Diazinon
Analysis of Risks
to
Endangered and Threatened Salmon and Steelhead

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Summary

Diazinon is an organophosphorus insecticide, acaricide, and nematicide widely used in agriculture and in residential areas. Primary agricultural uses are on orchard crops and vegetable crops. The residential use is being phased out and many of the agricultural uses are being modified or cancelled. Diazinon is toxic to fish, but does not exhibit the extreme toxicity that would warrant concerns for direct, lethal effects on fish. Nevertheless, the high toxicity to organisms that serve as food for threatened and endangered Pacific salmon and steelhead, and the potential effects on salmon olfaction, are of significant 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 reregistration process to determine the potential risks to the 26 listed Evolutionarily Significant Units of Pacific salmon and steelhead. The use of diazinon may affect 22 of these ESUs, and may affect but is not likely to adversely affect 4 ESUs.

Introduction

Problem Formulation - The purpose of this analysis is to determine whether the registration of diazinon as an insecticide for use on various crops and on residential areas during a phase out of that use may affect threatened and endangered (T&E or listed) Pacific anadromous salmon and steelhead and their designated critical habitat.

Scope - Although this analysis is specific to listed western salmon and steelhead and the watersheds in which they occur, it is acknowledged that diazinon 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.

Contents

1. Background

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

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

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

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

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

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

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

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

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

Inert Ingredients - OPP does take into account the potential effects of what used to be termed "inert" ingredients, but which are beginning to be referred to as "other ingredients". OPP has classified these ingredients into several categories. A few of these, such as nonylphenol, can no longer be used without including them on the label with a specific statement indicating the potential toxicity. Based upon our internal databases, 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.

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, 1991). This makes any quantitative analysis very difficult to address aquatic exposure from home use. It also indicates that a no-use or no-spray buffer approach for protection, which we consider quite viable for agricultural areas, may not be particularly useful for urban areas.

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

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

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

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

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

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

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

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

Table 2. Risk quotient criteria for fish and aquatic invertebrates

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

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

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

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

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

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

2. Description of diazinon

a. Registered uses

Diazinon was first registered in the United States in 1956 as an organophosphate insecticide, acaricide, and nematicide used on a variety of crops and other sites, for control of soil insects and pests of fruit, vegetables, and forage and field crops. The agricultural uses of diazinon, excepting cattle ear tags, are classified as restricted use due to avian and aquatic toxicity.

(1) Agricultural uses

Diazinon has a number of uses on crops. Some of these may be cancelled as part of the reregistration process. Those crops currently under consideration for continued use and which are grown in areas with Pacific salmon and steelhead are (see Appendix A of the Interim Reregistration Eligibility Decision (IRED) document which is included as Attachment 1):

almonds - CA only - dormant season only
apples - for woolly apple aphid only
apricots - dormant season only
beets, red
blueberries
broccoli

brussel sprouts
cabbage
caneberries
  blackberries
  loganberries
  raspberries
carrots
cattle ear tags
cauliflower
cherries
cranberries - OR & WA only
cucumbers - CA only
endive
figs
filberts
ginseng
lettuce
melons - all varieties, including watermelon
nectarines
onions - bulb and green onions
peaches
pears
peas - CA only
peppers
plums and prunes
potatoes - OR, WA, ID only
sweet potatoes - CA only
rutabagas
squash (winter and summer) - CA only
strawberries
tomatoes
turnips

Some crop uses are being cancelled; in general, these will be phased out over a two-year period. These are:

Chinese vegetables (broccoli, cabbage, mustard, radish)
corn
fruit trees - residential for Mediterranean fruit fly - CA only
grapes
grass grown for seed - OR only
hops
lima beans (seed treatment)

mushrooms
peas (seed treatment)
snap beans (seed treatment)
sugar beets
walnuts

In addition, all aerial applications are being cancelled, all seed treatments are being cancelled, all granular formulation uses are being cancelled except for cranberries, and all foliar uses on vegetables will be cancelled except for leafhoppers on honeydew melons. Lettuce foliar and granular use will have a five-year phase out. There will be limits on the number of applications for some crops. Current agricultural use labels are included as Attachment 2 and changes to these labels resulting from the reregistration effort and on pages 54-66 of the IRED

(2) non-agricultural uses

Diazinon currently is registered for various indoor and outdoor uses in and around residential areas. These are all in the process of being cancelled. All indoor residential product registrations, including pet collars will be canceled and retail sale will end by December 31, 2002. All outdoor residential product registrations will be phased out and canceled by December 31, 2004. Outdoor residential use sites include: outdoor ornamentals, home lawns, window and door screens, window sills, the house foundation, unenclosed porches (but not underneath porches), patios, entrance ways, walks, outdoor garbage cans and outdoor garbage can storage areas, tree trunks, into cracks and other places where insects hide, around the outside of the house next to the foundation, and use as an additive to paints or stains for application outside on exterior surfaces of homes. Additionally, as part of the phase out, for all lawn, garden and turf uses, manufacturing amounts will be decreased over time (25 percent decrease in production for 2002 and 50 percent decrease in production for 2003).

Use rates on commercially grown ornamentals will be reduced from 2 to 1 lb ai/A. A public health Section 24c registration in California for the use of diazinon dust to control plague infected fleas on squirrels apparently will continue.

b. Diazinon usage

Potential diazinon usage in the future is highly uncertain except that with the deletion of home uses and limitations for agricultural use, it will have to be less than it has been.

According to OPP's Qualitative Use Assessment (QUA - Attachment 3) and based on available pesticide usage information mainly for 1987 through 1996, but also taking into account 1997 data, total annual domestic usage of diazinon is approximately 6 million pounds active ingredient (a.i.), 69% of which was used in and around residential and associated areas. Sites with a high percentage of total U.S. acreage treated include brussels sprouts (90%), hops (63%), nectarines (54%), apricots (52%), cranberries (48%), romaine lettuce (45%), plums (39%), prunes (36%) and beets(35%). For agriculture, rates per application and rates per year are generally less than 3 and 4 pounds a.i. per acre, respectively, while for non-agricultural sites, corresponding rates apparently are generally less than 4 and 8 pounds a.i. per acre, respectively. States with significant usage include California, Florida and Texas.

All home and garden uses of diazinon are being cancelled, but the cancellation is not final until the end of 2004. With approximately 69% of diazinon being used in and around homes, this could remove 4,000,000 pounds of diazinon use. In addition, most uses of granular diazinon and many uses of liquid diazinon are also in the process of being cancelled. Other crops will have reduced numbers of applications that will affect usage.

Crops that appear likely to remain on the diazinon labels are almonds, cucurbits (e.g., squash & melons), cole crops (e.g., broccoli and brussel sprouts), carrots, cranberries, onions, lettuce, cherries, peaches, nectarines, pears, strawberries, tomatoes, and possibly some other minor acreage uses.

I have attached a map of pesticide use for diazinon as developed by the USGS. (Attachment 4). This is included as a quick and easy visual depiction of where diazinon may have been used on agricultural crops, but it should not be used for any quantitative analysis because it is based on 1992 crop acreage data and was developed from 1990-1995 statewide estimates of use that were then applied to that county acreage without consideration of local practices and usage. The map also does not take into account the significant changes likely to result from the reregistration process.

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

a. Aquatic toxicity of diazinon

There is a very large amount of aquatic toxicity data on diazinon, which has been registered in the United States since 1954. The quality of these data is highly variable. OPP has rigorous validation requirements for data used in assessments, and these data (Tables 3-7) are used in preference to other data. Compilations of diazinon toxicity data have also been developed by the U. S. Fish and Wildlife Service (Eisler, 1986) and the registration authority for Australia (NRA Australia, 2002). A rather large number of studies are summarized in the AQUIRE data base, but many of these are not accessible (e.g. published in Japanese and not translated) beyond the summary information in AQUIRE. In many cases, it is not even clear what the percentage of active ingredient diazinon was tested. Over the nearly 50 years that diazinon has been in use, there have been many formulations of diazinon that have been used that are no longer being used. An older test with what appears to be the same formulated product as used in a newer test may actually be testing a rather different product.

Caution is also necessary in using older data because diazinon, as originally developed, can react with trace amounts of moisture, air, elevated temperatures or UV radiation to produce degradation products, such as sulfotepp, that are 300-2500 times more toxic to mammals, than the diazinon itself (NRA Australia, 2002). These degradates are not formed when there is more than trace amounts of water; rather the diazinon is hydrolyzed to diethylthiophosphoric acid and 2-isopropyl-4-methyl-6-hydroxypyrimidine. NRA Australia (2002) found in a survey of diazinon products in 1993 that 8.2% of 159 products contained sulfotepp and 4.5% contained monotepp at levels above the UN Food and Agriculture Organization's benchmark limits. Meier et al. (1979) tested several aquatic species with both diazinon and sulfotepp. LC50 values were, for diazinon and sulfotepp, respectively, 10.3 and 0.178 mg/l for fathead minnow, 0.12 and 0.0016 mg/l for bluegill, 1.35 and 0.018 mg/l for rainbow trout, and 0.002 and 0.00023 mg/l for daphnia. The sulfotepp was 58-75 times more toxic to the fish than diazinon. They considered the sulfotepp as an impurity, unlike the NRA Australia (2002) analysis indicating that the sulfotepp is a degradation product. In addition, Meier et al. (1971) tested the hydrolytic degradation products of diazinon, diethylthiophosphoric acid and 2-isopropyl-4-methyl-6-hydroxypyrimidine, and found them to be practically non-toxic to bluegill, with LC50 values of 500 and 1200 mg/l, respectively.

As a result of the concerns for sulfotepp, both technical diazinon and the products formulated with technical diazinon are now stabilized, typically with epoxidized soybean oil, to prevent the formation of the very highly toxic degradate. It is not clear when this conversion was made, but it appears to have been sometime in the 1980s. Attribution of effects to diazinon, per se, would be appropriate if either it is known that the test material was stabilized or if the test concentrations were measured, even in older tests. Adequate information to address this issue is rarely available. As a result, data from unstabilized diazinon may reflect sulfotepp toxicity as much as diazinon toxicity.

Diazinon is activated internally to become diazoxon, which is a more potent cholinesterase inhibitor than is the diazinon, per se. Most of the data relating to this transformation are from terrestrial species. However, Tsuda et al (1997) actually tested both the parent diazinon and the diazoxon metabolite in killifish. They reported 48-hour LC50 values to be 4400 ppb for the diazinon and 220 ppb for the diazoxon; the diazoxon is approximately 20 times more toxic than the diazinon. Although this difference is relevant toxicologically, the use of the parent diazinon in toxicity testing does incorporate the transformation to diazoxon in the test subject. Fujii and Asaka (1982) noted that the differential sensitivity of various species to diazinon (and certain other cholinesterase inhibitors) is largely due to the transformation rates within those species. This includes both transformation from the parent diazinon to diazoxon as well as transformation of the diazoxon to the relatively non-toxic hydroxypyrimidine. They attributed the considerable species differences in transformation rates to the relative activity of cytochrome P-450.

If the diazoxon were formed to any degree in the environment, this would have consequences for its toxicity to fish and other organisms. But in a study in the Sacramento River Basin, Domagalski (1996) reported that only 2.5% (mean value) of the total diazinon and diazoxon residues occurred as diazoxon; the maximum amount was 4%. He also noted that the oxon analogues undergo more rapid hydrolysis than the parent compounds. With this small percentage of exogenous diazoxon and likelihood of quicker hydrolysis, it appears that the internal metabolic transformation from diazinon to diazoxon is the primary mode of exposure, as suggested by Fujii and Asaka (1982).

Although there are some concerns about data quality, the abundance of data is generally consistent. As a general rule of thumb (Mayer and Ellersieck, 1986), fish toxicity for different species should be approximately within an order of magnitude for similar test conditions. Diazinon LC50 values used by OPP exceed this amount of variation, however. Even within the genus *Oncorhynchus* and tests performed at the same laboratory (Columbia National Fisheries Research Laboratory), the LC50 for *Oncorhynchus mykiss* was 30 times lower than in one of the tests for *Oncorhynchus clarki* (Table 3) (Mayer and Ellersieck, 1986). Table 3 presents the acute toxicity data that have been reviewed in OPP's files. See also the Environmental Risk Assessment (Attachment 5) developed for inclusion into the IRED.

Table 3. Aquatic organisms: acute toxicity of diazinon to freshwater fish and invertebrates from EFED files.

