

**2,4-D ethylhexyl ester**  
Analysis of Risks  
to  
Endangered and Threatened Salmon and Steelhead

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**Summary**

2,4-D ethylhexyl ester is one of a family of 2,4-dichlorophenoxyacetic acid compounds that act as a selective herbicide used on many sites. These include food and non-food crops, fallow land, rights-of way, feed crops, agricultural drainage, commercial fisheries, lakes, reservoirs, streams, swamps, waste disposal systems, forestry, residential lawns, and many others. The selection of the agent for immediate application is based on economic and technical decisions, since all the varieties rapidly degrade to 2,4-D acid (<2.9 days).

2,4-D ethylhexyl ester functions as a broad spectrum herbicide. In forestry application it is used largely to enhance conifer release by suppression of ground foliage. The mechanism of action is believed to be an increase in cell wall plasticity, biosynthesis, and the production of ethylene. These alterations are believed to increase cell division beyond supportable levels and to damage vascular tissues. It must also be noted that the chemical can be use for many other purposes in forested areas, including trail preservation, campground clearance, and weed control near outbuildings. It is approved for use in clearing rights-of-way, roadsides, and cleared areas. Many of these uses are not readily available for quantitative analysis.

2,4-D is an herbicide in the phenoxy or phenoxyacetic acid family that is used post-emergence for selective control of broadleaf weeds. 2,4-D, a synthetic auxin herbicide, causes disruption of plant hormone responses. Endogenous auxins are plant hormones. Upon review and synthesis of this information, EFED believes use of 2,4-D on terrestrial sites presents the greatest potential risks to: (1) non-target terrestrial plants, (2) mammals, and (3) birds, while the use of 2,4-D for aquatic weed control presents potential risk to aquatic organisms and aquatic plants. Uses supported for 2,4-D and its chemical forms include terrestrial food crops, terrestrial food and feed crops, terrestrial and greenhouse food crops, terrestrial feed crops, terrestrial non-food crops, terrestrial non-food and outdoor residential uses, aquatic food crops, aquatic non-food outdoor uses, aquatic non-food industrial uses, forestry uses, outdoor residential uses, and indoor non-food uses.

<sup>1</sup> **Comment: Data and the analysis based upon it reflects information available at the time this report was completed. Additional data, which may be submitted or change in status after the submission date are not included in the authors evaluations, presentations, or comments.**

Scope - Although this analysis is specific to forestry and forest tree uses in the Northern California/Southern Oregon Coho salmon and the watersheds in which it occurs, it is acknowledged that 2,4-D ethylhexyl ester 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. Much of the quantitative information presented and used was derived from the Ecological Risk Assessment (ERA, Attachment 1) developed by the Environmental Fate and Effects Division (EFED) for the RED.

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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. Exceptions are known to occur for only an occasional pesticide, as based on the several dozen fish species that have 2,4-D been frequently tested. Sappington et al. (2001), Beyers et al. (1994) and Dwyer et al. (1999), among others, have shown that endangered and threatened fish tested to date are similarly sensitive, on an acute basis, to a variety of pesticides and other chemicals as are their non-endangered counterparts.

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

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

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

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

The inerts efforts in OPP are oriented only towards toxicity at the present time, rather than risk. It should be noted, however, that very many of the inerts are in exceedingly small

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

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

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

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

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

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

When there is a concern with the comparison of toxicity with the EECs identified in GENEEC model, a more sophisticated PRZM-EXAMS model is run to refine the EECs if a suitable scenario has 2,4-D En developed and validated. The PRZM-EXAMS model was developed with widespread collaboration and review by chemical fate and transport experts, soil scientists, and agronomists throughout academia, government, and industry, where it is in common use. As with the GENEEC model, the basic model remains as a 10 hectare field surrounding and draining into a 1 hectare pond. Crop scenarios have been developed by OPP for specific sites, and the model uses site-specific data on soils, climate (especially precipitation), and the crop or site. Typically, site-scenarios are developed to provide for a worst-case analysis for a particular crop in a particular geographic region. The development of site scenarios is very time consuming; scenarios have not yet been developed for a number of crops and locations. OPP attempts to match the crop(s) under consideration with the most appropriate scenario. For some of the older OPP analyses, a very limited number of scenarios were available. As more scenarios become available and are geographically appropriate to selected T&E species, older models used in previous analyses may be updated.

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

It is, however, quite necessary to address the potential that home and garden pesticides may affect T&E species, even in the absence of reliable data. Therefore, I have developed a hypothetical scenario, by adapting an existing scenario, to address pesticide use on home lawns where it is most likely that residential pesticides will be used outdoors. It is exceedingly important to note that there is no quantitative, scientifically valid support for this modified scenario; rather it is based on my best professional judgement. I do note that the original scenario, based on golf course use, does have a sound technical basis, and the home lawn scenario is effectively the same as the golf course scenario. Three approaches will be used.

First, the treatment of fairways, greens, and tees will represent situations where a high proportion of homeowners may use a pesticide. Second, I will use a 10% treatment to represent situations where only some homeowners may use a pesticide. Even if OPP cannot reliably determine the percentage of homeowners using a pesticide in a given area, this will provide two estimates. Third, where the risks from lawn use could exceed our criteria by only a modest amount, I can back-calculate the percentage of land that would need to be treated to exceed our criteria. If a smaller percentage is treated, this would then be below our criteria of concern. The percentage here would be not just of lawns, but of all of the treatable area under consideration; but in urban and highly populated suburban areas, it would be similar to a percentage of lawns. Should reliable data or other information become available, the approach will be altered appropriately.

