Disulfoton
Analysis of Risks
to
Endangered and Threatened Salmon and Steelhead

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Summary

Disulfoton is an organo-phosphorus insecticide that has been widely used in agriculture and in residential areas for control of thrips, mites, and aphids. Primary agricultural uses are on field crops, vegetable crops, ornamentals and shrubs. Commercial application is by ground broadcast into crop rows with incorporation into the soil at depths ranging from 2-12 inches. Alternatively, watering in of granular material is recommended. For foliar treatment, aerial spray is practiced in some areas (CA, WA, OR) for asparagus. Aerial application to cotton is not allowed. The residential use of disulfoton is being phased out and many of the agricultural uses are being modified or canceled. Disulfoton is toxic to fish, but does not exhibit the high levels of toxicity that would warrant concerns for direct, lethal effects on fish. A high toxicity to organisms that serve as food for threatened and endangered Pacific salmon and steelhead, and the potential effects on salmon olfaction, may be of concern, even in areas where uses are being phased out. 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 re-registration process to determine the potential risks to the listed Evolutionarily Significant Units of Pacific salmon and steelhead. The registered use of Disulfoton may affect 6 of these ESUs, and may affect but is not likely to adversely affect 12 ESUs, and has no effect in 8 of the ESU's considered.

Problem formulation - The purpose of this analysis is to determine the potential or actual effects of disulfoton on the threatened and endangered (T&E) salmon and steelhead Evolutionarily Significant Units (ESUs) located in California and the Pacific Northwest. Disulfoton is an insecticide, used primarily to control aphids, thrips, and mites. In the past, it was in widespread use in both residential and commercial agriculture sites. Like most other organophosphate agents, the use of disulfoton in recent years has declined, in part due to regulatory action, but also from commercial concerns and the response of the registrants, but also through an increased awareness of the wide ranging physiological impact of the compounds on many organisms.

[1] **Comment: Data and the analysis based upon these data reflect information available at the time this report was completed. Additional data, which may have submitted or changes in status after the submission date are not included in the authors evaluations, presentations, or comments.**

Scope - Although this analysis is specific to listed western salmon and steelhead and the watersheds in which they occur, it is acknowledged that Disulfoton 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 Interim Reregistration Eligibility Decision (IRED) and the Ecological Risk Assessment (ERA) developed by the Ecological Fate and Effects Division (EFED) for the IRED (Attachment 3).

Contents

Attachments:

1. Interim Reregistration Eligibility Decision for Disulfoton, Case 102
2. EPA Quantitative Usage Analysis, Disulfoton
3. EFED IRED Chapter, Disulfoton
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5. Inactive Products
6. Example Labels

1. Background

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Test data	Risk quotient	Presumption
Acute LC50	>0.5	Potentially high acute risk
Acute LC50	>0.1	Risk that may be mitigated through restricted use classification
Acute LC50	>0.05	Endangered species may be affected acutely, including sublethal effects
Chronic NOEC	>1	Chronic risk; endangered species may be affected chronically, including reproduction and effects on progeny
Acute invertebrate LC50[a]	>0.5	May be indirect effects on T&E fish through food supply reduction
Aquatic plant acute EC50[a]	>1[b]	May be indirect effects on aquatic vegetative cover for T&E fish

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

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

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

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

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

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

2. Description and use of Disulfoton

a. Chemical Identification

- Common Name: Disulfoton
- Chemical Name:
  O,O-dimethyl S-[(2ethylthio)ethyl]phosphorodithioate
- Chemical Family: Organophosphate
- Case Number: 0102
- OPP Chemical Code: 032501
- Empirical Formula: $C_8H_{19}O_2PS_3$
- Molecular Weight: 274.4 g/mole
- CAS Registry No: 298-04-4
- Trade and Other Names: Di-Syston
- Manufacturer: Bayer Corporation
  Agriculture Division

b. Application sites, methods, and rates:

The primary disulfoton registrant products are Di-Syston® 15% and 20% Granular Systemic Insecticide and Di-Syston® 8 Emulsifiable Systemic Insecticide (85% a.i.). Target pests include aphids, mites, thrips, and, less commonly, grasshoppers and beetles. Both products currently require a 25 foot vegetative buffer between areas to which the product is applied and permanent surface water features, including ponds, streams, and springs. Other formulations are low concentration (≈1-2%) single agent products for residential use, or in combination with a wide range of fertilizers and/or fungicides. Currently only 57 products (attachment 4) remain in active use, while 256 products (attachment 5) have been withdrawn from the market, either by registration decisions or the request of the manufacturer. These changes are consistent with the overall decline in organophosphate insecticides and will continue to reduce the effects of disulfoton on the named ESU's for Pacific salmon and steelhead. This commentary addresses the impact of current, registered products, on the Threatened and Endangered (T/E), Evolutionarily

Significant Units (ESU's) of Pacific Salmon and Steelhead in California, Oregon, Washington, and Idaho.

The review of disulfoton use in California, Oregon, Washington, and Idaho indicates expected usage and application rates, suggesting that the EPA models and known concentrations based on national data are appropriate. Several features are of significance. The CDPR 2002 report shows significantly lower usage than the other states, which are based on 1997 census data. In large measure this is due to the apparent elimination of disulfoton on wheat and barley in California (except in Siskiyou County). An additional factor in mitigating disulfoton effects in California is the presence of a well organized bulletin program, with strong usage recommendations. In the northwest, the largest crop for which disulfoton may be used is wheat (≅5,432,127 A), scheduled for phase out in June 2005 (with barley and potatoes). significantly reducing the overall environmental load. In this regard, the California information can be taken as being predictive of the effects to be expected in Oregon, Washington, and Idaho after June, 2005.

Because the areas of concern are typically flowing, well oxygenated streams, rivers, and tributaries, the levels of disulfoton can be expected to rapidly dissipate after crop treatments. Additionally, the ESU's of concern are often coastal and disulfoton concentrations can be expected to rapidly assume oceanic levels through circulation and, particularly in the northwest, tidal displacements. In a few areas, such as the Chinook Salmon, Puget Sound Run, California Central Valley and Sacramento River Chinook Runs, and the Steelhead Runs in similar locations, disulfoton use may have some effect by the combined actions of agriculture, documented here, and the heavy population densities with potential residential use of disulfoton containing products. Specific information on residential use was not available, however residential use of disulfoton is now required to have a maximum concentration of active ingredient of 2% or less and low application rates (0.3lbs ai/1000^2 ft for flowers, 0.01 lbs ai/4 ft shrub, 0.0013 lbs ai/bush for roses). The packaging requirements and prohibition against commercial use indicate that these products are intended for homeowner use.

Methods of Application: Disulfoton is applied by ground broadcast using devices that accurately dispense the granules, aerial application, soil incorporation, foliar treatments, as a seed or pre-plant or post-emergence application. Approximately 95% of cotton seed is pre-treated with concentrated (95% a.i.) disulfoton. When used in foliar application for potatoes, as a liquid or emulsifiable formulation, aerial application is approved. Disulfoton by ground application in granular form, acts by absorption through the root system and translocation into plant tissues and sap. The intent of this methodology is to make the pesticide available to target, sucking insects while limiting exposure to beneficial pollinating and predatory species.

Disulfoton is a common component of multiple ingredient formulations, where it provides the insecticidal elements of products marketed as fungicides and/or fertilizer. The most common active ingredients added are pentachloronitrobenzene (PCNB) and etradiazole. Both of these additional agents exhibit less fish toxicity than disulfoton and, by convention, the disulfoton effects are considered as the primary concern in multiple ingredient formulations. Currently there are 59 active products and many inactive products. In addition, there are 13 special local needs permits in the areas of interest (6 in California, 5 in Washington, and 2 in Oregon).

Residential use, for which there are 32 active labels, is generally limited to products containing ≤2% disulfoton. These products are for control of insects and mites on ornamentals, including roses, shrubs, flowers trees and varietal house plants. Various products are approved for both indoor and outdoor use. Generally the products are in granular form or as “spikes” for long term, slow release applications. The latter are intended for cancellation by the registrants (voluntary) in the future, but are currently still shown as registered products.

Agricultural usage includes granular, wettable powder, and emulsifiable concentrates. The concentration of disulfoton ranges from 6.5% to 85% in various formulations. Application is typically accomplished by drilling, injection, band application (8" to 40"rows), or metered ground broadcast on row crops, followed by tilling of the granulated product into the furrows and surrounding soil. Foliar application on some crops, such as potatoes is available, under the registered labels but is most common east of the Rocky Mountains. In addition, a 95% formulation is available for seed treatment for use only by commercial seed treaters, and not used on the farm. Although the various products contain a range of application rate definitions (lbs. a.i./A, oz/100 ft^2, lbs/drill row/acre, fl\ oz/1000 ft, etc.) they can be converted to the following application rates expressed as lbs a.i./A:

Table 3: Label Application Rates in Areas of Interest (lbs active ingredient/Acre)

Use Site	Max.Single Rate lbs/A, a.i.	Max. No. of Appl./Year	Max. lbs a.i per Crop Year
Asparagus	1.0 (foliar or soil)	2	2.0
Barley (phase out in June, 2005)	0.63 (foliar or soil)	2	1.26
Beans	1.0 (soil)	1	1.25
Broccoli	0.63 (soil)	1	0.63
Brussel Sprouts	0.63 (soil)	1	0.63
Cabbage	1.25 (soil)	1	1.25
Cauliflower	0.63 (soil)	1	0.63
Christmas Trees	4.5 (soil)	1	4.5
Clover for Seed (WA Only)	1.0 (soil)	1	1.0
Cotton	1.0 (soil or foliar-aerial prohibited)	1	1.0

Lentil;	1.6 (soil)		
Lettuce (liquid CA only)	1.25 (soil)	1	1.25
Peanuts	1.0 (soil)	1	1.0
Peas	1.6 (soil)	1	1.6
Potatoes (phase out June 2005)	1.9 (foliar or soil)	1	1.9
Raddish (for seed)	2.0 (soil)	1	2
Wheat (Foliar, S or F) (phase out in June 2005)	0.78 (soil or foliar)	1	1
Wheat-Fall (phase out in June, 2005)	0.63 (soil or foliar)	1	0.63

Total annual usage of disulfoton, as estimated by USGS (derived from the National Pesticide Use Database - NCFP), was 1,806,527 lbs in 1992 and 1,196,066 in 1997. Cotton, wheat and grains, and potatoes are the most significant crops for which disulfoton is used. The main usage areas are in the southeast, plains states, and the Pacific Northwest. Although this information is old, particular attention is given to the southeast quadrant of Washington, an area associated with the ESU's under review.

c. Disulfoton use

The EPA Quantitative Usage Analysis (Attachment 2) reports an average national usage of 1,217,000 lbs (weighted average) for the period 1987-1998. The major crops in the Northwest and California for disulfoton use appear to be Asparagus, Broccoli, Peppers, Barley, Potatoes, and Wheat. A summary of California trends in disulfoton use is given in table 4. Although a general trend toward reduced use of disulfoton is apparent, it was noted that conditions within a particular crop year dictate the amount of chemical use (i.e., 1996) and this can significantly alter the appearance of long term usage patterns.

Table 4: California Disulfoton Usage (lbs a.i.), 1992-2000 (CDPR)

1992	1993	1994	1995	1996	1997	1998	1999	2000
176,216	151,010	134,600	95,972	142,372	126,335	105,327	95,915	75,900

The National Pesticide Use Database (National Center for Agriculture Policy, 2001) indicates that, with respect to major crops in California and the Pacific Northwest, total application of disulfoton in 1992 (census report) was 821,337 lbs a.i./year. In the 1997 data, 560,367 lbs a.i of disulfoton (IRED QUA; Attachment 2) was applied to the same crops. The greatest decline was observed in total wheat application, which fell from 498,288 to 188,498 lbs ai/year.

Table 5: Domestic Usage of Disulfoton (lbs a.i.), 1992 and 1997 (NCFP)

Year	Crop	Location	Rate/Year (lbs a.i./A)	Total (lbs)
1992	Asparagus	National	1.267	40,216
1997	**Asparagus**	**National**	**1.90**	**64,451**
1992	Barley	National	0.826	35,613
1997	**Barley**	**National**	**0.845**	**57,156**
1992	Beans	National	1.024	40,126
1997	**Beans**	**National**	**1.021**	**19,484**
1992	Potatoes	National	2.582	207,094
1997	**Potatoes**	**National**	**3.219**	**230,778**
1992	Wheat	National	0.715	498,288
1997	**Wheat**	**National**	**0.806**	**188,498**

During this period, for the states of concern, the following use patterns were observed (Table 6)

Table 6: Usage Patterns for Disulfoton in California and the Pacific Northwest (NCFAP)

Year	Crop	Location	Rate/Year (lbs a.i./A)	Total (lbs)
1992	Asparagus	CA	1.270	16,212
1997	**Asparagus**	**CA**	**2.045**	**47,775**
1992	Asparagus	OR	1.720	1,740
1997	**Asparagus**	**OR**	**1.580**	**1,068**
1992	Asparagus	WA	1.240	22,264
1997	**Asparagus**	**WA**	**1.580**	**15,629**
1992	Barley	CA	0.880	11,088
1997	**Barley**	**CA**	**0.655**	**9,210**
1992	Barley	ID	0	0

1997	**Barley**	**ID**	**1.000**	**35,575**
1992	Potatoes	CA	2.891	7,441
1997	**Potatoes**	**CA**	**3.505**	**1,978**
1992	Potatoes	ID	3.350	37,989
1997	**Potatoes**	**ID**	**3.060**	**48,345**
1992	Potatoes	OR	2.390	19,359
1997	**Potatoes**	**OR**	**3.180**	**40,334**
1992	Potatoes	WA	2.760	102,010
1997	**Potatoes**	**WA**	**4.360**	**108,180**
1992	Wheat	CA	0.816	24,684
1997	**Wheat**	**CA**	**0.661**	**7,734**
1992	Wheat	ID	0	0
1997	**Wheat**	**ID**	**1.000**	**14,110**
1992	Wheat	OR	0.890	16,465
1997	**Wheat**	**OR**	**1.060**	**9,358**
1992	Wheat	WA	0.750	72,600
1997	**Wheat**	**WA**	**1.060**	**25,679**

In the state of California detailed accounting of disulfoton is available, indexed to both the major sites and the counties where the pesticide is applied commercially**.** Table 5 summarizes the major crop sites listed on which disulfoton was used in 2001, the most recent year available.