Species	Scientific name	% a. i.	96-hour LC50 (ppb)	Toxicity Category
Waterflea	*Daphnia magna*	tech	0.96 (48 hr EC50)	Very highly toxic
Waterflea	*Daphnia magna*	48	1.1 (48 hr EC50)	Very highly toxic
Waterflea	*Daphnia magna*	23ME	0.5 (48 hr EC50)	Very highly toxic
Waterflea	*Daphnia pulex*	89	0.8 (48 hr EC50)	Very highly toxic
Waterflea	*Simocephalus sp.*	89	1.4 (48 hr EC50)	Very highly toxic
Scud	*Gammarus fasciatus*	89	0.2	Very highly toxic
Stonefly larvae	*Pteronarcys sp.*	89	25	Very highly toxic
Rainbow trout	*Oncorhynchus mykiss*	89	90	Very highly toxic
Rainbow trout	*Oncorhynchus mykiss*	23ME	635	Highly toxic
Rainbow trout	*Oncorhynchus mykiss*	91	400	Highly toxic
Rainbow trout	*Oncorhynchus mykiss*	48	1800	Moderately toxic
Rainbow trout	*Oncorhynchus mykiss*	48	1650	Moderately toxic
Cutthroat trout	*Oncorhynchus clarki*	92	1700	Moderately toxic
Cutthroat trout	*Oncorhynchus clarki*	92	2760	Moderately toxic
Lake trout	*Salvelinus namaycush*	92	602	Highly toxic
Brook trout	*Salvelinus fontinalis*	92	770[a]	Highly toxic
Bluegill sunfish	*Lepomis macrochirus*	91	136	Highly toxic

Table 3. Aquatic organisms: acute toxicity of diazinon to freshwater fish and invertebrates from EFED files.

Bluegill sunfish	*Lepomis macrochirus*	92.5	460[b]	Highly toxic
Bluegill sunfish	*Lepomis macrochirus*	92	168	Highly toxic
Bluegill sunfish	*Lepomis macrochirus*	48	220	Highly toxic
Bluegill sunfish	*Lepomis macrochirus*	48	100	Highly toxic
Bluegill sunfish	*Lepomis macrochirus*	23ME	500	Highly toxic
Guppy	*Poecilia reticulata*	NR	1100	Moderately toxic
Fathead minnow	*Pimephales promelas*	92	7800[a]	Moderately toxic
Flagfish	*Jordanella floridae*	92.4	1600[b]	Moderately toxic

a. Average of three tests (Allison and Hermanutz, 1977)
b. Average of two tests (Allison and Hermanutz, 1977)

The chronic toxicity data cited in OPP's ERA for diazinon are summarized in Table 4. For fathead minnows, effects at the low test levels were most pronounced on the progeny. Survival and growth of parental fathead minnows was affected at 60.3 ppb, but not at 28 ppb. However, scoliosis in the parents was observed at concentrations as low as 3.2 ppb after 24 weeks of continuous exposure; scoliosis was not evident at 3.2 and 6.9 ppb after only 19 weeks of exposure (Allison and Hermanutz, 1977). With respect to effects on the progeny, hatchability of young was affected at 3.2 ppb. A NOEC was not determined for this parameter, but an examination of the data indicate that the LOEC of 3.2 ppb is probably not much above the no-observed-effect-level. Hatching success was not affected at 60.3 ppb when unexposed eggs were transferred into this medium after fertilization. There was no evidence of scoliosis in the progeny after two months exposure to diazinon. Effects on survival and growth were not statistically significant up to 60.3 ppb, but the raw numbers look like there was a small effect. The statistical significance may have been masked by high variance.

Brook trout were found to be substantially more sensitive than fathead minnows (Allison and Hermanutz, 1977). Parental growth was affected at concentrations as low as 4.8 ppb and survival at 9.6 ppb; 2.4 ppb was the parental NOEC. Hatching success of the progeny was reduced, but not statistically significant at 2.4 ppb. However, effects on the growth of progeny were significant at the lowest progeny concentration of 0.8 ppb. A NOEC for progeny was not determined.

Table 4. Aquatic organisms: chronic toxicity of diazinon to freshwater fish and invertebrates from EFED files

Species	Scientific name	duration	% a. i.	Endpoints affected	NOEC (ppb)	LOEC (ppb)
Waterflea	*Daphnia magna*	21 d	87.7	Mortality of young	0.17	0.32

Table 4. Aquatic organisms: chronic toxicity of diazinon to freshwater fish and invertebrates from EFED files						
Fathead minnow	*Pimephales promelas*	34 d	87.7	Growth of young	<92	not determined
Fathead minnow	*Pimephales promelas*	274 d	92.5	Hatchability	<03.2	03.2
Brook trout	*Salvelinus fontinalis*	240 d	92.5	Growth of young	<0.80	0.80

Effects on estuarine fish and invertebrates are consistent with those for freshwater fish, except that estuarine invertebrates do not appear to be as sensitive as freshwater invertebrates that have been tested (Tables 5 and 6).

Table 5. Aquatic organisms: acute toxicity of diazinon to estuarine fish and invertebrates from EFED files.

Species	Scientific name	% a. i.	LC50/EC50	Toxicity Category
Sheepshead minnow	*Cyprinodon variegatus*	89	1470 ppb (96 hr LC50)	Moderately toxic
Sheepshead minnow	*Cyprinodon variegatus*	95.1	150 ppb (96 hr LC50)	Highly toxic
Striped mullet	*Mugil cephalus*	95.5	150 ppb (48 hr LC50)	Highly toxic
brown shrimp	*Penaeus aztecus*	95.1	28 ppb (48 hr EC50)	Very highly toxic
Grass shrimp	*Palaemonetes pugio*	95.1	28 ppb (48 hr EC50)	Very highly toxic
Mysid shrimp	*Mysidopsis bahia*	89	25 ppb (96 hr EC50)	Very highly toxic
Eastern oyster	*Crassostrea virginica*	95.1	>1000 ppb (96 hr EC50)	Moderately toxic
Eastern oyster	*Crassostrea virginica*	87.7	880 ppb (96 hr EC50)	Highly toxic

Table 6. Aquatic organisms: chronic toxicity of diazinon to estuarine fish and invertebrates from EFED files

Species	Scientific name	duration	% a. i.	Endpoints affected	NOEC (ppb)	LOEC (ppb)
Sheepshead minnow	*Cyprinodon variegatus*	28 d	>89	egg production	<0.47	NR

There are very few data on aquatic plants or algae (Table 7). As an insecticide without known phytotoxicity, aquatic plant data are not considered necessary.

Table 7. Aquatic organisms: acute toxicity of diazinon to algae and aquatic plants from EFED files.

Species	Scientific name	% a. i.	7d EC50 (ppb)

Table 7. Aquatic organisms: acute toxicity of diazinon to algae and aquatic plants from EFED files.			
Green algae	Selanastrum capricornutum	NR	3700

As previously noted, there are very large amounts of aquatic toxicity data for diazinon. The following are summarized from the AQUIRE data base. With a very few exceptions, as indicated in the references section of this analysis, I did not look at the original papers. In the following tables 8-10, I only included the AQUIRE reference number because of the extensive list. The specific references can be provided if necessary.

The data do show considerable variation. It is likely that much of the variation has to do with the test material, which includes formulated products of varying percentages as well as active ingredients. In addition, the durations of tests ranged from 24 hours to 21 days. However, even test data for different species in the same papers shows that there is natural variation, which is consistent with the findings of Fujii and Asaka (1982) discussed above. In summary, fish acute toxicity LC50 values range from a low of 22 ppb for bluegill to a high of 24 ppm for medaka. As would be expected, there is even a greater range for aquatic invertebrates. LC50 values for various species of insects ranged from 0.03-2500 ppb, with mosquitoes alone having 24-hour LC50 variation form 1.8-80 ppb. Molluscs were generally less sensitive, with LC50 values ranging from 48 ppb to 20 ppm, and other phyla of aquatic invertebrates were also less sensitive with LC50 values ranging from 630-31,000 ppb.

There are no data on aquatic macrophytes. In two tests with green algae, LC50 values were 3.7 and >10 ppm.

Table 8. Aquatic organisms: summary of acute toxicity of diazinon to fish species, from AQUIRE literature.

Species	Scientific name	96-hour LC50 (ppm)	48-hour LC50 (ppm)	Reference
Freshwater species				
Goldfish	*Carassius auratus*	9.0 (1*)	5.1 (1)	13000; 15192
Carp	*Cyprinus carpio*	0.1-4.97 (4)	1.8- 5.2 (5)	7219, 9629, 15192; 6299; 10347; 5345; 45084
Crucian carp		5.0 - 23.4 (2)		7199; 12999
Medaka	*Oryzias latipes*		0.6-24 (5)	15192; 12497; 18398; 5301
Mollies	*Poecilia sp.*		1.3 (1)	12241
Molly	*Poecilia sphenops*	1.6 (7 day) (1)		7511
Guppy	*Poecilia reticulata*	0.8 - 3.4 (3)		7199; 5370; 3860

Table 8. Aquatic organisms: summary of acute toxicity of diazinon to fish species, from AQUIRE literature.				
Western mosquitofish	*Gambusia affinis*		1.27 (1)	5345
Eastern mosquitofish	*Gambusia holbrooki*	1.28 (duration not reported) (1)		283
Bluegill	*Lepomis macrochirus*	0.022-0.530 (10)		664; 5311; 866; 551; 2871; 13001;
Tanago minnow	*Acheilognathus moriokae*		3.2 (1)	7591
Fathead minnow	*Pimephales promelas*	3.3-10.3 (10)		551; 664; 866; 15462; 12859; 45073
Snake-head catfish	*Channa punctata*	0.455 - 3.1 (2)		5648; 5291
Black bullhead	*Ameirus melas*	8.0 (1)		7199
Walking catfish	*Clarias batrachus*	14.8 (1)	9.4 (duration not reported) (1)	283, 14634
Indian catfish	*Heteropneustes fossilis*	2.27 (1)		2890
Channel catfish	*Ictalurus punctatus*		0.074 (1)	4476
Common eel	*Anguilla anguilla*	0.08 - 0.086 (3)		4352; 11055; 6728
Japanese eel	*Anguilla japonica*		2.8 (1)	8570
Hill trout	*Barilius vagra*	1.9 (1)		7219
Cutthroat trout	*Oncorhynchus clarki*	2.76 - 3.85 (2)		6797; 13006
Rainbow trout	*Oncorhynchus mykiss*	0.4 - 6.2 (5)	0.170 - 8.0 (2)	551; 7199; 10337; 12999; 13000; 18916
Brook trout	*Salvelinus fontinalis*	0.45 - 1.05 (3)		664
Harlequin fish	*Rasbora heteromorpha*		1.45 (24 hr) (1)	542
Tilapia	*Tilapia sp.*		1.5 (1)	5345
Mozambique tilapia	*Tilapia mossambica*	2.88 - 3.06 (72 hr) (2)		45084
Flagfish	*Jordanella floridae*	1.5 - 1.8 (2)		664
Zebra danio	*Danio rerio*	2.12 - 8.0 (2)		3860; 12555
Silver orfe, Ide	*Leuciscus idus*	0.150 (1)		7199
Oriental weatherfish	*Misgurnus anguillicaudatus*		0.500 (1)	5761
Saltwater species				
Tooth carp	*Aphanius fasciatus* (SW)	0.151 (1)		5365
SW Agohaze goby	*Chasmichthys dolichognathus*	<0.01 - 0.08 (3)		5767
Green fish SW	*Girella punctata*	0.056 - 0.160 (2)	0.040 - 0.074 (2)	5767; 6128
White mullet	*Mugil curema*		0.250 (1)	2188

Table 8. Aquatic organisms: summary of acute toxicity of diazinon to fish species, from AQUIRE literature.				
Yellowtail	*Seriola quinquerdiata*		0.04 (1)	6128

* Numbers in parentheses are the numbers of tests

Table 9. Aquatic organisms: summary of acute toxicity of diazinon to aquatic invertebrate species, from AQUIRE literature.

Species	Scientific name	duration.	LC/EC50 (ppb) number of tests in parentheses	endpoint if not mortality	AQUIRE Reference number
Arthropods other than insects					
Water flea	*Moina macrocarpa*	3 hr	26 (1)		15192
Water flea	*Moina macrocarpa*	48 hr	1.0-10.0 (1)		17957
Water flea	*Moina macrocarpa*	3 hr	50 (1)		5761
Water flea	*Daphnia pulex*	3 hr	7.8 (1)		15192
Water flea	*Daphnia pulex*	48	0.9 (1)		888
Water flea	*Daphnia pulex*	48	0.65 (1)		821
Water flea	*Daphnia magna*	48 hr	0.7 - 1.25 (5)		866; 6449
Water flea	*Daphnia magna*	21d	NOEC = 0.2 (1)	Reproduction & mortality	6449
Water flea	*Daphnia magna*	21d	EC50 = 0.22 - 0.24 (2)	Mortality	6449
Water flea	*Daphnia magna*	21d	EC50 = 0.2 - 0.4 (3)	Reproduction	18872
Water flea	*Daphnia magna*	21d	LOEC = 0.18 (1) NOEC = 0.15	Mortality	18872
Water flea	*Daphnia magna*	21d	LOEC = 0.9 (1) NOEC = 0.22	Reproduction	18872
Water flea	*Simocephalus serrulatus*	48	1.4 - 2.0 (3)		888; 6797; 10337
Water flea	*Ceriodaphnia dubia*	96	0.32 - 0.41 (5)		16844; 18190
Water flea	*Ceriodaphnia dubia*	7d	NOEC=0.22 (1) LOEC= 0.52	Reproduction	16043
Amphipod	*Ampelisca abdita*	48	10 (1)		18129
Amphipod	*Ampelisca abdita*	24	LOEC = 30 (1) NOEC= 3	Biochemical measurements	18129
Amphipod	*Gammarus fasciatus*	96	0.2 (1)		6797
Amphipod	*Gammarus fasciatus*	7d	133 (1)		7581

Table 9. Aquatic organisms: summary of acute toxicity of diazinon to aquatic invertebrate species, from AQUIRE literature.

