Pendimethalin
Analysis of Risks
to
Endangered and Threatened Salmon and Steelhead

December 20, 2004

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Summary

Pendimethalin [N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] is a selective pre-emergent herbicide registered for control of broadleaf weeds and grassy weed species on a variety of terrestrial fruit and vegetable, and feed crops. It is also used to control weeds on ornamental crops, rights-of-way and homeowner turf.

An endangered species risk assessment is developed for federally listed Pacific salmon and steelhead. This assessment applies the findings of the Office of Pesticide Program's Environmental Risk Assessment developed for non-target fish and wildlife as part of the reregistration process to determine the potential risks to the 26 listed threatened and endangered Evolutionarily Significant Units (ESUs) of Pacific salmon and steelhead.

Pendimethalin exhibits high toxicity to fish and can affect aquatic plants, especially diatoms, in areas of high use. The use of pendimethalin will have no effect on 22 ESUs and may affect but is not likely to adversely affect 4 ESUs.

Introduction

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

The general aquatic risk assessment presented in the "Reregistration Eligibility Decision (RED) Pendimethalin" issued in June, 1997 was the starting basis for this assessment (Attachment A). This document (US EPA, 2002) is on line at: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg#C. Additional sources include OPP Quantitative Usage Analysis (1997), NAWQA, California Department of Pesticide Regulation pesticide database (2002), National Agricultural Statistical Service (1997), and Washington State Department of Agriculture report (2004). Biological effects data was obtained from EPA's Ecotox database.

Problem Formulation: The purpose of this analysis is to determine whether the registration of pendimethalin as an herbicide for use on various crops and non-crop areas 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 western salmon and steelhead and the watersheds in which they occur, it is acknowledged that pendimethalin 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. I 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.

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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. (Mayer, personal communication, 2002)

Metabolites and Degradates

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

Inert Ingredients

OPP does take into account the potential effects of what used to be termed "inert" ingredients, but which are beginning to be referred to as "other ingredients". OPP has classified these ingredients into several categories. A few of these, such as nonylphenol, can no longer be used without including them on the label with a specific statement indicating the potential toxicity. Based upon our internal databases, I can find no product in which nonylphenol is now an ingredient. Many others, including such ingredients as clay, soybean oil, many polymers, and chlorophyll, have been evaluated through structure-activity analysis or data and determined to be of minimal or no toxicity. There exist also two additional lists, one for inert ingredients with potential toxicity which are considered a testing priority, and one for inert ingredients 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 inert ingredient evaluation 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 inert ingredients 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 inert ingredients 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. The "comparable" sensitivity must take into account the natural variation in toxicity tests, which is up to 2-fold for the same species in the same laboratory under the same conditions, and which can be somewhat higher between different laboratories, especially when different stocks of test fish are used.

The comparison of formulated product and technical ingredient test results may not provide specific information on the individual inert ingredients, but rather is like a "black box" which sums up the effects of all ingredients. This approach is more appropriate than testing each individual inert and active ingredient because it incorporates any additivity, antagonism, and synergism effects that may occur and which might not be correctly evaluated from tests on the individual ingredients. However, 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, however, quite necessary to address the potential that home and garden pesticides may affect T&E species, even in the absence of reliable data. Therefore, I have used a generic Pennsylvania turf scenario to represent residential lawns in the PNW. This same scenario is generic enough that it also can represent sod farms, golf course fairways, and greens and tees. The soil texture in Pennsylvania is a silty, fine-loamy, mixed, mesic Aquic Fragiudult soil, having similar texture and saturation conditions of the PNW. Since the application rate of pendimethalin applied to residential turf is below the application rate of a modeled crop with extensive acreage and higher application rates, exposure from residential use should generally be lower than that of agriculture uses. Modeling estimates will therefore yield conservative assumptions with respect to protections to salmonid and steelhead from turf use.

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

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

Indirect Effects

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

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

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

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

Designated Critical Habitat

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

Risk Assessment Processes

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

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

Table 2. Risk quotient criteria for 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[a]	>1.0[b]	May be indirect effects on aquatic vegetative cover for T&E fish

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

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

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

Sublethal Effects

With respect to sublethal effects, Tucker and Leitzke (1979) did an extensive review of existing ecotoxicological data on pesticides. Among their findings was that sublethal effects as reported in the literature did not occur at concentrations below one-fourth to one-sixth of the lethal concentrations, when taking into account the same percentages or numbers affected, test system, duration, species, and other factors. This was termed the "6x hypothesis". Their review included cholinesterase inhibition, but was largely oriented towards externally observable parameters such as growth, food consumption, behavioral signs of intoxication, avoidance and repellence, and similar parameters. Even reproductive parameters fit into the hypothesis when the duration of the test was considered. This hypothesis supported the use of lethality tests for use in assessing 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.

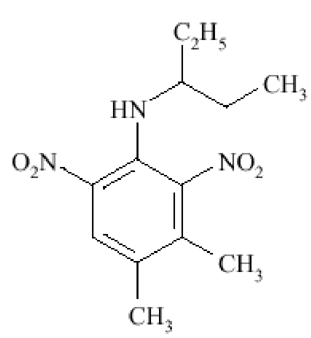
In recent years, Moore and Waring (1996) challenged Atlantic salmon with diazinon and observed effects on olfaction as relates to reproductive physiology and behavior. Their work indicated that diazinon could have sublethal effects of concern for salmon reproduction. However, the nature of their test 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. 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 of Pendimethalin

a. Description of Chemical

Pendimethalin [N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] is in the dinitroaniline family of chemicals and is an orange-yellow crystalline solid. As an herbicide for control of broadleaf weeds and grassy weed, it acts as a microtubule disruptor on pre-emergent plants. It works by inhibiting cell growth to prevent seedling development and is active on the roots and coleoptile of susceptible weeds. It does not work postemergence.



The chemical is stable under acidic and alkaline conditions and has a melting point of 54-58 deg. C. Figure 1 shows the chemical's physical structure. This parent compound is the only significant residue in environmental fate studies.

Figure 1. Chemical structure of pendimethalin.
Empirical Formula: $C_{13}H_{19}N_3O_4$
Molecular Weight: 281.3
CAS Registry No.: 40487-42-1
Chemical Code: 108501

It is a meristematic inhibitor that acts by disrupting microtubule formation in the mitotic division of root tips, inhibiting chromosome separation and cell wall formation. It is applied directly to the soil, has no foliar activity and does not translocate throughout the plant. Plants that are already established will not be affected. It is used for preemergent control of broadleaf weeds and grassy weed species in a number of crop and non-crop areas, on residential lawns, ornamentals and rights-of-way. It is applied by broadcast, chemigation, conservation tillage, containerized plant treatment, soil incorporation and directed spray. Aerial application is allowed.

b. Summary of Labeled Uses

Pendimethalin is primarily used in agricultural crops (92% of all uses), with soybeans leading total usage at 60% of all agriculture use sites. Other registered use sites are: almond, apple, apricot, beans (dried and succulent), carrot (including tops), cherry, citrus fruits, corn (field and sweet), fig, garbanzos (including chick peas), garlic, grapes, nectarine, olive, onion, peas, cowpea/blackeyed pea, garbanzos (including chick peas), peanuts, peach, pear, pecan, pistachio, plum, potato (white/Irish), prune, rice, shallot, sorghum, soybeans, sugarcane, sunflower and walnut (English/black).

Non-agricultural uses of pendimethalin that are characteristic of urban areas include outdoor homeowner use on lawns (both recreational and ornamental), paved areas (private roads/sidewalks), paths/patios, outdoor buildings/structures and industrial areas. Other non-agricultural uses (including feed crops) of pendimethalin include alfalfa, lupine, small seeded legumes, Christmas tree plantations, golf course turf, (outdoor), jojoba, nonagricultural, ornamental and/or shade trees, ornamental herbaceous plants, ornamental lawns and turf, ornamental nonflowering plants, ornamental sod farm (turf), ornamental woody shrubs and vines, tobacco, rights-of-way/fence rows/hedgerows, ornamental and/or shade trees, ornamental ground cover, and ornamental woody shrubs and vines.

Actual non-agricultural uses varies across different uses. Washington state use summary report for pendimethalin indicates that less than 1% of the land area of a typical golf course is treated with this chemical. Label directions advise to use the product on established turf using higher rates for first time treatment. Other non-agricultural areas typically treated are landscaped beds, nurseries and bare ground weed control. For rights-of-way, pendimethalin is rotated with other herbicides and may not be applied in a given year. In Washington state, no pendimethalin was used for the year 2001 to control weeds in rights-of-way (WSDA 2004).

BASF is the primary registrant and sells pendimethalin in the United States primarily under the trade names Prowl 3.3 EC, Prowl H2O, Pendulum, Pentagon, Prowl, Stomp, Repose, Hurdle and Herbadox. Formulations include liquid, solid, granular, emulsifiable concentrate and dry flowables. Formulations that include other active ingredients are displayed in table 3.

Table 3. Formulations with other active ingredients.

Formulation brand name	Registrant	Active Ingredients in addition to pendimethalin
Squadron NF Herbicide	BASF	3-Quinolinecarboxylic acid
Pursuit Plus EC Herbicide	BASF	Imazethapyr
Steel Herbicide	BASF	Imazaquin and Imazethapyr
Preclaim EW Herbicide	Bayer Environmental Science	Fenoxaprop-p-ethyl
Ornamental Herbicide II	The Scotts Company	Oxyfluorfen
Fertilizer with Weed Control	The Scotts Company	2-4,D and Mecoprop
Fertilizer Plus Preemergent Weed Control II	The Scotts Company	Oxadiazon
Setre Prowl Herbicide + Propanil	Helena Chemical Co.	Propanil
Turf Pride Fertilizer with Pen-Star II Herbicide	Howard Fertilizer & Chemical Co.	Oxadiazon

Formulation types registered:

Manufacturing product	90.0%
Liquid	60.0%
Solid	86.8%

End Use Product:

Emulsifiable concentrate	21.9 to 42.3%
Liquid	34.4%
Granular	0.7 to 2.0%
Soluble concentrate/liquid	22.0%
Water dispersible granules	Up to 60.0%
Wettable powder	50.0%

Registrant

BASF Corporation is the primary registrant for federal FIFRA section 3 registrations. Additional registrants include The Scotts Company, Bayer Environmental Science, Knox Fertilizer Co., Inc. The Anderson's Lawn F

ertilizer Division Inc., Harrell's Inc., Helena Chemical Co., Howard Fertilizer & Chemical Co., Lesco Inc., Loveland Products Inc., Howard Fertilizer & Chemical Co., and Arkansas Chemical International.

There are 25 FIFRA section 24c (Special Local Needs) registrations, and 7 experimental use permits issued for pendimethalin. In 2003 there were 35 Emergency Exemptions - Section 18 permits issued; Idaho was authorized for 6000 acres, Oregon for 5000 acres and Washington state for 12000 acres.

Methods of Application

Pendimethalin is applied by backpack sprayer, low pressure ground sprayer, low pressure hand wand, boom sprayer, center of pivot irrigation, moving wheel irrigation, solid set irrigation, sprayer and spreader. It may also be applied through layby, conservation tillage, soil incorporated or soil injected treatment, and aircraft. It is most effective when activated by 1/4 to ½ inch rainfall or irrigation within 30 days or incorporated into the soil by mechanical tillage. Pendimethalin can only be applied through a sprinkler system of the following type: center pivot, lateral move, end tow, side (wheel) roll, traveler, big gun, solid set or hand move. Some labels may restrict direct application by irrigation altogether.

Homeowners apply pendimethalin, which is often accompanied by a fertilizer, by push-spreaders. It is recommended to water after application to remove granules from the foliage and to move the product to the soil surface. It is not recommended to rake or aerify in order to maintain chemical barrier integrity at the soil surface.