Table 7: California Disulfoton Usage, lbs a.i. (California Department of Pesticide Regulation)

Crop Site	Pounds Applied	Acres
Asparagus	16,583	8,675
Barley	195	208
Beans	487	351
Bermuda Grass	221	293
Broccoli	4,915	4,764

Brussel Sprouts	208	205
Cabbage	1,348	696
Cauliflower	1,494	1,151
Cotton	505	997
Landscape	25	NR
Lettuce (leaf and head)	1,092	13,524
Peas	108	147
Pepper	3,313	1,984
Tomato	544	5,771
Wheat	1,991	3,011

Oregon, Washington, and Idaho do not release detailed reports on specific use of pesticides, but summaries of use are available from other sources (NCFAP, USDA Crop Census, etc.). The combination of state-wide totals, USDA crop census data, and actual use data, where available, does allow a reasonable approximation of the most extreme usage of disulfoton, within the accepted labeling restrictions (maximum rate x acres treated). Where specific data is available, surveys of specific crop applications, by National Center for Food and Agricultural Policy (Gianessi and Marcelli, 2000), and information from registrants was used to refine the number of pounds of disulfoton applied. In many cases, this estimate is a significant over estimate with regard to the ESU's of interest, i.e., most disulfoton in Idaho barley is used in the eastern portion of the state, but our estimates are averaged over the entire state. Sites indicated by "*" represent uncorrected, calculated use based on 100% application to all crops at the maximum label rate, and are considered to be a significant overestimation.

Table 8: Idaho Usage (lbs a.i) of Disulfoton (NCFAP, 2000 Report)

Crop Site	Pounds Applied	Acres treated
Potatoes	48,435	15,799
Christmas Trees	**Disulfoton not used (NAGS no use data)**	**1,020**
Barley	35,575	22,412
Wheat	14,110	14,110
Beans*	3,380	2704
Peas*	2,706	4,277
Asparagus*	227	361

Cabbage*	13	20
Lettuce*	10	16
Broccoli*	8	12
Cauliflower*	2.5	4

*Estimated maximum use under current label

Table 9: Washington Usage of Disulfoton, lbs a.i. (NCFAP Report, 2000)

Crop Site	Pounds Applied	Acres Treated
Asparagus[a]	15,629	9,892
Barley	436,289	**270,499**
Beans*	46,443	37,155
Cabbage*	376	597
Cauliflower	111	120
Christmas Trees*	6,670	6,670
Peas*	158,718	126,975
Potatoes	108,080	24,812
Radish*	206	327
Wheat	25,679	24,225

*Estimated maximum use under current registration

Table 10: Oregon Disulfoton Usage, lbs a.i., (NCFAP Report, 2000)

Crop Site	Pounds Applied	Acres Treated
Asparagus[a]	1,068	676
Barley*	6,874	10,911
Beans*	32,390	35,912
Broccoli*	2,438	3,869
Cabbage*	509	808
Cauliflower*	441	474
Christmas Trees	**Disulfoton not used (NAGS No Use Data)**	18,628

Peas*	39,493	31,594
Potatoes	40,334	12,684
Wheat	9,358	8,829
Lettuce*	173	274

*Estimated Maximum Use Under Current Registration

The tabulated data for Oregon, Washington, and Idaho represents a maximum application rate on all reported crop-land including wheat and barley. The more detailed information generated from the California report suggests that only a portion of the acres planted are actually treated with disulfoton and in some circumstances the application rate is significantly less that the maximum allowable application rate. The NCFAP data appears to support the reduced usage seen in the CDPR report, although the number of pounds reported as applied frequently appears to exceed currently approved application rates, but was within label guidelines at the time of the survey (1997). The data, however, is based on the 1997 crop census. The use of maximum application rates to all planted lands is also a source of overestimation due to the fiscal pressure to utilize pesticides on an "as needed" basis only. This suggests that Oregon, Washington and Idaho total use data is most likely a significant over-estimation, based on a comparable crop distribution in California where significantly less than 100% of the planted crops are treated, of actual pesticide use, however we have insufficient data to confirm this. A significant overestimate, however, would imply the risks calculated from model data for the species of interest is much lower than the following usage tables for specific ESUs suggest.

Within Oregon and Washington, large numbers of Christmas trees are grown. NAGS data indicates that disulfoton is definitely not applied in Oregon, and probably not in Washington. For this reason, Christmas tree applications will not be considered further in the single county/ESU tables below.

3. General Aquatic Risk Assessment for Endangered and Threatened Salmon and Steelhead

a. Aquatic Toxicity:

i. Freshwater Fish, Acute

The acute toxicity data for fresh water fish (Table 11) indicates that disulfoton and its major derivatives, the sulfoxide and sulfone are slightly to very highly toxic to freshwater fish (from the Interim Reregistration Eligibility Document for Disulfoton - D237134. (IRED)). The required tests were performed on Rainbow Trout (cold water species) and Bluegill Sunfish (a warm water fish) using technical grade disulfoton, major formulations and the major degradates, sulfoxide and the sulfone. Review of submitted data confirmed the significantly greater sensitivity to disulfoton in bluegill sunfish, when compared to rainbow trout. Mayer and Ellersieck (1986) reported that toxicity, particularly for organophosphate compounds, increased steeply with increasing temperature. Toxicity increased by a factor of 3.1 for each 10^o C increase, which they suggest is due to increased acetylcholinesterase (AChE) activity and simultaneous AChE inhibition. In their studies (410 chemicals and 66 freshwater species), the correlation between toxicity in rainbow trout and coho and chinook salmon was 0.95 and 0.98 respectively. While these findings may not completely explain the variation in sensitivity to disulfoton and it's major degradates seen between the bluegill sunfish and rainbow trout, the difference is acknowledged as extreme and the company (via email), Mayer (of Mayer and Ellersieck, telephone communication), and we have found no explanation for it. The rainbow trout, however, is a much more similar organism to those of interest for this report. Like salmon and steelhead, the trout model is a cold water fish and genetically much more closely related than is the bluegill. On this basis, toxicity data and the derived Risk Quotients (RQs) for the T&E species would likely be better represented by the trout model. The values presented for in this report, however, follow OPP policy by referring to data generated from the most sensitive species.

Table 11 Acute Toxicity of Disulfoton and Primary Degradates to Freshwater Fish

Fish Name	*Taxonomic Name*	*% a.i.*	*LC50 (ppb a.i.)*	*Toxicity Category*
Rainbow Trout	*Oncorhynchus mykiss*	Tech	3,000	Moderately Toxicity
Rainbow Trout	*Oncorhynchus mykiss*	D. Sulfone	>9,200 (saturation)	Moderately Toxic
Rainbow Trout	*Oncorhynchus mykiss*	D. Sulfoxide	60,300	Slightly Toxic
Rainbow Trout	*Oncorhynchus mykiss*	15G	13,900	Slightly Toxic
Rainbow Trout	*Oncorhynchus mykiss*	65EC	3,500	Moderately Toxic
Bluegill Sunfish	*Lepomis macrochirus*	Tech	39	Very Highly Toxic
Bluegill Sunfish	*Lepomis macrochirus*	D. Sulfone	112	Highly Toxic
Bluegill Sunfish	*Lepomis macrochirus*	D. Sulfoxide	188	Highly Toxic
Bluegill Sunfish	*Lepomis macrochirus*	15G	250	Highly Toxic
Bluegill Sunfish	*Lepomis macrochirus*	65EC	59	Very Highly Toxic

Bluegill Sunfish	*Lepomis macrochirus*	20E	8.2	Very Highly Toxic
Channel Catfish	*Ictalurus punctatus*	98	4,700	Moderately Toxic
Goldfish	*Carassius auratus*	90	7,200	Moderately Toxic

ii. Freshwater Invertebrates, Acute

. The preferred species is *Daphnia magna*. Results of acute toxicity testing for aquatic invertebrates are presented in Table 12 (from the IRED). Based on the known action and intended use of disulfoton as an insecticide, it would be predicted that invertebrates would show considerable sensitivity to disulfoton when it reaches water by runoff or drift.

Table 12: Acute Toxicity of Disulfoton and Primary Degradates to Freshwater Invertebrates

Name	***Taxonomic Name***	***% a.i.***	***LC50 ppb***	***Toxicity Category***
Waterflea	*Daphnia magna*	98.6	13	Very Highly Toxic
Waterflea	*Daphnia magna*	Sulphone Metabolite 87.4	35.2	Very Highly Toxic
Waterflea	*Daphnia magna*	Sulfoxide Metabolite 85.3	64	Very Highly Toxic
Scud	*Gammarus fasciatus*	98	52	Very Highly Toxic
Glass Shrimp	*Palaemonetes kadiakensis*	98	3.9	Very Highly Toxic
Stonefly	*Acroneuria pacifica*	89	<8.2	Very Highly Toxic
Stonefly	*Pteronarcys californica*	98	5.0	Very Highly Toxic

iii. Freshwater Fish, Chronic Toxicity:

The preferred test species is *Oncorhynchus mykiss*. Results of chronic toxicity testing for disulfoton are shown below. (from the IRED)

Table 13: Chronic Toxicity of Disulfoton to Freshwater Fish

Species	***Taxonomic Name***	***%a.i.***	***NOAEC ppb***	***LOAEC ppb***	***Duration ppb***	***Endpoint Affected***
Rainbow Trout	*Oncorhynchus mykiss*	98	220	420	35 Days (early life stage)	Growth of Young

B. Estuarine/Marine

iv. Freshwater Invertebrates, Chronic Toxicity

Results of chronic toxicity testing of disulfoton and its degradates are shown in Table 14 (from the IRED)

Table 14: Chronic Toxicity of Disulfoton and Primary Degradates to Freshwater Invertebrates

Species	***Taxonomic Name***	*%a.i.*	*NOAEC (ppb)*	***LOAEC*** *(ppb)*	***Time***	*Endpoints Affected*
Waterflea	*Daphnia magna*	98 (21D)	0.037	0.070	21 Days	Survival, Length, and #young/adult
Waterflea	*Daphnia magna*	Sulfone Metabolite (21D)	0.14	0.27	21 Days	Length
Waterflea	*Daphnia magna*	Sulfoxide Metabolite (21D)	1.53	2.97	21 Days	Length and Weight

b. Estuarine and Marine Toxicity

i.. Estuarine and Marine Fish, Acute Toxicity

Results obtained for disulfoton and major degradates, obtained for *Cyprinodon variegatus*, are presented in Table 15 (from the IRED).

Table 15: Acute Toxicity of Disulfoton and Primary Degradates to Marine/Estuarine Fish

Species	*Taxonomic Name*	*%a.i.*	*LC50(ppb)*	*Toxicity Category*
Sheepshead Minnow	*Cyprinodon variegatus*	95.5	520	Highly Toxic
Sheepshead Minnow	*Cyprinodon variegatus*	97.8	>1000	*at least* Highly Toxic
Sheepshead Minnow	*Cyprinodon variegatus*	Sulphone Metabolite - 100%	1060	Moderately Toxic
Sheepshead Minnow	*Cyprinodon variegatus*	Sulfoxide Metabolite 100%	11,300	Slightly Toxic

ii. Estuarine/Marine Invertebrates, Acute

Results of testing for Disulfoton with estuarine invertebrates are shown in Table 16 (from the IRED). Esturaine species appear much less sensitive than aquatic invertebrates.

Table 16: **Acute Toxicity of Disulfoton to Marine/Esturarine Invertebrates**

Species	*Taxonomic Name*	*%a.i.*	*LC50/EC50 ppb*	*Toxicity Category*
Eastern Oyster	*Crassostrea virginica* Spat EC50	97.8	720	Highly Toxic
Eastern Oyster	*Crassostrea virginica* Spat EC50	Tech	900	Highly Toxic
Eastern Oyster	*Crassostrea virginica* Spat EC50	95.5	720	Highly Toxic
Mysid	*Americamysis bahia*	97.8	100	Very Highly Toxic
Brown Shrimp	*Penaeus aztecus*	95.5	15	Very Highly Toxic

iii. Estuarine/Marine Fish, Chronic Toxicity

Results of esturarine chronic testing on marine fish was conducted using the Sheepshead minnow model (Table 17).

Table 17: Chronic Toxicity of Disulfoton to Marine/Esturaine Fish

Species	*Taxonomic Name*	*%a.i.*	*NOEC*	*LOEC ppb*	*Duration*	*Parameters Affected*
Sheepshead Minnow	*Cyprinodon variegatus*	94.7	16.2	32.9	33 Days	Survival, length, wet weight
Sheepshead Minnow	*Cyprinodon variegatus*	98	0.96[1]	2.9	110 Days	Fecundity, morphologic abnormalities growth, hatching success

[1]An actual NOEC was not achieved in this study. The value reported is an EC05, extrapolated using linear regression.

iv. Estuarine/Marine Invertebrates, Chronic Toxicity

. Results of disulfoton testing are shown in Table 18.(from the IRED)

Table 18: Chronic Toxicity of Disulfoton to Marine/Estuarine Invertebrates

Species	*Taxonomic Name*	*%a.i.*	*NOEC ppb*	*LOEC ppb*	*Duration*	*Parameters Affected*
Mysid	*Americamysis bahia*	98.5	2.35[1]	8.26	32 Days	Growth

[1] A NOEC was extrapolated from the EC05 using linear regression.

A review of the toxicity data demonstrates some variation between formulations. The 15G and 65EC products appear similar, but the 20E product was significantly more toxic relative to the a.i. content than the technical grade. This suggests potential synergistic effects with "inert" ingredients. We do not, however, have available data to evaluate the significance of this deviation from expected findings.

b. Environmental fate and transport:

Parent disulfoton has low to intermediate potential mobility (K_{oc}s 386-888) and is neither persistent (average half-life, $T_{1/2}$ is 4 days) nor volatile. Photochemical and aerobic metabolic mechanisms are the principal degradation pathways. Aerobic soil metabolism data indicated the sulfoxide ($T_{1/2}$ >17 Days) and sulfone ($T_{1/2}$ > 120 Days) degradates of disulfoton are more persistent and mobile than the parent. Field dissipation information indicates that the degradates may persist longer in the environment than under laboratory conditions. D. sulfoxide has a half life of 8 to 10 weeks and D. sulfone remained fairly stable over a 294 day period. There is insufficient environmental fate information on the degradates to fully characterize their fate and transport. The half life for total disulfoton residues was greater than 170 days. Open literature suggests that D. sulfoxide can be reduced back to disulfoton. Aerobic aquatic metabolism studies which could provide valid model input for the degradates D. sulfoxide and D. sulfone have not been submitted. Anaerobic studies have also not been submitted, but it is anicipated that both in the field and in the highly oxygenated habitat of stelhead and salmon, anaerobic degradation would play a minor role

The parent compound is essentially stable to abiotic hydrolysis at 20^{o} C. Photo-degradation is more rapid (half-life 93 hours) than hydrolytic breakdown. Aquatic degradation studies were not included in the EFED data, and a request for data from the registrant was included in the review Disulfoton photo-degrades within 2.4 days on soil and in water, under natural light, the $T_{1/2}$ is 4 days. Disulfoton is stable to hydrolysis at 20^{o} C at pH 5, 7, and 9, but hydrolyzes more rapidly at higher temperatures. Soil applied disulfoton will be oxidized rapidly by chemical reaction and microbial action to its corresponding D. sulfoxide and D sulfone. These degradation products are quantitatively less toxic than the parent disulfoton, however they still retain significant toxicity for both the species of concern in this report, but also maintain the potential for indirect risk through the possible compromise of invertebrate food sources for young, early stage fish in the spawning and rearing areas of the ESUs.