Amphipod	*Gammarus lacustris*	96	170 -200 (2)		885; 7581
Amphipod	*Gammarus pseudolimnaeus*	96	2 (1)		7581
Amphipod	*Gammarus pseudolimnaeus*	7d	0.5 (1)		7581
Amphipod	*Rhepoxynius abronius*	24	9.2 (1)		18129
Scud	*Hyalella azteca*	24	19 - 30 (2)		18129
Scud	*Hyalella azteca*	48	22 (1)		7581
Scud	*Hyalella azteca*	96	6.51 (1)		352
Aquatic sowbug	*Asellus communis*	96	21 (1)		7581
Aquatic sowbug	*Asellus hilgendorfi*	48	250 (1)		7690
Copepod	*Cyclops sp*	7d	2510 (1)		7511
Crayfish	*Orconectes propinquus*	7d	15 (1)		7581
Freshwater shrimp	*Paratya compressa improvisa*	48	>1<10 (1)		984
			Insects		
Stonefly	*Acroneuria ruralis*	96	16 (1)		7581
Stonefly	*Pteronarcys californicus*	96	25 (1)		666
Damsel fly	*Agriocnemis sp.*	24	160 (1)		45081
Damsel fly	*Ceriagrion sp.*	24	140 (1)		45081
Damsel fly	*Lestes congener*	96	50 (1)		7775
Dragonfly	*Orthetrum albistylum*	48	140 (1)		7119
Mayfly	*Paraleptophlebia pallipes*	7d	32 (1)		7581
Mayfly	*Baetis intermedius*	96	24 (1)		7581
Mayfly	*Cloeon dipterum*	48	7.8 (1)		5761
Caddis fly	*Ceratopsyche morosa*	6	500 - 2500 (2)		2822
Caddis fly	*Ceratopsyche oxa*	6	30 (1)		7581
Caddis fly	*Hydropsyche recurvata*	24	220 (1)		7581
Caddis fly	*Leptocella albida*	3	220 (1)		7581
Midge	*Chironomus tentans*	96	0.03 - 10.7 (2)		352; 7581
Rice bloodworm	*Chironomus tepperi*	24	35.5 (1)		13398

Table 9. Aquatic organisms: summary of acute toxicity of diazinon to aquatic invertebrate species, from AQUIRE literature.					
Mosquito	*Aedes cantans*	24	35.6 (1)		2914
Mosquito	*Aedes punctor*	24	69.5 (1)		2914
Mosquito	*Aedes vexans*	24	37.9 (1)		2914
House mosquito	*Culex pipiens fatigens*	24	1.8 - 5.7 (1)		17127
Mosquito	*Culex pipiens molestus*	72	50 (1)		5162
Mosquito	*Culex pipiens molestus*	24	30.8 (1)		2914
Mosquito	*Culex pipiens pipiens*	24	24.3 (1)		2914
Mosquito	*Culex pipiens quinquefasciatus*	24	33 - 80 (3 (1))		14106
Southern house mosquito	*Culex quinquefasciatus*	24	3 - 11 (3)		45077
Mosquito	*Culiseta annulata*	24	2.3 (1)		2914
Malaria mosquito	*Anopheles quadrimaculatus*	48	10 (1)		2808
Yellow fever mosquito	*Aedes aegypti*	24	1000 (LC100) (1)		2797
Saltwater species					
Pink shrimp	*Penaeus duorarum*	96	21 (1)		13513
Brown shrimp	*Penaeus aztecus*	24	44 (1)		2188
Kuruma shrimp	*Penaeus japonica*	24	8.5 - 10600 (9)		3043; 5318
Crab	*Portunus trituberculatus*	24	4.0-15 (1)		5318
Calanoid copepod	*Acartia tonsa*	96	2.57 (1)	Behavior	742
Opossum shrimp	*Americamysis bahia*	96	4.82 - 8.5 (2)		4891; 13513
Opossum shrimp	*Americamysis bahia*	28 d	NOEC = 1.15 (1) LOEC = 3.27		4891
Brine shrimp	*Artemia sp.*	24	17,000 - 20,000 (2)		18363
Molluscs					
Mud snail	*Cipangopaludina malleata*	48	16,000 (1)		9158
Oyster	*Crassostrea virginica*	48	1150 (1)	Growth	45074
Oyster	*Crassostrea virginica*	96	910 (1)	Growth	45074
Buffalo pebblesnail	*Gillia altilis*	96	11,000 (1)		693

Table 9. Aquatic organisms: summary of acute toxicity of diazinon to aquatic invertebrate species, from AQUIRE literature.					
Ramshorn snail	*Helisoma trivolvis*	7d	528 (1)		7581
Snail	*Indoplanorbis exustus*	48	20,000 (1)		9158
Bladder snail	*Physa fontinalis*	48	2500 (1)		7690
Pouch snail	*Physa gyrina*	96	48 (1)		7581
Bladder snail	*Physa acuta*	48	4800 (1)		9158
Marsh snail	*Semisulcospira libertina*	48	9500 (1)		9158
Other					
Asian leech	*Hirudo nipponia*	48	1500 - 2400 (2)		2890
Earthworm	*Lumbriculus variegatus*	96	6160 (1)		352
Tubificid worm	*Tubifex*	7d	3160 (1)		7511
Rotifers	*Brachionus calyciflorus*	48 hr	31,000 (1)		3963
Rotifers	*Brachionus calyciflorus*	48 hr	LOEC= 13,000 (1) NOEC = 8000	Reproduction	3963
Rotifers	*Brachionus plicatilis*	24 hr	27,000 - 30,000 (2)		18363
Flatworm	*Dugesia tigrina*	96 hr	630 (1)		13793

Table 10. Aquatic organisms: acute toxicity of diazinon to algae and aquatic plants from literature.

Species	Scientific name	duration	EC50 (ppb)	Endpoint	Reference
Green algae	*Selanastrum capricornutum*	24-72 hr	>10,000	population	2478

Sublethal effects

The basis used by OPP to address sublethal effects is to add a safety factor to the statistically robust median lethal effect levels, as proposed by Tucker and Leitzke (1979) and discussed above in the background section. This approach has worked very well and is expected to continue to be appropriate in most cases, based upon extensive data. However, the work by Scholz et al. (2000) warrants a re-evaluation with respect to diazinon and olfaction, and possibly for other cholinesterase inhibitors and olfaction. Their 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, and with apparent, but non-significant effects at 0.1 ppb. I do have some concerns about their study for the lack of a good dose-response, but it is clear that there were significant differences between the control group and the 1 ppb level. I also have to be somewhat concerned because the lowest test level did exhibit some response, even if that response was not statistically significant. If intermediate concentrations were tested, I would expect the no-observed-effect-level would actually be between 0.1 and 1 ppm.

Toxicity of degradates

No data were found on the aquatic toxicity of the major soil and water degradate, oxypyrimidine. However, WHO/FAO (1971) found that the cholinesterase activity of oxypyrimidine degradates was more than two orders of magnitude lower than that of diazinon. Rat LD50s were 2700 mg/kg and 5000 mg/kg for the two degradates, whereas the LD50 for diazinon was 250 mg/kg. It does not appear that these degradates are of toxicological significance relative to the parent diazinon.

b. Environmental fate and transport

The ERA contains considerable detail on the environmental fate of diazinon on pages 29-36. In summary, diazinon in the environment appears to degrade by hydrolysis in water and by photolysis and microbial metabolism and to dissipate by volatilization from impervious surfaces. Hydrolysis is rapid under acidic condition with a half-life of 12 days at pH 5. Under neutral and alkaline conditions, diazinon hydrolyzed more slowly with half-lives of 138 days at pH 7 and 77 days at pH 9. Diazinon is stable to photolysis in water, but photodegradation on soil surfaces may be important. The major route of dissipation for diazinon appears to be soil metabolism, where the aerobic soil half-life is 37 and 39 days in two soils; under anaerobic conditions, half-lives were 17 and 34 days. A laboratory anaerobic aquatic metabolism study showed rapid degradation of diazinon in a cranberry bog sediment:water system.

Diazinon is slightly mobile in most soils, but immobile in others. The major degradate is oxypyrimidine which appears to be more stable in the soil, as well as more mobile. Diazoxon, a toxic degradate, was not found in laboratory fate studies but was found in the field dissipation studies; it rapidly hydrolyzes to oxypyrimidine. Although the ERA indicates that the toxicity of the degradates is unknown, data in the literature were found. As noted above in the discussion on toxicity, diazoxon has an LC50 of 220 ppb to killifish (Tsuda et al, 1997) which is about 20 times more toxic than diazinon. The primary degradate, oxypyrimidine, appears to be the same as hydroxypyrimidine, which was found to be practically nontoxic to bluegill (Meier et al., 1979).

c. Incidents

OPP maintains two data bases of reported incidents. One, the (EFED Incident Information System or EIIS) is populated with information on environmental incidents which are provided voluntarily to OPP by state and federal agencies and others. There have been periodic solicitations for such information to the states and the U. S. Fish and Wildlife Service. The second is a compilation of incident information known to pesticide registrants and any data conducted by them that shows results differing from those contained in studies provided to support registration. These data and studies (together termed incidents) are required to be submitted to OPP under regulations implementing FIFRA section 6(a)(2).

There are five incidents known to OPP involving diazinon on fish. One of these involved intentional misuse and was probably due to azinphos-methyl. One involved a spill resulting from a fire and one involved an accidental spill from a sewer. Two appear to be from labeled use of diazinon, one in cranberries and one from an unknown use, but there are no further details except that diazinon was the "probable" cause.

d. Estimated and actual concentrations of diazinon in water

(1) EECs from models

A number of scenarios were modeled in the ERA (pages 74-77). I summarize selected ones in Table 11. However, for the most part and partly excepting almonds, these are quite unrealistic for use with Pacific salmon and steelhead. The primary difficulty is that all except the almonds were modeled for areas that will have far more runoff than will occur in the Pacific states, even including the more mesic parts of western Oregon and Washington because the precipitation there, while substantial, does not typically occur in large runoff events. In addition, the model is based upon the upper 10th percentile of runoff events. This would not be unrealistic if the precipitation scenarios were based upon the Western areas being addressed in this analysis. But the upper 10th percentile values further exacerbate the high rainfall events that occur occasionally (e.g., associated with hurricanes, tornadoes, etc) in the areas used for the models. The almonds are an exception, but even these might be somewhat unrealistic because all aerial uses will be canceled. The chronic EECs are based upon the farm pond model and would not relate to flowing water situations. I also note that the potato use in Oregon and Washington is limited to 4 lb ai/A, rather than the 10 lb ai/A modeled for Maine.

I note that in the NAWQA program (see discussion in next section) with 5155 samples from 1058 sites, which were not chosen with respect to pesticide application times, diazinon residues were found in 55% of the samples and peak residues were 3.8 ppb. In targeted monitoring, much of which was done in California, one instance of a 36.8 ppb residue was noted after a storm event following a dormant orchard spray; this event occurred after a 6 year drought, and the 95% percentile residues were 1.69 ppb. While higher residues have been found in discharge waters before reaching natural waters, the 36.8 ppb residue is the only one in receiving waters that exceeded the 3.8 ppb maximum found in the national NAWQA program. This high residue level was found in a 1991-1993 study. Since that time, California DPR's endangered species bulletins have been developed and disseminated for use, and call for exposure mitigations to address both spray drift and runoff near aquatic habitats. Thus, I again believe the modeled EECs are generally not applicable.

Table 11. Estimated environmental concentrations for diazinon and selected crops, as extracted from the Environmental Risk Assessment

crop	application	peak EEC (ppb)	acute risk quotient	60-day chronic EEC (ppb)	chronic risk quotient
Almonds, CA	aerial 1.5 lb ai/A - 3 appl.	8.9	0.10	6.4	11.6
Apples & pears, NY	aerial 2 lb ai/A - 3 appl	25.1	0.28	15.4	28
Blueberries MI	aerial 2 lb ai/A - 5 appl	75.4	0.84	44.8	81.5
Potatoes ME	ground 10 lb ai/A - 1 appl	182	2.0	114	208
Strawberries FL	aerial 1 lb ai/A - 4 appl	112	1.24	83	151
Stone fruits (cherries, peaches, etc) GA	aerial 2 lb ai/A - 3 appl	25.1	0.28	15.4	28
Cucumber FL	ground 1 lb ai/A - 4 appl	429	4.76	258	469

(2) Measured residues in the environment

The ERA discusses extensively the monitoring done by USGS under the NAWQA program and for other purposes. Details of the monitoring by USGS and others are on pages 37-73 of the ERA. The ERA summarizes these data (p39) as follows:

"Diazinon was the most frequently detected insecticide in surface water monitoring studies conducted by the United States Geological Survey under the National Water Quality Assessment Program (NAWQA) and Stream Quality Network programs, California state regulatory agencies, and other sources. It is detected more frequently and at higher concentrations in samples from urban sites than at agricultural sites. Surface waters sampled include rivers, streams, and creeks from areas with both agricultural and urban pesticide use. For example, diazinon was detected frequently (35% of NAWQA samples) at concentrations ranging from below the level of quantitation up to 3.8 µg/L."

