.1	5		
Citrus (CA)	maximum	<0.1	9		
	average	<0.1	3		

Use site[a]	application[a]	freshwater fish[b]	freshwater invertebrates[c]	estuarine fish[d]	estuarine invertebrates[e]
Tomatoes (CA)	maximum	<0.1	9		
	average	<0.1	0.7		
Apples (OR)	maximum	<0.1	9		
	average	<0.1	1.3		
Blackberries (OR)	maximum	<0.1	7		
	average	<0.1	4		
Snap beans (OR)	maximum	<0.1	0.7		
	average	<0.1	0.5		

[a] see Table 17 for application rates used to model EECs
[b] Atlantic salmon LC50 = 250 ppb and fathead minnow NOEC = 210 ppb
[c] stonefly EC50 = 5.1 ppb and water flea NOEC = 1.5 ppb
[d] sheepshead minnow LC50 = 2600 ppb
[e] mysid LC50 = 5.7 ppb
[f] peak EEC/LC50 or EC50; acute LOC is 0.05 for endangered fish and 0.5 for aquatic-invertebrate populations
[g] 60-day-average EEC for fish and 21-day-average EEC for invertebrates; chronic LOC is 1 for endangered fish and aquatic-invertebrate populations

Carbaryl's main degradate, 1-naphthol, also is moderately to highly toxic to fish and aquatic invertebrates and likely poses additional risk, particularly in alkaline waters where carbaryl rapidly degrades into 1-naphthol. However, we cannot calculate RQs, because sufficient environmental fate data are lacking to model aquatic EECs.

The environmental risk assessment also assessed risk to aquatic plants, based solely on the data for green algae. RQs range from 0.01 to 0.12 and do not exceed the LOC (1) for risk to aquatic-plant populations. Although data are lacking for macrophytes, we believe that carbaryl's potential impact on aquatic-plant cover is likely to be considerably less than its direct impact on salmonids and its indirect effect from depletion of their food supply.

The environmental risk assessment also notes that direct application of carbaryl to oyster beds in Washington tidelands poses a severe but localized and temporary acute risk to fish and nontarget arthropods in and around the target area. However, this tideland use is not expected to result in any exposure of carbaryl to listed Pacific salmon and steelhead, because they occur upstream from the treated oyster beds.

g. Existing protective measures

Nationally, there are no specific protective measures for endangered and threatened species beyond the generic statements on the current carbaryl labels. As stated on all pesticide labels, it is a violation of Federal law to use a product in a manner inconsistent with its labeling. FIFRA section 3 labels for carbaryl warn that "This product is extremely toxic to aquatic and estuarine invertebrates." and requires 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 apply when weather conditions favor drift from the treated area. Do not contaminate water when disposing of equipment washwaters."

Product labels also have a bee caution statement such as "MAY KILL HONEYBEES IN SUBSTANTIAL NUMBERS. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area. Contact your Cooperative Agricultural Extension Service for further information."

For use to control adult mosquitos, labels warn that "CAUTION: May kill shrimp and crabs. Do not use in areas where these are important resources."

Current labels do not have surface-water, groundwater, or spray-drift advisories, but any or all of these are likely to be required for reregistration.

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 an ongoing process, and there are no bulletins yet developed that would address fish in the Pacific Northwest. OPP is preparing such bulletins. The California Department of Pesticide Regulation (DPR), California Environmental Protection Agency, also creates county bulletins consistent with those developed by OPP. Carbaryl is addressed in these bulletins.

California also has a system of County Agricultural Commissioners form whom commercial applicators must obtain a permit before using any restricted use pesticide. The DPR requires that all carbaryl products marketed for agricultural uses in California be designated only for restricted use. Before issuing a permit, the County Commissioner may require that applicators adhere to the use limitations in the California county bulletins. The DPR believes that the vast majority of agricultural applicators in California follow the use limitations in these bulletins (Richard Marovich, Endangered Species Project, DPR, telephone communication, July 19, 2002). Those that apply to carbaryl are as follows:

> "Do not use in currently occupied habitat (see Species Descriptions for possible exceptions)."

> "For sprayable or dust formulations: when the air is calm or moving away from habitat, commence applications on the side nearest the habitat and proceed away from the habitat. When air currents are moving toward habitat, do not make applications within 200 yards by air or 40 yards by ground upwind from occupied habitat. The county agricultural

> commissioner may reduce or waive buffer zones following a site inspection, if there is an adequate hedgerow, windbreak, riparian corridor or other physical barrier that substantially reduces the probability of drift."
>
> "Provide a 20 foot minimum strip of vegetation (on which pesticides should not be applied) along rivers, creeks, streams, wetlands, vernal pools and stock ponds or on the downhill side of fields where run-off could occur. Prepare land around fields to contain run-off by proper leveling, etc. Contain as much water "on-site" as possible. The planting of legumes, or other cover crops for several rows adjacent to off-target water sites is recommended. Mix pesticides in areas not prone to run-off such as concrete mixing/loading pads, disked soil in flat terrain or graveled mix pads, or use a suitable method to contain spills and/or rinsate. Properly empty and triple-rinse pesticide containers at time of use."
>
> "Conduct irrigations efficiently to prevent excessive loss of irrigation waters through run-off. Schedule irrigations and pesticide applications to maximize the interval of time between the pesticide application and the first subsequent irrigation. Allow at least 24 hours between application of pesticides listed in this bulletin and any irrigation that results in surface run-off into natural waters. Time applications to allow sprays to dry prior to rain or sprinkler irrigations. Do not make aerial applications while irrigation water is on the field unless surface run-off is contained for 72 hours following the application."

The California DPR's requirement for a no-spray buffer and a vegetative filter strip between surface waters and carbaryl treatment sites (other than homeowner applications) should reduce exposure of aquatic organisms. However, we need to confer with NMFS to determine if these requirements are sufficient to mitigate risks to listed steelhead and salmon.

4. Listed salmon and steelhead ESUs and comparison with carbaryl 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 or potential use of carbaryl 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. Carbaryl-usage data for California was obtained from the DPR's 2001 Pesticide Use Summary Report Data, which provides county-level data for individual use sites (excluding homeowner uses). Statewide data for crops treated with carbaryl in Washington and Oregon are based on information from the WSDA (Table 8) and the USDA/NASS (Table 9). Crop acreage for individual counties in Washington, Oregon, and Idaho was obtained from the 1997 Agricultural Census. For Oregon, Washington, and Idaho, county-level use data (lb ai per county) was provided by Bayer CropScience LP, but these data are CBI. We utilize these data in making our determinations but cannot present them here.

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. However, home and garden uses make it likely that carbaryl would be used in these watersheds. There is also a potential for steelhead waters to drain agricultural areas in Ventura, Santa Barbara, and San Luis Obispo counties.

Usage of carbaryl in 2001 in counties where this ESU occurs is presented in Table 20.

Table 20. Use of carbaryl (excluding homeowner use) in 2001 in counties within the Southern California steelhead ESU

County	use site	carbaryl usage (lb ai)	acres treated
San Diego	*all sites*	*1144*	
	strawberries	379	292
	outdoor plants in containers	376	188
Los Angeles	*all sites*	*7142*	
	carrots	3472	1148
	landscape maintenance	2850	
	peaches	504	174
	potatoes	138	65
	apples	101	34

County	use site	carbaryl usage (lb ai)	acres treated
Riverside	*all sites*	*3856*	
	landscape maintenance	1399	
	oranges	664	143
	lemons	453	69
	animal premises	320	
	grapefruits	289	33
	radishes	224	140
Ventura	*all sites*	*15,084*	
	strawberries	7373	3096
	lemons	4172	108
	peppers	3000	1822
	outdoor plants in containers	135	
	raspberries	118	27
San Luis Obispo	*all sites*	*2541*	
	lettuce	925	715
	grapes	750	676
	celery	320	192
	walnuts	119	120
Santa Barbara	*all sites*	*1962*	
	strawberries	698	376
	lettuce	479	363
	grapes	287	151
	apples	236	239
	outdoor plants in containers	139	

We conclude that use of carbaryl may affect the Southern California steelhead ESU. We make this determination based on the amount of carbaryl applied in these counties, especially Ventura Co., in 2001. Carbaryl poses a direct acute risk to endangered fish and especially an indirect risk where there is acute and chronic exposure of this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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 21 shows carbaryl usage in 2001 in those counties where this ESU occurs.