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

Finally, the applicability of the overall EEC scenario, i.e., the 10 hectare watershed draining into a one hectare farm pond, may not be appropriate for a number of T&E species living in rivers or lakes. This scenario is intended to provide a “worst-case” assessment of EECs, but very many T&E fish do not live in ponds, and very many T&E fish do not have all of the habitat surrounding their environment treated with a pesticide. OPP does believe that the EECs from the farm pond model do represent first order streams, such as those in headwaters areas (Effland, et al. 1999). In many agricultural areas, those first order streams may be upstream from pesticide use, but in other areas, or for some non-agricultural uses such as forestry, the first order streams may receive pesticide runoff and drift. However, larger streams and lakes will very likely have lower, often considerably lower, concentrations of pesticides due to more dilution by the receiving waters. In addition, where persistence is a factor, streams will tend to carry pesticides away from where they enter into the streams, and the models do not allow for this. The variables in size of streams, rivers, and lakes, along with flow rates in the lentic 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 2,4-D En peer-reviewed by OPP’s Science Advisory Panel. The data from toxicity tests and environmental fate and transport studies undergo a stringent review and validation process in accordance with “Standard Evaluation Procedures” published for each type of test. In addition, all test data on toxicity or environmental fate and transport are conducted in accordance with Good Laboratory Practice (GLP) regulations (40 CFR Part 160) at least since the GLPs were promulgated in 1989.

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

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

Test data	Risk quotient	Presumption
Acute LC <sub>50</sub>	>0.5	Potentially high acute risk
Acute LC <sub>50</sub>	>0.1	Risk that may be mitigated through restricted use classification
Acute LC <sub>50</sub>	>0.05	Endangered species may be affected acutely, including sublethal effects
Chronic NOEC	>1	Chronic risk; endangered species may be affected chronically, including reproduction and effects on progeny
Acute invertebrate LC <sub>50</sub> <sup>a</sup>	>0.5	May be indirect effects on T&E fish through food supply reduction
Aquatic plant acute EC <sub>50</sub> <sup>a</sup>	>1 <sup>b</sup>	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 2,4-D En changed from our earlier requests. The basis is to bring the endangered species criterion for indirect effects on aquatic plant populations in line with EFED’s concern levels for these populations.

The Ecological Risk Assessment SEP (pages 2-6) discusses the quantitative estimates of how the acute toxicity data, in combination with the slope of the dose-response curve, can be used to predict the percentage mortality that would occur at the various risk quotients. The discussion indicates that using a “safety factor” of 10, as applies for restricted use classification, one individual in 30,000,000 exposed to the concentration would be likely to die. Using a “safety factor” of 20, as applies to aquatic T&E species, would exponentially increase the margin of safety. It has 2,4-D En 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  $2.39 \times 10^{-9}$ , 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 prohibits 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 Leask (1979) did an extensive review of existing ecotoxicological data on pesticides. Among their findings was that sublethal effects as reported in the literature did not occur at concentrations below one-fourth to one-sixth of the lethal concentrations, when taking into account the same percentages or numbers affected, test system, duration, species, and other factors. This was termed the “6x hypothesis”. Their review included cholinesterase inhibition, but was largely oriented towards externally observable parameters such as growth, food consumption, behavioral signs of intoxication, avoidance and repellency, and similar parameters. Even reproductive parameters fit into the hypothesis when the duration of the test was considered. This hypothesis supported the use of lethality tests for use in assessing acute ecotoxicological risk, and the lethality tests are well enough established and understood to provide strong statistical confidence, which can not always be achieved with sublethal effects. By providing an appropriate safety factor, the concentrations found in lethality tests can therefore generally be used to protect from sublethal effects. As discussed earlier, the entire focus of the early-life-stage and life-cycle chronic tests is on sublethal effects.

In recent years, Moore and Waring (1996) challenged Atlantic salmon with diazinon and observed effects on olfaction as relates to reproductive physiology and behavior. Their work indicated that diazinon could have sublethal effects of concern for salmon reproduction. However, the nature of their test system, direct exposure of olfactory rosettes, could not be quantitatively related to exposures in the natural environment. Subsequently, Scholz et al.

(2000) conducted a non-reproductive behavioral study using whole Chinook salmon in a model stream system that mimicked a natural exposure that is far more relevant to ecological risk assessment than the system used by Moore and Waring (1996). The Scholz et al. (2000) data indicate potential effects of diazinon on Chinook salmon behavior at very low levels, with statistically significant effects at nominal diazinon exposures of 1 ppb, with apparent, but non-significant effects at 0.1 ppb.

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

## 2. Description of 2,4-D ethylhexyl ester:

**A. Chemical History:** 2,4-D ethylhexyl ester was available prior to initiation of regulatory oversight.

### **B: Chemical Description:**

<input type="checkbox"/>	Common Name	2,4-D EHE
<input type="checkbox"/>	Chemical Name	2-ethylhexyl 2,4-dichlorophenoxyacetate
<input type="checkbox"/>	Molecular Formula	C <sub>16</sub> H <sub>22</sub> Cl <sub>2</sub> O <sub>3</sub>
<input type="checkbox"/>	CAS Number	192843-4
<input type="checkbox"/>	Molecular Weight	333.26
<input type="checkbox"/>	Vapor Pressure (20°C)	3.6 E-6mm Hg
<input type="checkbox"/>	Solubility	86.7 ppb @ 20° C
<input type="checkbox"/>	Henry's Law	1.82 E-5 atm-m <sup>3</sup> /mole
<input type="checkbox"/>	Log K <sub>ow</sub>	5.78

**C. Chemical Use:** The following is based on the currently registered uses of 2,4-D ethylhexyl ester:

<input type="checkbox"/>	Type of Agent:	Herbicide
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- Classification: Non-Restricted use herbicide (various formulations)

2,4-D EHE is a white crystalline powder. It has a slight phenolic odor. It is practically insoluble in water. 2,4-D EHE is an oil-soluble solid.