Even in targeted monitoring studies, diazinon residues in receiving waters exceeded the NAWQA maximum in only one instance where in the San Joaquin River watershed, California, one sample had 36.8 ppb. At that site, the 95% percentile high value was 1.69 ppb. (p65, ERA)

Another study conducted after the ERA was developed targeted diazinon use in dormant sprays in 2000. Based upon previous residue measurements showing that diazinon is found most frequently and at higher concentrations following winter dormant spray use in orchards, Dileanis, et al. (2002) measured residues after winter storms followed the dormant spray applications. Based upon gas chromatography methods, diazinon residues were found at median concentrations of 44 ng/l with a highest concentration of 2.89 μg/l (ppb); 30% of the samples exceeded 80 ng/l, the value being considered by California as a maximum criterion. Concentrations were highest in small tributaries and canals draining agricultural areas and one canal draining Yuba City. All samples collected in the Sacramento River were below 80 ng/l. The authors noted that the amount applied was about 60% of the average of the previous 4 years, suggesting that residues could be higher in years with more average use of diazinon.

This latter study, reported after the ERA was developed, is important because it was quite targeted, unlike other sampling regimens done under the NAWQA program, and it relates to the dormant orchard use of diazinon that will continue to be allowed based upon changes indicated in the ERA. Other USGS monitoring has detected diazinon frequently, but often in situations where the source was either urban or not clear. Home use of diazinon will be phased out, with no more sales after 2004. Thus, an analysis of future diazinon use based upon past sampling is weak unless the home uses, along with the moderate reduction of agricultural uses, can be separated out.

e. Recent changes in diazinon registrations

Most of the changes in the registration of diazinon are presented elsewhere, as pertinent. For example, registered use sites are indicated in section 2. For details on changes, see page 7 of the IRED for residential uses and pages 43-44 for agricultural uses.

f. Existing protections

Nationally, there are no specific protective measures for endangered and threatened species beyond the generic statements on the current diazinon labels. However, agricultural uses of diazinon are classified as restricted use, which means it can only be applied by certified applicators. The basis for restricted use classification is high avian and aquatic toxicity.

As stated on all pesticide labels, it is a violation of Federal law to use this product in a manner inconsistent with its labeling. There are a variety of measures on diazinon labels for the protection of agricultural workers and other humans, which are not discussed here, but which may be seen on the attached labels. The Environmental Hazards section, for a typical diazinon agricultural use label states:

> "This pesticide is highly toxic to birds, fish, and other wildlife. Birds, especially waterfowl, feeding or drinking on treated areas may be killed. Do not exceed maximum

> permitted label rates. Rates above those recommended significantly increase potential hazards to birds, especially waterfowl. Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Drift and runoff may be hazardous to aquatic organisms in neighboring areas. Shrimp and crab may be killed at application rates recommended on this label. Do not apply where fish, shrimp, crab, and other aquatic life are important resources. Do not contaminate water by cleaning of equipment or disposal of equipment washwaters.
>
> "This pesticide is highly toxic to bees exposed to direct treatment or to residues on blooming crops or weeds. Do not apply this pesticide or allow it to drift to blooming crops or weeds if bees are visiting the treatment area."

Some section 24c, Special Local Needs, labels contain additional protective labeling for endangered species. An example is the Special Local Needs label for diazinon use on potatoes in Oregon, which states:

> "This pesticide is highly toxic to birds, fish, and other wildlife. Diazinon should not be used under this SLN label where impact on listed threatened or endangered species is likely. You may contact the Oregon Department of Fish & Wildlife, National Marine Fisheries Service, or U. S. Fish and Wildlife Service for information on listed threatened or endangered species (e.g. Bull trout, Chinook Salmon). Consult the federal label for additional restrictions and precautions to protect aquatic organisms.
>
> "To protect endangered aquatic organisms, use one of the following options: (1) Apply only when there is a sustained wind away from fish-bearing waters, or (2) Leave an untreated buffer (25 feet for ground applications, 50 feet for chemigation applications) between treatment area and fish-bearing waters."

OPP's endangered species program has developed a series of county bulletins which provide information to pesticide users on steps that would be appropriate for protecting endangered or threatened species. Diazinon is included in these county bulletins where they have been developed. Bulletin development is an ongoing process, and there are no bulletins yet developed that would address fish in the Pacific Northwest. OPP is preparing such bulletins.

In California, the Department of Pesticide Regulation (DPR) in the California Environmental Protection Agency creates county bulletins consistent with those developed by OPP. However, California also has a system of County Agricultural Commissioners responsible for pesticide regulation, and all commercial applicators must get a permit for the use of any restricted use pesticide and must report all pesticide use, restricted or not. The California bulletins for protecting endangered species have been in use for about 5 years. Although they are "voluntary" in nature, the Agricultural Commissioners strongly promote their use by pesticide applicators. Diazinon is currently included in these bulletins for protection of terrestrial and aquatic animals. For aquatic animals, the protective measures include, among others, a 40 yard ground and 200 yard aerial no-spray buffer when the wind is blowing towards the water to protect against spray drift and a 20 foot vegetated buffer strip between the application site and water to protect against runoff. Agricultural and other commercial applicators are well sensitized to the need for protecting endangered and threatened species. DPR believes that the vast majority of agricultural applicators in California are following the limitations in these bulletins (Richard Marovich, Endangered Species Project, DPR, telephone communication, July 19, 2002).

g. Discussion and general risk conclusions for diazinon

There has been considerable controversy over many aspects of diazinon. In general, the most controversy has related to a number of bird kills, a major reason for the cancellation of granular formulations for most uses. However, there is also controversy regarding the determination of water quality standards; see, for example, California's Regional Water Quality Control Board, Central Valley Region, May, 2001 draft report "Sacramento/Feather River Water Quality Management Strategy for Diazinon: Potential Targets" (WQCB 2001).

A. Fish

The lowest fish LC50 used by EFED is 90 ppb for rainbow trout. Using our endangered species criterion of concerns when the EEC exceeds 0.05 x LC50, OPP would have concerns for diazinon concentrations that exceed 4.5 ppb. The work of Scholz et al. (2000) indicates statistically significant effects on chinook salmon olfaction at 1 ppb, with apparent, but non-significant effects at 0.1 ppb.

B. Invertebrates

The very high toxicity to many aquatic invertebrates has led to proposals to limit diazinon residues in water to acute standards of 0.08 ppb (California Department of Fish and Game) or 0.09 ppb (EPA, Office of Water). OPP's assessment used a *Gammarus* LC50 of 0.2 ppb as the most sensitive species in validated tests. At an EEC that is >0.5 times the LC50, there is a potential effect on populations of aquatic invertebrates that may serve as a food source for listed fish. On this basis, concerns for T&E fish would occur at 0.1 ppb. Because there is a plethora of aquatic invertebrate toxicity data for diazinon, there could be an argument that the less sensitive species would still be a food source at higher diazinon concentrations. For example, the typically used *Daphnia magna* has a low LC50 of 0.8 ppb which would result in a concern level of 0.4 ppb in the water, and many invertebrate species commonly used as food by fish would still be expected to be available at considerably higher diazinon concentrations in water.

Arthur et al. (1983) studied macroinvertebrate composition in artificial streams after dosing with 0.3 and 3 ppb diazinon. No consistent differences in the overall macroinvertebrate density was noticed, but the amphipod, *Hyalella azteca*, damselflies, caddisflies, and mayflies, were reduced at the lowest concentrations, while other amphipods, isopods, chironomid insects, and snails were less sensitive and their numbers seem to have compensated for the reductions in the most sensitive species.

There is merit in considering that many invertebrate species could still be available at higher concentrations. However, I note that OPP's criteria were developed on the basis of expecting to have very good data on only a quite limited array of aquatic invertebrates, with the full knowledge that there is a wide range of sensitivity across the many ecologically relevant species. Therefore, I consider it appropriate for this analysis to use the validated data on the most sensitive species as a basis for concerns for food for listed fish. NMFS has considerably more expertise on salmon and steelhead and their food requirements than OPP. I have presented as much of the aquatic invertebrate data as possible, and NMFS may reach different conclusions with respect to fish food sources.

C. Criteria

Although there are different approaches used, most water quality guidelines focus on a most sensitive species, an invertebrate in the case of diazinon, and set criteria to protect the sensitive species. Often, a safety factor is added to a low or the lowest value. Arthur et al. (1983) suggested a criterion of 0.08 ppb. The U.S. Fish and Wildlife Service (Eisler, 1986) accepted this recommendation, but suggested that it "may require adjustment, probably upwards, as more data become available". The Australian National Registration Authority (NRA Australia, 2002) has proposed 0.08 ppb also, as has the California Department of Fish and Game, whereas EPA's Office of Water has proposed 0.09 ppb (WQCB, 2001).

D. Conclusions

Making "typical" risk conclusions regarding the aquatic risk of diazinon to T&E Pacific salmon and steelhead is confounded by a number of factors. On a lethal basis, diazinon is not extremely toxic to fish, but can have sublethal effects on olfaction at considerably lower than expected concentrations. Invertebrate food supply may be affected if these fish feed on the most sensitive aquatic invertebrates, which are indeed very sensitive. But there are many less sensitive species and overall macroinvertebrate communities do not seem to be markedly affected at levels below 1 ppb and even somewhat higher. In addition, the usage of diazinon is expected to be quite different in the future, especially as relates to urban and suburban areas after the home uses are phased out. Finally, the disparity between the modeled EECs, which were based largely on non-salmon areas, and the extensive monitoring data showing generally much lower values even after dormant orchard sprays and runoff events, makes comparisons with toxicity data very difficult.

It is my best professional judgement that diazinon concentrations above 0.1 ppb may affect listed Pacific salmon and steelhead. This takes into account that 0.1 ppb was a statistical no-effect level on salmon olfaction and considers the potential effects on macroinvertebrate food supply for these fish. As Eisler (1986) thought, it may be that this number should be adjusted upwards somewhat as more data become available. In particular, the salmon olfaction effect levels could very well be closer to 1 ppb than 0.1 ppb, but determining this would require an additional study.

I do note, however, that risk is a function of both toxicity and exposure. While there may be some questions regarding toxicity levels, there is high uncertainty with respect to exposure levels. It is my opinion that as the requirements of the RED are phased in, the concentrations of diazinon in aquatic environments cannot help but go down. At the same time, my conclusions must be based upon the current situation and not what will be likely in the future. On this basis, I conclude that diazinon may affect 22 of the 26 Pacific salmon and steelhead ESUs and that diazinon may affect, but is not likely to adversely affect, the remaining 4 ESUs. I also believe that the future risks of diazinon for these ESUs will be lessened.

I can make recommendations to reduce the potential risks of agricultural diazinon use, but because of the uncertainty in future use, it is difficult to know the extent to which these recommendations are necessary. They certainly do seem necessary in addressing the dormant orchard use. At the present time, and since 1997, California's DPR has included diazinon as an aquatic hazard in their county bulletins to protect listed species. Although these bulletins are not currently mandatory throughout the state, most of the county agricultural commissioners will require that they be followed before issuing a permit to use a restricted use pesticide, which diazinon is for agricultural uses. I must note, however, that peak values of diazinon in the tributaries of the Sacramento River in 2000 did reach 2.89 ppb. I cannot tell if the bulletin limitations for diazinon were followed, in which case, they may not be sufficient for diazinon, or if they were not followed, or even if they were not included as a limitation with the permit for use issued by the county agricultural commissioners. I consider it likely that if the bulletins are followed, at least for uses other than dormant orchard sprays, aquatic concentrations will only rarely be high enough to be of concern. While I am not recommending additional research, I believe it appropriate to conduct further analysis of existing monitoring data to ascertain the degree to which the county bulletins are now providing protection.

I believe that buffers will provide adequate protection in the Pacific Northwest also, although I am again uncertain as to the appropriate size of such buffers given the uncertainties with respect to continued diazinon use. I further recommend that for the state of Washington, OPP work with the WSDA endangered species task force and NMFS to determine the appropriate size of buffers or to develop comparable protective measures for the agricultural uses of diazinon. While there are no current, known programs in Idaho and Oregon to address protection of salmon and steelhead from agricultural pesticide use, any OPP steps to implement measures to protect listed salmon and steelhead from the potential affects of diazinon will need to be taken in coordination with the appropriate state agencies in these States.

There appear to be no further authorities that OPP can use to address the home use of diazinon given that it is being phased out. However, OPP again should work with states that may have authority to address such use to determine whether the states could implement any further measures to reduce the potential for diazinon from these uses to reach water during the phase-out period that is part of the cancellation of these uses.

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

The sources of data available on diazinon use are considerably different for California than for other states. California has full pesticide use reporting by all applicators except homeowners. Oregon has initiated a process for full use reporting, but it is not in place yet. Washington and Idaho do not have such a mechanism to my knowledge. Information in the tables below for Oregon, Washington, and Idaho are for the acreage of the specific crops that were in the 1997 USDA agricultural census on which diazinon could be used, based upon the decisions included in the current proposal for diazinon. In the tables below for each ESU, I have not included crops for which diazinon use is being cancelled. I have also presented the acreage only for crops with more than 10 acres listed in the agricultural census.