Table 21. Use of carbaryl (excluding homeowner use) in 2001 in counties with the South Central California steelhead ESU

County	use site	carbaryl usage (lb ai)	acres treated
Santa Cruz	*all sites*	*5117*	
	apples	1952	983
	strawberries	3109	1722
Santa Clara	*all sites*	*2463*	
	landscape maintenance	1790	
	beans	262	203
San Benito	*all sites*	*2881*	
	asparagus	1043	596
	apples	661	499
	grapes	359	207
	tomatoes	186	170
	landscape maintenance	109	
	broccoli	139	71

County	use site	carbaryl usage (lb ai)	acres treated
Monterey	*all sites*	*20,310*	
	grapes	7794	4997
	strawberries	7125	4472
	uncultivated non-agriculture	1336	1083
	landscape maintenance	1243	
	peppers	485	394
	pastureland	447	465
	broccoli	317	201
	uncultivated agriculture	300	150
	cactus pear	289	150
	beans	157	117
	walnuts	110	80
San Luis Obispo	*all sites*	*2541*	
	lettuce	925	715
	grapes	750	676
	celery	320	192
	walnuts	119	120

We conclude that use of carbaryl may affect the South Central California steelhead ESU. We make this determination based on the amount of carbaryl applied in these counties, especially Monterey Co., in 2001. Carbaryl poses a direct acute risk to endangered fish and especially an indirect risk where there is acute and chronic exposure of this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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).

Usage of carbaryl in 2001 in counties in the Central California coast steelhead ESU is presented in Table 22.

Table 22. Use of carbaryl (excluding homeowner use) in 2001 in counties with the Central California Coast steelhead ESU

County	use site	carbaryl usage (lb ai)	acres treated
Santa Cruz	*all sites*	*5117*	
	apples	1952	983
	strawberries	3109	1722
San Mateo	*all sites*	*267*	
	landscape maintenance	218	
San Francisco	all sites	0	0
Marin	*all sites*	*244*	
	structural pest control	232	
Sonoma	*all sites*	*1360*	
	grapes	890	587
	apples	320	173
Mendocino	*all sites*	*602*	
	apples	587	60
Napa	*all sites*	*191*	
	grapes	160	171
Alameda	*all sites*	*1318*	
	landscape maintenance	1176	
	grapes	119	108

County	use site	carbaryl usage (lb ai)	acres treated
Contra Costa	*all sites*	*4475*	
	apples	3404	1332
	landscape maintenance	624	
	beans	123	121
Solano	*all sites*	*1956*	
	tomatoes	836	2256
	corn	301	570
	apples	258	113
	beans	183	123
Santa Clara	*all sites*	*2463*	
	landscape maintenance	1790	
	beans	262	203

We conclude that use of carbaryl may affect the Central California Coast steelhead ESU. We make this determination based on the amount of carbaryl applied in these counties in 2001. Carbaryl poses a direct acute risk to endangered fish and especially an indirect risk due to acute and chronic exposure of this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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.

Usage of carbaryl in 2001 in this ESU is provided in Table 23.

Table 23. Use of carbaryl (excluding homeowner use) in 2001 in counties with the California Central Valley steelhead ESU

County	use site	carbaryl usage (lb ai)	acres treated
Alameda	*all sites*	*1318*	
	landscape maintenance	1176	
	grapes	119	108
Amador	all sites	0	0
Butte	*all sites*	*5442*	
	rice	4841	3249
	peaches	408	97
Calaveras	all sites	<100	
Colusa	*all sites*	*395*	
	almonds	176	264
Contra Costa	*all sites*	*4475*	
	apples	3404	1332
	landscape maintenance	624	
	beans	123	121
Glenn	*all sites*	*2744*	
	rice	2199	1582
	walnuts	178	37
	almonds	106	27
Marin	all sites	244	

County	use site	carbaryl usage (lb ai)	acres treated
Merced	*all sites*	*17,730*	
	pistachio	6902	398
	tomatoes	3820	2401
	peaches	1244	398
	almonds	1232	714
	corn	1012	1764
	apricots	562	191
	walnuts	528	132
	cotton	438	483
	apples	375	200
	sugarbeets	272	286
	pastureland	160	160
	alfalfa	158	95
	oats	110	55
Nevada	all sites	<100	
Placer	all sites	602	
Sacramento	*all sites*	*2978*	
	corn	1425	1322
	apples	506	396
	grapes	401	431
	sudangrass	242	121
	tomatoes	164	397
	landscape maintenance	125	not reported
San Joaquin	*all sites*	*9133*	
	apples	5196	2997
	tomatoes	1217	1400
	cherries	746	307
	grapes	594	354
	rice	472	59
	walnuts	352	80
	cantaloupes	168	355
San Mateo	all sites	267	
San Francisco	all sites	0	0
Shasta	all sites	1339	
	forage hay/silage	1215	955

County	use site	carbaryl usage (lb ai)	acres treated
Solano	*all sites*	*1956*	
	tomatoes	836	2256
	corn	301	570
	apples	258	113
	beans	183	123
Sonoma	*all sites*	*1360*	
	grapes	890	587
	apples	320	173
Stanislaus	*all sites*	*11,446*	
	tomatoes	4851	4833
	apples	1677	1203
	peaches	1139	339
	almonds	1116	763
	grapes	1075	648
	beans	298	200
	corn	268	899
	cantaloupes	267	565
	melons	233	542
	cherries	205	152
	rice	148	37
	others	170	>139
Sutter	*all sites*	*8454*	
	peaches	4711	1243
	melons	2671	5003
	rice	502	386
	corn	395	747
	others	175	182
Tehama	all sites	200	
Tuloumne	all sites	224	

County	use site	carbaryl usage (lb ai)	acres treated
Yolo	*all sites*	*5250*	
	melons	2146	3563
	tomatoes	1867	2604
	almonds	320	80
	pastureland	240	161
	sunflowers	172	663
	apples	105	185
	others	399	>602
Yuba	*all sites*	*1371*	
	peaches	1369	454

We conclude that use of carbaryl may affect the California Central Valley steelhead ESU. We make this determination based on the amount of carbaryl applied in these counties in 2001. Carbaryl poses a direct acute risk to endangered fish and especially an indirect risk where there is acute and chronic exposure of this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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.

Carbaryl use in 2001 in this ESU is presented in Table 24.

Table 24. Use of carbaryl (excluding homeowner use) in 2001 in counties with the Northern California steelhead ESU

County	use site	carbaryl usage (lb ai)	acres treated
Humboldt	all sites	119	
Mendocino	<u>*all sites*</u> apples	<u>*602*</u> 587	 60
Trinity	all sites	0	0
Lake	all sites	777	

We conclude a no effect for the Northern California steelhead ESU. We make this determination based on the minimal amount of carbaryl applied in any one county within this ESU in 2001 and the California DPR's requirement for a no-spray buffer and vegetative filter strip between carbaryl treatment sites and surface waters. Some uncertainty exists regarding homeowner usage, but we believe it is apt to be more dispersed and in much smaller patches than are agricultural and commercial applications.

<u>6. Upper Columbia River steelhead ESU</u>

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.

Cropping information for counties within this ESU is provided in Tables 25 and 26. Data on homeowner and other noncrop uses are not available.