While the above and additional data on dissipation relate to loss of disulfoton and its degradates from lentic waters, in this current analysis, the concentrations of disulfoton in waters where most salmon and steelhead occur, are more likely to be controlled by direct dilution and dissipation through movement downstream.

The registrant provided the Agency with additional information concerning the fate of disulfoton residues in water under controlled conditions. These studies provide data concerning the combined effects of hydrolysis, photolysis, and metabolism, with photo degradation contributing significantly to dissipation. In this current review, however, the concentration of disulfoton on aquatic areas of interest is more likely due to direct dilution and dissipation. This is based on the limited half-life of disulfoton and typically low retention time in the fast flowing water preferred by salmon and steelhead. Except west of the Cascades, there is very limited precipitation that would cause runoff of disulfoton applied to the soil at planting time or to foliage after emergence of the crop. West of the cascades, precipitation is frequent, but not often of sufficient amount for significant runoff. Exceptions can be expected in drought periods, when flow is reduced, or during commonly encountered storms in mid-winter. The spring snowmelt also provides periods of maximum flow and, presumed, dissipation of disulfoton. (West Coast Chinook Salmon Biological Review Team, 1997). Additional studies have indicated that the length of time the juveniles remain in streams and tributaries and the duration of oceanic life cycles can vary considerably, based on a wide range of environmental factors, such as temperature, flow rates, water quality, oxygenation, and oceanic productivity (Reimers, 1973). These factors may contribute to the length of time the species are exposed to disulfoton, or its degradates.

c. Incidents

Since 1991, 3 incidents of fish kills are listed (report numbers B00002156-025, I001167-001, and I003826-002). Disulfoton was listed as an uncertan cause in two incidents and in one as probable. These incidents involved fish in private or commercial ponds, located in close proximity to treated agricultural sites. One each took place in California, Delaware, and South Carolina. In one instance, the event was associated with heavy rainfall after treatment of a wheat field. Water concentrations of disulfoton degradation products ranged from 29.5 to 48.7 ppb for the sulfoxide and 0.0199 - 0.214 ppb for the sulfone. Possible disulfoton effects were noted, however the oxygenation of the water, after flooding, was considered very likely as a prime cause. In another incident, disulfoton was identified in water at a level of 0.32 ppb, however endosulfan was detected at 1.2µg/L and was the more probable cause.

In the final report, probable involvement of disulfoton was associated with a registered use, on a golf course, however the restrictions and application guidelines were not adhered to (application uphill from and too close to a pond).

d. Estimated and actual concentrations of Disulfoton in water

The potential surface water contamination by Disulfoton (and its degradates) included Tier II estimated environmental concentrations (EECs) of disulfoton and total disulfoton residues (TDR sum of Disulfoton, D. sulfoxide, and D. sulfone) in surface water. Tier I was not included because levels of concern are generally exceeded in GENEEC models for organophosphate insecticides. The Tier II model for surface water was derived using the PRZM3 and EXAMS models applied to barley, cotton, potatoes, tobacco, and spring wheat using maximum label rates and several application methods. These estimates are based on the standard farm pond scenario, with runoff and drift to a 1 ha surface water body, 2 m deep situated in a 10 ha crop of barley, cotton, potato, tobacco, or spring wheat, all of which is treated. PRZM models were generated using maximum label application rates, maximum applications/year, and minimum application interval. Following EFED guidelines, high runoff sites were selected (barley in the Southern Piedmont of Virginia, cotton in the Southern Mississippi Valley Silty Uplands, potatoes in Maine and Eastern New York Upland of Maine, amd spring wheat in the Rolling Till Prarie of South Dakota), where runoff would is expected to be greater than 90% of the sites where the crop is grown. Spray drift is assumed to be 5% for aerial spray of liquid formulations; 1% for ground spray, and 0% for granular or soil incorporated applications. The modeled EECs also assume a lentic pond, surrounded by 100% cropped and treated land over a 20 -40 year period, with a 10% probability that in any given year the maximum will equal or exceed the EEC at that site. Relevant data for the crops in the areas of interest are presented below (Tables 19 and 20).The application rates used and the number of applications/season are significantly higher than those listed as eligible in the referenced IRED. At the present time, both application rates and the number of applications/year have been reduced. This would reduce EECs if model scenarios were repeated using current input variables. This information, or any potential for a re-evaluation, were not avilable to this reviewer and may not be under consideration due to the steady decline in product use and spectrum of formulations being marketed at the time of this report.

Table 19: Tier II Upper Tenth percentile EECs for parent disulfoton Used in Barley, Cotton, Potatoes, and Spring Wheat for several application (Label Maximum) rates using PRZMS/EXAMS Models in the Standard Farm Pond .

Crop	Application [1]	Peak µg/l	96 Hour Avg.µg/l	21 Day Avg µg/l	60 Day Avg µg/l	90 Day Avg µg/l	Annual Average µg/l	Mean of Annual Means µg/l
Barley	1.0/2/21/0/f	9.20	7.93	5.96	3.79	2.82	0.79	0.56
Barley	0.83/2/21/0/s/gran	7.14	6.37	4.36	2.37	1.73	1.73	0.21
Cotton	1.0/3/2/21/0/s	14.79	12.96	8.05	4.91	3.44	0.92	0.48
Potatoes	4.0/2/14/2.5/s	7.14	6.40	4.51	2.59	1.80	0.44	0.33
Potatoes	1.0/3/14/0/f	15.02	13.24	10.40	6.89	4.89	1.23	1.14
Sp. Wheat	0.75/2/30/0/f	8.90	7.95	5.47	3.81	2.76	0.73	0.66

[1]Rate/Number of Applications/Interval between applications//Incorporation depth in inches/method (Method of Application: f=foliar and s=soil)

Table 20: Tier II Upper Tenth Percentile EECs for total disulfoton residues on Barley, cotton, potatoes, and Spring Wheat for Several Application (Label Maximum) rates using PRZMS3/EXAMS in the Standard Pond

Crop	Application [1]	Peak µg/l	96-Hour Avg	21-Day Avg	60 Day Avg	90 Day Avg	Annual Mean	Mean of Annual Means
Barley	1.0/2/21/0/f	21.7	20.99	19.27	17.35	16.48	7.51	4.94
Barley	0.83/2/21/0/s/gran	19.95	19.34	17.44	15.02	14.46	6.0	3.89
Cotton	1.0/3/21/0/s	44.78	43.50	39.27	34.37	32.41	15.61	9.13
Potatoes	4.0/2/14/2.5/s	15.43	14.94	13.51	12.20	10.97	6.02	4.48
Potatoes	1.0/3/14/0/f	26.36	26.69	23.92	20.88	19.33	9.75	8..37
Sp. Wheat	0.75/2/30/0/f	16.92	16.36	14.91	12.56	11.29	5.65	4.73

[1]Rate/Number of Applications/Interval between applications//Incorporation depth in inches/method (Method of Application: f=foliar and s=soil)

Monitoring:

Surface water samples were collected in the Nomini Creek Watershed, Virginia during a study to evaluate Best Management Practices, in a watershed with a total area of 3,616 acres. Disulfoton was detected from monitoring sites at concentrations from 0.37 to 6.11 ppb. Specific sample times were not correlated to disulfoton application. The USGS NAWQA, study, with 5,196 samples detected parent disulfoton concentrations >0.01µg/l in 29 samples total. In California, CDPR examination of 860 samples from 10 counties demonstrated disulfoton in 2 samples, both of which were at concentrations of 0.06 ppb.

e. Recent changes in Disulfoton registrations

The manufacturer has reduced application rates and applications /year of disulfoton in at least four major crops of interest in the Northwest and California. For cotton the number of applications has been reduced from 3 /year to 1/year and aerial application is no longer acceptable. Ground application to potatoes has been reduced from 4 to1 lb ai/A and the application number reduced from 3 to 1/year. Application to wheat, barley, potatoes, and commercial ornamentals are listed for phaseout (by 2004), which could remove as much as 756,000 lbs. of the amount of disulfoton applied in the study area. These modifications can be expected to significantly reduce disulfoton release to the localities of interest. Residential use is limited to products with ≤2% a.i.

f. Discussion and general risk conclusions for Disulfoton

For all freshwater fish species, the level of concern (LOC) did not exceed the high risk criterion of RQs >0.5 (Table 21) for any of the relevant crop applications in CA,OR,WA and ID, including Potato (foliar), Potato (soil), Cotton (soil), Barley (foliar), Barley (soil), Spring Wheat (foliar) based on former application rates, multiple applications, and eastern climate and soil conditions.

. The LOC for restricted use pesticides (0.1) was exceeded for all crop scenarios in the bluegill sunfish, but not with the rainbow trout. The endangered species LOC (0.05) for acute risk is exceeded in all blue gill sunfish models, but in none of the rainbow trout examples cited. The greatest exceedances were observed with foliar Potato application and ground application to cotton (R.Q.= 0.3).

Review of the fish related data clearly indicates the greater sensitivity of Bluegill Sunfish to disulfoton relative to 6 of 9 other fish tested. Examination of testing methods revealed the only significant difference between the methodology used in the sunfish and that in the trout surrogate was temperature (cold water vs warm water systems). Although, as previously noted, the literature indicates higher toxicity with AChE inhibitors as temperature is elevated, this does not appear sufficient for the observed results. Review of data demonstrated that tests on the Guppy (LC_{50}=280 ppb) and Largemouth Bass (LC_{50}=60 ppb), both warm water fish, showed similar increased sensitivity as in the bluegill. Discussions with the registrant have, at this time, also failed to be revealing. Mayer (telephone conversation) suggested a general familial characteristic of Centrarchids. For purposes of this review, however, it is apparent that the Rainbow Trout is a superior model for the species of interest, due to closer genetic ties, the similar pattern of behavior, and the similarity of the preferred environmental conditions.

Table 21: Acute Risk Quotients-Fish

Use Pattern	PK EEC	Bluegill LC_{50}=39 ppb	Rainbow Trout LC_{50}=1850 ppb	Channel Catfish LC_{50}=4700 ppb
Potato, Foliar, 1lb ai/A, 3 App/14 days ,	15.0 ppb	0.3	<0.01	<0.01
Cotton, Soil 1lb ai/A, 3 Appl/21 days, not Incorp.	14.8 ppb	0.3	<0.01	<0.01
Barley, foliar, 1 lb ai/A, 2 Appl/21 days, not Incorp.	9.2 ppb	0.02	<0.01	<0.01
Spr. Wheat, foliar0.75 lb ai/A.,2 appl/30 days, not incorp.	8.9 ppb	0.2	<0.01	<0.01
Barley, soil gr/0.83 lb ai/A/2 appl/21 days, not incorp.	7.1 ppb	0.18	<0.01	<0.01
Potato, soil,4 lb ai/A,2 appl/14 days, incorp to 2.5 in.	7.1 ppb	0.18	<0.01	<0.01

Invertebrate acute risk was considered a matter of concern. The RQ values exceed the Agency risk levels for endangered acute risk, restricted use, and high acute risk for all applications and all species, except the mysid (exceeded restricted and endangered species levels)and the oyster.The elevated R.Q.'s for invertebrates is a factor in the label restrictions currently applied due to the possibility that reduction of invertebrates, a major food source for the fingerlings of T&E salmonids and steelhead, would pose a potential indirect risk. Fingerlings and smolts, however, develop an increasingly mobile life style, generally moving toward lower portions of the stream or tributary, and it would be expected that disulfoton concentration would be proportionally reduced by dilution and degradation. The influence of invertebrate loss on fry, which are less mobile and tend to remain for a variable period of time in the redds, is mitigated due to nutritional provision of the yolk sac. This sac, an extra-embryonic membrane in fish, in concert with the embryonic jelly layer, tends to isolate the alevins from the external environment due to circulatory patterns present during this life cycle stage. Because no yolk sac contents directly enter the fish, but rather are hydrolyzed in the sac, foreign materials that manage to cross the protective layers will be subjected to intense breakdown. These factors should reduce the potential T&E species risk through loss of invertebrate food sources and direct exposure to disulfoton. In addition, steelhead tend to disperse aggresively both upstream and downstream, reducing exposure. An area of concern is the enhanced growth rate seen when additional food is provided (artificially), which implies, perhaps, a reduction of growth might follow a reduction in food supply.

A summary of Acute Risk Quotients for invertebrates are shown below.

Table 22: Acute Risk Quotients-Invertebrates

Use Pattern	PK EEC	Glass Shrimp LC_{50}= 3.9ppb	Stonefly LC_{50}= 5.0 ppb	Waterflea LC_{50}= 13 ppb
Potato, Foliar, 1lb ai/A, 3 App/14 days	15.0 ppb	**3.8**	**3.0**	**1.1**
Cotton, Soil 1lb ai/A, 3 Appl/21 days, not Incorp.	14.8 ppb	**3.7**	**3.0**	**1.1**
Barley, foliar, 1 lb ai/A, 2 Appl/21 days, not Incorp.	9.2 ppb	**2.3**	**1.8**	**0.7**
Spr. Wheat, foliar 0.75 lb ai/A.,2 appl/30 days, not incorp.	50.8 ppb	**2.2**	**1.7**	**0.6**
Barley, soil ground, 0.83 lb ai/A/2 appl/21 days, not incorp.	701 ppb	**1.8**	**1.4**	0.5
Potato, soil,4 lb ai/A,2 appl/14 days, incorp to 2.5 in.	507 ppb	**1.8**	**1.4**	0.5

RQs Exceeding the acute risk LOC of 0.5 are highlighted

Chronic risk in freshwater and marine animals indicated that the chronic RQs for fish were not exceeded for any of the crop use patterns in the rainbow trout model. Chronic risk was exceeded in the bluegill for foliar potato and soil cotton applications. Full life cycle testing in the sheepshead minnow demonstrated exceedances for all crop scenarios applied (Table 22).

Table 22: Chronic RQs for Freshwater Fish

Application	EEC ppb	Bluegill NOEC=4.6ppb	Rainbow Trout NOEC=220ppb
Potato, foliar 1lb a.i/A, 3 Appl. @14 day interval, not inc.	21d= 17.9 60d=9.9	2.0	<0.1
Cotton, soil 1lb/A, 3 Appl. @21 day interval, not Incorp.	21d=10.4 60d=4.9	1.4	<0.1
Barley, foliar, 1lb/A, 2 Appl. @ 21 day interval, not incorp.	21d=5.9 60d=3.7	0.8	<0.1
S.Wheat, foliar, 0.75lb/A, 2 Appl. @ 30 day interval, not incorp.	21d= 4.5 60d=2.6	0.5	<0.1
Potato, soil, 4lb/A, 2 Appl. @ 14 day interv., incorp 2.5 in	21d= 4.3 60d=2.3	0.5	<0.1
Barley, soil, 0.63lb/A, 2 Appl. @ 21 day interv., not incorp.	21d=5.4 60d=3.8	0.08	<0.1

Freshwater and marine/estuarine testing of invertebrates revealed exceedances for all crop scenarios in both the freshwater (water flea) and marine species, full life cycle (mysid). Results are shown below.