There are certain restrictions and limitations for some California uses. It is prohibited to apply pendimethalin in no-till for corn and cotton and on lentils and peas, peanuts, and soybeans altogether. Also in California a single application is allowed on onions or shallots when they have 2 to 6 true leaves. It is recommended that pendimethalin not be used 12 months prior to planting of sugar beets, red beets or spinach.

c. Proposed label changes required by the RED

The development of a Reregistration Eligibility Decision (RED) document is a step in the process of reregistering existing pesticide products. The Environmental Risk Assessment used and referred to throughout much of this analysis provides an assessment at the point in time at which it is developed. Subsequent to the development of the RED, changes in uses may occur, label changes may be required, and additional data may be requested. As a result, there are nearly always changes in certain aspects of the registration that occur after the development of the RED.

Changes that may alter the aquatic risk analysis for pendimethalin since the Environmental Risk Assessment was completed are:

- Section 3 labels are in the process of being changed to highlight the concern that addresses spray drift from aerial application. Specifically reference is made to the responsibility of the applicator in following drift management guidelines.

- Additional label directions regarding droplet size, wind speed and direction, application height, and a prohibition of applications during temperature inversions should also reduce drift into aquatic habitats.

- Labeling on residential lawns and sod farm instructs users to follow the maximum application rate of 2.0 lbs active ingredient per acre.

d. Estimated usage of pendimethalin

Pendimethalin has a varied use rate depending on the crop. Table 4 summarizes this use rate for major agricultural crops for Pacific Northwest states based on label data. The lbs ai (active ingredient) / acre are derived from highest use rates found on product labels, Washington State Department of Agriculture use summaries and the summary reports found in the Reregistration Eligibility Decision. It should be noted that the user groups surveyed reported lower rates that are used. The figures itemized here are used to generate estimated maximum use rates for crops in each ESU that are summarized in Attachments C and D.

Table 4. Use rates for major agricultural crops.

Crop	lbs ai/acre	No. Apps.	% Acres Treated	Source
Alfalfa, all	3.00	1	90.00%	WA state summary
Beans, dry edible, excluding dry limas	1.50	1	100.00%	Prowl 3.3 EC label
Beans, lima	1.50	1	100.00%	Prowl 3.3 EC label
Beans, snap	1.50	1	100.00%	Prowl 3.3 EC label
Carrots[1]	2.00	1	100.00%	WA state summary
Corn, field	1.98	1	100.00%	Prowl 3.3 EC label

Corn, pop	1.98	1	100.00%	Prowl 3.3 EC label
Corn, sweet	1.98	1	100.00%	Prowl 3.3 EC label
Corn, sweet, for seed	1.98	1	100.00%	Prowl 3.3 EC label
Cotton	1.98	1	100.00%	Prowl 3.3 EC label
Cowpeas and southern peas, dry	1.50	1	100.00%	Prowl H20 label
Floriculture crops	3.96	1	100.00%	Anderson's ProTurf Fert.
Garlic	1.98	1	100.00%	Prowl 3.3 EC label
Grapes	3.96	1	50.00%	Prowl 3.3 EC label
Legume seeds, all	1.26	1	90.00%	Prowl 3.3 EC label
Lentils	1.50	1	100.00%	WA state summary
Nursery crops (in the open)	4.00	1	100.00%	Anderson's ProTurf Fert.
Onions, dry	5.94	3	100.00%	Prowl H2O
Orchards, all	4.00	1	100.00%	WA state summary
Peas, all	1.50	1	100.00%	WA state summ/label
Potatoes (excluding sweet potatoes)	1.50	1	100.00%	Ipimethalin-L label
Rice	1.00	1	100.00%	Ipimethalin-L label
Sod (harvested)	3	1	100.00%	Pendulum WDG label
Sunflower seed	1.5	1	100.00%	Prowl H2O label
Tobacco	1.50	1	100.00%	Pentagon DG label
Walnuts, English	3.96	1	100.00%	Prowl 3.3 EC label

1. Seed carrots only in WA state of 2500 acres.

Generally it is prohibited to use pendimethalin on muck soils except for onions and only for uses outside California. If used on muck soils, no more than 5.94 lbs ai/acre should be used per growing season. High organic content muck soil is not considered a typical soil type so the average high rate of 1.98 lbs ai/acres is used. For orchards, 4 lbs ai/acre application rates reflects long-term control of weeds for 6 to 8 months.

The maximum use rate for turfgrasses, ornamentals, landscapes and noncrop areas is generally 3 lbs ai/acre but may be used up to 9 lbs ai/acre on warm season turfgrasses. Although labels do not indicate alternatives, it is possible that this amount may be split into two applications, most likely in areas where a second crop could be grown; but it seems most likely that a single application would occur. Residential uses have much lower rates with maximum rates of 2.0 lbs ai / acre being phased in. Generally for both agricultural and field ornamental uses, applications are made to bare ground prior to weed emergence. It may be soil incorporated within the top 1 or 2 inches by various methods 7 days prior to planting. Restrictions exist for planting of certain crops.

In Washington state it is estimated that less than 1% of a typical golf course is treated with pendimethalin (WSDA 2004). This assumption is applied to Oregon and Idaho and is deemed not significant for purposes of analysis. It is likely that only on new golf courses there may be a 100% application rate, but on established greens there may be less. Furthermore, to reduce other risks, the maximum application rate is being reduced from 3.0 lb. ai/acre to 2.0 lb ai/acre to non-crop areas such as residential turf, golf course turf and sod farm turf. Use is not allowed on bentgrass, *dichondra, Poa annua*, and putting greens and tees.

Rights-of-way information is lacking for PNW states. However in eastern Washington, its use is rotated with other herbicides. For example, in eastern Washington state, 2,132 lbs were used in 2002 but none the previous year. When used, it is applied at an average rate of 3 lbs. ai/acre in the fall or late winter.

Annual Poundage

The latest information for pesticide usage in California is for the year 2002 [URL: http://www.cdpr.ca.gov/docs/pur/purmain.htm]. Table 5 indicates that for the latest year in which data are available (2002), 447,032 pounds active ingredient were used. I note that there is not any significant trend in usage over the last 10 years. By comparison, the RED indicates an estimated 30,198,000 pounds of pendimethalin active ingredient was applied annually in the U.S. in 1997.

For California, pendimethalin is ranked at 79 on an acreage basis and 42 on a pounds basis among all chemicals used in 2002. The amount on 288,451 acres averages to 1.5 lb ai/A, a figure similar to the quantitative usage analysis from the Reregistration Eligibility Decision (March, 1997). Overall about 1/3 was used on cotton alone, 1/4 on landscape maintenance and rights-of-way, and the remainder on agricultural crops and non-agricultural uses.

Very little was used on golf courses or for commercial treatment of home lawns; California does not require reporting of use by homeowners. There are no other reliable, appropriate data for use by homeowners.

Table 5. Reported use of pendimethalin in California, 1993-2002, in pounds of active ingredient.

1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
452,592	329,581	431,250	429,945	437,887	416,055	415,435	417,616	457,156	447,032

Table 6 shows the average lbs. of active ingredient applied nationally for the indicated crop (use site). Also shown is the percent crops treated at the average and maximum rate for the crop. Nationally, agriculture food crops accounted for more than 91% of all pendimethalin use, with lawn use accounting for the majority (84%) of non agricultural uses (RED, Quantitative Usage Analysis 1997).

Table 6. National pendimethalin use for selected sites (1997) [1].

Crop	Avg. lbs. of Active Ingredient Used	Maximum percent crops treated	Average percent crops treated
Alfalfa	150,000	0.5	0.3

Almonds	6,000	2.0	1.0
Apples	1,000	0.6	0.1
Beans/peas (green)	45,000	8.0	6.8
Beans/peas (dry)	66,000	4.7	3.7
Cole crops	1,600	2.5	0.7
Corn	4,000,000	5.0	4.7
Cotton	3,000,000	50.0	35.0
Cucurbits	2,800	1.7	0.9
Garlic	15,000	70.0	60.0
Grapevines	5,000	1.2	0.6
Idle crop land	6,000	0.2	0.1
Melons, all	10,000	7.6	3.1
Mint	40,000	15.0	12.0
Onions	100,000	35.0	25.0
Peaches	600	1.1	0.4
Peanuts	550,000	40.0	35.0
Potatoes	235,000	24.0	18.0
Rice	300,000	13.0	9.0
Sorghum	23,000	0.7	0.2
Soybeans	13,700,000	30.0	26.0
Sunflowers	400,000	21.0	19.0
Sweet corn	42,000	8.0	6.0
Vegetables, other [2]	1,000	5.0	0.9
Walnuts	1,000	1.1	0.3

1. The estimates might not exactly correspond because of rounding. The table shows that the average annual domestic pendimethalin usage on the different agricultural crops ranges from 23 to 27 million pounds of active ingredient. Between 2 and 3 million pounds of this chemical are used on non-agricultural sites (84 percent on lawns). The highest usage sites for this herbicide are soybeans, corn, cotton, peanuts, sunflower, sugarcane, rice, tobacco, and potatoes.
2. Vegetables other includes artichoke, asparagus, okra, oriental vegetables, and rhubarb.

Table 7 shows California reporting for 2002. Generally, pendimethalin is listed among top 5 chemicals applied for landscape maintenance, and rights-of-way for Contra Costa, Los Angeles, Marin, Placer, San Mateo, Santa Clara, Sonoma and Stanislaus counties. Stanislaus had the highest use by pounds at 17,188 lbs followed by Los Angeles at 9,798 lbs. Use in Los Angeles decreased dramatically from 2001 where 35,560 lbs. was used and in Placer which went from 9749 lbs. in 2001 to 1266 lbs. in 2002.

Table 7. Use of pendimethalin by use site in California (2002)

Crop	Pounds of Active Ingredient Used	Number of Applications	Acres Treated[1]
Alfalfa	11,130	67	3492
Almond	16,314	289	11,613
Apple	72	7	60
Apricot	21	3	24
Bean, dried	5,903	60	5,508
Bean, succulent	1,366	57	1,592
Bean, unspecified	1,832	41	1,748
Cantaloupe	66	1	72
Cherry	1,837	76	1,460
Christmas Tree	33	11	92
Citrus	41	4	26
Corn (forage, fodder)	6,733	109	5,620
Corn, human consumption	6,733	191	6,579
Cotton	154,781	1,458	139,914
Cotton (forage, fodder)	241	5	241
Garlic	10,456	112	11,331
Grape	5,637	129	2.954
Grape, wine	10,787	306	6,295
Kiwi	37	2	13
Landscape maintenance	61,241		
Lemon	625	26	1,304
Melon	2	1	2
N-greenhouse flower	625	37	222
N-greenhouse plants in containers	200	17	89
N-greenhouse transplants	1	1	1
N-outdoor flower	491	28	243
N-outdoor plants in containers	12,232	2,547	7,977
N-outdoor transplants	101	55	108
Nectarine	1,430	98	955
Oat	180	1	45
Onion, dry	17,665	418	24,503
Orange	4,853	74	2,256
Peach	2,826	170	1,760
Pear	34	2	30
Peas	16	1	16
Pistachio	23,126	156	12,933
Plum	1,615	69	809
Potato	7,150	177	11,030
Prune	995	18	552

Rangeland	60	1	15
Rice	1,802	47	1,966
Rights of way	44,115		
Soil fumigation/preplant	656	11	712
Sorghum/milo	252	4	247
Strawberry	28	1	68
Sugarcane	400	13	198
Sunflower	1,945	41	2,391
Tangelo	32	2	23
Tangerine	296	8	244
Tomato	119	1	102
Tomato, processing	816	10	771
Turf/sod	254	16	419
Uncultivated agriculture	18,883	51	12,501
Uncultivated non-ag	467	2	839
Vegetable	0.3	1	0.1
Walnut	6,878	187	4,281
Water (industrial)	8		20
Water area	110		45

1. California database only reports total number of pounds used. This number should be divided by the number of applications to determine the acres treated.

For agricultural use in 2002, Stanislaus and Monterey counties were the leading users of pendimethalin on almonds and grapes, respectively at around 3600 lbs. The next largest users were Merced and Yolo (cotton) at close to 3000 pounds each. In 2001, major use occurred for cotton in King county but this falls outside the watershed of concern. Los Angeles reported using 35,560 lbs for cotton in 2001 but had reduced this by a third the following year. Though there are twice as many uses on golf courses as on landscapes for non agricultural use, California reports significant usage for rights of way and landscapes maintenance.