Table 25. Cropping information for Washington counties where there is spawning and growth of the Upper Columbia River steelhead ESU

State	county	cultivated cropland[a]	crop	crop acreage
WA	Benton	268,372	apples	18,425
			grapes	15,929
			asparagus	1683
			pears	472
			peaches	149
WA	Franklin	291,696	apples	9000
			asparagus	8610
			carrots	3574
			grapes	2813
			sweet cherries	1665
			lima beans	988
			peaches	262
			snap beans	236
			pears	156
WA	Kittitas	57,456	apples	1859
			pears	331
WA	Yakima	264,490	apples	75,264
			grapes	15,529
			pears	10,190
			asparagus	7034
			sweet cherries	5922
			peaches	1438
			lima beans	731
			cucumbers	194
			cabbage	144
			snap beans	106
WA	Chelan	31,423	apples	17,096
			pears	8298
			sweet cherries	3678
			peaches	21

State	county	cultivated cropland[a]	crop	crop acreage
WA	Douglas	217,703	apples sweet cherries pears peaches	14,383 1834 1104 167
WA	Okanogan	72,732	apples pears sweet cherries peaches	24,164 3280 1001 67
WA	Grant	529,087	apples lima beans grapes carrots pears asparagus snap beans peaches	33,615 3878 3132 2207 998 940 671 261

[a] cultivated cropland includes all harvested acreage and all failed acreage

Table 26. Cropping information for Washington and Oregon counties that are migration corridors for the Upper Columbia River steelhead ESU

State	county	cultivated cropland[a]	crop	crop acreage
WA	Walla Walla	337,660	apples asparagus lima beans sweet cherries snap beans cucumbers	5222 1414 458 280 250 140
WA	Klickitat	93,193	pears apples grapes peaches	923 516 419 199

State	county	cultivated cropland[a]	crop	crop acreage
WA	Skamania	1205+	pears apples	477 75
WA	Clark	27,860	blueberries pears peaches apples grapes	85 75 46 33 32
WA	Cowlitz	8227+	apples pears sweet cherries	14 3 1
WA	Wahkiakum	3515+		0
WA	Pacific	5451	cranberries	1312
OR	Gilliam	100,729+		0
OR	Umatilla	384,163	apples snap beans	3927 587
OR	Sherman	127,018+		0
OR	Morrow	220,149 +		0
OR	Wasco	97,230	apples	463
OR	Hood River	17,346+	apples	2592
OR	Multnomah	14,692	snap beans blackberries apples sweet cherries	77 73 51 4
OR	Columbia	15,054+	apples	39
OR	Clatsop	4772		0

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Upper Columbia River steelhead ESU. This determination is made based on the high amount of crop acreage on which carbaryl can be used in this ESU, the acute risk of carbaryl to endangered fish, and especially the potential for indirect affects due to acute and chronic risks to their aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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 carbaryl 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 carbaryl. 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 27 and 28 provide the cultivated acreage 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. Data are not available for noncrop and homeowner uses in Oregon and Washington or for any carbaryl uses in Idaho.

Table 27. Cropping information for Pacific Northwest counties which provide spawning and rearing habitat for the Snake River Basin steelhead ESU

State	county	cultivated cropland[a]	crop	crop acreage
ID	Adams	16,779		0
ID	Idaho	147,557	apples	6
ID	Nez Perce	168,365	peaches	22
ID	Custer	34,754		0
ID	Lemhi	41,837+	apples	6
ID	Valley	6990+		0
ID	Lewis	119,860		0
ID	Clearwater	24,266		0
ID	Latah	200,691	cherries	19
WA	Adams	392,556	vegetables orchards asparagus apples snap beans	3668 3597 422 345 102
WA	Asotin	32,892	apples peaches pears	24 18 6
WA	Garfield	108,553		0
WA	Columbia	97,743		0
WA	Whitman	804,893	apples pears	19 2

State	county	cultivated cropland[a]	crop	crop acreage
WA	Franklin	291,696	apples asparagus carrots grapes sweet cherries lima beans peaches snap beans pears	9000 8610 3574 2813 1665 988 262 236 156
WA	Walla Walla	337,660	apples asparagus lima beans sweet cherries snap beans cucumbers	5222 1414 458 280 250 140
OR	Wallowa	54,138	apples	8
OR	Union	90.349	apples	39

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

Table 28. Cropping information for Washington and Oregon counties through which the Snake River Basin steelhead ESU migrates

State	county	cultivated acreage[a]	crop	crop acreage
WA	Benton	268,372	apples grapes asparagus pears peaches	18,425 15,929 1683 472 149
WA	Klickitat	93,193	pears apples grapes peaches	923 516 419 199

State	county	cultivated acreage[a]	crop	crop acreage
WA	Skamania	1205+	pears apples	477 75
WA	Clark	27,860	blueberries pears peaches apples grapes	85 75 46 33 32
WA	Cowlitz	8227+	apples pears sweet cherries	14 3 1
WA	Wahkiakum	3515+		0
WA	Pacific	5451	cranberries	1312
OR	Umatilla	384,163	apples snap beans	3927 587
OR	Morrow	220,149 +		0
OR	Gilliam	100,729+		0
OR	Sherman	127,018+		0
OR	Wasco	97,230	apples	463
OR	Hood River	17,346+	apples	2592
OR	Multnomah	14,692	snap beans blackberries apples sweet cherries	77 73 51 4
OR	Columbia	15,054+	apples	39
OR	Clatsop	4772		0

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Snake River Basin steelhead ESU. This determination is based on the high amount of crop acreage on which carbaryl can be used in several counties within this ESU, the acute risk of carbaryl to endangered fish, and especially the potential for indirect affects due to acute and chronic risks to their aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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 carbaryl 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 29 and 30 show the cultivated acreage, including potential carbaryl crop uses, for Oregon counties where the Upper Willamette River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 29. Cropping information for Oregon counties in the spawning and rearing habitat of the Upper Willamette River steelhead ESU

State	county	cultivated acreage[a]	crop	crop acreage
OR	Benton	69,214	snap beans grapes apples sweet cherries	3080 242 62 14
OR	Linn	248,392	snap beans apples blackberries	2688 133 35
OR	Polk	89,599	sweet cherries snap beans apples blackberries	1484 598 157 157
OR	Clackamas	59,923	blackberries snap beans apples	971 334 167
OR	Marion	202,353	snap beans blackberries sweet cherries apples	12,101 3609 1459 555
OR	Yamhill	95,440	snap beans sweet cherries apples blackberries	1838 1140 310 333
OR	Washington	85,190	blackberries snap beans apples sweet cherries	1077 988 279 141

[a] cultivated cropland includes all harvested acreage and all failed acreage

Table 30. Cropping information in Oregon and Washington counties that are part of the migration corridors of the Upper Willamette River steelhead ESU

State	county	cultivated acreage[a]	crop	crop acreage
WA	Clark	27,860	blueberries pears peaches apples grapes	85 75 46 33 32
WA	Cowlitz	8227+	apples pears sweet cherries	14 3 1
WA	Wahkiakum	3515+		0
WA	Pacific	5451	cranberries	1312
OR	Multnomah	14,692	snap beans blackberries apples sweet cherries	77 73 51 4
OR	Columbia	15,054+	apples	39
OR	Clatsop	4772		0

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Upper Willamette River steelhead ESU. This determination is based on the amount of crop acreage on which carbaryl can be used in spawning and rearing habitat in Oregon counties within this ESU. There is little crop acreage on which carbaryl might be used in the migration corridor. Carbaryl poses a direct acute risk to endangered fish and especially an indirect risk where there is acute and chronic exposure of this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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 31 and 32 show the cropping information for Oregon and Washington counties where the Lower Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 31. Cropping information in Oregon and Washington counties that provide spawning and rearing habitat for the Lower Columbia River Steelhead ESU