Table 23: Chronic RQs for Freshwater Invertebrates

Application	EEC ppb	Water Flea NOEC=0.037
Potato, foliar 1lb a.i/A, 3 Appl. @14 day interval, not inc.	21d=10.4 60d=6.9	281
Cotton, soil 1lb/A, 3 Appl. @21 day interval, not incorp.	21d=8.0 60d=4.9	216
Barley, foliar, 1lb/A, 2 Appl. @ 21 day interval, not incorp.	21d=5.9 60d=3.7	159
S.Wheat, foliar, 0.75lb/A, 2 Appl. @ 30 day interval, not incorp.	21d= 4.5 60d=2.6	121
Potato, soil, 4lb/A, 2 Appl. @ 14 day interv., incorp 2.5 in	21d= 4.3 60d=2.3	116
Barley, soil, 0.63lb/A, 2 Appl. @ 21 day interv., not incorp.	21d=5.4 60d=3.8	145

The above data suggests that chronic toxicity to freshwater invertebrates is significantly higher than that observed for fish. None of the model criteria groups for disulfoton reduced the LOC below the chronic LOC limit of 1.0, although chronic exposure is not expected.

In reviewing this information, it should be noted that some of the more recent mitigations in the current IRED were not taken into account. These include the reductions in application rates, the reduction in application number per season, and perhaps most importantly for the invertebrate populations, the presence of a well maintained 25 foot buffer zone. These factors, if applied, could reasonably be expected to reduce the RQs significantly, even if the amount can not be quantified.

Although results from bluegill fish testing appear to be of concern, the results from the trout tests significantly reduce the potential concerns for salmon and steelhead. As mentioned previously, there are sound reasons why the latter more likely reflects actual risk to Pacific salmon and steelhead. In regard to the possible indirect effects from loss of food sources, it was noted that the parent is not particularly mobile and effects would seem likely to be localized. Because the fish species of interest in the analysis are relatively mobile after leaving the redds, the localized effect is not likely to be significant.

The majority of the information relating to environmental risk and risk assessment is derived form models and application scenarios for commercial agriculture. Disulfoton is, however, approved for limited residential use on flower beds and shrubs. Previous use on spinach, tomatoes, vegetable gardens, and all indoor sites (including potted plants and greenhouses) are eliminated in the current IRED. Additionally, the concentration of active ingredient is limited to $\leq$ 2%. The same 25 foot buffer near permanent surface water used in commercial applications is required for residential use. Immediate soil incorporation or watering in of the product is a listed restriction and persons, other than the applicator, and pets are prohibited from entry until this is completed. These factors can be expected to reduce the overall introduction and dispersal of disulfoton to the environment, however the specific movement of pesticide in generally within urban areas is not well documented. The typically large portion of urban areas that is not available for soil absorption due to structures and pavement remains a matter not yet adequately understood. Nonetheless, I believe the homeowner use will have no effect on the ESU.

Disulfoton is available in formulations containing additional products. The two of relevance for this review are PCNB and etradiazole, primarily on California cotton. Both of these products provide fungicidal activity to augment the insecticidal actions of disulfoton and function through different biological pathways, suggesting they would not be additive to the toxicity directly. In addition, both are significantly less toxic independently to the T&E fish of interest (PCNB lowest fish LC_{50}=320 ppb; etradiazole lowest fish LC_{50}=770 ppb). Lacking evidence of specific synergism, the overall risk associated with a multi-compound product can generally be based on the effects of the most toxic component.

g. Existing protections

Maximum label were rates reduced to 0.3 lb/1000 ft^2 for residential flower beds; reduction to one application/year for all crops except barley and asparagus, where two applications/year are allowed. All formulations >2% a.i. are Restricted Use Only. Precautionary statements regarding aquatic toxicity are included and application to surface water prohibited. (EC and granular). Ecological mitigation includes a 25 foot vegetative buffer from permanent surface water sites.

In addition the IRED stipulates the use of disulfoton on barley, wheat, potatoes, and commercial ornamentals is eliminated by 2005 (Phase out by June 2005). It is not known to the reviewer if sales have already entered decline from this large reduction in use.

4. Listed Salmon and Steelhead ESUs and Comparison with Disulfoton Use Areas

The following is an estimate of disulfoton application, by counties and crops, the T&E Salmon and Steelhead in the listed ESU's from California, Oregon, Washington, and Idaho. Usage data for California is derived from the CDPR 2002 Annual Pesticide Use Report. Calculation methods for other states are the same as described in section 2: Description and Use, applied to individual counties and crops, based on the 1997 Crop Census. As in previous sections, where no additional data is available, the values represent total acres in crop multiplied by the maximum application rate. Where information on the relative percent of crops treated is available, this value is used rather than total acres. In those crops or counties where actual use indicates a reduced application rate, this is substituted for the label maximum. Suitable corrections have been included where warranted by specific data regarding use of disulfoton. Those indicated with a "*" were modified based on registrant information. Within the tables, crops listed as Vegetables (selected) include broccoli, cauliflower, and brussels sprouts. The common usage rate used is 0.63 lbs a.i./acre.

A. Steelhead

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

Steelhead typically migrate to marine waters after spending 2 years in fresh water. They then reside in marine waters for typically 2 or 3 years prior to returning to their natal stream to spawn as 4- or 5-year-olds. Unlike Pacific salmon, they are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying; most that do so are females. Steelhead adults typically spawn between December and June. Depending on water temperature, steelhead eggs may incubate in redds for 1.5 to 4 months before hatching as alevins. Following yolk sac absorption, alevins emerge as fry and begin actively feeding. Juveniles rear in fresh water from 1 to 4 years, then migrate to the ocean as ‘‘smolts.’’

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

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

<u>1. Southern California Steelhead ESU</u>

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, but unlikely, Topanga Creek. Neither of these creeks drain agricultural areas, however disulfoton products for residential use may constitute some stream impact. In addition, there is no use of disulfoton reported by DAR for either Los Angeles or San Diego counties for the year 2000. There is a potential for steelhead waters to drain agricultural areas in Ventura, Santa Barbara, and San Luis Obispo counties. Usage of Disulfoton in counties where this ESU occurs are presented in Table 18.

Table 18. Counties supporting the Southern California steelhead ESU

County	Crop	Disulfoton usage (pounds)	Acres
Los Angeles	Landscape	4	NR
San Diego	Landscape	3	NR
San Luis Obispo	Landscape	1	NR
San Luis Obispo	Pepper, Fruiting	821	406
San Luis Obispo	Peas	37	406
Santa Barbara	Landscape	1	NR
Santa Barbara	Peas	129	286
Santa Barbara	Pepper, Fruiting	100	76
Ventura	Landscape	3	NR
Ventura	Cabbage	1,977	1,165
Ventura	Pepper, Fruiting	741	405
Ventura	Mixed Vegetables	172	124

The greatest agricultural impact onthe Southern California Steelhead ESU would appear to be interests in Ventura and San Luis Obispo Counties, suggesting the most northern tributaries are likely to be those affected to the greatest degree. Significant consideration must be given to the southern borders of the ESU as a result of the Los Angeles metropolitan area. Because disulfoton is approved for residential use and not reported to CDPR, the potential total application of this product is relatively uncertain, particularly in contrast to the better understood and reported commercial agriculture sites. A combined effect of large, dense residential use of disulfoton with the potential for effect amplification due to limited soil retention in a largely paved and improved area leads to the concern that disulfoton in counties supporting this ESU may affect it.

2. South Central California Steelhead ESU

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

This ESU includes the Hydrologic units of Pajaro (upstream barriers - Chesbro Reservoir, North Fork Pachero Reservoir), Estrella, Salinas (upstream barriers - Nacimiento Reservoir, Salinas Dam, San Antonio Reservoir), Central Coastal (upstream barriers - Lopez Dam, Whale Rock Reservoir), Alisa-Elkhorn Sloughs, and Carmel. Counties of occurrence include Santa Cruz, San Benito, Monterey, and San Luis Obispo. There are agricultural areas in these counties, and these areas would be drained by waters where steelhead critical habitat occurs. Table 19 shows that Disulfoton usage is low in those counties where this ESU occurs.

Table 19: Counties supporting the South Central California steelhead ESU

County	Crop(s)	Disulfoton usage (pounds)	Acres
Monterey	Asparagus	2,380	2,359
Monterey	Bean	720	466
Monterey	Vegetables (labeled)	4,001	3,735
Monterey	Lettuce	3,475	1,937
Monterey	Pepper. Fruiting	32	32
Monterey	Pepper, spice	393	207
San Benito	Asparagus	293	290
San Benito	Cabbage	46	23
San Benito	Lettuce	687	360
San Benito	Pepper, Fruiting	451	244
San Benito	Vegetables (labeled)	2	2
San Mateo	Bean	20	13

San Luis Obispo	Landscape	1	NR
San Luis Obispo	Peas	39	22
San Luis Obispo	Pepper, Fruiting	821	406
Santa Clara	Vegetables (labeled)	246	220
Santa Clara	Landscape	4	NR
Santa Clara	Lettuce	544	258
Santa Clara	Mustard	43	21
Santa Clara	Pepper, Fruiting	1,000	508
Santa Clara	Tomato	460	227
Santa Cruz	Lettuce	508	251

This ESU is one in which a moderate degree of agriculture is present, but is often in the lower portions of rivers and streams. This location would appear to augment more rapid dissipation than high and, presumable smaller, tributaries are expected to do. In my opinion these finding indicate the disulfoton may affect this ESU, but is not likely to adversely affect it.

3. Central California Coast Steelhead ESU

The Central California coast steelhead ESU was proposed for listing as endangered on August 9, 1996 (61FR41541-41561) and the listing was made final, as threatened, a year later (62FR43937-43954, August 18, 1997). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787). This coastal steelhead ESU occupies California river basins from the Russian River, Sonoma County, to Aptos Creek, Santa Cruz County, (inclusive), and the drainage 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. Usage of Disulfoton in the counties where the Central California coast steelhead ESU is presented in Table 20.

Table 20: Counties supporting the Central California Coast steelhead ESU

County	Crop(s)	Disulfoton usage (pounds)	Acres
Alameda	Landscape	1	NR
Contra Costa	Landscape	1	NR
Marin		None	
Mendocino		None	
Napa		None	
San Francisco		None	
San Mateo	Bean	20	13
Santa Clara	Vegetables (labeled)	246	220
Santa Clara	Landscape	4	NR
Santa Clara	Lettuce	544	257
Santa Clara	Mustard	43	21
Santa Clara	Pepper, Fruiting	1,000	508
Santa Clara	Tomato, Processing	460	227
Santa Cruz	Lettuce	508	251
Solano	Research	2	NR
Sonoma	Landscape	1	NR

Beyond Santa Clara County, this ESU is not subjected to many areas of large scale, commercial disulfoton application. There are, however a few urban centers, the effects of which are difficult to predict based on current knowledge. The seasonal nature of the fish behavior, which coincides with late winter, early spring field preparation suggests that disulfoton use within counties supporting this ESU may affect the species, but is unlikely to adversely affect it.

4. California Central Valley Steelhead ESU

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

This ESU includes populations ranging from Shasta, Trinity, and Whiskeytown areas, along with other Sacramento River tributaries in the North, down the Central Valley along the San Joaquin River to and including the Merced River in the South, and then into San Pablo and San Francisco Bays. Counties at least partly within this area are Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Glenn, Marin, Merced, Nevada, Placer, Sacramento, San Francisco, San Joaquin, San Mateo, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tuloumne, Yolo, and Yuba. A large proportion of this area is heavily agricultural. Usage of Disulfoton in counties where the California Central Valley steelhead ESU occurs is presented in Table 21.

Table 21: Counties supporting the California Central Valley steelhead ESU.

County	Crop(s)	Disulfoton Applied (lbs)	Acres
Alameda	Landscape	1	NR
Amador		None	
Butte		None	
Calaveras		None	
Contra Costa	Landscape	None	
Glenn		None	
Marin		None	
Merced	Asparagus	129	128
Merced	Cabbage	16	8
Merced	Squash	16	3
Nevada		None	
Placer		None	
Sacramento	Asparagus	1,217	1,185
Sacramento	Landscape	1	NR
San Joaquin	Asparagus	13,736	13,716

San Mateo	Bean	20	13
San Francisco		None	
Shasta		None	
Solano	Research	3	NR
Sonoma	Landscape	1	NR
Stanislaus	Asparagus	41	40
Stanislaus	Vegetables (labeled)	56	56
Sutter	Asparagus	353	350
Tehama	Beans	121	313
Tuolumne		None	
Yolo	Asparagus	39	39
Yolo	Landscape	1	NR
Yuba		None	

The San Joaquin and Sacramento counties areas appear to be the major source of disulfoton use in this ESU, however other counties report rather minimal use, with the exception of application to asparagus. Little or no urban usage is reported, including major sites in San Francisco and Alameda Counties. The usage totals indicate that disulfoton use within the borders of the ESU will have no effect on T&E species of interest. The waterways are, however, subject to diversions and alterations in normal patterns. This I believe indicates that product use may affect the species, but is unlikely to adversely affect it.

5. Northern California Steelhead ESU

The Northern California steelhead ESU was proposed for listing as threatened on February 11, 2000 (65FR6960-6975) and the listing was made final on June 7, 2000 (65FR36074-36094). Critical Habitat has not yet been officially established.

This Northern California coastal steelhead ESU occupies river basins from Redwood Creek in Humboldt County, CA to the Gualala River, inclusive, in Mendocino County, CA. River entry ranges from August through June and spawning from December through April, with peak spawning in January in the larger basins and in late February and March in the smaller coastal basins. The Northern California ESU has both winter and summer steelhead, including what is presently considered to be the southernmost population of summer steelhead, in the Middle Fork Eel River. Counties included appear to be Humboldt, Mendocino, Trinity, and Lake. Table 22 shows the use of Disulfoton in the counties where the Northern California steelhead ESU occurs.

Table 22.: Counties supporting the Northern California steelhead ESU

County	Crop(s)	Disulfoton usage (pounds)	Acres
Humboldt		None	
Lake		None	
Mendocino		None	
Trinity		None	

Disulfoton is not used in this ESU and there will be no effect.