The latest information for California pesticide use is for the year 2001 [URL: http://www.cdpr.ca.gov/docs/pur/purmain.htm]. The reported information to the County Agricultural Commissioners includes pounds used, acres treated, and the specific location treated. The pounds and acres are reported to the state, but the specific location infomation is retained at the county level and is not readily available to EPA. Table 12 presents diazinon usage over the past nine years in California; however, there will be substantial changes. Table 13 presents all of the diazinon uses in California for 2001. Again changes may be expected. For example, crops which are likely to continue to be registered amount to about 375,000 pounds of the 966,000 pounds total usage reported. In the tables further below for each ESU, I have included all of the uses where more than 100 pounds was reported to California's Department of Pesticide Regulation (DPR), whether these uses are proposed to continue or not. I have highlighted in bold font the uses that are expected to continue. Please note that California does not have use reporting by homeowners. We know that homeowner is substantial, but cannot provide any quantitative data. Diazinon will no longer be sold for indoor homeowner use after 2002 and outdoor homeowner use after 2004.

Table 12. Reported use of diazinon in California, 1993-2001, in pounds of active ingredient

1993	1994	1995	1996	1997	1998	1999	2000	2001
1,412,733	1,368,358	1,216,935	1,093,121	955,108	900,596	979,458	1,053,407	996,943

Table 13. Reported use of diazinon, by crop, for 2001 in California. Only crops with 10 or more pounds of diazinon included. Crops highlighted in bold font are proposed for continued registration.

crop or site	pounds of active ingredient of diazinon used	acres treated
alfalfa	73	102
almonds	**63,203**	**32,155**
apples	**5712**	**4592**
apricots	**3171**	**2036**
beans	9555	4173
garden beets	**658**	**417**
bermuda grass	99	195
blackberries	**395**	**216**
bok choy	382	740
broccoli	**13,552**	**11,093**
brussel sprouts	**1669**	**2929**
cabbage	**2206**	**2881**
cactus leaf	20	6
cantaloupes	6227	11,343
carrots	**4451**	**6227**
cauliflower	**5531**	**3893**
celery	167	121
cherries	**7697**	**4264**
chicory	74	125
Chinese cabbage	466	928
Christmas trees	30	34
collards	32	130
corn (forage-fodder)	176	94
corn (human consumption)	3667	4356
cucumber	**193**	**247**
daikon (Chinese "radish")	10	37
endive	**664**	**825**
fig	**955**	**382**

forage hay	81	178
gai lot	70	144
grapes	5388	6465
kale	873	1581
landscape maintenance	25,622	nr
lettuce	**122,437**	**190,152**
melon	**1342**	**3004**
mushrooms	1193	(50)*
mustard	2053	923
nectarines	**13,842**	**7602**
nursery greenhouse flowers	**1241**	**1218**
nursery greenhouse container plants	**2017**	**(455)***
nursery greenhouse transplants	**590**	**(939)***
nursery-outdoor flowers	**785**	**(1021)***
nursery outdoor container plants	**2289**	**(2778)***
nursery outdoor transplants	**109**	**(106)***
onions	**17,058**	**9781**
parsley	32	19
peaches	**33,056**	**17,553**
pears	**4767**	**2526**
peas	**1053**	**1843**
peppers	**6595**	**3409**
plums	**12,586**	**6424**
potatoes	459	449
prunes	**28,594**	**16,225**
public health	**36**	**nr**
radish	789	726
rappini	719	1483
raspberry	**403**	**263**
regulatory pest control	200	nr

research commodity	177	(64)*
rights-of-way	1708	nr
shallot	**29**	**39**
soil fumigation	11	9
spinach	24,627	10,607
squash	**922**	**927**
strawberries	**2014**	**2819**
structural pest control	511,790	nr
sugar beet	14,689	30,896
swiss chard	531	325
tomatoes	**13,184**	**13,615**
turnip	**169**	**194**
uncultivated agriculture	700	(280)*
uncultivated non-agriculture	246	122
walnut	6367	3231
watermelon	**1201**	**1019**
state total	996,943	

* Acreage reported includes only a portion of use; some use reported in "units" or square feet.

While some aspects of future diazinon use are fairly clear, I must reiterate that the reregistration effort is not yet completed, and there are some uncertainties. Nevertheless, it appears the following changes in diazinon registrations will occur:

- granular diazinon will no longer be allowed for use, except on cranberries. However, there will be a 5-year phase-out of granular use on lettuce
- all aerial applications will be deleted
- certain uses are deleted: Chinese broccoli, Chinese cabbage, Chinese mustard, Chinese radish, corn, grapes, hops, mushrooms, sugarbeets, walnuts, and watercress. Watercress use will be phased out over 4 years.
- certain Special Local Needs [Section 24(c)] use sites will be deleted: grass grown for seed (Oregon); drenching around residential fruit trees for control of Mediterranean fruit fly (California).
- dormant orchard use is somewhat more limited, but by recommendation rather than requirement
- deletion of all foliar uses on vegetables crops except in honeydew melons; applications will be allowed only to soil. However, foliar applications in lettuce will be phased out over 5 years, during which there will be rate reduction from 4 lb ai/A to 1 lb ai/A.

- all seed treatment uses will be deleted
- all home and garden sales will cease by the end of 2004, and there are provisions for buying back existing stocks

My information on the various ESUs was taken almost entirely from various Federal Register Notices relating to listing, critical habitat, or status reviews. As noted above, usage data were derived from 1997 Agricultural Census, DPR's pesticide use reporting, and confidential sales information from the registrant. In the Pacific Northwest tables, I have also indicated, in the last column, the total acreage of land in each county and the acreage and percentage of land in farms, which includes ranches. Following this section, I make and discuss my conclusions.

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 nonanadromous forms: a coastal group and an inland group, separated approximately by the Cascade crest in Oregon and Washington. California is thought to have only coastal steelhead while Idaho has only inland steelhead.

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

1. Southern California Steelhead ESU

The Southern California steelhead ESU was proposed for listing as endangered on August 9, 1996 (61FR41541-41561) and the listing was made final a year later (62FR43937-43954, August 18, 1997). Critical Habitat was proposed February 5, 1999 (64FR5740-5754) and designated on February 16, 2000 (65FR7764-7787). This ESU ranges from the Santa Maria River in San Luis Obispo County south to San Mateo Creek in San Diego County. Steelhead from this ESU may also occur in Santa Barbara, Ventura and Los Angeles counties, but this ESU apparently is no longer considered to be extant in Orange County (65FR79328-79336, December 19, 2000). Hydrologic units in this ESU are Cuyama (upstream barrier - Vaquero Dam), Santa Maria, San Antonio, Santa Ynez (upstream barrier - Bradbury Dam), Santa Barbara Coastal, Ventura (upstream barriers - Casitas Dam, Robles Dam, Matilja Dam, Vern Freeman Diversion Dam), Santa Clara (upstream barrier - Santa Felicia Dam), Calleguas, and Santa Monica Bay (upstream barrier - Rindge Dam). Counties comprising this ESU show a very high percentage of declining and extinct populations.

River entry ranges from early November through June, with peaks in January and February. Spawning primarily begins in January and continues through early June, with peak spawning in February and March.

Within San Diego County, the San Mateo Creek runs through Camp Pendleton Marine Base and into the Cleveland National Forest. While there are agricultural uses of pesticides in other parts of California within the range of this ESU, it would appear that there are no such uses in the vicinity of San Mateo Creek. Within Los Angeles County, this steelhead occurs in Malibu Creek and possibly Topanga Creek. Neither of these creeks drain agricultural areas.

We have no quantitative knowledge of homeowner use, although it is being phased out. There is some agricultural or nursery use in all counties within this ESU. There is a potential for steelhead waters to drain agricultural areas. Reportable usage of diazinon in counties where this ESU occurs are presented in Table 14.

Table 14. Use of diazinon in counties with the Southern California steelhead ESU. Data do not include homeowner use.

County	Agricultural crop or other use site	Reported Usage (pounds)	Acres treated
San Diego	landscape maintenance	739	nr
	nursery (all)	**1068**	**646**
	structural pest control	14,550	nr
	county total		

Los Angeles	**beet**	**127**	**167**
	kale	151	224
	landscape maintenance	1284	nr
	nursery (all)	**820**	**237**
	onions	**4773**	**1145**
	peach	**722**	**355**
	radish	101	85
	spinach	100	50
	structural pest control	242,199	nr
	county total	249,735	
Ventura	beans	3219	1606
	corn	421	653
	lettuce	**148**	**279**
	mushroom	524	50
	nursery (all)	**551**	**679**
	onions	**1324**	**564**
	radish	446	281
	raspberry	**403**	**263**
	structural pest control	2419	nr
	county total	9968	
San Luis Obispo	beans	182	55
	broccoli	**275**	**70**
	carrot	**1143**	**229**
	chinese cabbage	339	678
	grapes	101	140
	landscape maintenance	173	nr

	lettuce	**2979**	**834**
	nursery (all)	**504**	**401**
	peach	**212**	**152**
	peas	**356**	**1064**
	pepper	**1647**	**411**
	squash	**238**	**124**
	structural pest control	1780	nr
	county total	10,329	
Santa Barbara	**broccoli**	**419**	**257**
	cauliflower	**468**	**166**
	lettuce	**683**	**191**
	nursery (all)	**283**	**299**
	peppers	**280**	**70**
	strawberry	**164**	**165**
	structural pest control	873	nr
	county total	3439	

Diazinon use within the Southern California steelhead ESU is moderate. I conclude that the use of diazinon may affect this ESU directly through effects on olfaction. I further conclude that there may be indirect effects on the food supply of this steelhead.

2. South Central California Steelhead ESU

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

This ESU includes the hydrologic units of Pajaro (upstream barriers - Chesbro Reservoir, North Fork Pachero Reservoir), Estrella, Salinas (upstream barriers - Nacimiento Reservoir, Salinas Dam, San Antonio Reservoir), Central Coastal (upstream barriers - Lopez Dam, Whale Rock Reservoir), Alisal-Elkhorn Sloughs, and Carmel. Counties of occurrence include Santa Cruz, San Benito, Monterey, and San Luis Obispo. There are substantial agricultural areas in these counties, and there are very large quantities of diazinon use reported.

We have no quantitative knowledge of homeowner use, although it is being phased out. There is considerable agricultural use in most counties within this ESU. There is a potential for steelhead waters to drain agricultural areas. Reportable usage of diazinon in counties where this ESU occurs are presented in Table 15.

Table 15. Use of diazinon in counties with the South Central California steelhead ESU. Data do not include homeowner use.

County	Agricultural crop or other use site	Reported Usage (pounds)	Acres treated
Santa Cruz	**blackberries**	**395**	**215**
	brussel sprouts	**748**	**1461**
	landscape maintenance	1020	nr
	lettuce	**3367**	**5946**
	nursery (all)	**290**	**263**
	spinach	781	449
	strawberry	**129**	**160**
	structural pest control	225	nr
	county total		
San Benito	**apricots**	**600**	**509**
	beets	**387**	**161**
	broccoli	**211**	**330**
	cabbage	**771**	**994**
	celery	100	25
	cherry	**256**	**185**
	corn	648	576

	endive	**238**	**153**
	landscape maintenance	184	nr
	lettuce	**6618**	**7304**
	onion	**2261**	**1191**
	peppers	**659**	**658**
	spinach	1781	783
	structural pest control	539	nr
	swiss chard	111	51
	tomatoes	**2459**	**1429**
	county total	19,722	
Monterey	beans	5205	1590
	beets	114	31
	bok choy	101	193
	broccoli	**7475**	**3815**
	brussel sprouts	**296**	**647**
	cabbage	**552**	**710**
	carrot	256	493
	cauliflower	**4650**	**3076**
	endive	**345**	**582**
	kale	672	1290
	landscape maintenance	1037	nr
	lettuce	**84,221**	**138,373**
	nursery (all)	**1537**	**412**
	onions	**2249**	**2479**
	peas	**526**	**326**
	peppers	**581**	**465**

	spinach	20,545	8445
	squash	**195**	**78**
	strawberry	**1278**	**1900**
	structural pest control	1794	nr
	tomatoes	**437**	**204**
	uncultivated agriculture	353	67
	county total	135,138	
San Luis Obispo	beans	182	55
	broccoli	**275**	**70**
	carrot	**1143**	**229**
	chinese cabbage	339	678
	grapes	101	140
	landscape maintenance	173	nr
	lettuce	**2979**	**834**
	nursery (all)	**504**	**401**
	peach	**212**	**152**
	peas	**356**	**1064**
	pepper	**1647**	**411**
	squash	**238**	**124**
	structural pest control	1780	nr
	county total	10,329	

Diazinon use within the South Central California steelhead ESU is very high, especially on lettuce. I conclude that the use of diazinon may affect this ESU directly through effects on olfaction. I further conclude that there may be indirect effects on the food supply of this steelhead.

3. Central California Coast Steelhead ESU

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

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

Counties of occurrence for this ESU are Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Mendocino, Napa, Alameda, Contra Costa, Solano, and Santa Clara counties. There is moderate agricultural use of diazinon in Santa Cruz County and in the inland counties. This ESU is associated with significantly large urban and suburban areas where diazinon will be phased out but where it is probably currently being used.

Table 16. Use of diazinon in counties with the Central California Coast steelhead ESU. Data do not include homeowner use.