State	county	cultivated acreage[a]	crop	crop acreage
OR	Hood River	17,346+	apples	2592
OR	Clackamas	59,923	blackberries snap beans apples	971 334 167
OR	Multnomah	14,692	snap beans blackberries apples sweet cherries	77 73 51 4
WA	Clark	27,860	blueberries pears peaches apples grapes	85 75 46 33 32
WA	Lewis	29,569	blueberries apples	137 77

State	county	cultivated acreage[a]	crop	crop acreage
WA	Cowlitz	8227+	apples pears sweet cherries	14 3 1
WA	Skamania	1205+	pears apples	477 75

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

Table 32. Cropping information in Oregon and Washington counties that are migratory corridors for the Lower Columbia River Steelhead ESU

State	county	cultivated acreage[a]	crop	crop acreage
OR	Columbia	15,054+	apples	39
OR	Clatsop	4772		0
WA	Pacific	5451	cranberries	1312
WA	Wahkiakum	3515+		0

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Lower Columbia River steelhead ESU. This determination is made based on the amount of carbaryl used in two counties where there is spawning and rearing of this ESU. Carbaryl poses a direct acute risk to endangered fish and especially an indirect risk where there is acute and chronic exposure of this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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 33 and 34 show the cropping information for Oregon and Washington counties where the Middle Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 33. Cropping information in Oregon and Washington counties that provide spawning and rearing habitat for the Middle Columbia River Steelhead ESU

State	county	cultivated acreage[a]	crop	crop acreage
OR	Gilliam	100,729+		0
OR	Morrow	220,149 +		0
OR	Umatilla	384,163	apples snap beans	3927 587
OR	Sherman	127,018+		0
OR	Wasco	97,230	apples	463
OR	Crook	35,824		0
OR	Grant	46,399	apples grapes pears	33,615 3132 998
OR	Wheeler	15,523	apples	23
OR	Jefferson	44,873	apples	4
WA	Benton	268,372	apples grapes asparagus pears peaches	18,425 15,929 1683 472 149
WA	Columbia	97,743		0
WA	Franklin	291,696	apples asparagus carrots grapes sweet cherries lima beans peaches snap beans pears	9000 8610 3574 2813 1665 988 262 236 156
WA	Kittitas	57,456	apples pears	1859 331

State	county	cultivated acreage[a]	crop	crop acreage
WA	Klickitat	93,193	pears apples grapes peaches	923 516 419 199
WA	Skamania	1205+	pears apples	477 75
WA	Walla Walla	337,660	apples asparagus lima beans sweet cherries snap beans cucumbers	5222 1414 458 280 250 140
WA	Yakima	264,490	apples grapes pears asparagus sweet cherries peaches lima beans cucumbers cabbage snap beans	75,264 15,529 10,190 7034 5922 1438 731 194 144 106

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

Table 34. Cropping information in Washington and Oregon counties through which the Middle Columbia River steelhead ESU migrates

State	county	cultivated acreage[a]	crop	crop acreage
WA	Skamania	1205+	pears apples	477 75

State	county	cultivated acreage[a]	crop	crop acreage
WA	Clark	27,860	blueberries pears peaches apples grapes	85 75 46 33 32
WA	Cowlitz	8227+	apples pears sweet cherries	14 3 1
WA	Pacific	5451	cranberries	1312
WA	Wahkiakum	3515+		0
OR	Hood River	17,346+	apples	2592
OR	Multnomah	14,692	snap beans blackberries apples sweet cherries	77 73 51 4
OR	Columbia	15,054+	apples	39
OR	Clatsop	4772		0

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Middle Columbia River steelhead ESU. This determination is based on the extensive acreage of crops on which carbaryl can be used in counties where there is spawning and rearing of this ESU. Carbaryl poses a direct acute risk to endangered fish and especially an indirect risk where there is acute and chronic exposure of this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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.

<u>1. Sacramento River Winter-run Chinook Salmon ESU</u>

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 carbaryl in this ESU in 2001 is presented in Table 35.

Table 35. Use of carbaryl (excluding homeowner uses) 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	use site	carbaryl usage (lb ai)	acres treated
Alameda	*all sites*	*1318*	
	landscape maintenance	1176	
	grapes	119	108
Butte	*all sites*	*5442*	
	rice	4841	3249
	peaches	408	97
Colusa	all sites	395	
Contra Costa	*all sites*	*4475*	
	apples	3404	1332
	landscape maintenance	624	
	beans	123	121
Glenn	*all sites*	*2744*	
	rice	2199	1582
	walnuts	178	37
	almonds	106	27
Marin	all sites	244	
Sacramento	*all sites*	*2978*	
	corn	1425	1322
	apples	506	396
	grapes	401	431
	sudangrass	242	121
	tomatoes	164	397
	landscape maintenance	125	
San Mateo	all sites	267	
San Francisco	all sites	0	0
Shasta	*all sites*	*1339*	
	forage hay/silage	1215	955

County	use site	carbaryl usage (lb ai)	acres treated
Solano	*all sites*	*1956*	
	tomatoes	836	2256
	corn	301	570
	apples	258	113
	beans	183	123
Sonoma	*all sites*	*1360*	
	grapes	890	587
	apples	320	173
Sutter	*all sites*	*8454*	
	peaches	4711	1243
	melons	2671	5003
	rice	502	386
	corn	395	747
Tehama	all sites	200	
Yolo	*all sites*	*5250*	
	melons	2146	3563
	tomatoes	1867	2604
	almonds	320	80
	pastureland	240	161
	sunflowers	172	663
	apples	105	185
	others	399	>602

We conclude that use of carbaryl may affect the Sacramento River winter-run chinook salmon ESU. We make this determination based on the widespread use of carbaryl in these counties. Carbaryl poses an acute risk to endangered fish and also indirect risks due to acute and chronic exposure of this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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 carbaryl would not be used in these areas. We have, however, kept Umatilla County as part of the migratory corridor.

Tables 36 and 37 show the cropping information for Pacific Northwest counties where the Snake River fall-run chinook salmon ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 36. Cropping information in Pacific Northwest counties which provide spawning and rearing habitat for the Snake River fall-run chinook ESU

State	county	cultivated acreage[a]	crop	crop acreage
ID	Adams	16,779		0
ID	Idaho	147,557	apples	6

State	county	cultivated acreage[a]	crop	crop acreage
ID	Nez Perce	168,365	peaches	22
ID	Valley	6990+		0
ID	Lewis	119,860		0
ID	Benewah	59,294	apples	6
ID	Shoshone	459+		0
ID	Clearwater	24,266		0
ID	Latah	200,691	cherries	19
WA	Adams	392,556	dry beans asparagus apples snap beans	8148 422 345 102
WA	Lincoln	471,220		0
WA	Spokane	297,722	apples sweet cherries peaches carrots pears cucumbers	227 47 42 34 24 11
WA	Asotin	32,892	apples peaches pears	24 18 6
WA	Garfield	108,553		0
WA	Columbia	97,743		0
WA	Whitman	804,893	dry beans apples pears	1283 19 2

State	county	cultivated acreage[a]	crop	crop acreage
WA	Franklin	291,696	apples asparagus carrots grapes dry beans sweet cherries lima beans peaches snap beans pears	9000 8610 3574 2813 2470 1665 988 262 236 156
WA	Walla Walla	337,660	dry beans apples asparagus lima beans sweet cherries snap beans cucumbers	5457 5222 1414 458 280 250 140
OR	Wallowa	54,138	apples	8
OR	Union	90.349	apples	39
OR	Wasco	97,230	apples	463
OR	Jefferson	44,873	apples	4
OR	Sherman	127,018+		0
OR	Gilliam	100,729+		0
OR	Wheeler	15,523	apples	23
OR	Morrow	220,149 +		0
OR	Grant	46,399	apples grapes pears	33,615 3132 998