In Oregon, Washington, and Idaho, information on the actual amount of pendimethalin used is rather limited, but the Washington State Department of Agriculture (WSDA) has provided information on the acreage of major pendimethalin-treated crops (see Table 8). There are additional details on amounts used for certain of these crops, and the full report is included as Attachment B. Some usage figures have been incorporated into the table used to generate Pacific Northwest (PNW) crop usage summaries that presents total maximum usage amounts by county for an ESU (see Attachment D).

Table 8. Major usage of pendimethalin in Washington (WSDA, 2004). Detailed application data available for only two crops.

crop	acres planted[1]	acres treated (% treated)	lbs ai/A	# apps	est lbs ai applied
Alfalfa, seed	12,000	90	3	1	10,800
Beans, dry	41,000				
Beans, garbanzo	11,000				
Corn, field	130,000				
Corn, sweet	97,400				
Grapes[2]	49,800				
Grass, seed crops	60,500				
Lentils	75,000				
Onions	17,100				
Orchards	220,400	1	0.75	2	3,300
Peas, dry	70,000				
Peas, green	36,800				
Potatoes	170,000				

1. Estimated 2002 acres from Washington Agricultural Statistics Service.
2. Not typically used.

The USDA's National Agricultural Statistcs Service provides some recent updated usage information in the Pacific Northwest for several crop categories. For nursery and floriculture uses, pendimethalin was not among the top three herbicides used. Only 3% of all nursery and floriculture operations, 1% of Christmas Tree operations, and 8% of the Broadleaf evergreen operations used pendimethalin in Oregon (USDA, 2004). Slightly more than half of the production chemicals (56%) were used in open areas. Overall, there was a decrease in active ingredients reported as being used on nursery and floriculture operations since 2000. Since 20% of these are herbicides, it is likely that pendimethalin use has also decreased. This may also be extrapolated for non-production nursery and floriculture applications in which almost all active ingredients used were herbicides. Fruit and vegetable usage of pendimethalin is presented in table 9.

Table 9. Estimated usage of pendimethalin on fruit and vegetable crops in Washington and Oregon.

Use Site and state[1]	Average % acres treated	# appls	rate/year (#ai/A)	total lb ai applied
Apples (WA)	n/a	2.3	3.05	700
Sweet corn, proc. (WA)	52%	1.4	0.69	35,000
Garlic (WA)	48%	1.3	1.15	16,000
Onions, dry bulb (OR)	94%	1.4	1.14	18,600
Onions, dry bulb (WA)	85%	1.0	0.73	10,600
Peas, green[1]	40%	1.0	0.66	55,900
Snap beans, fresh[2]	10%	1.0	1.01	29,400

1. Program states average which include FL, GA, NY, NC and TN.
2. States included are MN, NY, OR, WA and WI.

As a substitute for actual use data, OPP uses USDA's 1997 National Agricultural Census information which indicates the acreage planted to particular crops. For ESUs in Washington, Oregon and Idaho, the actual 1997 county acreage planted to crops on which pendimethalin may be used is provided; if no acreage is indicated, this means that there were either no crops grown or only 1-3 growers existed and USDA did not report acreage to protect privacy. In such cases, actual acreage is likely to be small, but may vary significantly. For example, preliminary census data for 2002 indicates that in Benton, Washington corn was not reported in 1997 but showed 18607 acres in the 2002 census. This could be the result of a new farm operator growing corn that opens up census counting for other corn growers. A summary of the total pounds used for sites within each county in a respective ESU watershed and residency type is provided in Attachment D.

The major uses that will be the focus of the assessment are almonds (CA), potato (OR, WA), peas (OR), corn (OR), and alfalfa (CA). The quantities of these crops grown warrant careful analysis for modeling scenarios.

3. General aquatic risk assessment for endangered and threatened species

a. Aquatic toxicity of pendimethalin

Among 30 pesticides assigned to a Pesticide Toxicity Index, where terbufos is the standard (1.00), pendimethalin has a relative value of 0.0064 for fish among all other contributions to toxicity in this taxa group (Munn and Gilliom, 2001). Applying this index on bluegill in a creek in Indiana, pendimethalin contributes even less to the overall toxicity for that fish.on a seasonal basis.

There are 38 studies for aquatic acute toxicity data for pendimethalin (from EPA's AQUIRE database, http://www.epa.gov/ecotox/). Data submitted to support registration were generated in accordance with Good Laboratory Practice regulations and have been through OPP's rigorous

validation requirements for data used in assessments; these data are used in preference to other data.

(1) Acute toxicity to freshwater fish

Table 10 shows the 96-hour acute toxicity of pendimethalin to freshwater fish. The technical grade active ingredient (TGAI) ranges from 138 ppb for rainbow trout to 418 for channel catfish. Results of selected tests on sensitive fish species are tabulated in Table 9 which only shows those studies producing the most sensitive results. All species were tested in static water except for the channel catfish where flowing water was used.

Table 10. Acute toxicity of pendimethalin to freshwater fish (EFED, RED).

Species	Scientific name	% a. i.	96-hour LC50 (ppb)	Toxicity Category
Formulated Product				
Rainbow trout	*Oncorhynchus mykiss*	45	520	Highly toxic
Bluegill sunfish	*Lepomis macrochirus*	45	920	Highly toxic
Channel catfish	*Ictalurus punctatus*	45	1900	Moderately toxic
Technical Product				
Rainbow trout	*Oncorhynchus mykiss*	93.2	138	Highly toxic
Bluegill sunfish	*Lepomis macrochirus*	93.2	199	Highly toxic
Channel catfish	*Ictalurus punctatus*	93.2	418	Highly toxic

The toxicity data indicate that pendimethalin is highly toxic to fish. The technical and formulated products range from moderately toxic to highly toxic.

(2) Acute toxicity to freshwater invertebrates

For acute effects on freshwater invertebrates, Table 11 shows that pendimethalin is moderately to highly toxic to the water flea and crayfish. The formulated product exhibits less toxicity to aquatic invertebrates than it does to fish.

Table 11. Acute toxicity of pendimethalin to freshwater invertebrates.

Species	Scientific name	% a. i.	48-hour EC50 (ppb)	Toxicity Category
Formulated Product				
Water flea	*Daphnia magna*	45.6	5100	Moderately toxic
Technical Material				
Water flea	*Daphnia magna*	93.2	280	Highly toxic
Crayfish	*Procambarus simulans*	94.2	1000[1]	Highly toxic

1. 96-hour LC50

(3) Chronic toxicity to freshwater fish and invertebrates

There is limited chronic data for pendimethalin on freshwater fish. Only the fathead minnow acts as a surrogate for chronic effects to fish (Table 12). This study indicates that at 9.8 ppb, reproductive effects may occur to fish and invertebrates. The water flea is slightly less sensitive, with an effect level of 35.8 ppb.

Table 12. Chronic toxicity of pendimethalin to freshwater fish and invertebrates (RED).

Species	Scientific name	duration	% a. i.	Endpoints affected	NOEC (ppb)	LOEC (ppb)
Fathead minnow	*Pimephales promelas*	288 d	98.3	Egg production reduced at 9.8 ppb; reduced hatch at 22 & 43 ppb.	6.3	9.8
Water flea	Daphnia magna	21 d	92.2	Mean brood size	14.5	35.8

(4) Acute toxicity to estuarine and marine fish

Acute toxicity tests indicate that pendimethalin is highly toxic to estuarine and marine fish for products close to technical grade (Table 13). Moderately toxic effects are exhibited for products containing about half the active ingredient.

Table 13. Acute toxicity of pendimethalin to estuarine and marine fish (from RED).

Species	Scientific name	% a.i.	96-hour LC50 (ppb)	Toxicity Category	Reference
Formulated Product					
Sheepshead minnow	*Cyprinodon variegatus*	45	1700	moderately toxic	EFED
Technical Product					
Sheepshead minnow	*Cyprinodon variegatus*	92.2	710	highly toxic	EFED

(5) Acute toxicity to estuarine and marine invertebrates

Results from acute toxicity tests with estuarine and marine invertebrates (Table 14) indicate that there is a variance in toxicity between being highly toxic to the oyster and slightly toxic to the pink shrimp. As with freshwater species, the aquatic arthropods that may serve as food for salmon and steelhead are less sensitive then fish.

Table 14. Acute toxicity of pendimethalin to estuarine & marine invertebrates (RED).

Species	Scientific Name	%a.i.	96-hour LC50 (ppb)	Toxicity Category
American/ Virginian oyster	*Crassostrea virginica*	92.2	210 (EC50)	highly toxic
American/ Virginian oyster	*Crassostrea virginica*	45	450 (EC50)	highly toxic
Pink shrimp	*Penaeus duorarum*	92.2	1600	moderately toxic
Pink shrimp	*Penaeus duorarum*	45	11,000	slightly toxic
Crayfish	*Procambarus simulans*	94.2	> 1000	moderately toxic

(6) Chronic toxicity to estuarine and marine fish and invertebrates

There are no studies of determining the chronic toxicity to estuarine and marine fish and invertebrates.

(7) Toxicity to aquatic plants and algae

For nontarget aquatic plants, the most sensitive species is the (non-vascular) marine diatom where detrimental effects may be observed at exposure levels greater than 5.2 ppb (Table 15). Other aquatic plants have NOEC levels only a few ppb higher, except for the Blue-green algae where concentrations above 174 ppb produces an effect. Because the vascular plant has about the same sensitivity as freshwater fish exposed chronically, long term effects may first show up in cover for salmon and steelhead.

Table 15. Nontarget aquatic plant toxicity (from RED and EFED).

Species	Scientific name	% a. i.	EC50 (ppb)
Freshwater diatom	*Navicula pelliculosa*	92.9	5.8
Marine diatom	*Skeletonema costatum*	92.9	5.2 (120 hour)
Duckweed	*Lemna gibba*	92.98	12.5 (14 day)
Green algae	*Selenastrum capricornutum*	92.98	5.4 (120 hour)
Blue-green algae	*Anabaena flos-aquae*	92.98	>174 (120 hour)

(8) Toxicity of multiple active ingredient products

There are no known fish toxicity data on pendimethalin products that contain other active pesticide ingredients. Table 16 presents fish toxicity data on active ingredients formulated with pendimethalin. Only atrazine and chlorpyrifos are as toxic as pendimethalin. Chlorpyrifos is more toxic to fish than pendimethalin but it constitutes only 0.54% of a single registered product label. It will only be mentioned that any adverse affect from this active ingredient will likely be less than that caused by pendimethalin alone. The product with atrazine constitutes 48% atrazine and less than half pendimethalin a.i.. A separate analysis for atrazine is beyond the scope of this report but it is worth mentioning that from the available studies, the LC50 for spot is in the range of less than 1 ppm which is generally in the range of pendimethalin toxicity to fish. The quinolinecarboxylic acid has no toxicity data; it only constitutes 3.8% active ingredient in a product that also contains pendimethalin.

Table 16. Fish toxicity of other pesticide active ingredients in pendimethalin products.

Pesticide	Most sensitive species	Lowest LC-50 value for technical material	Reference	Note
3-Quinolinecarboxylic acid				No tox data available in EFED
Fenoxaprop-p-ethyl	bluegreen algae	0.73 (EC-50) ppm	EFED	No fish tox data available
Imazaquin	rainbow trout	280 ppm	EFED	96-hour test
Imazethapyr	channel catfish	240 ppm	EFED	96-hour test
Oxadiazon	bluegill	880 ppb	EFED	96-hour test
Oxyfluorfen	bluegill	200 ppb	EFED	96-hour test

Propanil	rainbow trout	2.3 ppm	EFED	96-hour test
Xylene	rainbow trout	3.3 ppm	EFED	96-hour test
Atrazine	spot	> 1.0 ppm	EFED	48-hour test
2,4-D	bluegill	24.5 ppm	EFED	96-hour test
Mecoprop	blueill	92 ppm	EFED	96-hour test
Chlorpyrifos	bluegill	1.3 ppb	EFED	96-hour test

(9) Toxicity of degradates

There are no degradates of pendimethalin greater than 10% according to the RED. Those that were formed were primarily intact benzene rings with rearranged alkyl groups. These residues bind to sediment and degrade with half-lives of between 6 and 105 days (anaerobic) and 42-1322 days (aerobic). Pendimethalin degradates are not expected to cause adverse effects.