County	Agricultural crop or other use site	Reported Usage (pounds)	Acres treated
Santa Cruz	**blackberries**	**395**	**215**
	brussel sprouts	**748**	**1461**
	landscape maintenance	1020	nr
	lettuce	**3367**	**5946**
	nursery (all)	**290**	**263**

	spinach	781	449
	strawberry	**129**	**160**
	structural pest control	225	nr
	county total	8371	
San Mateo	**brussel sprouts**	**568**	**806**
	landscape maintenance	270	
	nursery (all)	**314**	**221**
	structural pest control	3530	nr
	county total	4695	
San Francisco	structural pest control	578	nr
	county total	582	
Marin	landscape maintenance	133	nr
	structural pest control	838	nr
	county total	972	
Sonoma	grapes	159	154
	landscape maintenance	414	nr
	mushrooms	640	nr - indoor?
	structural pest control	3009	nr
	county total	4651	
Mendocino	county total	124	
Napa	structural pest control	110	
	county total	186	
Alameda	landscape maintenance	1146	
	structural pest control	4153	
	county total	5303	
Contra Costa	**apple**	**1104**	**648**

	apricot	**226**	**122**
	landscape maintenance	8325	nr
	peach	**186**	**106**
	structural pest control	5404	nr
	walnut	105	114
	county total	15,592	
Solano	**prune**	**279**	**156**
	structural pest control	1175	nr
	tomatoes	**402**	**1329**
	county total	2864	
Santa Clara	**apricot**	**385**	**250**
	beans	351	175
	cherry	**2501**	**1277**
	corn	1311	1254
	landscape maintenance	4326	nr
	lettuce	**2708**	**1538**
	mustard	418	179
	nursery (all)	**710**	**970**
	onion	**112**	**205**
	peppers	**3333**	**1530**
	spinach	1212	479
	structural pest control	10,215	nr
	swiss chard	318	132
	tomatoes	**507**	**613**
	uncultivated agriculture	205	60
	uncultivated nonagriculture	223	75

	county total	29,192	

It is not clear how much use the Central California Coast steelhead ESU makes of Santa Clara, Solano and Contra Costa counties, which drain into the San Francisco Bay. For most of the other counties within this ESU, diazinon will be deleted or phased out for the uses that have been reported. There is still sufficient uncertainty that I conclude that diazinon may affect the Central California Coastal steelhead ESU.

4. California Central Valley Steelhead ESU

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

This ESU includes populations ranging from Shasta, Trinity, and Whiskeytown areas, along with other Sacramento River tributaries in the North, down the Central Valley along the San Joaquin River to and including the Merced River in the South, and then into San Pablo and San Francisco Bays. Counties at least partly within this area are Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Glenn, Marin, Merced, Nevada, Placer, Sacramento, San Francisco, San Joaquin, San Mateo, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tuloumne, Yolo, and Yuba. A large proportion of this area is heavily agricultural, but there are also large amounts of urban and suburban areas. Usage of diazinon in counties where the California Central Valley steelhead ESU occurs is presented in Table 17. Most agricultural use of diazinon would likely be as a dormant spray in orchards.

Table 17. Use of diazinon in counties with the California Central Valley steelhead ESU. Data do not include homeowner use.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated
Alameda	landscape maintenance	1146	
	structural pest control	4153	
	county total	5303	
Amador	structural pest control	106	nr
	county total	114	
Butte	**almond**	**1222**	**632**
	peach	**1178**	**672**

	prune	**3825**	**1865**
	structural pest control	1664	nr
	county total	8081	
Calaveras	structural pest control	1285	nr
	county total	1366	
Colusa	**prune**	**348**	**175**
	tomatoes	**246**	**713**
	walnut	469	159
	county total	1411	
Contra Costa	**apple**	**1104**	**648**
	apricot	**226**	**122**
	landscape maintenance	8325	nr
	peach	**186**	**106**
	structural pest control	5404	nr
	walnut	105	114
	county total	15,592	
Glenn	**almond**	**5480**	**3165**
	prune	**5210**	**3010**
	structural pest control	212	nr
	walnut	522	232
	county total	11,425	
Marin	landscape maintenance	133	nr
	structural pest control	838	nr
	county total	972	
Merced	**almond**	**2418**	**1463**
	cantaloupe	**813**	**1585**

	fig	**300**	**120**
	melon	**690**	**1380**
	nectarine	**427**	**214**
	peach	**1860**	**922**
	prune	**451**	**452**
	regulatory pest control	193	nr
	structural pest control	14,154	nr
	tomatoes	**465**	**155**
	walnut	224	114
	watermelon	**164**	**225**
	county total	23,996	
Nevada	structural pest control	492	nr
	county total	517	
Placer	landscape maintenance	272	nr
	peach	**123**	**91**
	plum	**134**	**121**
	structural pest control	2628	nr
	county total	3332	
Sacramento	**apple**	**262**	**161**
	cherry	**159**	**95**
	landscape maintenance	622	nr
	pear	**3603**	**1931**
	structural pest control	9673	nr
	tomatoes	**439**	**388**
	county total	14,780	
San Joaquin	**almond**	**7316**	**5220**

	apple	**518**	**320**
	cherry	**3017**	**1864**
	grape	133	144
	landscape maintenance	236	nr
	peach	**593**	**303**
	structural pest control	3766	nr
	tomatoes	**1348**	**633**
	walnut	452	251
	county total	17,664	
San Mateo	**brussel sprouts**	**568**	**806**
	landscape maintenance	270	
	nursery (all)	**314**	**221**
	structural pest control	3530	nr
	county total	4695	
San Francisco	structural pest control	578	nr
	county total	582	
Shasta	structural pest control	2112	nr
	county total	2217	
Solano	**prune**	**279**	**156**
	structural pest control	1175	nr
	tomatoes	**402**	**1329**
	county total	2864	
Sonoma	grapes	159	154
	landscape maintenance	414	nr
	mushrooms	640	nr - indoor?
	structural pest control	3009	nr

	county total	4651	
Stanislaus	**almond**	**3552**	**2074**
	apple	**507**	**272**
	apricot	**173**	**87**
	cantaloupe	**361**	**760**
	cherry	**192**	**84**
	landscape maintenance	311	nr
	nectarine	**153**	**78**
	peach	**1768**	**959**
	plum	**114**	**57**
	structural pest control	51,883	nr
	tomatoes	**1351**	**1028**
	walnut	1174	590
	county total	61,714	
Sutter	**almond**	**1206**	**524**
	corn	176	94
	peach	**4617**	**2426**
	prune	**7822**	**4000**
	structural pest control	560	nr
	tomatoes	**2933**	**4443**
	walnut	1440	528
	county total	19,561	
Tehama	**almond**	**674**	**541**
	prune	**2942**	**2309**
	structural pest control	584	nr
	county total	4314	

Tuolumne	landscape maintenance	590	nr
	structural pest control	2435	nr
	county total	3037	
Yolo	**apple**	**126**	**126**
	landscape maintenance	565	nr
	pear	**102**	**60**
	prune	**433**	**291**
	structural pest control	782	nr
	tomatoes	**1249**	**1518**
	uncultivated agriculture	109	136
	watermelon	**168**	**128**
	county total	3712	
Yuba	**peach**	**1935**	**981**
	prune	**1787**	**1023**
	structural pest control	172	nr
	walnut	1209	496
	county total	5135	

Diazinon use within the California Central Valley steelhead ESU can be substantial on orchard crops, in particular. I conclude that the use of diazinon may affect this ESU directly through effects on olfaction. I further conclude that there may be indirect effects on the food supply of this steelhead. These effects would likely be in tributaries to, rather than directly in, the Sacramento and San Joaquin Rivers.

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 18 shows limited reportable use of diazinon in these counties, and the structural pest control use will be phased out. These counties are also not strongly urban and suburban with respect to homeowner use of diazinon.

Table 18. Use of diazinon in counties with the Northern California steelhead ESU. Data do not include homeowner use.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated
Humboldt	county total	43	
Mendocino	county total	124	
Trinity	county total	10	
Lake	structural pest control	445	
	county total	535	

Diazinon use within the Northern California steelhead ESU is currently rather limited and should become close to zero after cancellation of residential uses. However, there is some current use and I conclude that the use of diazinon may affect, but is not likely to adversely affect this ESU.

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.

There is a considerable amount of acreage, especially orchard crops and potatoes, where diazinon may be used with the reproductive area of this ESU. It is uncertain how much of this will continue, but it could be significant. It would not appear that residential use would be a major factor in the reproductive and growth areas of this ESU. It seems likely that the Columbia River provides sufficient dilution for diazinon to not be a concern from residential use in the migratory corridor.

Tables 19 and 20 show the cropping information, where diazinon can be used for Washington counties where the Upper Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 19. Crops on which diazinon can be used in Washington counties where there is spawning and growth of the Upper Columbia River steelhead ESU

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Benton	potatoes (25,317), apples (18,245), onions (3398), pears (472), plums & prunes (180), apricots (174), peaches (149) nectarines (106), tomatoes, peppers, cucumbers, squash	51,445	1,089,993 640,370 58.7%
WA	Franklin	potatoes (35,770), apples (9000), onions (4074), carrots (3574), cherries (2165), peaches (262), pears (156), nectarines (129) caneberries (70), apricots (68), plums & prunes (43), strawberries (17), cucumbers, tomatoes, peppers, watermelons	55,332	794,999 670,149 84.3%
WA	Kittitas	apples (1859), potatoes (442), pears (331), filberts, peaches, plums & prunes,	2625	1,469,862 355,360 24.2%

WA	Yakima	apples (75264), pears (10,190), cherries (6129), potatoes (1929), peaches (1438), nectarines (605), plums & prunes (478), peppers (480), tomatoes (293), squash (292), apricots (285), watermelons (151), cabbage (144), turnips (40), caneberries (10), filberts, onions,	97,928	2,749,514 1,639,965 59.6%
WA	Chelan	apples (17,096), pears (8298), cherries (3704), apricots (81), nectarines (22), peaches (21), plums & prunes, cucumbers	29,225	1,869,848 112,085 6%
WA	Douglas	apples (14,383), cherries (1842), pears (1104), apricots (315), peaches (167), nectarines (91), tomatoes	17,902	1,165,168 918,033 78.8%
WA	Okanogan	apples (24164), pears (3280), cherries (1003), peaches (67), nectarines (38), apricots (13), filberts (10), peppers, broccoli, caneberries, carrots, plums & prunes, squash, cabbage, tomatoes	28,582	3,371,698 1,291,118 38.3%
WA	Grant	potatoes (44,263), apples (33,615), onions (6214), cherries (3470), carrots (2207), pears (998), apricots (266), peaches (261), nectarines (163), tomatoes, plums & prunes, squash, peppers, strawberries, caneberries, cucumbers, filberts, watermelons	91,958	1,712,881 1,086,045 63.4%

Table 20. Crops on which diazinon can be used in Oregon and Washington counties that are migration corridors for the Upper Columbia River steelhead ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Walla Walla	potatoes (9256), apples (5222), onions (2172), endive (306), cherries (280), cucumbers (140), plums & prunes (22), cabbage, beets, radishes, lettuce	17,406	813,108 710,546 87.4%

WA	Klickitat	pears (923), apples (516), cherries (457), peaches (199), apricots (18), peppers (12), tomatoes, plums & prunes, squash, cucumbers, potatoes	2135	1,198,385 689,639 57.5%
WA	Skamania	pears (477), apples (75)	552	1,337,179 4043 0.4%
WA	Clark	caneberries (642), strawberries (162), filberts (87), blueberries (85), pears (75), peaches (46), apples (33), tomatoes (10), plums & prunes (10), squash, lettuce, cucumbers, cherries	1152	401,850 82,967 20.6
WA	Cowlitz	caneberries (439), apples (14), pears, cherries, filberts, tomatoes, blueberries, carrots	460	728,781 35,678 4.9%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
WA	Pacific	cranberries (1312), apples, cherries	1312	623,722 32,637 5.2%
OR	Gilliam	none	0	770,664 766,373 99.4%
OR	Umatilla	potatoes (15,003), apples (3927), onions (3914), watermelons (837), plums & prunes (365), cherries (349), peppers (121)tomatoes (27), apricots (14), strawberries, peaches, caneberries, pears, nectarines, blueberries cucumbers	24,584	2,057,809 1,466,580 71.3%
OR	Sherman	none	0	526,911 487,534 92.5%
OR	Morrow	potatoes (17,030), onions (1284), apples	18,314	1,301,021 1,119,004 86%

OR	Wasco	cherries (7342), apples (463), pears (385), apricots (32), peaches (30), plums & prunes, strawberries	8262	1,523,958 1,152,965 75.7%
OR	Hood River	pears (11,788), apples (2592), cherries (1081), blueberries (29), peaches (13), caneberries, broccoli	15,504	334,328 27,201 8.1%
OR	Multnomah	caneberries (814), cabbage (553), potatoes (336), cucumbers (297), strawberries (171), squash (163), endive (62), lettuce (62), blueberries (62), cauliflower (55), peaches (36), broccoli (29), pears (25), beets (21), tomatoes (20), cherries, peppers, plums & prunes, carrots	2772	278,570 31,294 11.2%
OR	Columbia	blueberries (101), apples (39), pears (12), cherries, strawberries, plums & prunes, caneberries, peaches, filberts	186	420,332 71,839 17.1%
OR	Clatsop	cranberries (32), apples, blueberries	32	529,482 24,740 4.7%

There is substantial acreage where diazinon can be used in the reproductive and growth areas of this precarious ESU. I conclude that the use of diazinon may affect the Upper Columbia River steelhead ESU, both through effects on olfaction and on the invertebrate food supply. These effects should be limited to tributaries of the Columbia River.