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

Table 37. Cropping information in Washington and Oregon counties through which the Snake River fall-run chinook and the Snake River spring/summer-run chinook ESUs migrate

State	county	cultivated acreage[a]	crop	crop acreage
WA	Benton	268,372	apples grapes asparagus pears peaches	18,425 15,929 1683 472 149
WA	Klickitat	93,193	pears apples grapes peaches	923 516 419 199
WA	Skamania	1205+	pears apples	477 75
WA	Clark	27,860	blueberries pears peaches apples grapes	85 75 46 33 32
WA	Cowlitz	8227+	apples pears sweet cherries	14 3 1
WA	Wahkiakum	3515+		0
WA	Pacific	5451	cranberries	1312
OR	Umatilla	384,163	apples snap beans	3927 587
OR	Morrow	220,149 +		0
OR	Gilliam	100,729+		0
OR	Sherman	127,018+		0
OR	Wasco	97,230	apples	463
OR	Hood River	17,346+	apples	2592

State	county	cultivated acreage[a]	crop	crop acreage
OR	Multnomah	14,692	snap beans blackberries apples sweet cherries	77 73 51 4
OR	Columbia	15,054+	apples	39
OR	Clatsop	4772		0

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Snake River fall-run chinook ESU. This determination is made based on the high amount of crop acreage on which carbaryl can be used in this ESU. Carbaryl poses a direct acute risk to endangered fish and especially an indirect risk where there is acute and chronic exposure of this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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 carbaryl can be used. Counties with migratory corridors are all of those down stream from the confluence of the Snake and Columbia Rivers.

Table 38 shows the cropping information for Oregon and Washington counties where the Snake River spring/summer-run chinook salmon ESU occurs. The cropping information for the migratory corridors is the same as for the Snake River fall-run chinook salmon (Table 37).

Table 38. Cropping information in Pacific Northwest counties which provide spawning and rearing habitat for the Snake River spring/summer run chinook ESU

State	county	cultivated acreage[a]	crop	crop acreage
ID	Adams	16,779		0
ID	Idaho	147,557	apples	6
ID	Nez Perce	168,365	peaches	22
ID	Custer	34,754		0
ID	Lemhi	41,837+	apples	6
ID	Valley	6990+		0
ID	Lewis	119,860		0
ID	Latah	200,691	cherries	19
WA	Asotin	32,892	apples peaches pears	24 18 6
WA	Garfield	108,553		0
WA	Columbia	97,743		0
WA	Whitman	804,893	apples pears	19 2

State	county	cultivated acreage[a]	crop	crop acreage
WA	Franklin	291,696	apples	9000
			asparagus	8610
			carrots	3574
			grapes	2813
			sweet cherries	1665
			lima beans	988
			peaches	262
			snap beans	236
			pears	156
OR	Wallowa	54,138	apples	8
OR	Union	90.349	apples	39

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Snake River spring/summer run chinook ESU. This determination is made based on the high amount of crop acreage on which carbaryl can be used in Franklin Co., Washington where there is spawning and rearing of this ESU and in several counties in the migration corridor. Carbaryl poses a direct acute risk to endangered fish and especially an indirect risk where there is acute and chronic exposure of this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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

Table 39. Use of carbaryl (excluding homeowner uses) in 2001 in counties with the Central Valley spring run chinook salmon ESU

County	use site	carbaryl usage (lb ai)	acres treated
Alameda	*all sites*	*1318*	
	landscape maintenance	1176	
	grapes	119	108
Butte	*all sites*	*5442*	
	rice	4841	3249
	peaches	408	97
Colusa	all sites	395	
Contra Costa	*all sites*	*4475*	
	apples	3404	1332
	landscape maintenance	624	
	beans	123	121
Glenn	*all sites*	*2744*	
	rice	2199	1582
	walnuts	178	37
	almonds	106	27
Marin	all sites	244	
Napa	all sites	191	
Nevada	all sites	43	
Placer	all sites	602	

County	use site	carbaryl usage (lb ai)	acres treated
Sacramento	*all sites*	*2978*	
	corn	1425	1322
	apples	506	396
	grapes	401	431
	sudangrass	242	121
	tomatoes	164	397
	landscape maintenance	125	
San Mateo	all sites	267	
San Francisco	all sites	0	0
Shasta	*all sites*	*1339*	
	forage hay/silage	1215	955
Solano	*all sites*	*1956*	
	tomatoes	836	2256
	corn	301	570
	apples	258	113
	beans	183	123
Sonoma	*all sites*	*1360*	
	grapes	890	587
	apples	320	173
Sutter	*all sites*	*8454*	
	peaches	4711	1243
	melons	2671	5003
	rice	502	386
	corn	395	747
	others	175	182
Tehama	all sites	200	
Yolo	*all sites*	*5250*	
	melons	2146	3563
	tomatoes	1867	2604
	almonds	320	80
	pastureland	240	161
	sunflowers	172	663
	apples	105	185
	others	399	>602

County	use site	carbaryl usage (lb ai)	acres treated
Yuba	*all sites* peaches	*1371* 1369	 454

We conclude that carbaryl may affect the Central Valley spring run chinook salmon ESU. We make this determination based on the amount of carbaryl applied in these counties. Carbaryl poses a direct acute risk to endangered fish and especially an indirect risk where there is acute and chronic exposure of this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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

Table 40 contains usage information for the California counties supporting the California coastal chinook salmon ESU.

Table 40. Use of carbaryl (excluding homeowner uses) in 2001 in counties within the California coastal chinook salmon ESU

County	use site	carbaryl usage (lb ai)	acres treated
Humboldt	all sites	119	
Mendocino	*all sites* apples	*602* 587	 60

County	use site	carbaryl usage (lb ai)	acres treated
Sonoma	_all sites_ grapes apples	_1360_ 890 320	 587 173
Marin	all sites	244	
Trinity	all sites	0	0
Lake	all sites	777	

We conclude that carbaryl may effect but is not likely to adversely affect the California coastal chinook salmon ESU. Some carbaryl was used by commercial and agricultural applicators in this ESU in 2001, but the reported treated acreage was small. Because use was minor, we believe that the California DPR's requirement for a no-spray buffer and a vegetative filter strip between surface waters and treatment sites (other than homeowner applications) should reduce exposure of aquatic organisms. Homeowners also could contribute to use of carbaryl within these counties.

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 41 shows the cropping information for Washington counties where the Puget Sound chinook salmon ESU is located.

Table 41. Cropping information in Washington counties within the Critical Habitat of the Puget Sound chinook salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
WA	Skagit	57,978	cucumbers carrots apples blueberries snap beans	2540 555 357 330 4
WA	Whatcom	65,679	blueberries pears grapes	482 15 10
WA	San Juan	4057	apples grapes pears	64 13 5
WA	Island	9764	apples grapes	18 14
WA	Snohomish	28,836	apples pears snap beans	47 27 10
WA	King	9827	cabbage apples blueberries	88 64 32
WA	Pierce	13,430	cabbage snap beans blueberries apples	242 200 70 61
WA	Thurston	12,130+	blueberries apples	96 23
WA	Lewis	29,569	blueberries apples	137 77
WA	Grays Harbor	15,682	cranberries	240
WA	Mason	1703+	apples	5
WA	Clallam	6119	apples	29
WA	Jefferson	2151+	apples	5
WA	Kitsap	1300+	apples	21

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect but is not likely to adversely affect on the Puget Sound chinook salmon ESU. Our determination is based on the low amount of crop acreage on which carbaryl might be used within this ESU. However, homeowners also could contribute to use of carbaryl within these counties.

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 carbaryl would not likely be used.

Table 42 shows the cropping information for Oregon and Washington counties where the Lower Columbia River chinook salmon ESU occurs.