(10) Toxicity of inerts

Tables 10, 11 and 13 showing effects to fish and invertebrates do not indicate that inert ingredients cause any significant additional toxicity to pendimethalin. It is possible that some inerts may cause some additional toxic effect, but there are no studies available that bear this out.

(11) Sublethal and endocrine effects

Pendimethalin is known to affect the pituatary-thyroid axis in humans which places it in the category of endocrine disrupter. Whether this effect also applies to a species like fish remains to be discovered, especially at the dose of 0.1 mg/kg/day for 14 and 28 days in which changes to the thyroid were observed (RED). Appropriate screening and/or testing protocols are being considered by the Agency for endocrine disruptors under the Endocrine Disruptor Screening Program (EDSP). When these have been developed, pendimethalin will be subject to additional screening and/or testing to better characterize effects on Pacific salmon and steelhead.

b. Environmental fate and transport

The environmental fate and transport of pendimethalin is presented in the RED on page 59. Assessment of water resources, including surface and ground water monitoring, is on pages 67-69. EECs and model inputs are on pages 70-75.

(12) Field effects

Pendimethalin is relatively stable and immobile in soil but degrades slowly under aqueous photolysis, with a half-life of 21 days; aerobic soil metabolism is around 172 days. Pendimethalin persists with decreased temperatures, decreased moisture and increased soil organic matter. Neither abiotic hydrolysis, soil photolysis or anaerobic soil metabolism are major degradation processes. Residues are composed of intact benzene rings with rearranged alkyl groups.

Pendimethalin has the potential to be transported on suspended sediment in runoff to surface waters where it is expected to persist in sediment as it does not partition into the aqueous phase. Based on the chemical's high sorption capacity and low residue concentrations found in two states, it is not expected to exceed the groundwater level of concern.

Mobility field studies are not satisfied for major cotton and soybean terrestrial and aquatic dissipation scenarios. On California almond orchards in sandy loam soils, the half-life was calculated to be 34 days, with absence of leaching below six inches of depth. On batch equilibrium unaged mobility studies, it was practically immobile on a variety of U.S. loam soil types containing up to 3 percent organic content: loamy sand, sandy loam, silt loam, loam, silty clay loam and sandy clay loam soils.

Pendimethalin can readily volatilize, achieving up to 50% volatilization 30-40 days from the first surface application. Moist field conditions can accelerate this and reduce the time it takes to volatilize half the chemical. Strandberg and Scott-Fordsmand (2004) show that 10-20% evaporates during the first weeks after application and supports the conclusions that reduced temperature and drought prolong dissipation time.

Pendimethalin residues are tightly bound to soil particles, even in aquatic environments and the high K_d and K_{oc} values indicate its tight binding to soil organic matter. The major dissipation routes are soil adsorption, microbially-mediated metabolism and volatization. Pendimethalin has a potential to bioaccumulate in fish and has a reported whole body bioconcentration factor of 5100X at 3 ppb but depuration is rapid. Reductions of 87-91% can be achieved in clean water in 14 days.

A study on pendimethalin runoff and leaching from turfgrass indicates that the highest concentration in runoff occurs at the initial onset of rain while slowly decreasing exponentially with time and that there was generally low runoff and leaching (Lee, 2000). This agrees with pendimethalin's tendency to be highly absorbed to soil particles and with established turf grass retaining those soil particles from washing away, little is expected to wash away.

A more complete analysis of environmental fate and transport data is contained on page 58 of the attached revised Environmental Risk Assessment.

c. Incidents

OPP maintains two data bases of reported incidents. One, the (EFED Incident Information System or EIIS) is populated with 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 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).

Since the RED was published, there have been 57 incidents resulting in effects to aquatic, terrestrial, and plant taxa. The single aquatic incident occurred in Medina county, Ohio, that resulted in a kill of bass (*centrarchidae*) and bluegill (*lepomis macrochirus*) after a one inch rainfall subsequent to application of PROWL 3.3 EC (emulsifiable concentrate). This happened in the summer of 1998 and affected a 2-3 acre pond at a depth of 4-6 feet. The area treated was a 4-acre corn field having a distance from the pond of 14-70 feet. The herbicide was broadcast on corn at the rate of 3 pints /acre, which equates to a nominal rate of 1.23 lbs a.i./acre. It was reported that Lorsban was also applied but no other information, including residue analysis, is available. Using the scenario where pendimethalin is applied exclusively and one quarter of the a.i. mixed into the pond, the concentration would be 228 ppb (average pond depth assumed to be 3 ft). This amount represents about half the concentration needed to achieve the LC50 for acute toxicty to fish. It is possible that all fish mortalities are due to Lorsban and/or a synergistic effect with pendimethalin.

d. Estimated and actual concentrations of pendimethalin in water.

(1) EECs from models

There are two "tiers" of models (see background section above for more details). In the RED, pendimethalin aquatic EECs were estimated using EFED's Tier I GENEEC surface water model for alfalfa (for seed), cotton, corn, onions, soybeans and sugarcane. This Tier I model is a screening tool. If concentrations predicted from the GENEEC screen warrant further investigation, then a more sophisticated PRZM-EXAMS model is used to estimate environmental concentrations and the more refined EEC is produced.

EFED provided Tier II EECs for this analysis and which can be found in Attachment A. The scenarios chosen were almonds, potatoes, peas, corn and and turf scenario, since pendimethalin is widely used in these sites. The inputs and results are presented and discussed and summarized below.

It should be noted that while they are useful for comparative purposes, neither of the GENEEC or PRZM-EXAMS models is appropriate for a pesticide such as pendimethalin in considering the risks to salmon and steelhead. The primary difficulty relates to the use of the 10 hectare pond with no outflow as the receiving water and the persistence of pendimethalin. Repeated use of pendimethalin over a number of years would result in an accumulation in a pond with no outflow, and the PRZM-EXAMS model using a high rainfall year could include many years of accumulation and yield unrealistically high EECs. In such circumstances, the GENEEC model is a more appropriate model for developing EECs. The GENEEC model is too conservative for moderate to large size streams, but is reasonably representative of first-order streams for single applications.

In both models, it is considered that a 10-hectare watershed will all be treated with the maximum rate, maximum numbers of applications, and minimum intervals between applications. Runoff and drift from this 10-hectare watershed will go into a 1-hectare pond, 2 meters deep. This is a conservative model for salmon and steelhead. While first order streams may be reasonably predicted for a single application, salmon and steelhead, except sockeye, occur primarily in streams and rivers where natural flow of water, and any contaminants in the water column, will move downstream and preclude continued exposure from a single application. Multiple applications may provide for chronic exposure, most likely in a pulsed mode.

Table 17 shows risk quotients for pendimethalin uses on major use sites found in the Pacific Northwest at maximum rates to all acres assuming clay soils. The standard PRZM-EXAMS model ran under the assumption of 1application for all modeled crops, by ground broadcast method (1% spray drift), and aerial (5% spray drift). The model yielded initial peak and long term estimated environmental concentrations to surface waters. Acute and chronic risk quotients were summarily calculated for rainbow trout and water flea for each use site. The complete report can be found in Attachment E.

Table 17. Risk Quotients (RQ) for freshwater fish and invertebrates on drift scenarios from Tier II EECs[1]

Crop	Peak EEC (ppb)	Acute fish RQ[1]	Acute invert RQ[1]	21-day EEC	Chronic invert RQ[2]	60-day EEC	Chronic fish RQ[2]
Ground Spray/Broadcast							
Alfalfa (CA)	1.39	0.01	0.005	0.27	0.019	0.14	0.022
Almonds (CA)	0.96	0.007	0.003	0.23	0.016	0.15	0.023
Potato (OR,WA)	1.00	0.007	0.003	0.29	0.021	0.19	0.030
Peas (OR)	4.2	0.030	0.015	1.6	0.114	1.3	0.206
Corn (OR)	6.1	0.044	0.022	2.9	0.207	1.9	0.302
Turf	3.006	0.022	0.011	0.621	0.044	0.367	0.058
Aerial Spray							
Alfalfa (CA)	6.7	0.048	0.024	1.2	0.086	0.5	0.079
Almonds (CA)	2.8	0.02	0.01	0.6	0.043	0.3	0.048
Potato (OR,WA)	4.1	0.029	0.015	0.9	0.064	0.5	0.079
Peas (OR)	4.9	0.035	0.017	1.9	0.136	1.3	0.206
Corn (OR)	7.8	0.056	0.028	2.9	0.207	1.9	0.302

1 Based on acute fish LC_{50} (Rainbow trout) = 138 ppb; invertebrate LC_{50} (waterflea) = 280 ppb.
2 Based on chronic invertebrate NOEC (waterflea) = 14 ppb; chronic fish NOEC (Fathead minnow) = 6.3 ppb.
Acute RQ = peak EEC/LC_{50}; chronic invertebrate RQ = 21-day EEC/invertebrate NOEC; chronic fish RQ = 60-day EEC/chronic fish NOEC.

Inputs for PRZM-EXAMS model:
KOC = 19,768 (average from 9 soils)

Aerobic Soil T1/2 = 516 days
Anaerobic Soil T1/2 = stable (98% remains after 60 days)
Solubility = 3.75 ppm
Aerobic Aquatic T1/2 = 136 hr
Foliar application with 5 percent spray drift; 95 percent application efficiency - conforms with current EFED guidance.
Application rates: alfalfa, 3 lbs ai/A; almonds, 1.25 lbs ai/A; potato 1.8 lbs ai/A; peas 1.8 lbs ai/A; corn 2.4 lbs ai/A; turf 2.4 lbs ai/A.

(2) Other uses

There are no other uses of pendimethalin other than as an herbicide.

(3) Measured residues in the environment

<u>NAWQA Data</u>

The National Water-Quality Assessment Program (NAWQA) has published data available on measured concentrations of pendimethalin in surface waters for five basins throughout California, Oregon, Washington and Idaho. This data is accessible at (http://infotrek.er.usgs.gov/servlet/page?_pageid=543&_dad=portal30&_schema=PORTAL30). The basins on which the study is divided reflect important hydrologic and ecologic resources, including sources of contaminants, such as irrigated agriculture.

Table 18 lists the results of NAWQA surface water monitoring at periodic intervals since 1997 when the RED for pendimethalin was published. The data is current through 9/30/2003. Summary statistics were applied only on samples that had detects.

Table 18. Pendimethalin Residues for Surface Water (ug/L).

State	# samples	# detects	average	median	std. dev.	max residue	% detects
National	9611	1041	0.0429	0.0190	0.085	1.16	11
California	2806	340	0.04672	0.01775	0.092	0.679	12
Oregon	206	50	0.01535	0.01565	0.012	0.0899	24
Washington	668	33	0.02764	0.01610	0.027	0.129	5
Idaho	171	1	-	-	0	0.0195	1

These results show higher sample frequencies in states with more intensive agriculture. I suspect that one reason California has a five-fold maximum residue concentration over Washington state is because the higher sampling frequency was able to catch the spikes in pendimethalin in surface waters, perhaps after rain storm events. The high standard deviation for California supports this when compared to Oregon and Washington. The descriptive statistics further indicate a generally higher concentration for California on average, although the median is about the same. These spikes warrant further investigation to determine their nature with respect to seasonality, rainstorm events, landform factors and use timing. Regular sampling according to a predetermined schedule may not detect peak residues unless the samples happen to be taken shortly afterwards and adjacent to sites treated with pendimethalin. It is possible that the increased rainfall for Washington and Oregon could be diluting the spikes in those states to a significant extent. Nationally, the residue spikes are not quite as pronounced as in California, but there were more samples in which to catch any peak concentration, a value twice as high as California which occurred in a Colorado stream.