- Summary of Sites:

<b>Table 3. Registered 2,4-D Uses</b>	
<b>Crop Grouping</b>	<b>Representative Crops</b>
Terrestrial food crop	Pear, Pistachio, Stone fruits
Terrestrial food and feed crop	Agricultural fallow/idle land, Agricultural rights-of-way/fence rows/hedge rows, Agricultural uncultivated areas, Apple, Barley, Citrus fruits, Corn (unspecified), Corn, field, Corn, pop, Corn, sweet, Fruits (unspecified), Grapefruit, Lemon, Oats, Orange, Pome fruits, Rice, Rye, Small fruits, Soil, preplant/outdoor, Sorghum, Sorghum (unspecified), Soybeans (unspecified), Sugarcane, Tangelo, Tree nuts, Wheat,
Terrestrial and greenhouse food crop	Pear, Stone fruits
Terrestrial feed crop	Grass forage/fodder/hay, Pastures, Rangeland, Rye, Sorghum
Terrestrial non-food crop	Agricultural fallow/idle land, Agricultural rights-of-way/fence rows/hedge rows, Agricultural uncultivated areas, Airports/landing fields, Christmas tree plantations, Commercial/industrial lawns, Commercial/institutional/industrial, premises/equipment (outdoor), Forest nursery plants (for transplant purposes), Golf course turf, Grasses grown for seed, Industrial areas (outdoor), Nonagricultural outdoor buildings/structures, Nonagricultural rights-of-way/fence rows/hedge rows, Nonagricultural uncultivated areas/soils, Ornamental and/or shade trees, Ornamental lawns and turf, Ornamental sod farm (turf), Ornamental woody shrubs and vines, Paved areas (private roads/sidewalks), Potting soil/topsoil, Recreation area lawns, Recreational areas, Soil, preplant/outdoor, Urban areas

Terrestrial non-food and outdoor residential	Fence rows/hedge rows, Nonagricultural rights-of-way/fence rows/hedge rows, Ornamental and/or shade trees, Ornamental lawns and turf, Ornamental woody shrubs and vines, Paths/patios, Paved areas (private roads/sidewalks), Urban areas
Aquatic food crop	Agricultural drainage systems, Aquatic areas/water, Commercial fishery water systems, Irrigation systems, Lakes/ponds/reservoirs (with human or wildlife use), Rice, Streams/rivers/channeled water, Swamps/marshes/wetlands/stagnant water
Aquatic non-food industrial	Drainage systems, Industrial waste disposal systems, Lakes/ponds/reservoirs (without human or wildlife use)
Forestry	Conifer release, Forest plantings (reforestation programs)(tree farms, tree plantations, etc.), Forest tree management/forest pest management, Forest trees (all or unspecified), Forest trees (hardwoods, broadleaf trees), Pine (forest/shelter belt)
Outdoor residential	Residential lawns
Indoor non-food	Commercial transportation facilities-nonfeed/nonfood

- Formulation Types Registered:  
Technical Grade/Manufacturing-Use Product (MUP) 2,4-D ethylhexyl ester  
End-use Product: Agent White, Bladex-B, Brush Killer-B, Dicoflur, Dormon, Ipaner, Moxon, Netagrone, Pielik, Verton 38, Moto Maskros, Silva Prop1, Agricon D, Acme LV4, Croprider, Fernisia, Lawn-Keep, Penamin, Plantguard, Tribufon. Weed-B-Gone, Weedaful, Agroxone, Weedar, Salvo, Green Cross Weed-No-More, Red Devil Dry Weed Killer, Scotts 4XD, Weed Rhap LV40, Weedone 100, 2,4,Dichloro-phenoxyacetic acid.

In total, the Agency finds in excess of 1,500 registered products containing 2,4-D in one or more of its chemical forms.

- Methods of Application:
  - Equipment: airplane, helicopter, ground spreader, backpack

sprayers, ground boom, spray cans, hand pumps

- ▶ Method and Rate:  
Broadcast  
    Ground (GB)  
    Aerial (AA)  
High Volume Foliar (HVF)  
Low Volume Foliar (LVF)  
Individual Plant Treatment (IPT)
  
- ☐ Rates of Application - Forestry, reforestation, tree farms, tree plantations
  - ▶ Currently the Agency is concluding rates analysis for this chemical as a component of the RED for 2,4-D. The data used for this review are derived from the EFED chapter for that RED.

The EPA estimated usage of 2,4-D both acid and ester form, is shown below:

**Table 4: Modeled use of 2,4-D Usage by Site**

<b>Table 4. 2,4-D Modeling Application Information for Various Scenarios Derived from the 2,4-D Master Label (Assumes all other registered labels will be adjusted to match the 2,4-D Master Label)</b>				
Crop Scenario	Application Rate in Acid Equivalents per Acre (ae/A)	Number of Applications per Year	Application Timing	PCA Adjustment Factor (Drinking Water Only)
FL Sugarcane	2.0 lb ae/A	2	January 1, 19xx April 1, 19xx	0.87
FL Turf	2.0 lb ae/A	2	April 1, 19xx September 28, 19xx	1.0
PA Turf	2.0 lb ae/A	2	May 1, 19xx August 29, 19xx	1.0
ND Spring Wheat	1.25 lb ae/A	1	June 1, 19xx	0.56
OR Wheat	1.25 lb ae/A	1	April 1, 19xx	0.56
IL Corn	1.0 lb ae/A 1.0 lb ae/A 1.0 lb ae/A	3	April 15, 19xx May 30, 19xx September 27, 19xx	0.46
CA Corn	1.0 lb ae/A 1.0 lb ae/A 1.0 lb ae/A	3	March 15, 19xx April 29, 19xx August 27, 19xx	0.46
TX Sorghum	1.0 lb ae/A	1	June 7, 19xx	0.87
KS Sorghum	1.0 lb ae/A	1	June 7, 19xx	0.87
MS soybean	1.0 lb ae/A	1	March 10, 19xx	0.41