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

Critical Habitat also includes the migratory corridors of the Columbia River from the confluence of the Snake River to the Pacific Ocean. Additional counties in the migratory corridors are Umatilla, Gilliam, Morrow, Sherman, Wasco, Hood River, Multnomah, Columbia, and Clatsop in Oregon; and Benton, Klickitat, Skamania, Clark, Cowlitz, Wahkiakum, and Pacific in Washington.

The USDA census indicates that there is limited acreage of crops on which diazinon can be used in Idaho counties within this ESU, nor in the Washington counties bordering on Idaho. There is rather large acreage of potatoes in several counties along the lower Snake River and in the migratory corridors for this ESU.

Tables 21 and 22 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. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 21. Crops on which diazinon can be used in Pacific Northwest counties which provide spawning and rearing habitat for the Snake River Basin steelhead ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
ID	Adams	apples	0	873,399 221,209 25.3%
ID	Idaho	apples, pears, tomatoes, filberts, plums	11	5,430,522 744,295 13.7%

ID	Nez Perce	peaches (22), apples, cherries, apricots, potatoes	66	543,434 477,839 87.9%
ID	Custer	potatoes (507)	507	3,152,382 140,701 4.5%
ID	Lemhi	cherries, apples, peaches, pears, apricots	20	2,921,172 193,908 6.6%
ID	Valley	potatoes (225), carrots	225	2,354,043 78,813 3.3%
ID	Lewis	none	0	306,601 211,039 68.8%
ID	Clearwater	none	0	1,575,396 103,246 6.6%
ID	Latah	cherries (19), apples, pears	22	689,089 347,293 50.4%
WA	Adams	potatoes (27,914), apples (3457), onions (1453), pears, cherries	32,824	1,231,999 996,742 80.9%
WA	Asotin	apples (24), peaches (18), cherries (17), pears, apricots	70	406,983 274,546 67.5%
WA	Garfield	none		454,744 325,472 84.3%
WA	Columbia	apples	0	556,034 304,928 54.8%
WA	Whitman	apples (19), pears	21	1,382,006 1,404,289 101.6%

WA	Franklin	potatoes (35,770), apples (9000), onions (4074), carrots (3574), cherries (2165), peaches (262), pears (156), nectarines (129) caneberries (70), apricots (68), plums & prunes (43), strawberries (17), cucumbers, tomatoes, peppers, watermelons	55,332	794,999 670,149 84.3%
WA	Walla Walla	potatoes (9256), apples (5222), onions (2172), endive (306), cherries (280), cucumbers (140), plums & prunes (22), cabbage, beets, radishes, lettuce	17,406	813,108 710,546 87.4%
OR	Wallowa	apples, peaches	8	2,013,071 694,304 34.5%
OR	Union	potatoes (660), cherries (596), apples (39), peaches (12), apricots, pears, carrots, plums & prunes	1307	1,303,476 473,316 36.3%

Table 22. Crops on which diazinon can be used in Washington and Oregon counties through which the Snake River Basin steelhead ESU migrates

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Walla Walla	potatoes (9256), apples (5222), onions (2172), endive (306), cherries (280), cucumbers (140), plums & prunes (22), cabbage, beets, radishes, lettuce	17,406	813,108 710,546 87.4%
WA	Benton	potatoes (25,317), apples (18,245), onions (3398), pears (472), plums & prunes (180), apricots (174), peaches (149) nectarines (106), tomatoes, peppers, cucumbers, squash	51,445	1,089,993 640,370 58.7%
WA	Klickitat	pears (923), apples (516), cherries (457), peaches (199), apricots (18), peppers (12), tomatoes, plums & prunes, squash, cucumbers, potatoes	2135	1,198,385 689,639 57.5%
WA	Skamania	pears (477), apples (75)	552	1,337,179 4043 0.4%

WA	Clark	caneberries (642), strawberries (162), filberts (87), blueberries (85), pears (75), peaches (46), apples (33), tomatoes (10), plums & prunes (10), squash, lettuce, cucumbers, cherries	1152	401,850 82,967 20.6
WA	Cowlitz	caneberries (439), apples (14), pears, cherries, filberts, tomatoes, blueberries, carrots	460	728,781 35,678 4.9%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
WA	Pacific	cranberries (1312), apples, cherries	1312	623,722 32,637 5.2%
OR	Umatilla	potatoes (15,003), apples (3927), onions (3914), watermelons (837), plums & prunes (365), cherries (349), peppers (121)tomatoes (27), apricots (14), strawberries, peaches, caneberries, pears, nectarines, blueberries cucumbers	24,584	2,057,809 1,466,580 71.3%
OR	Morrow	potatoes (17,030), onions (1284), apples	18,314	1,301,021 1,119,004 86%
OR	Gilliam	none	0	770,664 766,373 99.4%
OR	Sherman	none	0	526,911 487,534 92.5%
OR	Wasco	cherries (7342), apples (463), pears (385), apricots (32), peaches (30), plums & prunes, strawberries	8262	1,523,958 1,152,965 75.7%
OR	Hood River	pears (11,788), apples (2592), cherries (1081), blueberries (29), peaches (13), caneberries, broccoli	15,504	334,328 27,201 8.1%

OR	Multnomah	caneberries (814), cabbage (553), potatoes (336), cucumbers (297), strawberries (171), squash (163), endive (62), lettuce (62), blueberries (62), cauliflower (55), peaches (36), broccoli (29), pears (25), beets (21), tomatoes (20), cherries, peppers, plums & prunes, carrots	2772	278,570 31,294 11.2%
OR	Columbia	blueberries (101), apples (39), pears (12), cherries, strawberries, plums & prunes, caneberries, peaches, filberts	186	420,332 71,839 17.1%
OR	Clatsop	cranberries (32), apples, blueberries	32	529,482 24,740 4.7%

There is a fairly large amount acreage where diazinon can be used in the reproductive and growth areas of this ESU. I conclude that the use of diazinon may affect the Snake River Basin steelhead ESU, both through effects on olfaction and on the invertebrate food supply. These effects should be limited to tributaries of the Snake and Columbia Rivers.

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 diazinon 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.

Acreage where agricultural diazinon use may occur is moderate to high in several counties in this ESU. Urban and suburban areas where residential use can occur for the next several years would be most pronounced in Portland, which is in the migratory corridor, and its surrounding suburbs of Washington and Clackamas counties.

Tables 23 and 24 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. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 23. Crops on which diazinon can be used that are part of the spawning and rearing habitat of the Upper Willamette River steelhead ESU.

St	County	Crops and acres planted	Acres	<u>total acreage</u> land in farms % farmed
OR	Benton	squash (881), filberts (493), beets (202), blueberries (109), apples (62) cherries (18) strawberries (17), endive (10), lettuce (10), pears, peaches, tomatoes, plums & prunes, caneberries, peppers, onions, cucumbers, potatoes, watermelon, broccoli	1848	<u>432,961</u> 118,818 27.4%
OR	Linn	filberts (1820), squash (479), cabbage (431), caneberries (422), broccoli (267), cauliflower (164), cherries (157), apples (133), beets (78), peaches (73), blueberries (58), strawberries (52), pears (26), plums & prunes (14), tomatoes, cucumbers, nectarines, onions, peppers, carrots	4190	<u>1,466,507</u> 380,464 25.9%

OR	Polk	filberts (2394), cherries (1888), plums & prunes (595), caneberries (157), apples (157), pears (63), peaches (51), strawberries (22), blueberries (21), tomatoes, beets, squash, peppers, watermelons, carrots, broccoli	5355	<u>474,296</u> 167,880 35.4%
OR	Clackamas	filberts (3994), caneberries (2409), cucumbers (830), strawberries (608), cabbage (593), endive (512), squash (380), blueberries (334), cauliflower (319), broccoli (184), apples (167), radishes (144), onions (140), lettuce (132), beets (80), peaches (78), cherries (53), pears (37), plums & prunes (37), peppers (29), tomatoes (21), potatoes	11,082	<u>1,195,712</u> 148,848 12.4%
OR	Marion	filberts (7061), cabbage (4210), caneberries (4182), broccoli (2548), onions (2036), strawberries (1858), cherries (1568), cauliflower (1505), squash (1281), cucumbers (993), apples (555), blueberries (545), beets (184), peaches (179), pears (150), plums & prunes (145), carrots (76), celery (32), peppers (33), tomatoes (16), watermelons, nectarines, potatoes, lettuce	29,159	<u>758,394</u> 302,462 39.9%
OR	Yamhill	filberts (7110), cherries (1693), caneberries (453), plums & prunes (369), blueberries (324), apples (310), cabbage (308), broccoli (308), strawberries (265), beets (176), squash (133), peaches (104), pears (54), peppers (13), tomatoes, potatoes	11,630	<u>457,986</u> 179,787 39.3%

OR	Washington	filberts (5595), caneberries (2227), strawberries (1257), blueberries (654), broccoli (400), cabbage (400), plums & prunes (358), apples (279), cherries (211), onions (196), cucumbers (188), beets (168), peaches (168), squash (82), endive (75), pears (69), tomatoes (27), lettuce, watermelons, peppers, carrots, potatoes, cauliflower	12,362	<u>463,231</u> 139,820 30.2%

Table 24. Crops on which diazinon can be used in Oregon and Washington counties that are part of the migration corridors of the Upper Willamette River steelhead ESU.

St	County	Crops and acres planted	Acres	<u>total acreage</u> land in farms % farmed
WA	Clark	caneberries (642), strawberries (162), filberts (87), blueberries (85), pears (75), peaches (46), apples (33), tomatoes (10), plums & prunes (10), squash, lettuce, cucumbers, cherries	1152	<u>401,850</u> 82,967 20.6
WA	Cowlitz	caneberries (439), apples (14), pears, cherries, filberts, tomatoes, blueberries, carrots	460	<u>728,781</u> 35,678 4.9%
WA	Wahkiakum	none	0	<u>169,125</u> 12,611 7.5%
WA	Pacific	cranberries (1312), apples, cherries	1312	<u>623,722</u> 32,637 5.2%
OR	Multnomah	caneberries (814), cabbage (553), potatoes (336), cucumbers (297), strawberries (171), squash (163), endive (62), lettuce (62), blueberries (62), cauliflower (55), peaches (36), broccoli (29), pears (25), beets (21), tomatoes (20), cherries, peppers, plums & prunes, carrots	2772	<u>278,570</u> 31,294 11.2%

OR	Columbia	blueberries (101), apples (39), pears (12), cherries, strawberries, plums & prunes, caneberries, peaches, filberts	186	<u>420,332</u> 71,839 17.1%
OR	Clatsop	cranberries (32), apples, blueberries	32	<u>529,482</u> 24,740 4.7%

There is moderate to high acreage where diazinon can be used in the reproductive and growth areas of this ESU. I conclude that the use of diazinon may affect the Upper Willamette River steelhead ESU, both through effects on olfaction and on the invertebrate food supply. These effects should be generally limited to tributaries of the Willamette River.

<u>9. Lower Columbia River steelhead ESU</u>

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.

Both Hood River and Clackamas counties have high acreage where diazinon may be used within this ESU. Several counties are urban/suburban where diazinon may be used for the next several years in residential areas. The migratory corridors for this ESU have limited acreage where diazinon can be used; the limited amount of cranberry acreage in Pacific County may not drain into the Columbia River, but would be adequately diluted if it did.

Tables 25 and 26 show the cropping information for Oregon and Washington counties where the Lower Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 25. Crops and acreage where diazinon can be used in counties that provide spawning and rearing habitat for the Lower Columbia River Steelhead ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Hood River	pears (11,788), apples (2592), cherries (1081), blueberries (29), peaches (13), caneberries, broccoli	15,504	334,328 27,201 8.1%
OR	Clackamas	filberts (3994), caneberries (2409), cucumbers (830), strawberries (608), cabbage (593), endive (512), squash (380), blueberries (334), cauliflower (319), broccoli (184), apples (167), radishes (144), onions (140), lettuce (132), beets (80), peaches (78), cherries (53), pears (37), plums & prunes (37), peppers (29), tomatoes (21), potatoes	11,082	1,195,712 148,848 12.4%
OR	Multnomah	caneberries (814), cabbage (553), potatoes (336), cucumbers (297), strawberries (171), squash (163), endive (62), lettuce (62), blueberries (62), cauliflower (55), peaches (36), broccoli (29), pears (25), beets (21), tomatoes (20), cherries, peppers, plums & prunes, carrots	2772	278,570 31,294 11.2%
WA	Clark	caneberries (642), strawberries (162), filberts (87), blueberries (85), pears (75), peaches (46), apples (33), tomatoes (10), plums & prunes (10), squash, lettuce, cucumbers, cherries	1152	401,850 82,967 20.6

WA	Cowlitz	caneberries (439), apples (14), pears, cherries, filberts, tomatoes, blueberries, carrots	460	728,781 35,678 4.9%
WA	Skamania	pears (477), apples (75)	552	1,337,179 4043 0.4%

Table 26. Crops and acreage where diazinon can be used in counties that are migratory corridors for the Lower Columbia River Steelhead ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Columbia	blueberries (101), apples (39), pears (12), cherries, strawberries, plums & prunes, caneberries, peaches, filberts	186	420,332 71,839 17.1%
OR	Clatsop	cranberries (32), apples, blueberries	32	529,482 24,740 4.7%
WA	Pacific	cranberries (1312), apples, cherries	1312	623,722 32,637 5.2%
WA	Wahkiakum	none	0	169,125 12,611 7.5%

There is fairly high acreage in several counties where diazinon can be used in the reproductive and growth areas of this ESU. I conclude that the use of diazinon may affect the Lower Columbia River steelhead ESU, both through effects on olfaction and on the invertebrate food supply. These effects should be limited to tributaries of the Columbia River.