California Data

Table 19 presents a summary of 13 years of surface water monitoring data from California's Department of Pesticide Regulation (8/90 to 4/03). The information is available at http://www.cdpr.ca.gov/docs/sw/surfdata.htm. California as a whole had 9% detect rate for the counties supporting Pacific salmon and steelhead waters with 62 detects. The detections were generally much lower than the 0.7 ug/L spike in Sacramento county. Stanislaus county represents this point with 38 detects out of 130 samples, but the maximum concentration was only 0.23 ug/L. The table represents data that are only available for half of the counties affecting salmon and steelhead waters. Of these data about 75% had significant sampling levels for pendimethalin concentrations.

Table 19. California DPR Database Pesticide Residue Concentrations for Surface Waters (8/90-4/03).

Location	# samples	# detects	max residue (ug/L)	% detects
California*	693	62	0.7	9
Butte	37	1	0.18	3
Colusa	31	0		0
Contra Costa	1	0		0
Glenn	0	0		0
Merced	145	2	0.054	1
Monterey	6	0		0
Sacramento	122	20	0.7	16
San Joaquin	99	1	0.2	1
San Mateo	0	0		0
Santa Clara	0	0		0
Santa Cruz	8	0		0
Shasta	4	0		0
Solano	5	0		0
Sonoma	0	0		0
Stanislaus	130	38	0.227	29
Sutter	23	0		0
Tehama	15	0		0
Yolo	61	0		0
Yuba	6	0		0

*California total only includes counties residing in an ESUs.

The Agency cannot state with confidence that the concentrations detected in the NAQWA and California DPR monitoring studies represent the highest surface-water concentrations that might occur in areas of pendimethalin use. However in a study of pesticides detected in urban streams during rainstorms in King county, WA, pendimethalin was not detected in any of the sample sites even though sales data of pendimethalin trade name PROWL was available (USGS, 1999).

e. Recent changes in pendimethalin registrations

The only application rate change on the label is that for residential lawn and sod farm use with the restriction of 2.0 lbs. ai/acre maximum application rate. This is below the 2.43 lbs ai/acres under which the Tier II model was run. Homeowners following the label rate will result in a lower RQ and may not exceed the level of concern. However this conclusion may not reflect actual practices of homeowners.

f. General risk conclusions

The EEC is intended to determine the maximum potential risk that may occur from the use of pendimethalin. Therefore, it can be expected that any site-specific or species-specific analysis is likely to determine that risks are less than the maximum potential. In part, this is reflected in the western EEC scenarios, which are modified by less runoff and somewhat higher drift than eastern scenarios.

According to the RED, pendimethalin will not cause acute adverse effects in freshwater invertebrates or fish under cotton and corn use patterns with typical application rates up to 2.0 lbs ai/A (aerial or ground). This rate is simliar to the maximum application rate used for the Tier II PRZM/EXAMS scenario runs where we find that levels of concern are not expected to be exceeded, except for aerial broadcast application to corn in Oregon. The refined analysis therefore supports the more general analysis from Tier I modeling. There is no chronic risk to fish and invertebrates.

The modeling results indicate that the endangered fish criterion (RQ> 0.05) for acute risks are not likely to be exceeded for the indicated agricultural uses of pendimethalin, with the exception of Oregon corn aerially treated with pendimethalin. The risk criterion is exceeded by a small margin based on maximum application rates and may result in direct effects to fish. The increased spray drift from corn and the large number of acres where it is grown can contribute to the increased concentration in water and the risk to steelhead and salmonids. This will be a factor in determining effects to particular ESUs where corn is widely grown. However the endangered fish criterion for chronic risks (RQ>1) indicates a risk quotient that is below the level of concern, for all scenarios.

For indirect effects to invertebrates that can serve as a food source to salmonids and steelhead, there is also no concern that the LC50 will be exceeded (RQ>0.5) in all use scenarios. This finding from the Tier II analysis means that endangered fish will have a stable food source for sustenance and growth.

The effects on aquatic plants is summarized in Table 20 uses the Tier II results and applies them to *Lemna gibba* (vascular plant) to determine effects. This indicator specie has an EC50 of 12.5 ppb.

Table 20. Risk Quotients (RQ) for aquatic plants on drift scenarios from Tier II EECs.

Crop	Peak EEC (ppb)	Acute vascular plants RQ[1] (EC_{50})
Ground Spray/Broadcast		
Almonds (CA)	0.96	0.08
Potato (OR,WA)	1.00	0.08
Peas (OR)	4.2	0.34
Corn (OR)	6.1	0.49
Turf	3.01	0.24
Aerial Spray		
Almonds (CA)	2.8	0.22
Potato (OR,WA)	4.1	0.32
Peas (OR)	4.9	0.39
Corn (OR)	7.8	0.62

1. Acute RQ=peak EEC/EC50 of 12.5 ppb for Duckweed.

The RED publishes the risk quotient for non-endangered vascular and non-vascular plants based on the EC_{50} of 12.5 ppb for duckweed where it is noted that typical application rates do not represent a risk to aquatic plants. The calculated RQ based on Tier II analysis for aquatic vascular plants also support the conclusion that there is no concern for all scenarios as the risk quotient of 1.0 is not exceeded. Aquatic plants that provide cover for PNW steelheads and salmonids are not jeapordized and therefore will not have effects on the fish that depend on them.

An additional turf scenario was run that was not modeled in the Tier I scenario. The RED mentions that for uses that include, turf, landscaping, ornamentals, and non-cropland, the risk is not higher than for other ground application use patterns with similar application rates. The Tier II EEC modeling run for turf supports this conclusion at the 2.4 lb ai/acre application rate. However there are many variables in urban use patterns that could change this conclusion and possibly result in the chronic RQ for fish to be exceeded. Pendimethalin would most likely be used on a variety of cool season and warm season grasses. It is speculated that some homeowners would not control weeds, others would achieve control without herbicides, and others would use different herbicides, but this cannot be quantified. Other factors that confound a more detailed analysis include topography, impervious surface, storm drainage, retention areas, and landscaping. Model runs for 0% drift were not performed as it is not considered to be a realistic scenario and modeling runs would likely produce RQs that fall below the 1% drift scenarios.

g. Existing protections

Specific guidelines to control spray drift have been included in the RED. These instructions include boom length, distance between outermost nozzle and boom, downward nozzle angle limit 45○ and measures to control droplet size. In addition, meterological condition factors are taken into account.

Nationally, there are no specific protective measures for endangered and threatened species beyond the generic statements on the current pendimethalin labels. As stated on all pesticide labels, “It is a violation of Federal law to use this product in a manner inconsistent with its labeling”. The Environmental Hazards section, for section 3 labels for pendimethalin products that may be applied to the various use sites, state: “This pesticide is toxic to fish. DO NOT apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Drift and runoff from treated areas may be hazardous to aquatic organisms in adjacent aquatic sites. DO NOT contaminate water when disposing of equipment washwaters.” The environmental hazards section also contains a warning regarding bee toxicity and concerns for effects on avian reproduction.

OPP’s Endangered Species Protection 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. However OPP does have county bulletins that list pendimethalin along with the corresponding use limitaitons.

In California, the Department of Pesticide Regulation (DPR) in the California Environmental Protection Agency creates county bulletins consistent with those developed by OPP. California also has a system of County Agricultural Commissioners responsible for pesticide regulation, and all commercial applicators must get a permit for the use of any restricted use pesticide and must report all pesticide use, restricted or not. The California bulletins for protecting endangered species have been in use for about 5 years. Although they are “voluntary” in nature, the Agricultural Commissioners strongly promote their use by pesticide applicators. Pendimethalin is included in these bulletins only for protection of listed plants, but it could be listed for aquatic species should the results of the consultation so specify. Agricultural and other commercial applicators are well sensitized to the need for protecting endangered and threatened species. DPR believes that the vast majority of agricultural applicators in California are following the limitations in these bulletins (Richard Marovich, Endangered Species Project, DPR, telephone communication, July 19, 2002). Bulletins issued by California DPR for pendimethalin specify the following use limitations:

> 11. Do not use in currently occupied habitat except: (1) as specified in Habitat Descriptors, (2) in organized habitat recovery programs, or (3) for selective control of invasive exotic plants.

17. 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.

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

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

In Oregon, Washington, and Idaho, information on the actual amount of pendimethalin used is rather limited. For ESUs in these three states, I have indicated the amount of acreage, by county, where pendimethalin could be used according to the labels. The actual 1997 acreage is provided; if no acreage is indicated, this means that there were only 1-3 growers and USDA did not report acreage to protect privacy. In such cases, actual acreage is likely to be small, but I cannot be certain.

The sources of data available on pendimethalin use are considerably different for California than for other states. California has full pesticide use reporting by all applicators except homeowners; commercial applications in residential areas do have to be reported.

The latest information for California pesticide use is for the year 2001 [URL: http://www.cdpr.ca.gov/docs/pur/purmain.htm]. The reported information to the County Agricultural Commissioners includes pounds used, acres treated (for agricultural uses), and the specific location treated. The pounds and acres are reported to the state, but the specific location information is retained at the county level and is not readily available to EPA. For the non-agricultural uses in California, a “research” use typically involves efficacy testing or perhaps testing to satisfy a data requirement for registration, e.g., for “tolerances” in human food items. Landscape maintenance could possibly mean use by commercial applicators in residential sites, but for pendimethalin, this term most likely means use on golf course greens and tees. Structural pest control usually involves termites or rodents; when herbicides are involved, it is likely to mean removing rodent cover around buildings.

In the following discussion of specific ESUs and pendimethalin use, I present information on the listed salmon and steelhead ESUs and discuss the potential for the use of pendimethalin where they occur. My information on the various ESUs was taken almost entirely from various Federal Register Notices relating to listing, critical habitat, or status reviews. As noted above, usage data were derived from 1997 Agricultural Census and DPR’s pesticide use reporting. In the Pacific Northwest tables, I have also indicated, in the last column, the total acreage of land in each county and the acreage and percentage of land in farms, which includes ranches. Following this section, I present and discuss my conclusions.

A. Chinook

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

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

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

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

1. 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 pesticides 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 pendimethalin would not be used in the forested upper elevation areas.

Table C-1 (see Attachment C) contains usage information for the California counties supporting the California coastal chinook salmon ESU. Reportable usage of pendimethalin in this ESU is 12,482 lbs. Housing density where home lawn use could occur may be moderate on the San Francisco Bay side of Marin County, but should be low in the other counties.

Based upon the relatively low agricultural use, I conclude no effect from agricultural use of pendimethalin on the California coastal chinook ESU. Also, because the only moderate density housing where pendimethalin could be used on lawns would expose the bay areas where dilution would be significant enough to reduce concentrations below levels of concern, I conclude no effect from use on home lawns.

2. Central Valley Spring-run Chinook Salmon ESU

The Central valley Spring-run chinook salmon ESU was proposed as threatened in 1998 (63FR11482-11520, March 9, 1998) and listed on September 16, 1999 (64FR50393-50415). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches accessible to listed chinook salmon in the Sacramento River and its tributaries in California, along with the 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 C-2 contains usage information for the California counties supporting the Central Valley spring-run chinook salmon ESU. This ESU (habitat residency only) has a total of 47,468 lbs of pendimethalin that was used in 2002. Butte, Glenn, and Yolo counties have about half of this usage. In addition, some areas are heavily urban/suburban where home lawn use could occur. About 0.2% of the area of this ESU is treated.

Some counties could be discounted from use due to actual low figures but we cannot quantify the likely use of pendimethalin on home lawns in these counties although the agriculture reports indicate low use. While there is considerable population throughout this ESU, the density to the point of expecting more than 20% or 36% of the area to be in once or twice treated lawns is likely only in the immediate vicinity of Sacramento.