<b>Table 4. 2,4-D Modeling Application Information for Various Scenarios</b> <b>Derived from the 2,4-D Master Label</b> <b>(Assumes all other registered labels will be adjusted to match the 2,4-D Master Label)</b>				
Crop Scenario	Application Rate in Acid Equivalents per Acre (ae/A)	Number of Applications per Year	Application Timing	PCA Adjustment Factor (Drinking Water Only)
NC pasture	2.0 lb ae/A	2	June 1, 19xx	0.87
NC apples	2.0 lb ae/A	2	June 1, 19xx August 15, 19xx	0.87
OR apples	2.0 lb ae/A	2	July 1, 19xx September 14, 19xx	0.87
PA apples	2.0 lb ae/A	2	July 1, 19xx September 14, 19xx	0.87
OR filberts	1.0 lb ae/A	4	June 1, 19xx July 1, 19xx July 31, 19xx August 30, 19xx	0.87
CA citrus	0.21 lb ae/A	1	NA	1.0
Aquatic Use	10.8 lb ae/acre-foot (target concentration of 4 ppm)	1	NA	1.0
Rice Use	1.5 lb ae/A	1	NA	1.0

#### D. Environmental Fate:

##### ▶ Abiotic Hydrolysis (MRID 42735401)

Radiolabeled 2,4-D EHE, at 30 ug/L, had a first-order half-life of 99.7 days ( $R^2=0.931$ ) in pH 5 buffer solution, 48.3 days ( $R^2=0.929$ ) in pH 7 buffer solution, and 52.2 hours ( $R^2=0.975$ ) in pH 9 buffer solution. The major degradate was identified as 2,4-D. Unknown radiolabeled degradates were also detected (<2.5% of applied).

- **Microbial-mediated and Surface-catalyzed Hydrolysis** (MRID 42770502; 42770501; Grover, 1973. Weed Research 13:51-58; Smith, 1972. Weed Science 12:364-372; Smith, 1976. Weed Research 16:19-22; Wilson and Cheng. 1978 J. Environ. Qual. 7:281-286; Schwarzenbach et al. 1993; Paris et al, 1981; (Wolfe, et al, 1989 and Wolfe, 1990).

Radiolabeled 2,4-D EHE, at 30 ug/L, had a first-order half-life of 6.2 hours ( $R^2=0.997$ ) in nonsterile, Tittabawasse River water (pH=8.0), 1.25 hours in a Catlin silty loam slurry, and 1.45 hours in Hanford sandy loam slurry. The major degradate product was 2,4-D.

Open literature data indicate that carboxylic acid esters are prone to both surface-catalyzed hydrolysis and microbial mediated hydrolysis (Schwarzenbach, et al.1993). Sediment and soils may promote hydrolysis through reactions with surface hydroxyl groups from transition metal oxide and hydroxide mineral coatings on sediments or soils. Another theory is that the diffuse

double layer at the interface of sediment or soil surfaces has higher hydroxide concentrations causing alkaline-catalyzed hydrolysis.

Microbial-mediated hydrolysis of carboxylic acid esters is an enzymatic controlled process (Schwarzenbach, et al.1993). Paris, et al (1981) tested the rate of microbial degradation of 2,4-D EHE in natural waters from 31 sites with varying temperature and pH conditions (5.4 to 8.2). The authors found that in waters typical of natural conditions and at concentrations normally encountered in rivers and lakes, the rate constants from all sites were within a factor of eight and estimated a mean half life of 2.6 hours. Degradation kinetics could be described using second order kinetics. Paris, et al (1983) found hydrolysis rates of 2,4-D n-alkyl esters in natural waters could be predicted using a linear regression equation using log Kow as the independent variable [ $\log k_b = (0.799 \pm 0.098) * \log Kow - (11.643 \pm 0.204)$ ]. Although the available data indicate rapid degradation of 2,4-D esters in natural waters, microbial mediated hydrolysis rates in soils may be dependent on clay mineralogy, organic carbon content, temperature, and moisture content (Wolfe, et al, 1989 and Wolfe, 1990).

Phenoxyacetate esters of 2,4-D (iso-propyl, -butyl, iso-octyl) rapidly hydrolyzed ( $t_{1/2} = 30$  minutes) in alkaline salt solutions (Smith, 1972). Phenoxyacetate esters of 2,4-D, 2,4,5-T, 2,4-DP and 2,4-DB (iso-propyl, iso-octyl, -butyl) rapidly hydrolyzed in moist Canadian soils and soil slurries (Smith, 1976). The rate of hydrolysis of the phenoxyacetate esters was reduced in soils with a low moisture content (Smith, 1976, Smith, 1972, Groom, 1973).

- **Photodegradation in Water (MRID 42749702)**

Radiolabeled 2,4-D EHE, at 30 ug/L, had a first-order half-life of 128.2 days in pH 5 buffer solution irradiated with natural light. The degradation half-life of 2,4-D EHE was 252.5 days in dark controls. Photodegradates were identified as 2,4-D (0.3 to 6.0% of applied), 2,4-dichlorophenol (2,4-DCP) (0.5 to 7.6% of applied), 2-ethylhexyl 4-chlorophenoxyacetate (0.1 to 1.5% of applied). Unknown degradates (0.3 to 6.6% of applied) were also detected. The main degradate in dark control samples was 2,4-D. The reported data indicate 2,4-D EHE should not rapidly photodegrade in acidic aquatic environments.