Table 42. Cropping information in Oregon and Washington counties that are in the Critical Habitat of the Lower Columbia River chinook salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
OR	Wasco	97,230	apples	463

State	county	cultivated acreage[a]	crop	crop acreage
OR	Hood River	17,346+	apples	2592
OR	Marion	202,353	snap beans blackberries sweet cherries apples	12,101 3609 1459 555
OR	Clackamas	59,923	blackberries snap beans apples	971 334 167
OR	Multnomah	14,692	snap beans blackberries apples sweet cherries	77 73 51 4
OR	Washington	85,190	blackberries snap beans apples sweet cherries	1077 988 279 141
OR	Columbia	15,054+	apples	39
OR	Clatsop	4772		0
WA	Pacific	5451	cranberries	1312
WA	Wahkiakum	3515+		0
WA	Clark	27,860	blueberries pears peaches apples grapes	85 75 46 33 32
WA	Cowlitz	8227+	apples pears sweet cherries	14 3 1
WA	Lewis	29,569	blueberries apples	137 77

State	county	cultivated acreage[a]	crop	crop acreage
WA	Klickitat	93,193	pears apples grapes peaches	923 516 419 199
WA	Skamania	1205+	pears apples	477 75

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Lower Columbia River chinook salmon ESU. This determination is based on the amount of crop acreage on which carbaryl can be used in several counties within this ESU. Carbaryl poses an acute risk to endangered fish and has potential for indirect affects due to acute and chronic risks to their aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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 carbaryl would not be used. Salmon habitat for this ESU is exceedingly limited in Douglas County also, but we cannot rule out future carbaryl use in Douglas County.

Tables 43 and 44 show the cropping information for Oregon counties where the Upper Willamette River chinook salmon ESU occurs and for the Oregon and Washington counties where this ESU migrates.

Table 43. Cropping information for Oregon counties encompassing spawning and rearing habitat of the Upper Willamette River chinook salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
OR	Douglas	37,498	apples sweet cherries snap beans blackberries	148 60 19 14
OR	Lane	73,841	snap beans apples sweet cherries blackberries	1796 174 158 91
OR	Benton	69,214	snap beans grapes apples sweet cherries	3080 242 62 14
OR	Linn	248,392	snap beans apples blackberries	2688 133 35
OR	Polk	89,599	sweet cherries snap beans apples blackberries	1484 598 157 157
OR	Clackamas	59,923	blackberries snap beans apples	971 334 167
OR	Marion	202,353	snap beans blackberries sweet cherries apples	12,101 3609 1459 555

State	county	cultivated acreage[a]	crop	crop acreage
OR	Yamhill	95,440	snap beans sweet cherries apples blackberries	1838 1140 310 333
OR	Washington	85,190	blackberries snap beans apples sweet cherries	1077 988 279 141

[a] cultivated cropland includes all harvested acreage and all failed acreage

Table 44. Cropping information for Washington and Oregon counties that are part of the migration corridors of the Upper Willamette River chinook salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
WA	Clark	27,860	blueberries pears peaches apples grapes	85 75 46 33 32
WA	Cowlitz	8227+	apples pears sweet cherries	14 3 1
WA	Wahkiakum	3515+		0
WA	Pacific	5451	cranberries	1312
OR	Multnomah	14,692	snap beans blackberries apples sweet cherries	77 73 51 4
OR	Columbia	15,054+	apples	39
OR	Clatsop	4772		0

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Upper Willamette River chinook salmon ESU. Our determination is based on the amount of crop acreage on which carbaryl can be used in this ESU. Carbaryl poses an acute risk to endangered fish and has potential for indirect affects due to acute and chronic risks to their aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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 (Table 31), with the lower river reaches being migratory corridors (Table 32).

Tables 45 and 46 present cropping information for those Washington counties that support the Upper Columbia River chinook salmon ESU and for Oregon and Washington counties where this ESU migrates.

Table 45. Cropping information for Washington counties where there is spawning and rearing habitat for the Upper Columbia River chinook salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
WA	Benton	268,372	apples	18,425
			grapes	15,929
			asparagus	1683
			pears	472
			peaches	149
WA	Kittitas	57,456	apples	1859
			pears	331

State	county	cultivated acreage[a]	crop	crop acreage
WA	Chelan	31,423	apples	17,096
			pears	8298
			sweet cherries	3678
			peaches	21
WA	Douglas	217,703	apples	14,383
			sweet cherries	1834
			pears	1104
			peaches	167
WA	Okanogan	72,732	apples	24,164
			pears	3280
			sweet cherries	1001
			peaches	67
WA	Grant	529,087	apples	33,615
			lima beans	3878
			grapes	3132
			carrots	2207
			pears	998
			asparagus	940
			snap beans	671
			peaches	261

[a] cultivated cropland includes all harvested acreage and all failed acreage

Table 46. Cropping information for Washington and Oregon counties that are migration corridors for the Upper Columbia River chinook salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
WA	Franklin	291,696	apples	9000
			asparagus	8610
			carrots	3574
			grapes	2813
			sweet cherries	1665
			lima beans	988
			peaches	262
			snap beans	236
			pears	156

State	county	cultivated acreage[a]	crop	crop acreage
WA	Yakima	264,490	apples grapes pears asparagus sweet cherries peaches lima beans cucumbers cabbage snap beans	75,264 15,529 10,190 7034 5922 1438 731 194 144 106
WA	Walla Walla	337,660	apples asparagus lima beans sweet cherries snap beans cucumbers	5222 1414 458 280 250 140
WA	Klickitat	93,193	pears apples grapes peaches	923 516 419 199
WA	Skamania	1205+	pears apples	477 75
WA	Clark	27,860	blueberries pears peaches apples grapes	85 75 46 33 32
WA	Cowlitz	8227+	apples pears sweet cherries	14 3 1
WA	Wahkiakum	3515+		0
WA	Pacific	5451	cranberries	1312
OR	Gilliam	100,729+		0

State	county	cultivated acreage[a]	crop	crop acreage
OR	Umatilla	384,163	apples snap beans	3927 587
OR	Sherman	127,018+		0
OR	Morrow	220,149 +		0
OR	Wasco	97,230	apples	463
OR	Hood River	17,346+	apples	2592
OR	Multnomah	14,692	snap beans blackberries apples sweet cherries	77 73 51 4
OR	Columbia	15,054+	apples	39
OR	Clatsop	4772		0

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Upper Columbia River chinook salmon ESU. This determination is based on the extensive amount of crop acreage on which carbaryl can be used in a number of counties encompassing this ESU. Carbaryl poses an acute risk to endangered fish and has potential for indirect affects due to acute and chronic risks to their aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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.

Table 47 contains usage information for the California counties supporting the Central California coast coho salmon ESU.

Table 47. Use of carbaryl (excluding homeowner uses) in 2001 in counties with the Central California Coast coho ESU

County	use site	carbaryl usage (lb ai)	acres treated
Santa Cruz	<u>all sites</u> apples strawberries	<u>5117</u> 1952 3109	 983 1722
San Mateo	all sites	267	
Marin	all sites	244	
Sonoma	<u>all sites</u> grapes apples	<u>1360</u> 890 320	 587 173
Mendocino	<u>all sites</u> apples	<u>602</u> 587	 60
Napa	all sites	191	

We conclude that use of carbaryl may affect the Central California Coast coho salmon ESU. We make this determination based on the amount of carbaryl applied in these counties, especially Santa Cruz and Sonoma counties, in 2001. Carbaryl poses a direct acute risk to endangered fish and especially an indirect risk due to acute and chronic risks to this ESU's aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

<u>2. Southern Oregon/Northern California Coast Coho Salmon ESU</u>

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

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

Use of carbaryl in counties occupied by this ESU is presented in Tables 48 and 49.