Unlike the Sacramento River winter run chinook, for the Central Valley spring run chinook it is my understanding that this ESU does get into a number of tributaries to the Sacramento River. Many of these tributaries may be large up to the impassable barriers or dams that preclude further movement. I do not know if there are first order streams in Sacramento County where young chinook from this ESU may occur. In addition, there were 16% detects of pendimethalin in the Sacramento River where a peak of 700 ppb was recorded at one event. However the Tier II modeling suggests that this is an outlier event and there is likely no effect to this ESU.

3. Lower Columbia River Chinook Salmon ESU

The Lower Columbia River chinook salmon ESU was proposed as threatened in 1998 (63FR11482-11520, March 9, 1998) and listed a year later (64FR14308-14328, March 24, 1999). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches accessible to listed chinook salmon in Columbia River tributaries between the Grays and White Salmon Rivers in Washington and the Willamette and Hood 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. I have excluded Pierce County, Washington because the very small part of the Cowlitz River watershed in this county is at a high elevation where pendimethalin would not be used.

Tables D-3 shows the cropping information for Oregon and Washington counties where the Lower Columbia River chinook salmon ESU occurs. An upper limit of 595,000 lbs is estimated for potential use in this ESU. Marion County has the highest acreage where pendimethalin could be used (at 174,000 lbs), but is only marginally within the Critical Habitat of this ESU. Clackamas, Hood River and Klickitat counties have the next highest maximum estimated usage rates and these counties also are heavily urban and suburban where home lawn use is possible. Klickitat, WA is in the upper 10% acreage category for counties growing a single crop (alfalfa). In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available. Approximately 1.5% of the ESU is treated.

Based on Tier II modeling scenarios, there is a no effect of pendimethalin on this ESU. It is unlikely that pendimethalin will be aerially sprayed at 100% coverage on corn which would result in exceedances.

4. Puget Sound Chinook Salmon ESU

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

The hydrologic units and upstream barriers are the Strait of Georgia, San Juan Islands, Nooksack, Upper Skagit, Sauk, Lower Skagit, Stillaguamish, Skykomish, Snoqualmie (upstream barrier - Tolt Dam), Snohomish, Lake Washington (upstream barrier - Landsburg Diversion), Duwamish, Puyallup, Nisqually (upstream barrier - Alder Dam), Deschutes, Skokomish, Hood Canal, Puget Sound, Dungeness-Elwha (upstream barrier - Elwha Dam). Affected counties in Washington, 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 D-4 shows the acreage information for Washington counties where the Puget Sound chinook salmon ESU is located. Most of these counties have relatively low acreage of crops where pendimethalin could be used, but Skagit and Whatcom counties have moderate acreage, and Jefferson, Kitsap, Mason and San Juan Counties all have low acreage. In addition, King and Pierce counties, in particular are heavily urban and suburban where home use could occur. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

About 149,000 lbs have the potential to affect the habitat residency of the Puget Sound chinook salmon. Of the total acreage in this ESU, one half is estimated to be potentially treated. There is also potential for considerable lawn use in the Seattle, Tacoma, and Olympia areas, although we have a very high degree of uncertainty about the lawn use of pendimethalin in this area. Due to relatively low agriculture use, I conclude that pendimethalin will not affect the Puget Sound chinook ESU.

5. Sacramento River Winter-run Chinook Salmon ESU

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

Critical Habitat has been designated to include the Sacramento River from Keswick Dam, Shasta County (river mile 302) to Chipps Island (river mile 0) at the west end of the Sacramento-San Joaquin delta, and then westward through most of the fresh or estuarine waters, north of the

Oakland Bay Bridge, to the ocean. Estuarine sloughs in San Pablo and San Francisco bays are excluded (58FR33212-33219, June 16, 1993).

Table C-5 shows the pendimethalin usage in California counties supporting the Sacramento River winter-run chinook salmon ESU. In these tables, crops are listed in order of the greatest use of pendimethalin to the smallest. Approximately 47,000 lbs of pendimethalin has the potential to affect the habitat and spawning and growth residency of Chinook for this ESU. In general, the agricultural uses of pendimethalin within this ESU are low. In addition to the reportable use sites, some of these areas are heavily urban and suburban where pendimethalin could be used on home lawns.

As with the Central Valley steelhead ESU, I believe there is such low use of pendimethalin except in Butte, Glenn and Yolo counties, as to be discountable. Home lawn use will contribute an amount but this is expected to be small. While there is considerable human habitation throughout this ESU, the density to the point of expecting more than 20% or 36% of the area to be in once or twice treated lawns is likely only in the immediate vicinity of Sacramento.

The spawning area for chinook this ESU is the Sacramento River. It is my understanding that the young chinook of this ESU are likely to stay in the river, and because our concerns for pendimethalin relate only to ponds and small tributaries, I conclude that pendimethalin will have no effect on this ESU.

6. Snake River Fall-run Chinook Salmon ESU

The Snake River fall-run chinook salmon ESU was proposed as threatened in 1991 (56FR29547-29552, June 27, 1991) and listed about a year later (57FR14653-14663, April 22, 1992). Critical habitat was designated on December 28, 1993 (58FR68543-68554) to include all tributaries of the Snake and Salmon Rivers accessible to Snake River fall-run chinook salmon, except reaches above impassable natural falls and Dworshak and Hells Canyon Dams. The Clearwater River and Palouse River watersheds are included for the fall-run ESU, but not for the spring/summer run. This chinook ESU was proposed for reclassification on December 28, 1994 (59FR66784-57403) as endangered because of critically low levels, based on very sparse runs. However, because of increased runs in subsequent 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. I have not included these counties here; however, I 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, I have excluded them from consideration because pendimethalin would not be used in these areas. I have, however, kept Umatilla County as part of the migratory corridor.

The USDA census indicates that there are no crops where pendimethalin can be used in Idaho counties within this ESU, nor in the Washington counties bordering on Idaho. Table D-6 shows that within the migration residency of this ESU, an upper limit of 1.1 million pounds of pendimethalin is estimated to be used, representing 1% of the land acreage in this ESU. Significant acreage comes from Benton, WA and Umatilla, Oregon (600,000 lbs). For the spawning and growth residency, even more usage is estimated at 1.7 million pounds, representing 2% of the acreage in the ESU. Half a million pounds come from Franklin, WA for alfalfa, potatoes and onions. Residential lawn use could be scattered throughout the ESU, but could be pronounced in the Portland area. If there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Tier II modeling indicates that there will be no effect to this ESU from pendimethalin usage. If all treated crops were grown beside streams and tributaries, and have aerial spray application to corn, then there may be some concern. However this is unrealistic especially with the flowing waters found in this area.

7. Snake River Spring/Summer-run Chinook Salmon

The Snake River Spring/Summer-run chinook salmon ESU was proposed as threatened in 1991 (56FR29542-29547, June 27, 1991) and listed about a year later (57FR14653-14663, April 22, 1992). Critical habitat was designated on December 28, 1993 (58FR68543-68554) to include all tributaries of the Snake and Salmon Rivers (except the Clearwater River) accessible to Snake River spring/summer chinook salmon. Like the fall-run chinook, the spring/summer-run chinook ESU was proposed for reclassification on December 28, 1994

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

Hydrologic units in the potential spawning and rearing areas include Hells Canyon, Imnaha, Lemhi, Little Salmon, Lower Grande Ronde, Lower Middle Fork Salmon, Lower Salmon, Lower Snake-Asotin, Lower Snake-Tucannon, Middle Salmon-Chamberlain, Middle Salmon - Panther, 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 as inhabited watersheds 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, I have excluded Umatilla and Baker counties in Oregon and Blaine County in Idaho because accessible river reaches are all well above areas where pendimethalin can be used. Counties with migratory corridors are all of those down stream from the confluence of the Snake and Columbia Rivers.

The USDA census indicates that there are no crops where pendimethalin can be used in Idaho counties within this ESU, nor in the Washington counties bordering on Idaho. There is moderate acreage in Walla Walla and Franklin counties along the lower Snake River. Except for the moderate acreage of onions in Walla Walla and Benton counties, WA and Umatilla County, OR, crops where pendimethalin may be used are generally very low in the migratory corridors for this ESU. Residential lawn use could be scattered throughout the ESU, but could be pronounced in the Portland area.

Table D-7 shows the crop-acreage information for Oregon and Washington counties where the Snake River spring/summer-run chinook salmon ESU occurs. Approximately 1.2 million lbs of pendimethalin has the potential to be used in each of the migration and spawning/growth residency of the Snake River Spring/Summer Run chinook ESU. A total land area of 2.3% has the potential to be treated, given the crops grown in this ESU. If there is no acreage given for a specific crop in table D-7, this means that there are too few growers in the area for USDA to make the data available.

As with the Snake River fall-run chinook, there is a slight chance for agricultural exposure of concern to the Snake River spring/summer run chinook ESU in Benton, WA, Umatilla, OR, Whitman, WA and Franklin, WA counties due to total estimated use. However it is unlikely that pendimethalin will affect this ESU based on Tier II modeling results so I conclude no effect to this ESU.

8. Upper Columbia River Spring-run Chinook Salmon ESU

The Upper Columbia River Spring-run Chinook Salmon ESU was proposed as endangered in 1998 (63FR11482-11520, March 9, 1998) and listed a year later (64FR14308-14328, March 24, 1999). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches accessible to listed chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River, as well as all down stream migratory corridors to the Pacific Ocean. Hydrologic units and their upstream barriers are Chief Joseph (Chief Joseph Dam), Similkameen, Methow, Upper Columbia-Entiat, Wenatchee, Upper Columbia-Priest Rapids, Middle Columbia-Lake Wallula, Middle Columbia-Hood, Lower Columbia-Sandy, Lower Columbia-Clatskanie, Lower Columbia, and Lower Willamette. Counties in which spawning and rearing occur are Chelan, Douglas, Okanogan, Grant, Kittitas, and Benton with the lower river reaches being migratory corridors (D-8).

Table D-8 shows the cropping information for Washington counties that support the Upper Columbia River chinook salmon ESU and for the Oregon and Washington counties where this ESU migrates. There can be up to 1.9 million lbs of pendimethalin used in the counties where migration occurs and 1.6 million lbs in the counties where spawning and growth occur. A total of 4.4% of the land are in this ESU can potentially be treated and affect the Chinook. There is significant alfalfa and orchard acreage in these areas that can contribute to significant amounts of pendimethalin usage.

Urbanization is likely low density except in the Portland and surrounding area. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Corn acreage is not significant in this ESU in which pendimethalin could be used aerially. There is considerable alfalfa acreage but Tier II modeling results indicate that pendimethalin will not adversely affect this ESU. I conclude no effect.

9. Upper Willamette River Chinook Salmon ESU

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

The hydrologic units included are the Lower Columbia-Sandy, Lower Columbia-Clatskanie, Lower Columbia, Middle Fork Willamette, Coast Fork Willamette (upstream barriers - Cottage Grove Dam, Dorena Dam), Upper Willamette (upstream barrier - Fern Ridge Dam), McKenzie (upstream barrier - Blue River Dam), North Santiam (upstream barrier - Big Cliff Dam), South Santiam (upstream barrier - Green Peter Dam), Middle Willamette, Yamhill, Molalla-Pudding, Tualatin, Clackamas, and Lower Willamette. Spawning and rearing habitat is in the Oregon counties of Clackamas, Douglas, Lane, Benton, 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 pendimethalin would not be used. Salmon habitat for this ESU is exceedingly limited in Douglas County also, but I cannot rule out future pendimethalin use on a small amount of acreage in Douglas County.

Table D-9 shows the cropping information for Oregon counties where the Upper Willamette River chinook salmon ESU occurs and for the Oregon and Washington counties where this ESU migrates. There is relatively low pendimethalin usage for the migration residency counties, totaling only 32,000 lbs. By contrast, about 600,000 lbs of pendimethalin can potentially be used in Marion, Washington, and Yamhill, OR where spawning and growth occur. Marion, OR is in the top 10% for all crops by acreage throughout the ESUs with corn being the major crop. Because of this, I conclude that agricultural use of pendimethalin may affect, but not likely to adversely affect the the Upper Willamette River chinook ESU.