- **Laboratory Volatility (MRID 42059601)**

Radiolabeled 2,4-D EHE, applied as Esteron 99 Concentrate at a rate of 15.8 lbs ae/A, was not volatile (< 0.22% of applied) from sandy loam soil. At 1 to 1.5 days posttreatment, the observed volatilization rate and air concentration of 2,4-D EHE was  $8.06 \times 10^{-4}$  ug/cm<sup>2</sup>/hr and 34.84 ug/m<sup>3</sup> and  $3.45 \times 10^{-3}$  ug/cm<sup>2</sup>/hr during air flow rates of 100 ml/min and 300 ml/min, respectively. During the volatility study, 2,4-D EHE was rapidly degraded ( $t_{1/2} = 8$  days) to form 2,4-D. The reported data indicate 2,4-D, EHE, formulated in ESTERON 99 Concentrate, and its major degradate 2,4-D are not volatile from soil.

- **Terrestrial Field Dissipation (MRIDs 43914701; 43762401; 43762402; 43514601; 43533401; 43864001; 43592801; 43762403; 43762404; 43640601; 43831702; 43872703; 43849102; 43831701; 43705202 )**

**General:** The registrant submitted 15 terrestrial field dissipation studies using 2,4-D EHE. Field studies were conducted on bareground, pasture, corn, turf, and wheat. In addition, two forest field dissipation studies were conducted using 2,4-D EHE.



The registrant conducted a total of 15 terrestrial field dissipation studies in CA, CO, NC, ND, NE, OH and TX on bareground plots as well as plots cropped to corn, pasture, turf and wheat. **2,4-D EHE had first-order half lives ranging between 0.9 days to 14.3 days with a median half-life of 2.9 days. The first-order half-life of 2,4-D acid ranging from 1.2 days to 42.5 days with a median half-life of 6.2 days.** These half-lives reflect dissipation from the surface soil layer (0 to 6 inches) and do not include residues which have leached below the surface layer. The data indicate a rapid to moderately rapid dissipation rate for 2,4-D. Similar degradation rates were found in aerobic soil metabolism laboratory studies (MRIDs 00116625 and 43167501). Dissipation rates for 2,4-D degradation products (2,4-DCP and 2,4-DCA) were not estimated because of their sporadic occurrence patterns in surface soils. 2,4-D EHE was not persistent (median half-life =2.9 days) under field conditions.

2,4-D residues were detected below a depth of 18 inches in eleven of the terrestrial field dissipation studies reviewed and was detected below 30 inches in five studies (**MRID 43914701, 43762402, 43831703, 43849101, and 43872702**). Leaching appears to be a route of dissipation when precipitation or irrigation exceed evapotranspiration.

The registrant submitted storage stability studies for 2,4-D, 2,4-DCP, and 2,4-DCA. These studies were conducted on soils taken from field dissipation studies in Colorado, North Carolina, and Texas. An analysis of storage stability studies indicate that 2,4-D and 2,4-DCA are stable (average half-lives 2605 to 2876 days respectively), during frozen storage for up to 454 days. However, the frozen storage stability half-lives for 2,4-D 2-EHE (114, 194, and 1066 days) and 2,4-DCP (85, 257, 2310 and 3465 days) indicate that 2,4-D 2-EHE and 2,4-DCP may not be stable under all storage conditions. Thus, there is uncertainty about the quality of the 2,4-D 2-EHE and 2,4-DCP field dissipation data because of the variable nature of the storage stability studies.

The following summary table presents the basic results of the individual field dissipation studies submitted for 2,4-D EHE. For a more detailed review of the individual studies the reader is directed to review individual Date Evaluation Records (DER)

**Table 5: Field Dissipation Studies**

MRI D #	S T	County	EU P	For m	Use	Sing le App Rate (lbs ai/A)	No of App s	Annu al App Rate (lbs ai/A)	Surface Soil Half-life (First Application)-Days		Surface Soil Half-life (Second Application)- Days		Surface Soil Half-life (Third Application)- Days		Surface Soil Half-life (Fourth Application)- Days		Maximum Depth of Detection (inches)				Peci p + Irrig (in)	Pan Evap (in)
									2,4-D EHE	2,4-D	2,4-D EHE	2,4-D	2,4-D EHE	2,4-D	2,4-D EHE	2,4-D	2,4-D EHE	2,4-D	2,4-DCP	2,4-DCA		
43914701	CA	Tulare	EHE	Conc	Bare	2.2	2	4.4	2.3	3.8	2.6	6.2					30	48	6	18	26.8	
43762401	CA	Tulare	EHE	Conc	Bare/Past	2.2	2	4.4	3.5	7.5	5.1	39.2					12	24	6	6		
43762402	CA	Tulare	EHE	Conc	Turf	2.2	2	4.4	2.1	6.2	2.2	9.7					6	42	18	NA		
43514601	CO	Eaton	EHE	Conc	Bare	1.25	2	2.5	1.7	6.6	1.7	2.2					6	12	6	NA	12.7	26.2