6. Upper Columbia River steelhead ESU

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

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

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

Tables 23 and 24 show the cropping information and maximum potential Disulfoton use for Washington counties where the Upper Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 23. Spawning and rearing areas supporting the Upper Columbia River steelhead ESU

St	County	Crops and acres planted	Disulfoton [1] Applied (lbs)	Acres
WA	Benton	Asparagus	3,726	1,638
WA	Benton	Vegetables (labeled)	13,721	21,779
WA	Benton	Barley	274*	435
WA	Benton	Wheat	82,529	130,998
WA	Franklin	Asparagus	17,228	8,610
WA	Franklin	Bean	1,752	1,752
WA	Franklin	Vegetables (labeled)	12,461	19,793
WA	Grant	Bean	9,525	9,525
WA	Grant	Vegetables (labeled)	29,829	47,347
WA	Grant	Asparagus	1,880	940
WA	Grant	Potatoes	1,023	44,263
WA	Grant	Barley	4,125*	6,548
WA	Grant	Wheat	128,204	203,498
WA	Kittitas	Christmas trees	28	28
WA	Okanogan	Wheat	5,298	8,410
WA	Okanogan	Barley	387*	614
WA	Yakima	Asparagus	14,060	7,034
WA	Yakima	Cabbage	188	144
WA	Yakima	Bean	8,929	8,929
WA	Yakima	Barley	316	502
WA	Yakima	Wheat	8,929	14,174

[1] Some of these values are calculated, based on methods outlined section 4.
* Denotes values modified from standard calculation on the basis of sales information provided by the registrant.

Table 24: Oregon and Washington counties that are migration corridors for the Upper Columbia River steelhead ESU.

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
OR	Clatsop		None	
OR	Columbia		None	
OR	Gilliam	Barley	8,300	13,175
OR	Gilliam	Wheat	74,556	95,584
OR	Hood River		None	
OR	Morrow	Wheat	131,983	167,067
OR	Morrow	Barley	≤100*	2,668
OR	Multnomah	Bean	146	77
OR	Multnomah	Barley	≤100*	220
OR	Multnomah	Wheat	1,063	1,688
OR	Sherman	Wheat	102,926	99,837
OR	Sherman	Barley	39,973	21,402
OR	Umatilla	Vegetables (labeled)	24,203	38,417
OR	Umatilla	Asparagus	2,478	1,239
OR	Umatilla	Wheat	163,656	259,772
OR	Umatilla	Barley	≤100*	16,364
OR	Wasco	Barley	≤100*	2,413
OR	Wasco	Wheat	39,923	63,369
WA	Clark	Barley	≤100*	830
WA	Cowlitz	Christmas trees	358	358
WA	Klickitat	Wheat	22,365	35,501
WA	Klickitat	Barley	≤100*	7,464
WA	Pacific	Christmas trees	22	22
WA	Skamania		None	
WA	Wahkiakum		None	

WA	Walla Walla	Wheat	146,432	232,419
WA	Walla Walla	Barley	≤100*	22,584
WA	Walla Walla	Asparagus	2,828	1,414
WA	Walla Walla	Bean	9,585	9,585
WA	Walla Walla	Vegetables (labeled)	7,803	12,386

The Upper Columbia Steelhead ESU is located in an extensively agricultural region with large crop sites and associated large quantities of disulfoton application. This finding appears to apply to both the critical spawning and rearing habitat and to the migratory corridors. Several major crops are currently scheduled for phase out in 2005 (wheat, barley, potatoes) which may require a reevaluation, however at this time, based on the information available I conclude that product use may affect the ESU.

7. Snake River Basin steelhead ESU

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

Spawning and early growth areas of this ESU consist of all areas upstream from the confluence of the Snake River and the Columbia River as far as fish passage is possible. Hells Canyon Dam on the Snake River and Dworshak Dam on the Clearwater River, along with Napias Creek Falls near Salmon, Idaho, are named as impassable barriers. These areas include the counties of Wallowa, Baker, Union, and Umatilla (northeastern part) in Oregon; Asotin, Garfield, Columbia, Whitman, Franklin, and Walla Walla in Washington; and Adams, Idaho, Nez Perce, Blaine, Custer, Lemhi, Boise, Valley, Lewis, Clearwater, and Latah in Idaho. Baker County, Oregon, which has a tiny fragment of the Imnaha River watershed was excluded. While a small part of Rock Creek that extends into Baker County, this occurs at 7200 feet in the mountains (partly in a wilderness area) and is of no significance with respect to disulfoton use in agricultural areas. Similarly excluded are 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. They have been excluded because they are not relevant to use of disulfoton. 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 it 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.

Tables 25 and 26 show 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.

Table 25: Rearing/spawning areas supporting the Snake River Basin steelhead ESU .

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
ID	Adams	Barley	20	312
ID	Adams	Wheat	126	200
ID	Clearwater	Wheat	45,623	72,419
ID	Clearwater	Barley	382	6,058
ID	Custer	Barley	149	2,368
ID	Custer	Wheat	813	1,290
ID	Idaho	Wheat	43,505	69,057
ID	Idaho	Barley	1,819	28,872
ID	Latah	Barley	11,728	18,615
ID	Latah	Wheat	65,774	104,403
ID	Lemhi		none	
ID	Lewis	Wheat	45,094	71,580
ID	Lewis	Barley	1,173	21,851
ID	Nez Perce	Barley	1,332	21,135
ID	Nez Perce	Wheat	55,235	87,675
ID	Valley	Wheat	411	652
OR	Union	Wheat	22,928	36,394
OR	Union		none	
OR	Wallowa		None	
WA	Adams	Bean	10,282	10,282

WA	Adams	Vegetables (labeled)	644	1,339
WA	Adams	Asparagus	844	422
WA	Asotin	Wheat	13,304	21,118
WA	Asotin	Barley	≤100*	10,205
WA	Columbia	Wheat	48,831	77,511
WA	Columbia	Barley	≤100*	17,567
WA	Franklin	Asparagus	17,228	8,610
WA	Franklin	Wheat	69,065	109,627
WA	Franklin	Bean	1,752	1,752
WA	Garfield	Wheat	45,164	71,689
WA	Garfield	Barley	≤100	36,082
WA	Walla Walla	Bean	9,585	9,585
WA	Walla Walla	Asparagus	2,828	1,414
WA	Walla Walla	Vegetables (labeled)	7,803	12,386
WA	Walla Walla	Wheat	146,432	232,419
WA	Walla Walla	Barley	≤100*	22,584
WA	Whitman	Barley	≤100*	160,111
WA	Whitman	Wheat	301,201	478,098

Table 26: Washington and Oregon counties through which the Snake River Basin steelhead ESU migrates

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
OR	Clatsop		None	
OR	Columbia		None	
OR	Gilliam	Wheat	74,556	95,584
OR	Gilliam	Barley	8,300	13,175
OR	Hood River		None	

OR	Morrow	Wheat	131,983	167,067
OR	Morrow	Barley	≤100*	2,668
OR	Multnomah	Potatoes	638	336
OR	Multnomah	Bean	77	77
OR	Multnomah	Barley	≤100*	220
OR	Multnomah	Wheat	1,063	1,688
OR	Sherman	Wheat	102,926	99,837
OR	Sherman	Barley	39,973	21,402
OR	Umatilla	Vegetables (labeled)	24,303	38,417
OR	Umatilla	Barley	≤100*	16,364
OR	Umatilla	Asparagus	2,478	1,239
OR	Umatilla	Wheat	163,656	259,772
OR	Wasco	Wheat	39,922	63,369
OR	Wasco	Barley	≤100*	2,413
WA	Benton	Vegetables (labeled)	13,721	21,779
WA	Benton	Asparagus	3,726	1,638
WA	Benton	Barley	≤100*	435
WA	Benton	Wheat	82,529	130,998
WA	Clark	Barley	≤100*	830
WA	Cowlitz	Christmas trees	358	358
WA	Klickitat	Wheat	22,365	35,501
WA	Klickitat	Barley	≤100*	7,464
WA	Pacific	Christmas trees	22	22
WA	Skamania		None	
WA	Wahkiakum		None	
WA	Walla Walla	Vegetables (labeled)	7,803	12,386
WA	Walla Walla	Wheat	146,432	232,419

WA	Walla Walla	Asparagus	2,828	1,414
WA	Walla Walla	Barley	≤100*	22,584
WA	Walla	Bean	9,585	9,585

This Snake River Basin Steelhead ESU is located in an extensively agricultural region with large crop sites and associated large quantities of disulfoton application. This finding appears to apply to both the critical spawning and rearing habitat and to the migratory corridors. Several major crops are currently scheduled for phase out in 2005 (wheat, barley, potatoes) which may require a reevaluation, however at this time, based on the information available, I conclude that disulfoton use may affect the ESU.

8 Upper Willamette River steelhead ESU

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

Spawning and rearing areas are river reaches accessible to listed steelhead in the Willamette River and its tributaries above Willamette Falls up through the Calapooia River. This includes most of Benton, Linn, Polk, Clackamas, Marion, Yamhill, and Washington counties, and small parts of Lincoln and Tillamook counties. However, the latter two counties are small portions in forested areas where disulfoton 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 migrations corridors, and include Multnomah, Columbia and Clatsop counties, Oregon, and Clark, Cowlitz, Wahkiakum, and Pacific counties, Washington.

Tables 27 and 28 show the cropping information for Oregon counties where the Upper Willamette River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 27: Spawning and rearing habitat of the Upper Willamette River steelhead ESU.

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
OR	Benton	Vegetables (labeled)	4,545	7,215
OR	Benton	Bean	6,168	3,080
OR	Benton	Wheat	2,733	4,338
OR	Clackamas	Wheat	1,123	1,783
OR	Linn	Wheat	3,343	5,306
OR	Marion	Wheat	6,514	10,341
OR	Marion	Bean	12,216	12,216
OR	Marion	Vegetables (labeled)	16,194	25704
OR	Marion	Barley	≤100*	134
OR	Polk	Wheat	6,137	9,741
OR	Washington	Barley	≤100*	153
OR	Washington	Wheat	10,722	17,028
OR	Yamhill	Wheat	8,813	13,989
OR	Yamhill	Barley	≤100*	363

Table 28. Oregon and Washington counties that are part of the migration corridors of the Upper Willamette River steelhead ESU.

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
OR	Clatsop		None	
OR	Columbia		None	
OR	Multnomah	Potatoes	638	336
OR	Multnomah	Bean	77	77
OR	Multnomah	Barley	≤100*	220
OR	Multnomah	Wheat	1,063	1,688
WA	Clark	Barley	≤100*	830
WA	Cowlitz	Christmas trees	358	358

WA	Pacific	Christmas trees	22	22
WA	Wahkiakum		None	

Several counties within the Upper Willamette River Steelhead ESU are moderately significant agricultural zones, with a proportionate use of disulfoton. Specific information on crop distribution relative to actual, permanent surface water was not available, but it would appear that in consideration of the large geographic area involved and the complex watershed present, a potential for some effect on the species is possible. In my opinion, disulfoton use may affect the ESU, but is not likely to adversely affect it.

9. Lower Columbia River steelhead ESU

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

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

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

Tables 29 and 30 show the cropping information for Oregon and Washington counties where the Lower Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 29. Spawning/rearing areas for the Lower Columbia steelhead ESU

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
OR	Clackamas	Wheat	1,123	1,783
OR	Hood River		None	
OR	Multnomah	Potatoes	638	336
OR	Multnomah	Bean	77	77
OR	Multnomah	Wheat	1,063	1,688
OR	Multnomah	Barley	139	220
WA	Clark	Barley	523	830
WA	Cowlitz	Christmas trees	358	358
WA	Skamania		None	

Table 30: Migratory corridors for the Lower Columbia River Steelhead ESU.

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
OR	Clatsop		None	
WA	Pacific	Christmas trees	22	22
WA	Wahkiakum		None	

This Lower Columbia River Steelhead ESU is located in the Columbia River watershed, near the egress to the Pacific. Characteristic of these lower reaches, the rivers and tributaries are large and carry very large flow rates. Disulfoton use, within the ESU is modest, particularly in comparison to use in the more upstream, agricultural counties. Some urban, residential use is assumed but the relative input to the mainstem of the Columbia can be considered of little relevance.
I believe there will be no effects from use of disulfoton.

<u>10. Middle Columbia River Steelhead ESU</u>

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. Although I am unsure of the status of these Dog and Collins creeks, they have little relevance to the analysis of disulfoton because there are only 716 acres of potential use sites in Skamania for disulfoton, and it would be expected that these acres would be in the agricultural rather than forest areas of the county.

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 are excluded counties for this analysis.

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

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

Table 31. Spawning/Rearing areas for the Middle Columbia Steelhead ESU

State	County	Crop	Disulfoton Use (lbs)	Acres
OR	Crook	Wheat	1,488	2,362
OR	Gilliam	Wheat	75.556	95,584
OR	Gilliam	Barley	8,300	13,175
OR	Jefferson	Wheat	7,846	12,470
OR	Jefferson	Barley	≤100*	543
OR	Morrow	Wheat	131,983	167,067
OR	Morrow	Barley	≤100*	2,668
OR	Sherman	Wheat	102,926	99,837
OR	Sherman	Barley	39,973	21,402
OR	Umatilla	Vegetables (labeled)	24,203	38,417
OR	Umatilla	Asparagus	24,78	1,239
OR	Umatilla	Wheat	163,656	259,772
OR	Umatilla	Barley	≤100*	16,364
OR	Wasco	Wheat	5,656	8,979
OR	Wheeler	Barley	≤100*	61
WA	Benton	Wheat	82,529	130,998
WA	Benton	Barley	≤100*	435
WA	Benton	Vegetables (labeled)	14,753	268
WA	Columbia	Barley	≤100*	17,547
WA	Columbia	Wheat	48,832	77,511
WA	Franklin	Wheat	69,065	109,627
WA	Franklin	Asparagus	17,228	8,610
WA	Franklin	Vegetables (labeled)	12,461	19,793
WA	Grant	Asparagus	1,880	940
WA	Grant	Barley	≤100*	4,125

WA	Grant	Vegetables (labeled)	29,829	47,347
WA	Grant	Bean	9,525	9,525
WA	Grant	Potatoes	1,023	44,263
WA	Grant	Wheat	203,498	128,204
WA	Kittitas	Christmas trees	28	28
WA	Klickitat	Wheat	22,365	35,501
WA	Klickitat	Barley	≤100*	7,464
WA	Skamania		None	
WA	Walla Walla	Vegetables (labeled)	7,803	12,386
WA	Walla Walla	Asparagus	2,828	1,414
WA	Walla Walla	Wheat	146,432	232,419
WA	Walla Walla	Barley	≤100*	22,584
WA	Yakima	Barley	≤100*	316
WA	Yakima	Wheat	14,174	8,929
WA	Yakima	Bean	10,282	10,282
WA	Yakima	Asparagus	14,060	7,034
WA	Yakima	Cabbage	188	144

Table 32. Washington and Oregon counties through which the Middle Columbia River steelhead ESU migrates

St	County	Crops	Disulfoton Use (lbs)	Acres
OR	Clatsop		None	
OR	Columbia		None	
OR	Hood River		None	
OR	Multnomah	Barley	≤100*	220
OR	Multnomah	Bean	146	77
OR	Multnomah	Wheat	1,063	1,688

WA	Clark	Barley	≤100*	830
WA	Cowlitz	Christmas trees	358	358
WA	Pacific	Christmas trees	22	22
WA	Wahkiakum		None	

Both the migratory pathway and spawning/rearing areas for the Middle Columbia Steelhead ESU lie within areas of high agricultural use, and proportionate application of disulfoton. The rivers and tributaries are, however, commonly large and fast moving, providing a margin of protection through rapid dissipation of incidental contamination. The magnitude of disulfoton use, I believe, indicates it may affect this ESU.