Table 48. Use of carbaryl (excluding homeowner uses) in 2001 in California counties within the Southern Oregon/Northern California coastal coho salmon ESU

County	use site	carbaryl usage (lb ai)	acres treated
Humboldt	all sites	119	
Mendocino	*all sites* apples	*602* 587	 60
Del Norte	all sites	0	0
Siskiyou	all sites	0	0
Trinity	all sites	0	0
Lake	all sites	777	

Table 49. Cropping information for Oregon counties where there is habitat for the Southern Oregon/Northern California coastal coho salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
OR	Curry	1807	apples	27
OR	Jackson	33,529	apples sweet cherries blackberries	360 22 8

OR	Josephine	9015	apples sweet cherries blackberries snap beans	181 9 4 1
OR	Douglas	37,498	apples sweet cherries snap beans blackberries	148 60 19 14

[a] cultivated cropland includes all harvested acreage and all failed acreage

We conclude that carbaryl will have no effect on the Southern Oregon/Northern California coastal coho salmon ESU. Our determination is made based on small amount of acreage treated in California counties in 2001 and little potential acreage on which carbaryl might be used in the Oregon counties within this ESU's habitat. Some uncertainty exists regarding homeowner usage, but we believe it is apt to be more dispersed and in much smaller patches than are agricultural and commercial applications.

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 50 shows the cultivated acreage for Oregon counties where the Oregon coast coho salmon ESU occurs.

Table 50. Cropping information for Oregon counties where there is habitat for the Oregon coast coho salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
OR	Curry	1807	apples	27
OR	Coos	14,115+	apples sweet cherries blackberries	28 3 1
OR	Douglas	37,498	apples sweet cherries snap beans blackberries	148 60 19 14
OR	Lane	73,841	snap beans apples sweet cherries blackberries	1796 174 158 91
OR	Lincoln	3626+	apples blackberries snap beans	22 2 1
OR	Benton	69,214	snap beans grapes apples sweet cherries	3080 242 62 14
OR	Polk	89,599	sweet cherries snap beans apples blackberries	1484 598 157 157
OR	Tillamook	6448		0
OR	Clatsop	4772		0

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Oregon coast coho salmon ESU. This determination is based on the amount of crop acreage on which carbaryl can be used in several counties included in the habitat of this ESU. Carbaryl poses an acute risk to endangered fish and has potential for indirect affects due to acute and chronic risks to their aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

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 51 shows the cultivated acreage for Washington counties where the Hood Canal summer-run chum salmon ESU occurs.

Table 51. Cropping information for Washington counties where there is habitat for the Hood Canal Summer-run chum salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
WA	Mason	1703+	apples	5
WA	Clallam	6119	apples	29
WA	Jefferson	2151+	apples	5
WA	Kitsap	1300+	apples	21
WA	Island	9764	apples grapes	18 14
WA	Grays Harbor	15,682	cranberries	240

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl will have no effect on the Hood Canal Summer-run chum salmon ESU, because there is almost no acreage on which carbaryl might be used in the counties comprising this ESU. Some uncertainty exists regarding homeowner usage, but we believe it is apt to be more dispersed and in much smaller patches than are agricultural and commercial applications.

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 52 shows the cultivated acreage for Oregon and Washington counties where the Columbia River chum salmon ESU occurs.

Table 52. Cultivated acreage and crops on which carbaryl can be used in counties where there is habitat for the Columbia River chum salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
WA	Skamania	1205+	pears apples	477 75
WA	Clark	27,860	blueberries pears peaches apples grapes	85 75 46 33 32
WA	Lewis	29,569	blueberries apples	137 77
WA	Cowlitz	8227+	apples pears sweet cherries	14 3 1
WA	Pacific	5451	cranberries	1312
WA	Wahkiakum	3515+		0
OR	Multnomah	14,692	snap beans blackberries apples sweet cherries	77 73 51 4
OR	Columbia	15,054+	apples	39

State	county	cultivated acreage[a]	crop	crop acreage
OR	Washington	85,190	blackberries snap beans apples sweet cherries	1077 988 279 141
OR	Clatsop	4772		0

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Columbia River chum salmon ESU. Our determination is based solely on the extent of usage of carbaryl in one Washington county within this ESU. However, that county cannot be identified, because the usage data are CBI. Homeowners also could contribute to use of carbaryl within these counties.

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 53).

Table 53. Cropping information for Clallum County where there is habitat for the Ozette Lake sockeye salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
WA	Clallam	6119	apples	29

[a] cultivated cropland includes all harvested acreage and all failed acreage

We conclude that carbaryl will have no effect on the Ozette Lake sockeye salmon ESU, because there is minimal acreage on which carbaryl might be applied in Clallum, Co. Some uncertainty exists regarding homeowner usage, but we believe it is apt to be more dispersed and in much smaller patches than are agricultural and commercial applications.

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. Carbaryl cannot be used in this area. It is possible that this salmon ESU could be exposed to carbaryl in the lower and larger river reaches during its juvenile or adult migration.

Tables 54 and 55 show the cropping information for counties where this ESU occurs.

Table 54. Cropping information for Idaho counties where there is spawning and rearing habitat for the Snake River sockeye salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
ID	Custer	34,754		0
ID	Blaine	47,565		0

[a] cultivated cropland includes all harvested acreage and all failed acreage

Table 55. Cropping information for Pacific Northwest counties within the migratory corridors for the Snake River sockeye salmon ESU

State	county	cultivated acreage[a]	crop	crop acreage
ID	Idaho	147,557	apples	6
ID	Lemhi	41,837+	apples	6
ID	Lewis	119,860		0
ID	Nez Perce	168,365	peaches	22
ID	Valley	6990+		0
WA	Asotin	32,892	apples peaches pears	24 18 6
WA	Garfield	108,553		0
WA	Whitman	804,893	apples pears	19 2
WA	Columbia	97,743		0

State	county	cultivated acreage[a]	crop	crop acreage
WA	Walla Walla	337,660	apples asparagus lima beans sweet cherries snap beans cucumbers	5222 1414 458 280 250 140
WA	Franklin	291,696	apples asparagus carrots grapes sweet cherries lima beans peaches snap beans pears	9000 8610 3574 2813 1665 988 262 236 156
WA	Benton	268,372	apples grapes asparagus pears peaches	18,425 15,929 1683 472 149
WA	Klickitat	93,193	pears apples grapes peaches	923 516 419 199
WA	Skamania	1205+	pears apples	477 75
WA	Clark	27,860	blueberries pears peaches apples grapes	85 75 46 33 32
WA	Cowlitz	8227+	apples pears sweet cherries	14 3 1
WA	Wahkiakum	3515+		0

State	county	cultivated acreage[a]	crop	crop acreage
WA	Pacific	5451	cranberries	1312
OR	Wallowa	54,138	apples	8
OR	Umatilla	384,163	apples snap beans	3927 587
OR	Morrow	220,149 +		0
OR	Gilliam	100,729+		0
OR	Sherman	127,018+		0
OR	Wasco	97,230	apples	463
OR	Hood River	17,346+	apples	2592
OR	Multnomah	14,692	snap beans blackberries apples sweet cherries	77 73 51 4
OR	Columbia	15,054+	apples	39
OR	Clatsop	4772		0

[a] cultivated cropland includes all harvested acreage and all failed acreage; failed cropland acreage is not reported for some counties due to privacy concerns when only a few farms report such acreage - we denote this acreage with a "+" in the cultivated cropland column in the relevant tables; such acreage typically is small and statewide accounts for only 0.7% of harvested cropland acreage in Washington, 3.7% in Oregon, and 3.2% in Idaho

We conclude that carbaryl may affect the Snake River sockeye salmon ESU. This determination is based on the high amount of crop acreage on which carbaryl can be used in several counties within the migration corridor of this ESU. Carbaryl poses an acute risk to endangered fish and has potential for indirect affects due to acute and chronic risks to their aquatic-invertebrate food supply. Homeowners also could contribute to use of carbaryl within these counties.