MRI D #	S T	County	EU P	For m	Use	Sing le App Rate (lbs ai/A)	No of App s	Annu al App Rate (lbs ai/A)	Surface Soil Half-life (First Application)-Days		Surface Soil Half-life (Second Application)- Days		Surface Soil Half-life (Third Application)- Days		Surface Soil Half-life (Fourth Application)- Days		Maximum Depth of Detection (inches)				Preci p + Irrig (in)	Pan Evap (in)
									2,4-D EHE	2,4-D	2,4-D EHE	2,4-D	2,4-D EHE	2,4-D	2,4-D EHE	2,4-D	2,4-D EHE	2,4-D	2,4-DCP	2,4-DC A		
43533401	C O	Eaton	EH E	Conc	winte r wheat	1.25	2	2.5	3.4	6.5	2	2.8					6	6	6	6	12.7	27
43864001	N E	York	EH E	Conc	Bare	varia ble rates	4	5.5	2.6	42.5	5.8	4.4	2.9	4.7	7.5	4.5	12	18	6	6	31.3	
43592801	N C	Rowland	EH E	Conc	Bare	1.25	2	2.5	14.2	5.5	2.8	3.2					6	6	6	6	33.1	42.5
43762403	N C	Rowland	EH E	Conc	Bare	2.2	2	4.4	0.9	2.7	1.2	1.8					12	12	6	6	20.4	31.99
43762404	N C	Rowland	EH E	Conc	Turf	2.2	2	4.4	NA	4.5	NA	2.2					6	18	6	6	31	34.04
43640601	N C	Rowland	EH E	Conc	Whea t	1.25	2	2.5	11.4	9.4	1.8	9.6					6	6	6	6	33.1	41
43831702	N D	Northwo od	EH E	Conc	Bare	1.4	2	2.8	4.4	6.1	3.6	5.6					12	12	6	6	16.02	
43872703	O H	New Holland	EH E	Gran	Bare	2.2	2	4.4	6	10.7	6.3	10.3					12	12	6	6	18.72	
43849102	O H	New Holland	EH E	Conc	Bare	varia ble rates	4	5.68	10.9	31.5	6.6	5.4	2.8	1.2	2.9	9	12	12	6	NA	30.8	
43831701	O H	New Holland	EH E	Gran	Turf	2.2	2	4.4	14.3	24.6	1.1	13					12	12	6	6	18.67	
43705202	T X	Eagle Lake	EH E	Conc	Past	2	2	4	1.4	4.2	1.1	13.1					6	12	6	NA	36.9	39.9

### Forest Field Dissipation ( MRID 43908303 & 43927101)

2,4-D EHE, broadcast applied as a spray at a nominal rate of 4.0 lb a.e./A to a forested plot of sandy clay loam soil in Georgia, dissipated with registrant-calculated half-lives for 2,4-D acid of 1.7 days ( $r^2 = 0.92$ ; 0-7 day data) in protected soil, 7.2 days ( $r^2 = 0.75$ ; 0-62 day data) in foliage, and 51.0 days ( $r^2 = 0.55$ ) in leaf litter. The 2,4-D EHE was detected in the exposed soil at only two sampling intervals and was not detected after 3 days posttreatment. The major degradate 2,4-D acid dissipated with registrant-calculated half-lives of 4.0 days ( $r^2 = 0.61$ ; 0-30 day data) in exposed soil, 3.6 days ( $r^2 = 0.51$ ; 0-15 day data) in protected soil, 23.5 days ( $r^2 = 0.73$ ; 0-180 day data) in foliage, and 52.2 days ( $r^2 = 0.57$ ) in leaf litter. EFED estimated half-lives on foliage for 2,4-D of 32.5 days ( $r^2 = 0.80$ ) and for 2,4-D EHE of 32.7 days ( $r^2 = 0.51$ ). EFED estimated half-lives in leaf litter for 2,4-D of 51.7 days ( $r^2 = 0.55$ ) and for 2,4-D EHE of 50.5 days ( $r^2 = 0.53$ ).

In the exposed soil, the parent was initially present in the 0- to 6-inch depth at 0.14 ppm, was not

detected at 1 day posttreatment, and was last detected at 0.029 ppm at 3 days; the parent was not detected below the 0- to 6-inch depth. The major degradate 2,4-D acid was initially (day 0) present in the 0- to 6-inch depth at a maximum of 0.15 ppm, was not detected at 1 day posttreatment, was 0.074 ppm at 3 days, and was last detected at 0.010 ppm (one of three replicates) at 15 and 30 days; 2,4-D acid was not detected below the 0- to 6-inch depth. The degradates 2,4-DCP and 2,4-DCA were not detected at any sampling interval or depth.

In the protected soil, the parent was initially present in the 0- to 6-inch depth at 0.058 ppm, decreased to 0.036 ppm by 1 day posttreatment, and was last detected at 0.010 ppm (one of three replicates) at 7 days. The parent was detected once in the 6- to 12 inch depth, at 0.016 ppm (one of three replicates) at 1 day posttreatment. The parent was not detected at any other sampling interval below the 0- to 6-inch depth. The major degradate 2,4-D acid was initially (day 0) present in the 0- to 6-inch depth at 0.11 ppm, was a maximum of 0.19 ppm at 1 day posttreatment, and was last detected at 0.012 ppm (two of three replicates) at 15 days; 2,4-D acid was detected once in the 6- to 12 inch depth, at 0.014 ppm (two of three replicates) at 1 day posttreatment. The degradates 2,4-DCP and 2,4-DCA were not detected at any sampling interval or depth.

In the foliage, the parent was initially present at 36.9 ppm, decreased to 15.5 ppm by 1 day and 11.1 ppm by 3 days, was 0.36-2.5 ppm at 7-30 days posttreatment, and was last detected at 0.13 ppm (one of three replicates) at 62 days. The major degradate 2,4-D acid was initially (day 0) present at a maximum of 43.0 ppm, decreased to 25.0 ppm by 3 days and 4.3 ppm by 7 days, was 0.33-0.90 ppm at 62-118 days, and was last detected at 0.33 ppm at 180 days posttreatment. The major degradate 2,4-DCP was initially (day 0) present at 0.34 ppm, increased to a maximum of 0.39 ppm by 1 day posttreatment, was 0.12-0.34 ppm at 3-91 days, and was last detected at 0.24 ppm (one of three replicates) at 118 days. The major degradate 2,4-DCA was only detected twice, at 0.16 ppm at 7 days posttreatment and at 0.10 ppm (two of three replicates) at 180 days.

In the leaf litter, the parent was initially present at 50.6 ppm, was 11.1-13.9 ppm at 1-7 days and 0.25-1.0 ppm at 15-180 days, and was 0.12 ppm at 359 days posttreatment. The major degradate 2,4-D acid was initially (day 0) present at a maximum of 30.6 ppm, decreased to 15.9 ppm by 7 days and 1.5-1.9 ppm by 15-30 days, and was 0.18 ppm at 359 days posttreatment. The major degradate 2,4-DCP was initially (day 0) present at a maximum of 2.9 ppm, was 0.95-2.2 ppm at 1-7 days and 0.046-0.21 ppm at 15-180 days posttreatment, and was 0.036 ppm at 359 days. The major degradate 2,4-DCA was initially (day 0) present at 0.24 ppm, was a maximum of 0.37 ppm at 7 days, was 0.042-0.11 ppm at 15-180 days, and was 0.015 ppm (two of three replicates) at 359 days.