B. Chinook salmon

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

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

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

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

1. Sacramento River Winter-run Chinook Salmon ESU

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

Critical Habitat has been designated to include the Sacramento River from Keswick Dam, Shasta County (river mile 302) to Chipps Island (river mile 0) at the west end of the Sacramento-San Joaquin delta, and then westward through most of the fresh or estuarine waters, north of the Oakland Bay Bridge, to the ocean. Estuarine sloughs in San Pablo and San Francisco bays are excluded (58FR33212-33219, June 16, 1993).

Table 33 shows the Disulfoton usage in California counties supporting the Sacramento River winter-run chinook salmon ESU. Use of Disulfoton in counties with the Sacramento River winter-run Chinook salmon ESU. Spawning areas are primarily in Shasta and Tehama counties above the Red Bluff diversion dam.

Table 33: California counties supporting the Sacramento River, winter-run chinook ESU.

County	Crop(s)	Disulfoton usage (pounds)	Acres treated
Alameda	Landscape	1	NR
Butte		None	
Colusa	Asparagus	10	10
Contra Costa	Landscape	1	NR
Glenn		None	
Marin		None	
Sacramento	Landscape	1	NR
Sacramento	Asparagus	1,217	1,185
San Francisco		None	

San Mateo	Bean	20	13
Shasta		None	
Solano	Vegetables (labeled)	15,286	19,916
Solano	Research	3	NR
Sonoma	Landscape	1	NR
Sutter	Asparagus	353	350
Tehama	Beans	121	313
Yolo	Asparagus	39	39
Yolo	Landscape	1	NR

Direct agricultural use of disulfoton within the boundaries of the Sacramento River Winter-run Chinook Salmon ESU is modest, and largely confined to two counties (Sacramento and Solano). On this basis it would appear that disulfoton would have minimal or no effects within the ESU. It should, however, be noted that the Sacramento watershed receives considerable input from more inland, highly agricultural counties and that the river is under close management with numerous diversions and flow modifications for both agricultural and other uses. Reduced and interrupted flow patterns can diminish effective dilution. These interpretations indicate to me that disulfoton use may affect the ESU, but is not likely to have an adverse effect

2. Snake River Fall-run Chinook Salmon ESU

The Snake River fall-run chinook salmon ESU was proposed as threatened in 1991 (56FR29547-29552, June 27, 1991) and listed about a year later (57FR14653-14663, April 22, 1992). Critical habitat was designated on December 28, 1993 (58FR68543-68554) to include all tributaries of the Snake and Salmon Rivers accessible to Snake River fall-run chinook salmon, except reaches above impassable natural falls and Dworshak and Hells Canyon Dams. The Clearwater River and Palouse River watersheds are included for the fall-run ESU, but not for the spring/summer run. This chinook ESU was proposed for reclassification on December 28, 1994 (59FR66784-57403) as endangered because of critically low levels, based on very sparse runs. However, because of increased runs in subsequent year, this proposed reclassification was withdrawn (63FR1807-1811, January 12, 1998).

In 1998, NMFS proposed to revise the Snake River fall-run chinook to include those stocks using the Deschutes River (63FR11482-11520, March 9, 1998). The John Day, Umatilla, and Walla Walla Rivers would be included; however, fall-run chinook in these rivers are believed to have been extirpated. It appears that this proposal has yet to be finalized. 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, they were excluded them from consideration because disulfoton would not be used in these areas.

Tables 34 and 35 show the cropping information for Pacific Northwest counties where the Snake River fall-run chinook salmon ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 34 : Spawning/rearing areas supporting the Snake River Fall-run chinook salmon ESU

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
ID	Adams	Barley	20	312
ID	Adams	Wheat	323	512
ID	Benewah	Barley	1,472	23,364
ID	Benewah	Wheat	18,542	29,431
ID	Clearwater	Barley	372	6,058
ID	Clearwater	Vegetables (labeled)	12	19
ID	Clearwater	Wheat	45,623	72,419
ID	Idaho	Wheat	43,505	69,057
ID	Idaho	Barley	1,819	28,872
ID	Latah	Wheat	65,774	104,403
ID	Latah	Barley	1,173	18,615
ID	Lewis	Wheat	45,094	71,850
ID	Lewis	Barley	1,377	21,851
ID	Nez Perce	Wheat	55,235	87,675
ID	Shoshone		None	

ID	Valley	Wheat	411	652
OR	Union	Wheat	22,928	36,394
OR	Wallowa		None	
WA	Adams	Barley	≤100*	10,022
WA	Asotin	Wheat	13,304	21,118
WA	Asotin	Barley	≤100*	10,205
WA	Franklin	Bean	1,752	1,752
WA	Franklin	Wheat	69,065	109,627
WA	Franklin	Asparagus	17,228	8,610
WA	Franklin	Vegetables (labeled)	12,461	19,793
WA	Garfield	Wheat	45,164	71,689
WA	Walla Walla	Asparagus	2,828	1,414
WA	Walla Walla	Vegetables (labeled)	7,803	12,386
WA	Walla Walla	Wheat	146,432	232,419
WA	Walla Walla	Barley	≤100*	22,584
WA	Whitman	Barley	≤100*	160,111
WA	Whitman	Wheat	301,201	478,098

Table 35: Washington and Oregon counties through which the Snake River fall-run chinook and the Snake River spring/summer-run chinook ESUs migrate.

St	County	Crops	Disulfoton Use (lbs)	Acres
OR	Clatsop		None	
OR	Columbia		None	
OR	Gilliam	Wheat	74,556	95,584
OR	Gilliam	Barley	8,300	13,175
OR	Hood River		None	
OR	Morrow	Wheat	131,983	167,067

OR	Morrow	Barley	≤100*	2,668
OR	Multnomah	Bean	77	77
OR	Multnomah	Wheat	1,063	1,688
OR	Multnomah	Barley	≤100*	220
OR	Sherman	Wheat	102,926	99,837
OR	Sherman	Barley	39,973	21,402
OR	Umatilla	Vegetables	24,203	38,417
OR	Umatilla	Wheat	163,656	259,772
OR	Umatilla	Asparagus	2,478	1,239
OR	Umatilla	Barley	≤100*	16,364
OR	Wasco	Barley	≤100*	2,413
OR	Wasco	Wheat	39,923	63,369
WA	Benton	Asparagus	3,276	1,638
WA	Benton	Barley	≤100*	435
WA	Benton	Wheat	82,529	130,998
WA	Clark	Barley	≤100*	830
WA	Cowlitz	Christmas trees	358	358
WA	Klickitat	Wheat	25,453	40,401
WA	Klickitat	Barley	≤100*	7,464
WA	Pacific	Christmas trees	22	22
WA	Skamania		None	
WA	Wahkiakum		None	

The Snake River Fall-run Chinook ESU is located in an extensively agricultural region with large crop sites and associated large quantities of disulfoton application. This finding appears to apply to both the critical spawning and rearing habitat and to the migratory corridors. Several major crops are currently scheduled for phase out in 2005 (wheat, barley, potatoes) which may require a reevaluation, however at this time, based on the information available, it must be concluded that disulfoton use may affect this ESU.

3. Snake River Spring/Summer-run Chinook Salmon

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

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

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

Table 36 shows the Oregon and Washington counties where the Snake River spring/summer-run chinook salmon ESU occurs. The cropping information for the migratory corridors is the same as for the Snake River fall-run chinook salmon and is in the table above.

Table 36: Spawning/rearing area supporting the Snake River spring/summer chinook ESU

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
ID	Adams	Wheat	32	512
ID	Adams	Barley	20	312
ID	Custer	Barley	149	2,386
ID	Custer	Wheat	406	645

ID	Idaho	Wheat	43,505	69,057
ID	Idaho	Barley	1,819	28,872
ID	Latah	Wheat	65,774	104,403
ID	Latah	Barley	1,173	18,615
ID	Lewis	Wheat	45,094	71,850
ID	Lewis	Barley	1,377	21,851
ID	Nez Perce	Wheat	55,235	87,675
ID	Nez Perce	Barley	1,332	21,135
ID	Valley	Potatoes	1,317	1,317
ID	Valley	Wheat	411	652
OR	Union	Wheat	22,928	36,394
OR	Wallowa		None	
WA	Asotin	Barley	≤100*	10,205
WA	Asotin	Wheat	13,304	21,118
WA	Columbia	Barley	≤100*	17,547
WA	Franklin	Wheat	69,065	109,627
WA	Franklin	Asparagus	17,228	8,610
WA	Franklin	Vegetables (labeled)	12,461	19,793
WA	Franklin	Bean	1,752	1,752
WA	Garfield	Wheat	45,164	71,689
WA	Walla Walla	Wheat	146,432	232,419
WA	Walla Walla	Asparagus	2,828	1,414
WA	Walla Walla	Vegetables (labeled)	7,803	12,386
WA	Walla Walla	Bean	9,585	9,585
WA	Walla Walla	Barley	≤100*	22,584
WA	Whitman	Wheat	301,201	478,098
WA	Whitman	Barley	≤100*	160,111

The Snake River Spring/Summer Chinook ESU is located in an extensively agricultural region with large crop sites and associated large quantities of disulfoton application. This finding appears to apply to both the critical spawning and rearing habitat and to the migratory corridors. Several major crops are currently scheduled for phase out in 2005 (wheat, barley, potatoes) which may require a reevaluation, however at this time, based on the information available, it must be concluded that disulfoton use may affect this ESU.

4. Central Valley Spring-run Chinook Salmon ESU

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

Hydrologic units and upstream barriers within this ESU are the Sacramento-Lower Cow-Lower Clear, Lower Cottonwood, Sacramento-Lower Thomas (upstream barrier - Black Butte Dam), Sacramento-Stone Corral, Lower Butte (upstream barrier - Chesterville Dam), Lower Feather (upstream barrier - Orville Dam), Lower Yuba, Lower Bear (upstream barrier - Camp Far West Dam), Lower Sacramento, Sacramento-Upper Clear (upstream barriers - Keswick Dam, Whiskey town dam), Upper Elder-Upper Thomas, 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 37: California counties supporting the Central Valley spring-run chinook salmon ESU.

County	Crop(s)	Disulfoton Applied (lbs)	Acres
Alameda	Landscape	1	NR
Amador		None	
Butte		None	
Calaveras		None	
Colusa	Asparagus	10	10
Contra Costa	Landscape	1	NR
Glen		None	

Marin		None	
Merced	Asparagus	129	128
Merced	Cabbage	16	8
Merced	Squash	16	1
Nevada		None	
Placer		None	
Sacramento	Asparagus	1,217	1,185
Sacramento	Landscape	1	NR
San Francisco		None	
San Joaquin	Asparagus	13,736	13,716
San Mateo	Bean	20	13
Shasta		None	
Solano	Research	3	NR
Solano	Vegetables (labeled)	15,286	19,916
Sonoma	Landscape	1	NR
Stanislaus	Asparagus	41	40
Stanislaus	Vegetables (labeled)	56	56
Sutter	Asparagus	353	350
Tehama	Beans	121	313
Tuloumne		None	
Yolo	Asparagus	39	39
Yolo	Landscape	1	NR
Yuba		None	

Commercial use of disulfoton within the borders of the Central Valley Spring-run Chinook ESU is low, except for asparagus in the San Joaquin Valley. Residential use in large urban areas, including the San Francisco-Oakland basin, and the uncertainties associated with homeowner use prevent accurate quantitation. Disulfoton use, in my opinion, may affect the ESU, but is not likely to have an adverse effect.

5. California Coastal Chinook Salmon ESU

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

The Hydrologic units and upstream barriers are Mad-Redwood, Upper Eel (upstream barrier - Scott Dam), Middle Fort Eel, Lower Eel, South Fork Eel, Mattole, Big-Navarro-Garcia, Gualala-Salmon, Russian (upstream barriers - Coyote Dam; Warm Springs Dam), and Bodega Bay. Counties with agricultural areas where Disulfoton 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 disulfoton would not be used in the forested upper elevation areas.

Table 38: California counties supporting the California coastal chinook salmon ESU.

County	Crop(s)	Disulfoton usage (pounds)	Acres treated
Humboldt		None	
Lake		None	
Marin		None	
Mendocino		None	
Sonoma	Landscape	1	NR
Trinity		None	

The extremely low usage of disulfoton in the California Coastal Chinook Salmon ESU (1lb ai/year) indicates it will have no effect on the species.

6. Puget Sound Chinook Salmon ESU

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

The Hydrologic units and upstream barriers are the Strait of Georgia, San Juan Islands, Nooksack, Upper Skagit, Sauk, Lower Skagit, Stillaguamish, Skykomish, Snoqualmie (upstream barrier - Tolt Dam), Snohomish, Lake Washington (upstream barrier - Landsburg Diversion), Duwamish, Puyallup, Nisqually (upstream barrier - Alder Dam), Deschutes, Skokomish, Hood Canal, Puget

Sound, Dungeness-Elwha (upstream barrier - Elwha Dam). Affected counties in Washington, apparently all of which could have spawning and rearing habitat, are Skagit, Whatcom, San Juan, Island, Snohomish, King, Pierce, Thurston, Lewis, Grays Harbor, Mason, Clallam, Jefferson, and Kitsap.

Table 39 Washington counties where the Puget Sound chinook salmon ESU is located.

St	County	Crops	Disulfoton Use (lbs)	Acres
WA	Clallam		None	
WA	Grays Harbor	Christmas trees	4	4
WA	Island		None	
WA	Jefferson	Christmas trees	13	13
WA	King	Christmas trees	207	207
WA	Kitsap	Christmas trees	874	874
WA	Lewis	Christmas trees	4,042	4,042
WA	Lewis	Barley	≤100*	873
WA	Lewis	Wheat	8,674	13,769
WA	Mason	Vegetables (labeled)	95	150
WA	Mason	Christmas trees	437	437
WA	Pierce	Bean	200	200
WA	Pierce	Christmas trees	196	196
WA	San Juan		None	
WA	Skagit	Barley	≤100*	851
WA	Skagit	Wheat	2,191	3,477
WA	Skagit	Christmas trees	63	63
WA	Snohomish	Christmas trees	82	82
WA	Thurston	Christmas trees	137	137
WA	Whatcom	Vegetables (labeled)	441	700
WA	Whatcom	Potatoes	1,585	1,585

WA	Whatcom	Christmas trees	157	157

There is evidence of modest agricultural activity within the Puget Sound Chinook ESU, but large and very large sites are not observed. This is most likely the result of extensive urban development, including Seattle, Tacoma, and the now highly populated inter-urban zone. Although the potential effects from commercial agriculture do not appear extreme, the lower smaller tributaries entering the sound are under considerable flow control and some are almost seasonal. Disulfoton use may affect this ESU, but is not likely to have an adverse affect.