B. Chum Salmon

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

Most chum salmon mature between 3 and 5 years of age, usually 4 years, with younger fish being more predominant in southern parts of their range. Chum salmon usually spawn in coastal areas, typically within 100 km of the ocean where they do not have surmount river blockages and falls. However, in the Skagit River, Washington, they migrate at least 170 km.

During the spawning migration, adult chum salmon enter natal river systems from June to March, depending on characteristics of the population or geographic location. In Washington, a variety of seasonal runs are recognized, including summer, fall, and winter populations. Fall-run fish predominate, but summer runs are found in Hood Canal, the Strait of Juan de Fuca, and in southern Puget Sound, and two rivers in southern Puget Sound have winter-run fish.

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.

10. 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 D-10 shows the cropping information for Oregon and Washington counties where the Columbia River chum salmon ESU occurs. The habitat residency is most affected by maximum potential use of pendimethalin at 140,000 lbs with more than half coming from Washington, OR where there are appreciable amounts of orchards grown. Given that Washington state reports that only 1% of orchard acres are treated, the potential usage amount is dramatically reduced. There is essentially no acreage and very little housing in Grays River and Hardy and Hamilton Creeks which are the locations of existing populations within this ESU. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Based upon the exceedingly low acreage where pendimethalin can be used (less than 1% of the ESU potentially treatable) and the very low housing density, I conclude that pendimethalin will have no effect on the Columbia River chum salmon ESU. Furthermore, this ESU does not have any counties growing crops that are in the top 10%, by acreage, of all crops grown in the ESUs being evaluated.

11. 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 D-11 shows that the acreage where pendimethalin can be used is very low for the habitat residency for the Hood Canal summer-run chum salmon. Most potential use occurs in Clallam and Island counties on alfalfa. Given that nationally only 0.5% of acres are treated, the potential use will be much less than determined. Maximum use in areas where there are crops on which pendimethalin can be used will only result in 0.17% of the total ESU being treated.

Housing density as relates to home lawn use is generally low throughout the ESU, especially in the vicinity of first order streams. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Based on the low agricultural acreage for pendimethalin use and the low housing density, I conclude that there is no effect of pendimethalin on the Hood Canal chum salmon ESU.

C. Coho Salmon

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

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

After spawning in late fall and early winter, eggs incubate in 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.

12. 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 C-12 contains usage information for the California counties supporting the Central California coast coho salmon ESU. Except for low use in Sonoma County for grapes, there is very little reportable pendimethalin use within this ESU. Housing density where lawn use could occur may be high in San Mateo County and moderate in Santa Cruz and Marin counties.

There is not a lot of agricultural sites where pendimethalin may be used. California DPR reports that only 1529 acres used 2854 lbs. However, much of this area is strongly urban and suburban where pendimethalin lawn use may occur. Given the relatively low agricultural use along the coast, I would expect that pendimethalin would not affect this ESU. There could be a significant contribution from home lawn use but Tier II modeling indicates that any runoff will fall below the level of concern.

13. 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 are primarily forested areas where pendimethalin cannot be used, and I have eliminated them in this analysis.

Table D-13 show the acreage where pendimethalin can be used for Oregon counties where the Oregon coast coho salmon ESU occurs. There is essentially no relevant acreage in the strictly coastal counties. Benton, Lane, and Polk counties show the majority of potential use on orchards and corn. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available. Housing density is low enough that lawn use would not be a concern. In all the ESU, only 0.9% has the potential to be treated with pendimethalin.

Based upon the relatively low usage and the very high likelihood that the agricultural use of pendimethalin in counties associated with this ESU does not occur to any significant degree in the coastal watersheds, and because of the low housing density, I conclude there is no effect of pendimethalin on the Oregon coast coho salmon ESU.

14. Southern Oregon/Northern California Coast Coho Salmon ESU

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

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

Reservoir), Chetco, Illinois (upstream barrier - Selmac Dam-Lake Selmac), Lower Rogue, Applegate (upstream barrier - Applegate Dam-Applegate Reservoir), Middle Rogue (upstream barrier - Emigrant Lake Dam-Emigrant Lake), Upper Rogue (upstream barriers - Agate Lake Dam-Agate Lake; Fish Lake Dam-Fish Lake; Willow Lake Dam-Willow Lake; Lost Creek Dam-Lost Creek Reservoir), and Sixes. Related counties are Humboldt, Mendocino, Trinity, Glenn, Lake, Del Norte, Siskiyou in California and Curry, Jackson, Josephine, Klamath, and Douglas, in Oregon. However, I have excluded Glenn County, California from this analysis because the salmon habitat in this county is not near areas where pendimethalin can be used.

There were 2200 lbs of pendimethalin usage in 2002 for Northern California.(see Table C-14). By contrast Southern Oregon has approximately 262,000 lbs of pendimethalin that can potentially be used on crops listed in Tables D-14. Most of the potential use is on alfalfa in Klamath, though there is potential for some orchard use in Jackson county. In Table D-14 if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available. Housing density would be generally low throughout both states within this ESU.

Because corn is not widely grown in which there could be an effect from aerial application, I conclude that there is no effect to this ESU.

D. Sockeye Salmon

Sockeye salmon, *Oncorhynchus nerka*, are the third most abundant species of Pacific salmon, after pink and chum salmon. Sockeye salmon exhibit a wide variety of life history patterns that reflect varying dependency on the fresh water environment. The vast majority of sockeye salmon typically spawn in inlet or outlet tributaries of lakes or along the shoreline of lakes, where their distribution and abundance is closely related to the location of rivers that provide access to the lakes. Some sockeye, known as kokanee, are non-anadromous and have been observed on the spawning grounds together with their anadromous counterparts. Some sockeye, particularly the more northern populations, spawn in 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. 15. Ozette Lake Sockeye Salmon ESU

15. 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 D-15 shows that there is only some 2000 acres of agriculture use, most being alfalfa. A total potential use of pendimethalin is 5400 lbs which is a minor amount and the sites where used represent less than 0.2% of the land area of the ESU. There is also limited housing where pendimethalin could be used on lawns within this ESU.

Because there is relatively no agricultural acreage where pendimethalin can be used within this ESU and because of the very low density of housing in areas around Ozette Lake and its tributaries, I conclude that there will be no effect of pendimethalin on the Ozette Lake sockeye salmon ESU.

16. 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. Pendimethalin cannot be used on such a site, and therefore there will be no exposure in the spawning and rearing habitat. There is a possibility that this salmon ESU could be exposed to pendimethalin in the lower and larger river reaches during its juvenile or adult migration, but considering that the migratory corridors are larger rivers where pendimethalin could be used, concentrations could be well below our criteria of concern.

Table D-16 shows that there is about 43,000 acreage of crops in Idaho counties where this ESU reproduces or migrates which can be potentially treated by about 115,000 lbs of pendimethalin that can affect spawning and growth. By contrast, 2.1 million lbs of pendimethalin has the potential to be used in counties where the Snake River sockeye salmon migrates. Most of this agriculture area is in Benton, WA that has crops that fall in the top 10% by acreage in all the ESUs being evaluated. One of these crops is corn, though orchards, potatoes, and alfalfa are also grown. In total, almost 2.75% of the land area in this ESU has the potential to be treated. Because the corn grown here has the potential to be aerially treated and this ESU has large numbers of corn acreage, I conclude that pendimethalin may affect, but not likely adversely affect, this ESU.

D. Steelhead

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

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

17. Central California Coast Steelhead ESU

The Central California coast steelhead ESU was proposed for listing as endangered on August 9, 1996 (61FR41541-41561) and the listing was made final, as threatened, a year later (62FR43937-43954, August 18, 1997). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787). This coastal steelhead ESU occupies California river basins from the Russian River, Sonoma County, to Aptos Creek, Santa Cruz County, (inclusive), and the drainages of San Francisco and San Pablo Bays eastward to the Napa River (inclusive), Napa County. The Sacramento-San Joaquin River Basin of the Central Valley of California is excluded. Steelhead in most tributary streams in San Francisco and San Pablo Bays appear to have been extirpated, whereas most coastal streams sampled in the central California coast region do contain steelhead.

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

Counties of occurrence for this ESU are Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Mendocino, Napa, Alameda, Contra Costa, Solano, and Santa Clara counties. Pendimethalin use is very low in most of the counties associated with this ESU. The only moderate usage is in Sonoma County with 2100 potential lbs. out of 4800 lbs in the whole ESU where the residency type is habitat. We cannot be certain, but it appears that Santa Clara County is largely outside the Critical Habitat for this ESU.

There is not a lot of agricultural pendimethalin use in the area where the Central California Coast steelhead occurs. Much of this area is strongly urban and suburban where pendimethalin lawn use may also occur but Tier II modeling indicates no effect from lawn use. Given the relatively low agricultural use along the coast, and the limited parts of Santa Clara County within the ESU, I would expect that pendimethalin would not affect this ESU.

18. California Central Valley Steelhead ESU

The California Central Valley steelhead ESU was proposed for listing as endangered on August 9, 1996 (61FR41541-41561) and the listing was made final in 1998 (63FR 13347-

13371, March 18, 1998). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787).

This ESU includes populations ranging from Shasta, Trinity, and Whiskeytown areas, along with other Sacramento River tributaries in the North, down the Central Valley along the San Joaquin River to and including the Merced River in the South, and then into San Pablo and San Francisco Bays. Counties at least partly within this area are Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Glenn, Marin, Merced, Nevada, Placer, Sacramento, San Francisco, San Joaquin, San Mateo, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tuloumne, Yolo, and Yuba. A large proportion of this area is heavily agricultural, but there are also large amounts of urban and suburban areas that may have lawns. Usage of pendimethalin in counties where the California Central Valley steelhead ESU occurs is presented in Table C-18, and is surprisingly small in most counties. Only 0.2% of the area in this ESU has the potential to be treated.

Except in Glenn, Merced and San Joaquin where there is the potential for 5-8,000 lb usage, there is quite low use of concern for pendimethalin. Only 45,000 lbs has the potential to affect the habitat residency of this steelhead ESU. It is possible that some of this could occur near smaller water bodies, although designating pendimethalin as an aquatic hazard in DPR's county bulletins would provide more than adequate protection for the agricultural uses.

As everywhere, we cannot quantify the likely use of pendimethalin on home lawns. While there is considerable population throughout this ESU, the density to the point of expecting more than 20% or 36% of the area to be in once or twice treated lawns is likely only in the immediate vicinity of Sacramento. But the variability in homeowner use precludes any finding of inconsequential effect.

I conclude that there is no effect of pendimethalin usage on this ESU based on Tier II modeling and the fact that corn is not widely grown in which pendimethalin could be aerially applied.

19. 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 D-19 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. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

There is very little potential of pendimethalin use in counties where this steelhead migrates (2200 lbs total). By contrast, the counties where spawning and growth occur may have up to 168,000 lbs used on 49,000 acres, representing 0.6% of the ESU that can potentially be treated. Overall, 1.7% of the ESU can be treated with pendimethalin with areas where a habitat residency occurs having the most potential for treatment. The migratory corridors for this ESU have generally have very low density housing, at least below Portland so homeowner and landscape use is considered insignificant.

Based upon the relatively low amounts of usage I conclude that pendimethalin will have no effect on the Lower Columbia River steelhead ESU, especially on migratory corridors.

20. Middle Columbia River Steelhead ESU

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

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

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

In the John Day River watershed, I 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 I 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.

Table D-20 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. The acreage where pendimethalin can be used is moderate for counties in which migration occurs but substantial for spawning and growth where the difference in potenial use being 100,000 lbs to 2.3 million lbs, respectively. A significant amount comes form Yakima, WA in treating orchards. However, Washington state only reports that 1% of orchard acres are treated. Approximately 3% of the land area in the ESU can potentially be treated. Residential lawn use could be scattered throughout the ESU, but could be pronounced in the Portland area.