#### **E. Incidents:**

The EIIS database reports pesticide incidents which have been voluntarily submitted to the EPA by state agencies. The report assigns a certainty index of 0 (unrelated), 1 (unlikely), 2 (possible) 3 (probable) or 4 (highly probable) to each incident. In addition a judgement of registered use, accidental misuse, intentional misuse, or undetermined is assigned. There were 227 terrestrial incidents reported for 2,4-D, and 155 of these incidents were reported as plant incidents under the acid form only. Two incidents were reported as both terrestrial and aquatic.

Among the terrestrial incidents 10 were reported as accidental misuse with a certainty index of "possible". Forty three incidents were reported as undetermined and possible, while seven were recorded as registered uses and possible. The remaining incident (#1003151-001) was recorded as a probable registered use on corn. However, the affected species was also listed

as corn, and no residue analysis was conducted.

One of the two incidents which were recorded as terrestrial/aquatic showed an application to corn in Illinois (#B000150-002) which affected bluegill, catfish, crappie, fox squirrel, greengill, largemouth bass, silver minnow, smallmouth bass, sunfish and watersnake. This incident was “highly probable” and was not listed as a misuse, however, no residue analysis was obtained. The remaining incident was recorded as “possible” and the use was “undetermined”.

**F. Estimated and actual concentrations of 2,4-D ethylhexyl ester in water:**

**Estimated and actual concentrations of triclopyr in water:** An analysis of toxicity, whether acute or chronic, lethal or sublethal, must be combined with an analysis of how much chemical 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 Tier II screening models PRZM and EXAMS were used to determine estimated surface water concentration of 2,4-D EHE. The index reservoir represents a potentially vulnerable drinking water source based on the geometry of an actual reservoir and its watershed (located in Illinois). The PCA is a generic watershed based adjustment factor which represents the portion of a watershed planted to a crop and will be applied to pesticide concentration estimates for surface water exposure.

**G. Ecological Effects Toxicity Assessment:**

Specific data relating to acute and chronic toxicity of 2,4-D EHE have not, as yet, been released. For purposes of this review the Risk Quotients (RQ) released by EFED on May 6, 2004 will be used to evaluate the risk to northern California/Southern Oregon Coho salmon.

**H. Risk Quotients for Species:**

Based on toxicity and EEC data, risk quotients were calculated relevant to the T&E species of interest. The results of these calculations are presented in Table 11. The EECs presented are those considered significant to forestry and are estimated by direct application to 6" of lentic water.

**Table 6: Risk Aquatic Quotients For 2,4-D Ethylhexyl Ester**

<b>Aquatic Organism Risk Quotient Calculations for 2,4-D Ethylhexyl Ester from Drift</b>			
<b>Scenario</b>	<b>Acute Toxicity Threshold, LC<sub>50</sub> or EC<sub>50</sub> (mg ae/L)</b>	<b>Peak Water Concentration (mg ae/L)</b>	<b>Acute RQ<sup>a</sup></b>
<b>Turf - Florida(2 lbs ae/A/app, 2 broadcast or aerial applications)</b>			
Freshwater Fish	3.2	0.00110	0.00
Estuarine Fish	>0.1564	0.00110	< 0.01
Freshwater Amphibian	0.505	0.00110	0.00
Freshwater Invert.	3.4	0.00110	0.00

<b>Aquatic Organism Risk Quotient Calculations for 2,4-D Ethylhexyl Ester from Drift</b>			
<b>Scenario</b>	<b>Acute Toxicity Threshold, LC<sub>50</sub> or EC<sub>50</sub> (mg ae/L)</b>	<b>Peak Water Concentration (mg ae/L)</b>	<b>Acute RQ<sup>a</sup></b>
Estuarine Invert.	121.4	0.00110	0.00
<b>Turf - Pennsylvania(2 lbs ae/A/app, 2 broadcast or aerial applications)</b>			
Freshwater Fish	3.2	0.00110	0.00
Estuarine Fish	>0.1564	0.00110	< 0.01
Freshwater Amphibian	0.505	0.00110	0.00
Freshwater Invert.	3.4	0.00110	0.00
Estuarine Invert.	121.4	0.00110	0.00
<b>Wheat - North Dakota (1.25 lbs ae/A/app, 2 broadcast or aerial applications up to 1.75 lbs ae/A/Yr)</b>			
Freshwater Fish	3.2	0.00280	0.00
Estuarine Fish	>0.1564	0.00280	< 0.02
Freshwater Amphibian	0.505	0.00280	0.01
Freshwater Invert.	3.4	0.00280	0.00
Estuarine Invert.	121.4	0.00280	0.00
<b>Wheat - Oregon (1.25 lbs ae/A/app, 2 broadcast or aerial applications up to 1.75 lbs ae/A/Yr)</b>			
Freshwater Fish	3.2	0.00280	0.00
Estuarine Fish	>0.1564	0.00280	< 0.02
Freshwater Invert.	3.4	0.00280	0.00
Freshwater Amphibian	0.505	0.00280	0.01
Estuarine Invert.	121.4	0.00280	0.00
<b>Corn - Illinois (1 lbs ae/A/app, 3 broadcast or aerial applications.)</b>			
Freshwater Fish	3.2	0.00280	0.00
Estuarine Fish	>0.1564	0.00280	< 0.02
Freshwater Amphibian	0.505	0.00280	0.01
Freshwater Invert.	3.4	0.00280	0.00
Estuarine Invert.	121.4	0.00280	0.00
<b>Corn - California (1 lbs ae/A/app, 3 broadcast or aerial applications.)</b>			
Freshwater Fish	3.2	0.00280	0.00
Estuarine Fish	>0.1564	0.00280	< 0.02
Freshwater Amphibian	0.505	0.00280	0.01
Freshwater Invert.	3.4	0.00280	0.00