7. Lower Columbia River Chinook Salmon ESU

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

The Hydrologic units and upstream barriers are the Middle Columbia-Hood (upstream barriers - Condit Dam, The Dalles Dam), Lower Columbia-Sandy (upstream barrier - Bull Run Dam 2), Lewis (upstream barrier - Merlin Dam), Lower Columbia-Clatskanie, Upper Cowlitz, Lower Cowlitz, Lower Columbia, Clackamas, and the Lower Willamette. Spawning and rearing habitat would be in the counties of Hood River, Waco, 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. Pierce County, Washington was excluded because the very small part of the Cowlitz River watershed in this county is at a high elevation where disulfoton would not be used.

Table 40: Oregon and Washington counties where the Lower Columbia River chinook salmon ESU occurs.

St	County	Crops	Disulfoton Use (lbs)	Acres
OR	Clackamas	Wheat	1,123	1,783
OR	Clatsop		None	
OR	Columbia		None	
OR	Hood River		None	
OR	Marion	Barley	≤100*	134

OR	Marion	Bean	12,216	12,216
OR	Marion	Wheat	6,514	10,341
OR	Marion	Vegetables (labeled)	16,194	25,704
OR	Multnomah	Bean	77	77
OR	Multnomah	Barley	≤100*	220
OR	Multnomah	Wheat	1,063	1,688
OR	Wasco	Barley	≤100*	2,413
OR	Wasco	Wheat	39,992	63,369
OR	Washington	Wheat	10,722	17,028
OR	Washington	Barley	≤100*	153
WA	Clark	Barley,	≤100*	830
WA	Cowlitz	Christmas trees	358	358
WA	Klickitat	Barley	≤100*	7,464
WA	Klickitat	Wheat	25,453	40,401
WA	Lewis	Barley	≤100*	873
WA	Lewis	Wheat	8,674	13,769
WA	Lewis	Christmas trees	4,042	4,042
WA	Pacific	Christmas trees	22	22
WA	Skamania		None	
WA	Wahkiakum		None	

The Lower Columbia ESU is located in an area of low to moderate agriculture use, as suggested by the calculated disulfoton application. It also a component of a large, relatively fast moving river system that is likely to provide mitigation for any incidental introduction of pesticide. The use of disulfoton will not have an effect on this ESU.

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8. Upper Willamette River Chinook Salmon ESU

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

The Hydrologic units included are the Lower Columbia-Sandy, Lower Columbia-Clatskanie, Lower Columbia, Middle Fork Willamette, Coast Fork Willamette (upstream barriers - Cottage Grove Dam, Dorena Dam), Upper Willamette (upstream barrier - Fern Ridge Dam), McKenzie (upstream barrier - Blue River Dam), North Santiam (upstream barrier - Big Cliff Dam), South Santiam (upstream barrier - Green Peter Dam), Middle Willamette, Yamhill, Molalla-Pudding, Tualatin, Clackamas, and Lower Willamette. Spawning and rearing habitat is in the Oregon counties of Clackamas, Douglas, Lane, Benton, Lincoln, Linn, Polk, Marion, Yamhill, Washington, and Tillamook. However, Lincoln and Tillamook counties include salmon habitat only in the forested parts of the coast range where Disulfoton would not be used. Salmon habitat for this ESU is exceedingly limited in Douglas County also, but we cannot rule out future Disulfoton use in Douglas County.

Tables 41 and 42 show the cropping information for Oregon counties where the Upper Willamette River chinook salmon ESU occurs and for the Oregon and Washington counties where this ESU migrates.

Table 41: Spawning/Rearing areas for the Upper Willamette River chinook ESU

St	County	Crops	Disulfoton Use (lbs)	Acres
OR	Benton	Wheat	2,733	4,348
OR	Benton	Vegetables (labeled)	4,658	7,393
OR	Benton	Bean	3,080	3,080
OR	Clackamas	Bean	334	334
OR	Clackamas	Vegetables (labeled)	2,899	4,601
OR	Clackamas	Wheat	1,123	1,783
OR	Douglas	Vegetables (labeled)	396	628
OR	Douglas	Bean	19	19
OR	Lane	Vegetables (labeled)	3,430	5,445
OR	Lane	Bean	1	1
OR	Lane	Wheat	1,670	2,651
OR	Lane	Barley	≤100*	147
OR	Linn	Bean	2,688	2,688

OR	Linn	Vegetables (labeled)	4,620	7,333
OR	Linn	Wheat	3,343	5,306
OR	Marion	Barley	≤100*	134
OR	Marion	Bean	12,216	12,216
OR	Marion	Vegetables (labeled)	15,947	25,312
OR	Marion	Wheat	6,514	10,341
OR	Polk	Barley	≤100*	371
OR	Polk	Bean	598	598
OR	Polk	Vegetables (labeled)	1,245	1,976
OR	Polk	Wheat	6,132	9,742
OR	Washington	Barley	≤100*	153
OR	Washington	Bean	988	988
OR	Washington	Vegetables (labeled)	4,523	7,179
OR	Washington	Wheat	10,722	17,028
OR	Yamhill	Bean	1,838	1,838
OR	Yamhill	Vegetables (labeled)	3,345	5,310
OR	Yamhill	Wheat	8,813	13,989
OR	Yamhill	Barley	≤100*	363

Table 42: Migration corridors of the Upper Willamette River chinook salmon ESU.

St	County	Crops	Disulfoton Use (lbs)	Acres
OR	Clatsop		None	
OR	Columbia		None	
OR	Multnomah	Wheat	1,063	1,688
OR	Multnomah	Bean	146	77
OR	Multnomah	Potatoes	638	336
OR	Multnomah	Barley	≤100*	220

WA	Clark	Barley	≤100*	830
WA	Cowlitz	Christmas trees	358	358
WA	Pacific	Christmas trees	22	22
WA	Wahkiakum		None	

Th Upper Willamette River Chinook ESU is encompassed by a large areas of diverse agricultural usage, with a significant amount of disulfoton. Most of the sites, however, are of small to moderate size and this may serve to reduce the potential for a large, point event. It is also noted that the general population is relatively low. Although these conditions clearly tend to minimize risk, the volume and wide geographic scope of the ESU implies that disulfoton may affect the ESU, but is not likely to adversely affect it.

9. Upper Columbia River Spring-run Chinook Salmon ESU

The Upper Columbia River Spring-run Chinook Salmon ESU was proposed as endangered in 1998 (63FR11482-11520, March 9, 1998) and listed a year later (64FR14308-14328, March 24, 1999). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches accessible to listed chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River, as well as all down stream migratory corridors to the Pacific Ocean. Hydrologic units and their upstream barriers are Chief Joseph (Chief Joseph Dam), Similkameen, Methow, Upper Columbia-Entiat, Wenatchee, Upper Columbia-Priest Rapids, Middle Columbia-Lake Wallula, Middle Columbia-Hood, Lower Columbia-Sandy, Lower Columbia-Clatskanie, Lower Columbia, and Lower Willamette. Counties in which spawning and rearing occur are Chelan, Douglas, Okanogan, Grant, Kittitas, and Benton (Table 31), with the lower river reaches being migratory corridors (Table 32).

Sales data indicate considerable use of disulfoton, almost all on potatoes, vegetables, wheat, and barley. Most of this usage occurs upstream from the confluence of the Snake River with the Columbia River, but not as far north as Chelan, and Okanogan counties, where there is limited acreage of the major crops for disulfoton. However, a modest amount is used on the same crops below that confluence in counties on either side of the Columbia River, but all upstream of the John Day Dam.

Tables 43 and 44 show 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.

Table 43. Counties Supporting the Upper Columbia Chinook ESU Spawning/Rearing Area

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
WA	Benton	Asparagus	3,726	1,638
WA	Benton	Vegetables (labeled)	13,721	21,779
WA	Benton	Wheat	82,529	130,998
WA	Benton	Barley	≤100*	435
WA	Chelan	Vegetables (labeled)	34	54
WA	Douglas	Wheat	140,625	178,006
WA	Grant	Bean	9,525	9,525
WA	Grant	Vegetables (labeled)	57,812	420*
WA	Grant	Asparagus	1,880	940
WA	Grant	Barley	≤100*	4,125
WA	Grant	Potatoes	84,138	44,283
WA	Grant	Wheat	203,498	128,204
WA	Kittitas	Christmas trees	28	28
WA	Kittitas	Vegetables (labeled)	2,795	4,437
WA	Okanogan	Wheat	8,410	5,298
WA	Okanogan	Christmas trees	437	437
WA	Okanogan	Barley	≤100*	387

Table 44.Migration corridors for the Upper Columbia River Chinook salmon ESU.

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
OR	Clatsop		None	
OR	Columbia		None	
OR	Gilliam	Wheat	74,556	95,584
OR	Gilliam	Barley	8,300	13,175
OR	Hood River		None	

OR	Morrow	Wheat	131,983	167,067
OR	Morrow	Barley	≤100*	2,668
OR	Multnomah	Bean	77	77
OR	Multnomah	Potato	638	336
OR	Multnomah	Barley	≤100*	220
OR	Multnomah	Wheat	1,063	1,688
OR	Sherman	Wheat	102,926	99,837
OR	Sherman	Barley	39,973	21,402
OR	Umatilla	Vegetables (labeled)	24,203	38,417
OR	Umatilla	Barley	≤100*	16,364
OR	Umatilla	Asparagus	2,478	1,239
OR	Umatilla	Wheat	163,656	259,772
OR	Wasco	Wheat	39,992	63,369
OR	Wasco	Barley	≤100*	2,413
WA	Clark	Barley	≤100*	830
WA	Cowlitz	Christmas trees	358	358
WA	Franklin	Vegetables (labeled)	12,461	19,793
WA	Franklin	Asparagus	17,228	8,610
WA	Franklin	Bean	1,752	1,752
WA	Franklin	Wheat	69,065	109,627
WA	Klickitat	Wheat	25,453	40,401
WA	Klickitat	Barley	≤100*	7,464
WA	Pacific	Christmas trees	22	22
WA	Skamania		None	
WA	Wahkiakum		None	
WA	Walla Walla	Asparagus	8,828	1,414
WA	Walla Walla	Bean	9,585	9,585

WA	Walla Walla	Barley	≤100*	22,584
WA	Walla Walla	Wheat	146,432	232,419
WA	Walla Walla	Vegetables (labeled)	7,803	12,386
WA	Yakima	Asparagus	14,060	7,034
WA	Yakima	Cabbage	188	144
WA	Yakima	Bean	8,929	8,929
WA	Yakima	Barley	≤100*	316
WA	Yakima	Wheat	14,174	8,929

The Upper Columbia River Chinook ESU is situated within a major agricultural area. Eligible crops of substantial size are present both with the upstream areas, where spawning and rearing habitat is expected, and along a major portion of the migratory pathways. Although many of the rivers and tributaries are large and fast moving, it must also be noted that extensive river control and utilization facilities are also present. Under free flowing conditions, the size of the water paths would suggest rapid dissipation of disulfoton, however the presence of river flow control and large scale agricultural use can not be evaluated at this time. I conclude that disulfoton may affect this ESU, but is not likely to adversely affect it.

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 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.

1. Central California Coast Coho Salmon ESU

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

Hydrologic units within the boundaries of this ESU are: San Lorenzo-Soquel (upstream barrier - Newell Dam), San Francisco Coastal South, San Pablo Bay (upstream barrier - Phoenix Dam-Phoenix Lake), Tomales-Drake Bays (upstream barriers - Peters Dam-Kent Lake; Seeger Dam-Nicasio Reservoir), Bodega Bay, Russian (upstream barriers - Warm springs dam-Lake Sonoma; Coyote Dam-Lake Mendocino), Gualala-Salmon, and Big-Navarro-Garcia. California counties included are Santa Cruz, San Mateo, Marin, Napa, Sonoma, and Mendocino.

Table 45: California counties supporting the Central California coast Coho salmon ESU.

County	Crop(s)	Disulfoton usage (pounds)	Acres
Marin		None	
Mendocino		None	
Napa		None	
San Mateo	Bean	20	13
Santa Cruz	Lettuce	508	251
Sonoma	Landscape	1	NR

Agricultural applications within this ESU are quite low, with a reported total usage of 529 lbs a.i/year (CDPR). The low rate of use and large geographic area lead me to conclude disulfoton will have no effect in this ESU

2. Southern Oregon/Northern California Coast Coho Salmon ESU

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

The Southern Oregon/Northern California Coast coho salmon ESU occurs between Punta Gorda, Humboldt County, California and Cape Blanco, Curry County, Oregon. Major basins with this salmon ESU are the Rogue, Klamath, Trinity, and Eel river basins, while the Elk River, Oregon, and the Smith and Mad Rivers, and Redwood Creek, California are smaller basins within the range. Hydrologic units and the upstream barriers are Mattole, South Fork Eel, Lower Eel, Middle Fork Eel, Upper Eel (upstream barrier - Scott Dam-Lake Pillsbury), Mad-Redwood, Smith, South Fork Trinity, Trinity (upstream barrier - Lewiston Dam-Lewiston Reservoir), Salmon, Lower Klamath, Scott, Shasta (upstream barrier - Dwinnell Dam-Dwinnell Reservoir), Upper 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. However, I have excluded Glenn County, California from this analysis because the salmon habitat in this county is not near the agricultural areas where disulfoton can be used. Klamath county is excluded because it lies beyond an impassable barrier.

Tables 46 shows the usage of disulfoton in the California counties supporting the Southern Oregon/Northern California coastal coho salmon ESU. Table 47 shows the cropping information for Oregon counties where the Southern Oregon/Northern California coastal coho salmon ESU occurs.

Table 46.:California Counties where the Southern Oregon/Northern California Coastal Coho Salmon ESU Occurs

County	Crop(s)	Disulfoton usage (pounds)	Acres treated
Del Norte	Outdoor Transplants	3,376	452
Humboldt		None	
Lake		None	
Mendocino		None	

Siskiyou	Wheat	1,453	1,913
Siskiyou	Research	37	48
Siskiyou	Barley	1,142	1,364
Trinity		None	

Table 47. Oregon counties where there is habitat for the Southern Oregon/Northern California coastal coho salmon ESU.