About 52,000 acres of corn is grown in this ESU. If all of this acreage were grown beside streams and pendimethalin was applied aerially at maximum rates, there there may be a concern. Since this ESU has one of the highest potential pendimethalin usage by volume, I would expect some probability that agricultural use next to smaller tributaries may affect this ESU. I believe there would be no effect from the home lawn use or along the migratory corridors. I conclude that pendimethalin use may cause an affect, but is not likely to adversely affect this ESU.

21. 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. Table C-21 shows very low use of pendimethalin where 913 lbs is used in two counties. These counties are also not strongly urban and suburban with respect to homeowner use of pendimethalin.

Based upon the very low lack of agricultural use of pendimethalin and the lack of high density housing with associated lawns, I conclude there will be no effect of pendimethalin on the Northern California steelhead ESU.

22. 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. I have excluded Baker County, Oregon, which has a tiny fragment of the Imnaha River watershed. While a small part of Rock Creek 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 pendimethalin use in agricultural or residential areas. I 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. I have excluded these areas because they are not relevant to use of pendimethalin. 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 I was 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.

The USDA Agricultural Census indicates there are no crops on which pendimethalin can be used in Idaho counties within this ESU, nor in the Washington counties bordering on Idaho. There is moderate acreage in Walla Walla and Franklin counties along the lower Snake River. Except for the moderate acreage of onions in Walla Walla and Benton counties, WA and Umatilla County, OR, crops where pendimethalin may be used are generally very low in the migratory corridors for this ESU.

Table D-22 shows the cropping information for the Pacific Northwest counties where the Snake River Basin steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. About 1.1 million lbs can be used where thie steelhead migrates and 1.6 million lbs where there is spawning and growth. About 2.5% of the land area in the ESU has the potential to be treated with pendimethalin. Only about 25,000 acres has corn grown which is the crop of concern if aerially treated with pendimethalin. I conclude no effect to this ESU based on Tier II modeling results.

23. 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. Again, there could be unspecified use of pendimethalin on home lawns.

Table C-23 shows that only about 6200 lbs of pendimethalin could be potentially used on four counties, with much use on grapes in Monterey county. It is also possible, but we have inadequate use data for a sound conclusion, that the home lawn use may affect this ESU even more than the low agriculture amounts. However Tier II modeling suggests that this ESU will not be affected by pendimethalin usage on home lawns so I conclude no effect on this ESU.

24. 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. But both may be associated with residential areas, and pendimethalin may be used on home lawns. There is a potential for steelhead waters to drain agricultural areas in Ventura, Santa Barbara, and San Luis Obispo counties; agricultural pendimethalin usage is moderate in these counties. In all of these counties, there may be unquantified use of pendimethalin on home lawns. Usage of pendimethalin in counties where this ESU occurs are presented in Table C-24.

About 5500 lbs of pendimethalin could be used in 5 counties, with the majority consumed by Los Angeles (mainly outdoor plants in containers, and potatoes). This is a relatively minor amount and Tier II modeling supports that conclusion that there will be no adverse effect to this ESU. I conclude no effect to this ESU.

25. Upper Columbia River steelhead ESU

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

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

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

There is a moderate amount of acreage, primarily onions, where pendimethalin may be used with the reproductive area of this ESU. OPP's Quantitative Use Assessment indicates that nationally, an average of 11% of the onion crop is treated with pendimethalin. However, the QUA also indicates that 100% of the pendimethalin use on onions occurs in Texas, Idaho, and Oregon. There is no explanation as to why pendimethalin would be used on onions in Oregon and Idaho, but not in Washington. I suspect there is use of pendimethalin on Washington onions.

Table D-24 shows uses by county. Those counties supporting migration corridors can potentially use 830,000 lbs while those counties supporting spawning and growth can potentially use over three times that amount or 2.7 million lbs. Umatilla and Wallawalla counties are the potential heavy pendimethalin users that can affect the migration residency of the Upper Columbia River steelhead. For the spawning and growth corridors, Benton, Franklin, Grant and Yakima counties can contribute significant amounts to the watershed.

Other than the Portland area, neither the reproductive areas nor the migratory areas are heavily urbanized. Some pendimethalin home lawn use may occur above Portland, but is probably insignificant relative to the size of the water into which the pendimethalin could run off.

Approximately 4.4% of the ESU has the potential to be treated for agricultural purposes. This is the highest percentage of all the ESUs evaluated. Also, 120,000 acres of corn are grown. It is possible that some of this acreage is grown beside streams and aerial application can occur on them. Tier II modeling suggest that the level is concern is slightly exceeded for aerial application on corn. For this reason I conclude that this may be an affect, but it is not likely to adversely affect this ESU.

26. 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 pendimethalin 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.

Acreage where agricultural pendimethalin use may occur is low in some counties in this ESU, but is high in Marion, Washington and Yamhill counties. Urban and suburban areas where home lawn use could occur would be most pronounced in Portland, which is in the migratory corridor, and its surrounding suburbs of Washington and Clackamas counties. However, the Willamette Valley may have moderate amounts of home lawns throughout.

Table D-26 show the cropping information for Oregon counties that include migration and spawning and growth residencies. About 33,000 lbs of pendimethalin can potentially be used in areas that affect the migration corridor. By contrast, 546,000 lbs can be used in counties where spawning and growth occurs. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Based upon the moderate acreage in most counties, I conclude that agricultural use of pendimethalin will have no effect to this ESU.

5. Specific conclusions for Pacific salmon and steelhead

1. There is very limited use associated with several salmon and steelhead ESUs. Therefore, I conclude that there is “no effect” for almost all the ESUs except the ones described below. Tier II modeling indicates sufficient protection to receiving waters based on the mechanics of this chemical.

2. The Upper Willamette River Chinook ESU has a small possibility that it will be affected by pendimethalin use. Marion, OR has corn acreage that is in the top 10% by acreage for crops grown compared to all the other ESUs. It is possible that some of this could occur beside streams and that corn crop could be treated aerially.

3. The Snake River Sockeye ESU also has a small possibility that it could be adversely affected. About 2.75% of the land area in the ESU has the potential to be treated and some of this could be corn beside streams where the sockeyes inhabit. The possibility that they will be acutely exposed cannot be discounted.

4. The Middle Columbia Steelhead ESU has the highest potential pendimethalin usage by volume. Although only about 52,000 acres of corn is grown in this ESU, there is a remote possibility that the steelhead could be acutely exposed and therefore may affect, but not likely to adversely affect conclusion.

5. The Upper Columbia River Steelhead ESU has the concern that it has a high percentage of acres that can be treated and the most corn grown. There again is the small possibility that there may be acute exposure due to aerial spraying of corn beside streams.

6. All ESUs have the uncertainty of home use. I rely on Tier II modeling to indicate that at maximum label rates, receiving waters will not be adversely affected from runoff unless new studies indicate otherwise.

Table 21. Summary conclusions on specific ESUs of salmon and steelhead for pendimethalin.

Species	ESU	Appendix - Table	Conclusion
Chinook Salmon	California Coastal	C-1	no effect
Chinook Salmon	Central Valley spring-run	C-2	no effect
Chinook Salmon	Lower Columbia	D-3	no effect
Chinook Salmon	Puget Sound	D-4	no effect
Chinook Salmon	Sacramento River winter-run	C-5	no effect
Chinook Salmon	Snake River fall-run	D-6	no effect
Chinook Salmon	Snake River spring/summer-run	D-7	no effect
Chinook Salmon	Upper Columbia	D-8	no effect
Chinook Salmon	Upper Willamette	D-9	may affect, but not likely to adversely affect
Chum salmon	Columbia River	D-10	no effect
Chum salmon	Hood Canal summer-run	D-11	no effect
Coho salmon	Central California	C-12	no effect
Coho salmon	Oregon Coast	D-13	no effect
Coho salmon	Southern Oregon/Northern California Coast	C-14 D-14	no effect
Sockeye salmon	Ozette Lake	D-15	no effect
Sockeye salmon	Snake River	D-16	may affect, but not likely to adversely affect
Steelhead	Central California Coast	C-17	no effect
Steelhead	Central Valley, California	C-18	no effect
Steelhead	Lower Columbia River	D-19	no effect
Steelhead	Middle Columbia River	D-20	may affect, but not likely to adversely affect
Steelhead	Northern California	C-21	no effect
Steelhead	Snake River Basin	D-22	no effect
Steelhead	South-Central California	C-23	no effect
Steelhead	Southern California	C-24	no effect
Steelhead	Upper Columbia River	D-25	may affect, but not likely to adversely affect
Steelhead	Upper Willamette River	D-26	no effect

5. References

California Department of Pesticide Regulation. 2002. Pesticide Use Reporting. Online at: http://www.cdpr.ca.gov/docs/pur/pur02rep/02_pur.htm

Effland WR, Thurman NC, Kennedy I. 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.

Hasler AD, Scholz AT. 1983. Olfactory Imprinting and Homing in Salmon. New York: Springer-Verlag. 134p.

Johnson WW, Finley MT. 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. USFWS Publication No. 137.

Lee YD, Kim HJ, Chung JB, and Jeong BR. 2000. Loss of pendimethalin in runoff and leaching from turfgrass land under simulated rainfall. *Journal of Agricultural and Food Chemistry*, 48:5376-5382.

Mayer FL. 2002. Personal communication, Foster L. Mayer Jr., U.S. EPA, Environmental Research Laboratory, Gulf Breeze, Florida. August 2002.

McCorkle FM, Chambers JE, and Yarbrough JD. 1977. Acute toxicities of selected herbicides to fingerling channel catfish, *Ictalurus punctatu*s. Bull. Environ. Contam.Toxicol. 18: 267-270.

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

Munn MD, Gilliom RJ. 2001. Pesticide Toxicity Index for Freshwater Aquatic Organisms. U.S. Geological Survey Water-Resources Investigations Report 01-4077.

Office of Pesticide Programs. 2000. Pesticide Ecotoxicity Database (Formerly: Environmental Effects Database (EEDB)) Environmental Fate and Effects Division, U.S.EPA, Washington, D.C.

Sappington LC, Mayer FL, Dwyer FJ, Buckler DR, Jones JR, Ellersieck MR. 2001. Contaminant sensitivity of threatened and endangered fishes compared to standard surrogate species. Environ. Toxicol. Chem. 20:2869-2876.

Scholz NT, Truelove NK, French BL, Berejikian BA, Quinn TP, Casillas E, Collier TK. 2000. Diazinon disrupts antipredator and homing behaviors in chinook salmon (*Oncorhynchus tshawytscha*). Can. J. Fish. Aquat. Sci., 57:1911-1918.

Strandberg M, Scott-Fordsmand JJ. 2004. Effects of pendimethalin at lower trophic levels – a review. Ecotoxicol Environ Saf., 57(2):190-201.

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

Tucker RK, Leitzke JS. 1979. Comparative toxicology of insecticides for vertebrate wildlife and fish. Pharmacol. Ther., 6, 167-220.

Urban DJ, Cook NJ. 1986. Hazard Evaluation Division - Standard Evaluation Procedure - Ecological Risk Assessment, U. S. EPA Publication 540/9-86-001.

WSDA 2004. Washington State: Pendimethalin Use Summary. Unpublished report developed by the Washington State Department of Agriculture. 19p.

U. S. Department of Agriculture. 2004. Agricultural Chemical Usage: 2003 Nursery and Floriculture Summary, USDA National Agricultural Statistics Service. Online at: http://jan.mannlib.cornell.edu/reports/nassr/other/pcu-bb/#nursery

U. S. Department of Agriculture. 2004a. Agricultural Chemical Usage: 2003 Fruit Summary, USDA National Agricultural Statistics Service. Online at: http://jan.mannlib.cornell.edu/reports/nassr/other/pcu-bb/#fruits

U. S. Department of Agriculture. 2003. Agricultural Chemical Usage: 2002 Vegetable Summary, USDA National Agricultural Statistics Service. Online at: http://jan.mannlib.cornell.edu/reports/nassr/other/pcu-bb/#vegetables

U.S. Geological Survey. 1999. USGS Fact Sheet 097-99.

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