5. Summary conclusions for listed Pacific salmon and steelhead

Based on the available information and best professional judgement, our conclusions on potential adverse direct and indirect effects of carbaryl on listed Pacific salmon and steelhead are provided in Table 56. We conclude that carbaryl may affect 20 ESUs, may affect but is not likely to adversely affect two ESUs, and will have no effect on four ESUs.

For those ESUs in California, we base our determinations on reported usage of carbaryl in each county in 2001, the potential direct risk to endangered steelhead and salmon, and the potential for indirect effects from loss of aquatic-invertebrate food resources. Except for homeowner uses, carbaryl is designated as a restricted use pesticide by the state of California, and applicators are encouraged to follow the use limitations in the California bulletins. Those bulletins include a 200-yard buffer for aerial application and a 40-yard buffer for ground application as well as a 20-foot minimum vegetative strip between the treatment site and surface waters. Although the use limitations in the bulletins are voluntary, applicators must obtain a permit from their County Ag. Commissioner's Office. The Ag. Commissioner's Office may require in the permit that the applicator must adhere to the use limitations.

No buffers or vegetative strip are required for carbaryl applications in Oregon, Washington, and Idaho. We suggest that a no-spray buffer would help reduce loading of carbaryl into surface waters and help reduce risks to salmonids and their food resources. However, we will need to confer with NMFS as to whether these measures provide adequate protection for these ESUs or if other mitigation measures also are needed. A buffer is impractical for homeowner products. It would be of value to discuss any proposed mitigation strategy with the affected state pesticide regulatory agencies to ensure consideration of local conditions and use practices.

Table 56. Summary conclusions on specific ESUs of listed Pacific salmon and steelhead for carbaryl

Species	ESU	Finding
Steelhead	Southern California	may affect
Steelhead	South-Central California Coast	may affect
Steelhead	Central California Coast	may affect
Steelhead	Central Valley, California	may affect
Steelhead	Northern California	no effect
Steelhead	Upper Columbia River	may affect
Steelhead	Snake River Basin	may affect
Steelhead	Upper Willamette River	may affect
Steelhead	Lower Columbia River	may affect
Steelhead	Middle Columbia River	may affect
Chinook Salmon	Sacramento River winter-run	may affect
Chinook Salmon	Snake River fall-run	may affect

Species	ESU	Finding
Chinook Salmon	Snake River spring/summer-run	may affect
Chinook Salmon	Central Valley spring-run	may affect
Chinook Salmon	California Coastal	may affect, but not likely to adversely affect
Chinook Salmon	Puget Sound	may affect, but not likely to adversely affect
Chinook Salmon	Lower Columbia	may affect
Chinook Salmon	Upper Willamette	may affect
Chinook Salmon	Upper Columbia	may affect
Coho salmon	Central California	may affect
Coho salmon	Southern Oregon/Northern California Coasts	no effect
Coho salmon	Oregon Coast	may affect
Chum salmon	Hood Canal summer-run	no effect
Chum salmon	Columbia River	may affect
Sockeye salmon	Ozette Lake	no effect
Sockeye salmon	Snake River	may affect

References

Beyers, D.W., T.J. Keefe, and C.A. Carlson. 1994. Toxicity of carbaryl and malathion to two federally endangered fishes, as estimated by regression and ANOVA. Environ. Toxicol. Chem. 13:101-107.

Bridges, C.M., 1997. Tadpole swimming performance and activity affected by acute exposure to sublethal levels of carbaryl. *Environ. Toxicol. Chem*. 16:1935-1939.

Carlson, A.R., 1972. Effects of long-term exposure to carbaryl (Sevin), on survival, growth, and reproduction of the fathead minnow (*Primephales promelas*). *J. Fish. Res. Board Can.* 29(5):583-587.

Choudhury, C., A.K. Ray, and S. Bhattacharya, 1993. Nonlethal concentrations of pesticide impair ovarian function ion the freshwater perch, *Anabas testudineus*. *Environ. Biol. Fishes*. 36(3):319-324

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

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

Ghosh, P. and S. Bhattacharya, 1990. Impairment of the regulation of gonadal function in *Channa punctatus* by Metacid-50 and Carbaryl under laboratory and field conditions. *Biomed. Environ. Sci*. 3(1):106-112.

Hanazato, T., 1995. Combined effect of the insecticide carbaryl and the *Chaoborus* kairomone on helmet development in *Daphnia ambigua*. *Hydrobiologia*, 310 (2): 95-100.

Hanazato, T. and M. Yasuno. 1989. *Environ. Pollut*. 56(1): 1-10.

Hardersen, S. and S.D. Wratten, 1998. The effects of carbaryl exposure of the penultimate larval instars of *Xathocnemis zealandica* on emergence and fluctuating asymmetry. *Ecotoxicology* 7:297-304.

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

Havens, K.E., 1995. Insecticide (carbaryl, 1-napthyl-N-methylcarbamate) effects on a freshwater plankton community: zooplankton, size, biomass, and algal abundance. *Water Air Soil Pollut*. 84:1-10.

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

Klotz, D.M., S.F. Arnold, and J.A. McLachlan, 1997. Inhibition of 17 beta-estradiol and progesterone activity in human breast and endometrial cancer cells by carbamate insecticides. *Life Sciences* 60(17): 1467-1475.

Larson, Steven J., Robert Gilliom, and Paul Capel, 1999. Pesticides in Streams of the United States--Initial Results from the National Water-Quality Assessment Program. U.S.G.S. Water-Resources Investigations Report 98-4222.

Moore, A. and C. P. Waring. 1996. Sublethal effects of the pesticide diazinon on the olfactory function in mature male Atlantic salmon parr. J. Fish Biol. 48:758-775.

Mora, B.R., Martinez-Tabche, L., Sanchez-Hildalgo, E., Hernandez, G.C., Ruiz, M.C. and Murrieta, F.F. 2000. Relationship between toxicokinetics of carbaryl and effect on acetylcholinesterase activity in *Pomacea patula* snail. *Ecotoxicol. Environ. Saf.* 46:234-239.

Pozorycki, S.V. 1999. Sublethal effects of estuarine carbaryl application on juvenile English sole (*Pleuronectes vetulus*). *Diss. Abstr. Int. Pt.B. Sci. & Eng.* 60:2424.

Sappington, L.C., F.L. Mayer, F.J. Dwyer, D.R. Buckler, J.R. Jones, and M.R. Ellersieck. 2001. Contaminant sensitivity of threatened and endangered fishes compared to standard surrogate species. Environ. Toxicol. Chem. 20:2869-2876.

Scholz, N.T., N.K. Truelove, B.L. French, B.A. Berejikian, T.P. Quinn, E. Casillas, and T.K. Collier. 2000. Diazinon disrupts antipredator and homing behaviors in chinook salmon (*Oncorhynchus tshawytscha*). Can. J. Fish. Aquat. Sci., 57:1911-1918.

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

Tucker, R.K. and J.S. Leitzke. 1979. Comparative toxicology of insecticides for vertebrate wildlife and fish. Pharmacol. Ther., 6:167-220.

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

WSDA . 2003. Carbaryl Use Profile: Crop Use Only. Washington State Department of Agriculture. 8 pp.

Weis, P. and J.S. Weis, 1974. Schooling behavior of *Menidia menidia* in the presence of the insecticide Sevin (carbaryl). *Marine Biol.* 28: 261-263.

Weis, J.S. and P. Weis, 1975. Retardation of fin regeneration in *Fundulus* by several insecticides. Trans. Am. Fish. Soc. 104(1):135-137.

Zucker E. 1985. Hazard Evaluation Division - Standard Evaluation Procedure - Acute Toxicity Test for Freshwater Fish. U. S. EPA Publication 540/9-85-006.