St	County	Crops and acres planted	Disulfoton use (lbs)	Acres
OR	Curry		None	
OR	Douglas	Vegetables (labeled)	396	628
OR	Douglas	Bean	19	19
OR	Jackson	Vegetables (labeled)	302	606
OR	Jackson	Barley	≤100*	674
OR	Jackson	Wheat	815	1,294
OR	Josephine	Vegetables (labeled)	63	132
OR	Josephine	Bean	1	1
OR	Josephine	Potatoes	13	7

Although the Southern Oregon/Northern California Coastal Coho Salmon ESU contains portions of two agricultural states, the area included shows evidence of low agricultural activity and related disulfoton use. Relatively large rivers and tributaries are a common feature (Rogue, Trinity, Klamath Eel Rivers) and can be expected to rapidly dissipate the pesticide. Additional features include a low population density and comparatively low agricultural pesticide use. These findings lead me to conclude disulfoton will have no effects within this ESU.

<u>3. Oregon Coast coho salmon ESU</u>

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

This ESU includes coastal populations of coho salmon from Cape Blanco, Curry County, Oregon to the Columbia River. Spawning is spread over many basins, large and small, with higher numbers further south where the coastal lake systems (e.g., the Tenmile, Tahkenitch, and Siltcoos basins) and the Coos and Coquille Rivers have been particularly productive. Critical Habitat includes all accessible reaches in the coastal Hydrologic reaches Necanicum, Nehalem, Wilson-Trask-Nestucca (upstream barrier - McGuire Dam), Siletz-Yaquina, Alsea, Siuslaw, Siltcoos, North Umpqua (upstream barriers - Cooper Creek Dam, Soda Springs Dam), South Umpqua (upstream barrier - Ben Irving Dam, Galesville Dam, Win Walker Reservoir), Umpqua, Coos (upstream barrier - Lower Pony Creek Dam), Coquille, Sixes. Related Oregon counties are Douglas, Lane, Coos, Curry, Benton, Lincoln, Polk, Tillamook, Yamhill, Washington, Columbia, Clatsop. However, the portions of Yamhill, Washington, and Columbia counties that are within the ESU do not include agricultural areas where disulfoton can be used, and they were eliminated in this analysis.

Table 48: Oregon counties where the Oregon coast coho salmon ESU occurs.

St	County	Crops	Disulfoton Use (lbs)	Acres
OR	Benton	Beans	3,080	3,080
OR	Benton	Vegetables (labeled)	4,656	7,393
OR	Benton	Wheat	2,733	4,338
OR	Clatsop	Vegetables (labeled)	17	27
OR	Coos	Vegetables (labeled)	2	3
OR	Curry	Vegetables (labeled)	3	4
OR	Douglas	Vegetables (labeled)	396	628
OR	Douglas	Bean	19	19
OR	Lane	Barley	≤100*	147
OR	Lane	Wheat	1,670	2,651
OR	Lane	Vegetables (labeled)	3,430	5,445
OR	Lane	Bean	1	1
OR	Lincoln	Vegetables (labeled)	8	13
OR	Polk	Wheat	6,137	9,741
OR	Polk	Bean	598	598
OR	Polk	Vegetables (labeled)	1,245	1,976
OR	Tillamook		None	

The Oregon Coast Coho Salmon ESU occupies much of the seaward limit of Oregon, and does not appear to be among the major NW agricultural zones. The principal use counties within the ESU are Benton and Polk counties, and the agriculture acreage (Douglas and Lane counties also) are likely in the Willamette watershed. The size of this area, close proximity to the Pacific, generally low population levels, and calculated, modest disulfoton usage under “worst case conditions”, indicate, in my opinion, no effect on the ESU from disulfoton use.

D. Chum Salmon

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

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

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

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

1. Hood Canal Summer-run chum salmon ESU

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

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

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

Tables 49: Washington counties where the Hood Canal summer-run chum salmon ESU Occurs.

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
WA	Clallam	Vegetables (labeled)	62	98
WA	Island	Vegetables (labeled)	67	106
WA	Island	Christmas trees	27	27
WA	Jefferson	Vegetables (labeled)	6	10
WA	Jefferson	Christmas trees	13	13
WA	Kitsap	Christmas trees	674	674

The Hood anal Chum salmon ESU is situated on a large area, bounded to the west by the Olympic range, to the east by Puget Sound, and to the north by the straits of Juan de Fuca. The latter two are large bodies of eater, well navigated by trans-oceanic commercial and military vessels and serving as a barrier to agricultural input from the more easterly, major agricultural zones. Hood canal itself, toward the northern portion, is also a major maritime route. Combining this relative isolation with the light agricultural use of disulfoton (879 lbs/ai total/year at maximum calculated application rates), low population density, and probable lack of use on Christmas trees, I conclude disulfoton use will have no effect in this ESU.

2. Columbia River Chum Salmon ESU

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

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

Table 50: Oregon and Washington counties where the Columbia River chum salmon ESU occurs.

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
OR	Clatsop		None	
OR	Columbia		None	
OR	Multnomah	Wheat	1,063	1,688
OR	Multnomah	Bean	146	146
OR	Multnomah	Potatoes	638	336
OR	Multnomah	Barley	≤100*	220
OR	Washington	Barley	≤100*	153
OR	Washington	Wheat	≤100*	17,028
WA	Clark	Barley	≤100*	153
WA	Cowlitz	Christmas trees	358	358
WA	Lewis	Wheat	8,674	13,769
WA	Lewis	Barley	550	873
WA	Pacific	Christmas trees	22	22
WA	Skamania		None	
WA	Wahkiakum		None	

The Columbia River Chum Salmon ESU is located downstream, generally in large, fast flowing rivers and tributaries, away from major agricultural sites. Based on both the cultivated acreage and total, calculated maximum usage I conclude disulfoton will have no effects on this ESU.

E. Sockeye Salmon

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

Growth is influenced by competition, food supply, water temperature, thermal stratification, and other factors, with lake residence time usually increasing the farther north a nursery lake is located. In Washington and British Columbia, lake residence is normally 1 or 2 years. Incubation, fry emergence, spawning, and adult lake entry often involve intricate patterns of adult and juvenile migration and orientation not seen in other *Oncorhynchus* species.
Upon emergence from the substrate, lake-type sockeye salmon juveniles move either downstream or upstream to rearing lakes, where the juveniles rear for 1 to 3 years prior to migrating to sea. Smolt migration typically occurs beginning in late April and extending through early July.

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

1. Ozette Lake Sockeye Salmon ESU

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

While Lake Ozette, itself, is part of Olympic National Park, its tributaries extend outside park boundaries, much of which is private land. There is limited agriculture in the whole of Clallam County, and most of this is well away from the Ozette watershed.

Table 51: Clallum County where there is habitat for the Ozette Lake sockeye salmon ESU.

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
WA	Clallam		None	

The Ozette Lake Sockeye Salmon ESU is not a site of disulfoton use and there is, therefore, no effect on this ESU.
.
2. Snake River Sockeye Salmon ESU

The Snake River sockeye salmon was the first salmon ESU in the Pacific Northwest to be listed. It was proposed and listed in 1991 (56FR14055-14066, April 5, 1991 & 56FR58619-58624, November 20, 1991). Critical habitat was proposed in 1992 (57FR57051-57056, December 2, 1992) and designated a year later (58FR68543-68554, December 28, 1993) to include river reaches of the 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. Disulfoton cannot be used on such a site, and therefore there will be no exposure in the spawning and rearing habitat. There is a probability that this salmon ESU could be exposed to disulfoton in the lower and larger river reaches during its juvenile or adult migration.

Table 52 shows the limited acreage of crops in Idaho counties where this ESU reproduces. All of this crop production is away from and at a much lower elevation than the spawning and rearing habitat. The critical spawning zones demonstrate, at the maximum allowable application levels, the potential for 2,050 lbs of disulfoton, distributed over 23,600 A of cultivated land and a much larger area including non-agricultural properties

Table 53 shows the acreage of crops where Disulfoton can be used in Oregon and Washington counties along the migratory corridor for this ESU.

Table 52. Idaho counties where there is spawning and rearing habitat for the Snake River sockeye salmon ESU.

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
ID	Blaine	Barley	1,088	17,270
ID	Custer	Barley	149	2,368
ID	Custer	Wheat	813	1,290

Table 53. Oregon and Washington counties that are in the migratory corridors for the Snake River sockeye salmon ESU.

St	County	Crops and acres planted	Disulfoton Use (lbs)	Acres
ID	Idaho	Wheat	43,505	69,057
ID	Idaho	Barley	1,819	28,872
ID	Lemhi		None	
ID	Nez Perce	Barley	1,332	21,135
ID	Nez Perce	Wheat	55,235	87,675
OR	Clatsop		None	
OR	Columbia		None	
OR	Gilliam	Wheat	74,556	95,584

OR	Gilliam	Barley	8,300	13,175
OR	Hood River		None	
OR	Morrow	Wheat	131.,983	167,067
OR	Morrow	Barley	≤100*	2,668
OR	Multnomah	Bean	77	77
OR	Multnomah	Potatoes	638	336
OR	Multnomah	Wheat	1,063	1,688
OR	Multnomah	Barley	≤100*	220
OR	Sherman	Wheat	102,926	99,837
OR	Sherman	Barley	39,973	21,402
OR	Umatilla	Vegetables (labeled)	24,203	38,417
OR	Umatilla	Barley	10,309	16,364
OR	Umatilla	Asparagus	2,478	1,239
OR	Umatilla	Wheat	≤100*	259,772
OR	Wallowa	Barley	≤100*	8,796
OR	Wallowa	Wheat	9,136	14,502
OR	Wasco	Wheat, barley	≤100*	65,782
WA	Asotin	Wheat	13,304	21,118
WA	Asotin	Barley	≤100*	10,205
WA	Benton	Asparagus	3,398	1,698
WA	Benton	Barley	≤100*	435
WA	Benton	Wheat	82,529	130,998
WA	Benton	Vegetables (labeled)	13,721	21,779
WA	Clark	Barley	≤100*	830
WA	Columbia		None	
WA	Franklin	Wheat	69,065	109,627
WA	Franklin	Vegetables (labeled)	12,461	19,793
WA	Franklin	Wheat	69,065	109,627

WA	Franklin	Asparagus	17,228	8,610
WA	Franklin	Bean	1,752	1,752
WA	Garfield	Barley	≤100*	36,082
WA	Garfield	Wheat	45,164	71,689
WA	Klickitat	Wheat	25,453	40,401
WA	Klickitat	Barley	≤100*	7,464
WA	Pacific	Christmas trees	22	22
WA	Skamania		None	
WA	Wahkiakum		None	
WA	Walla Walla	Wheat	146,432	232,419
WA	Walla Walla	Bean	9,585	9,585
WA	Walla Walla	Vegetables (labeled)	7,803	12,386
WA	Walla Walla	Asparagus	2,828	1,414
WA	Walla Walla	Barley	≤100*	22,584
WA	Whitman	Barley	≤100*	160,111
WA	Whitman	Wheat	301,201	478,098

Although the migratory passages of the Snake River Sockeye Salmon ESU includes many areas of significant agricultural use, the T&E species are more likely to be in larger, downstream rivers and tributaries, where the dilution effects on disulfoton are likely to be maximized. The important spawning and rearing areas are at a higher elevation than these agricultural areas, and therefore will not be exposed to the pesticide. It should also be noted that the principal spawning area (Redfish Lake) is located on controlled parklands and not within an area of commercial agriculture. Because the spawning and rearing areas are well protected and the migratory corridors are in large, fast moving rivers, I conclude disulfoton will have no effect on this ESU.

5. Specific conclusions for Pacific salmon and steelhead

The review of disulfoton use in California, Oregon, Washington, and Idaho indicates expected usage and application rates, suggesting that the EPA models and known concentrations based on national data, as available, are appropriate. Several features are of significance. The CDPR 2002 report shows significantly lower usage than the other states, which are based on 1997 census data. In large measure this is due to the apparent elimination of disulfoton on wheat and barley in California (except in Siskiyou County). An additional factor in mitigating disulfoton effects in California is the presence of a well organized bulletin program, with strong usage recommendations on usage. In the northwest, the largest crop for which disulfoton may be used is wheat (≅5,432,127 A), scheduled for phase out in June 2005 (with barley and potatoes). significantly reducing the overall environmental load. In this regard, the California information can be taken as being predictive of the effects to be expected in Oregon, Washington, and Idaho after June, 2005 phase out.

Because the areas of concern are typically flowing, well oxygenated streams, rivers, and tributaries, the levels of disulfoton can be expected to rapidly dissipate after crop treatments. Additionally, the ESU's of concern are often coastal and disulfoton concentrations can be expected to rapidly assume oceanic levels through circulation and, particularly in the northwest, tidal displacements.In a few areas, such as the Chinook Salmon, Puget Sound Run, California Central Valley and Sacramento River Chinook Runs, and the Steelhead Runs in similar locations, disulfoton use may have some effect by the combined actions of agriculture, documented here, and the heavy population densities with potential residential use of disulfoton containing products. Specific information on residential use was not available, however residential use of disulfoton is reregistration requirements reduced the maximum concentration of active ingredient to 2% or less and the use of low application rates (0.3lbs ai/1000^2 ft for flowers, 0.01 lbs ai/4 ft shrub, 0.0013 lbs ai/bush for roses). The packaging requirements and prohibition against commercial use indicate that these products are intended for homeowner use.

The indirect effects of disulfoton on the T&E ESU's must be considered due the high toxicity of the compound to aquatic invertebrates. These organisms are a principal food source for the fingerling and smolt stages of salmon and steelhead. A significant deposition of the agent to water in spawning and early life cycle could be seen as a risk to the food supply. The current prohibition of water application and establishment of a "well maintained", vegetated zone of 25 feet from permanent bodies of water will reduce exposure of aquatic invertebrates. Reductions in application rates and application frequency and phase out of major application sites will further reduce exposure of the non-target species. A significant unknown pertains directly to those ESU's in close proximity to urban areas, where runoff from home use is facilitated by paved roads and other surfaces that preclude significant capture of runoff. Largely this applies to residential use of disulfoton.

The spawning and early stages of most salmon and steelhead tend to be located in upstream sites, often at higher elevations than are suitable for agriculture. Many are also located in national and state parks or in wilderness areas. Disulfoton use in such areas is greatly reduced or prohibited. This, again, would reduce loss of aquatic invertebrates in areas of greatest significance to salmon and steelhead and preserve food sources.

Table 54: Final conclusions on the use of disulfoton and it's effects on Western Salmon and Steelhead ESU's.

Species	ESU	Finding
Chinook Salmon	Upper Columbia	may affect but not likely to adversely affect
Chinook Salmon	Snake River spring/summer-run	may affect
Chinook Salmon	Snake River fall-run	may affect

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

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Attachment 1

Interim Reregistration Eligibility Decision for Disulfoton

Case 102

Attachment 2

Quantitative Usage Analysis

Disulfoton Case 102

Attachment 3

EFED Registration Eligibility Decision Chapter

Disulfoton

Attachment 4

Disulfoton Products in Active Use

Attachment 5

Disulfoton Products Canceled or Removed from Use

Attachment 6

Example Labels,
Disulfoton