## **I. Discussion and Characterization of Risk Assessment.**

2,4-D ethylhexyl ester is categorized as being moderately to highly toxic to most animals tested, including fish, birds, and mammals. Risk evaluation, however, depends on many factors in addition to acute toxicity. The estimated concentration and expected duration of contact are of equal significance. In respect to 2,4-D EHE, the expected and measured environmental concentrations are low. The half-life of the chemical can be as short as 4 hours under some natural conditions. These factors significantly mitigate the potential adverse effects from 2,4-D EHE.

**J. Existing Protections:** Currently the expected precautions regarding spray drift and personal safety measures are components of the label language for 2,4-D EHE. Application to natural surface water for terrestrial applications is prohibited (application to commercial ponds, swamps, drainage ditches, and still water is allowed).

**K. Proposed Protections.** New, proposed restrictions for 2,4-D EHE will be available upon completion and review of the pending RED.

## **3. Description of Pacific salmon Evolutionarily Significant Units relative to Specific Usage by County:**

### **Specific Usage by County:**

The data for counties within California were taken directly from the California Department of Pesticide Regulation agricultural pesticide use tables within the 2002 reporting period. The values indicated are exact reported treatment areas and pounds of active ingredient used for each county. Because Oregon does not provide such data, the data presented for Oregon are calculated values. The area treated represents an estimate of total forested area based on US Geological Service mapping by planimetric approximation of county size and the Oregon Department of Forestry that 75% of that area is forested. EPA has not estimated use of the chemical, therefore application to 100% of the area was presumed. The maximum application rate of 2.75 lbs ae./A was used to determine the pounds applied. This is probably a significant overestimate of the actual number of pounds applied.

### **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 re-colonized 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.

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, and Douglas, in Oregon. Klamath county is excluded because it lies beyond an impassable barrier.

Table 7 shows the usage of 2-4-D ethylhexyl ester in the California counties supporting the Southern Oregon/Northern California coastal Coho salmon ESU. Table 8 shows the cropping information for Oregon counties where the Southern Oregon/Northern California coastal Coho salmon ESU occurs.

**Table 7: California Counties where the Southern Oregon/Northern California Coastal Coho Salmon ESU Occurs**

<b>County</b>	<b>Crop(s)</b>	<b>Acres Treated</b>	<b>Pounds Applied</b>
<b>Del Norte</b>	<b>Forest Trees</b>		<b>None</b>
<b>Glenn</b>	<b>Forest Trees</b>		<b>None</b>
<b>Humboldt</b>	<b>Forest Trees</b>		<b>None</b>

<b>Lake</b>	<b>Forest Trees</b>		<b>None</b>
<b>Mendocino</b>	<b>Forest Trees</b>		<b>None</b>
<b>Siskiyou</b>	<b>Forest Trees</b>	<b>956</b>	<b>1808</b>
<b>Trinity</b>	<b>Forest Trees</b>		<b>None</b>

**Table 8: Oregon counties where there is habitat for the Southern Oregon/Northern California coastal coho salmon ESU.**

<b>St</b>	<b>County</b>	<b>Crops and acres planted</b>	<b>Acres Treated</b>	<b>Pounds Applied</b>
<b>OR</b>	<b>Curry</b>	<b>Forest Trees</b>	<b>27400</b>	<b>75350</b>
<b>OR</b>	<b>Douglas</b>	<b>Forest Trees</b>	<b>4275</b>	<b>11756</b>
<b>OR</b>	<b>Jackson</b>	<b>Forest Trees</b>	<b>17200</b>	<b>47308</b>
<b>OR</b>	<b>Josephine</b>	<b>Forest Trees</b>	<b>28000</b>	<b>77000</b>

There is minimal use of 2,4-D EHE in California, and it will pose no risk to endangered Coho Salmon within the Northern California/Southern Oregon ESU. The calculation method used to determine use in Oregon is certainly an overestimate of the actual use, however without specific data the Agency assumes the worst-case position of maximum application. Refinement of these data may significantly alter the determination. After review of EFED RQ calculations, it can be concluded, however, that use of 2,4-D EHE will have no effects in this ESU.

**Summary of Review:**

**Table 9: Summary of Review for 2,4-Dichlorophenoxyacetic acid, 2 ethylhexyl ester in the Northern California and Southern Oregon Coho Salmon ESU**

<b>Species</b>	<b>ESU</b>	<b>Finding</b>
Coho	Northern California/Southern Oregon	No Effect

**Assessment:**

2,4-Dichlorophenoxyacetic acid, 2-ethylhexyl ester is one of a large family of compounds derived from the base 2,4-D. The compounds, and all derivatives, are currently under review by the agency for preparation of a Reregistration Eligibility Decision. In reviewing available data, 2,4-D EHE appears to be a transient chemical under natural conditions (< 1 day), degrading to 2,4-D acid. Previous reports have noted that 2,4-D acid is essentially non-toxic to animals. The highest RQ values relative to this review were <0.02 (estuarine fish) which does not exceed the Agency's Level of Concern for endangered species. These findings, despite the calculated use in Oregon, lead to the conclusion that 2,4-D EHE will have no effect on the species of concern.

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Attachment 1  
EFED Fate and Risk Assessment Chapter  
for the 2,4-Dichlorophenoxyacetic acid  
RED

# Attachment 2

## Sample Product Labels

# Attachment 3

## USGS Usage Map