10. Middle Columbia River Steelhead ESU

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

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

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

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

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

The acreage where diazinon can be used is moderate to high in several counties within this ESU and is mostly potatoes and orchard crops. Residential use that can continue for the next several years could be scattered throughout the ESU, but pronounced in the Portland area.

Tables 27 and 28 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. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 27. Crops and acreage where diazinon can be used in counties that provide spawning and rearing habitat for the Middle Columbia River Steelhead ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Gilliam	none	0	770,664 766,373 99.4%
OR	Morrow	potatoes (17,030), onions (1284), apples	18,314	1,301,021 1,119,004 86%
OR	Umatilla	potatoes (15,003), apples (3927), onions (3914), watermelons (837), plums & prunes (365), cherries (349), peppers (121)tomatoes (27), apricots (14), strawberries, peaches, caneberries, pears, nectarines, blueberries cucumbers	24,584	2,057,809 1,466,580 71.3%
OR	Sherman	none	0	526,911 487,534 92.5%
OR	Wasco	cherries (7342), apples (463), pears (385), apricots (32), peaches (30), plums & prunes, strawberries	8262	1,523,958 1,152,965 75.7%
OR	Crook	none	0	1,906,892 894,853 46.9%
OR	Grant	apricots (19), apples, pears	19	2,898,444 1,154,399 39.8%
OR	Wheeler	apples (23)	23	1,097,601 728,131 66.3%
OR	Jefferson	potatoes (973), apples	977	1,139,744 530,960 46.6%

WA	Benton	potatoes (25,317), apples (18,245), onions (3398), pears (472), plums & prunes (180), apricots (174), peaches (149) nectarines (106), tomatoes, peppers, cucumbers, squash	51,445	1,089,993 640,370 58.7%
WA	Columbia	apples	0	556,034 304,928 54.8%
WA	Franklin	potatoes (35,770), apples (9000), onions (4074), carrots (3574), cherries (2165), peaches (262), pears (156), nectarines (129) caneberries (70), apricots (68), plums & prunes (43), strawberries (17), cucumbers, tomatoes, peppers, watermelons	55,332	794,999 670,149 84.3%
WA	Kittitas	apples (1859), potatoes (442), pears (331), filberts, peaches, plums & prunes,	2625	1,469,862 355,360 24.2%
WA	Klickitat	pears (923), apples (516), cherries (457), peaches (199), apricots (18), peppers (12), tomatoes, plums & prunes, squash, cucumbers, potatoes	2135	1,198,385 689,639 57.5%
WA	Skamania	pears (477), apples (75)	552	1,337,179 4043 0.4%
WA	Walla Walla	potatoes (9256), apples (5222), onions (2172), endive (306), cherries (280), cucumbers (140), plums & prunes (22), cabbage, beets, radishes, lettuce	17,406	813,108 710,546 87.4%
WA	Yakima	apples (75264), pears (10,190), cherries (6129), potatoes (1929), peaches (1438), nectarines (605), plums & prunes (478), peppers (480), tomatoes (293), squash (292), apricots (285), watermelons (151), cabbage (144), turnips (40), caneberries (10), filberts, onions,	97,928	2,749,514 1,639,965 59.6%

Table 28. Crops on which diazinon can be used in Washington and Oregon counties through which the Middle Columbia River steelhead ESU migrates

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Skamania	pears (477), apples (75)	552	1,337,179 4043 0.4%
WA	Clark	caneberries (642), strawberries (162), filberts (87), blueberries (85), pears (75), peaches (46), apples (33), tomatoes (10), plums & prunes (10), squash, lettuce, cucumbers, cherries	1152	401,850 82,967 20.6
WA	Cowlitz	caneberries (439), apples (14), pears, cherries, filberts, tomatoes, blueberries, carrots	460	728,781 35,678 4.9%
WA	Pacific	cranberries (1312), apples, cherries	1312	623,722 32,637 5.2%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
OR	Hood River	pears (11,788), apples (2592), cherries (1081), blueberries (29), peaches (13), caneberries, broccoli	15,504	334,328 27,201 8.1%
OR	Multnomah	caneberries (814), cabbage (553), potatoes (336), cucumbers (297), strawberries (171), squash (163), endive (62), lettuce (62), blueberries (62), cauliflower (55), peaches (36), broccoli (29), pears (25), beets (21), tomatoes (20), cherries, peppers, plums & prunes, carrots	2772	278,570 31,294 11.2%
OR	Columbia	blueberries (101), apples (39), pears (12), cherries, strawberries, plums & prunes, caneberries, peaches, filberts	186	420,332 71,839 17.1%

OR	Clatsop	cranberries (32), apples, blueberries	32	529,482 24,740 4.7%

There is moderate to high acreage where diazinon can be used in the reproductive and growth areas of this ESU. I conclude that the use of diazinon may affect the Middle Columbia River steelhead ESU, both through effects on olfaction and on the invertebrate food supply. These effects should be limited to tributaries of the Columbia River.

B. Chinook salmon

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

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

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

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

1. Sacramento River Winter-run Chinook Salmon ESU

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

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

Table 29 shows the diazinon usage in California counties supporting the Sacramento River winter-run chinook salmon ESU. In general, the agricultural uses of diazinon that will continue within this ESU are moderate for orchard crops. Diazinon residential use could be considerable in parts of this ESU prior to its phase-out. Although recent monitoring of dormant orchard sprays did not find residues of concern in the Sacramento River itself (Dileanis, 2002), the authors noted that the period under study had lower than average diazinon use.

Table 29. Use of diazinon in counties with the Sacramento River winter-run Chinook salmon ESU. Spawning areas are primarily in Shasta and Tehama counties above the Red Bluff diversion dam.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated
Alameda	landscape maintenance	1146	
	structural pest control	4153	
	county total	5303	
Butte	**almond**	**1222**	**632**
	peach	**1178**	**672**
	prune	**3825**	**1865**

	structural pest control	1664	nr
	county total	8081	
Colusa	**prune**	**348**	**175**
	tomatoes	**246**	**713**
	walnut	469	159
	county total	1411	
Contra Costa	**apple**	**1104**	**648**
	apricot	**226**	**122**
	landscape maintenance	8325	nr
	peach	**186**	**106**
	structural pest control	5404	nr
	walnut	105	114
	county total	15,592	
Glenn	**almond**	**5480**	**3165**
	prune	**5210**	**3010**
	structural pest control	212	nr
	walnut	522	232
	county total	11,425	
Marin	landscape maintenance	133	nr
	structural pest control	838	nr
	county total	972	
Sacramento	**apple**	**262**	**161**
	cherry	**159**	**95**
	landscape maintenance	622	nr
	pear	**3603**	**1931**
	structural pest control	9673	nr

	tomatoes	**439**	**388**
	county total	14,780	
San Mateo	**brussel sprouts**	**568**	**806**
	landscape maintenance	270	
	nursery	**314**	**221**
	structural pest control	3530	nr
	county total	4695	
San Francisco	structural pest control	578	nr
	county total	582	
Shasta	structural pest control	2112	nr
	county total	2217	
Solano	**prune**	**279**	**156**
	structural pest control	1175	nr
	tomatoes	**402**	**1329**
	county total	2864	
Sonoma	grapes	159	154
	landscape maintenance	414	nr
	mushrooms	640	nr - indoor?
	structural pest control	3009	nr
	county total	4651	
Tehama	**almond**	**674**	**541**
	prune	**2942**	**2309**
	structural pest control	584	nr
	county total	4314	
Yolo	**apple**	**126**	**126**
	landscape maintenance	565	nr

	pear	**102**	**60**
	prune	**433**	**291**
	structural pest control	782	nr
	tomatoes	**1249**	**1518**
	uncultivated agriculture	109	136
	watermelon	168	128
	county total	3712	

There is moderate use of diazinon on orchards throughout much of this ESU. I conclude that the use of diazinon may affect the Sacramento River winter run chinook salmon, although I expect this would be limited because of the low residues of diazinon that have been found. In two to three years after the changes in diazinon use have been phased in, it may be worthwhile to revisit the potential exposure and possibly re-evaluate this conclusion.

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, I have excluded them from consideration because diazinon would not be used in these areas. I have, however, kept Umatilla County as part of the migratory corridor.

The USDA census indicates that there are very few acres of crops where diazinon can be used in Idaho counties within this ESU, nor in the Washington counties bordering on Idaho. Within the spawning and rearing habitat of this ESU, there is substantial acreage of potatoes along the lower Snake River. While there is substantial acreage of potential use along the migratory corridors, dilution in the Columbia River should be sufficient to remove concerns.

Tables 30 and 31 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. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 30. Crops on which diazinon can be used in Pacific Northwest counties which provide spawning and rearing habitat for the Snake River fall-run chinook ESU

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
ID	Adams	apples	0	873,399 221,209 25.3%
ID	Idaho	apples, pears, tomatoes, filberts, plums	11	5,430,522 744,295 13.7%
ID	Nez Perce	peaches (22), apples, cherries, apricots, potatoes	66	543,434 477,839 87.9%
ID	Valley	potatoes (225), carrots	225	2,354,043 78,813 3.3%
ID	Lewis	none		306,601 211,039 68.8%

ID	Benewah	apples	6	496,662 111,510 22.5%
ID	Shoshone	none		1,685,770 4,428 0.3%
ID	Clearwater	none		1,575,396 103,246 6.6%
ID	Latah	cherries (19), apples, pears	22	689,089 347,293 50.4%
WA	Adams	potatoes (27,914), apples (3457), onions (1453), pears, cherries	32,824	1,231,999 996,742 80.9%
WA	Lincoln	potatoes (771), cherries, carrots, apples	772	1,479,196 1,465,788 99.1%
WA	Spokane	apples (227), squash (58), cherries (50), peaches (42), carrots (34), strawberries (30), pears (24), caneberries (15), apricots (11), cucumbers (11), peppers, tomatoes, lettuce, endive, potatoes, onions	517	1,128,835 625,769 55.4%
WA	Asotin	apples (24), peaches (18), cherries (17), pears, apricots	70	406,983 274,546 67.5%
WA	Garfield	none		454,744 325,472 84.3%
WA	Columbia	apples	0	556,034 304,928 54.8%
WA	Whitman	apples (19), pears	21	1,382,006 1,404,289 101.6%

WA	Franklin	potatoes (35,770), apples (9000), onions (4074), carrots (3574), cherries (2165), peaches (262), pears (156), nectarines (129) caneberries (70), apricots (68), plums & prunes (43), strawberries (17), cucumbers, tomatoes, peppers, watermelons	55,332	794,999 670,149 84.3%
WA	Walla Walla	potatoes (9256), apples (5222), onions (2172), endive (306), cherries (280), cucumbers (140), plums & prunes (22), cabbage, beets, radishes, lettuce	17,406	813,108 710,546 87.4%
OR	Wallowa	apples, peaches	8	2,013,071 694,304 34.5%
OR	Union	potatoes (660), cherries (596), apples (39), peaches (12), apricots, pears, carrots, plums & prunes	1307	1,303,476 473,316 36.3%

Table 31. Crops on which diazinon can be used in 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 and acres planted	Acres	total acreage land in farms % farmed
WA	Walla Walla	potatoes (9256), apples (5222), onions (2172), endive (306), cherries (280), cucumbers (140), plums & prunes (22), cabbage, beets, radishes, lettuce	17,406	813,108 710,546 87.4%
WA	Benton	potatoes (25,317), apples (18,245), onions (3398), pears (472), plums & prunes (180), apricots (174), peaches (149) nectarines (106), tomatoes, peppers, cucumbers, squash	51,445	1,089,993 640,370 58.7%
WA	Klickitat	pears (923), apples (516), cherries (457), peaches (199), apricots (18), peppers (12), tomatoes, plums & prunes, squash, cucumbers, potatoes	2135	1,198,385 689,639 57.5%

WA	Skamania	pears (477), apples (75)	552	1,337,179 4043 0.4%
WA	Clark	caneberries (642), strawberries (162), filberts (87), blueberries (85), pears (75), peaches (46), apples (33), tomatoes (10), plums & prunes (10), squash, lettuce, cucumbers, cherries	1152	401,850 82,967 20.6
WA	Cowlitz	caneberries (439), apples (14), pears, cherries, filberts, tomatoes, blueberries, carrots	460	728,781 35,678 4.9%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
WA	Pacific	cranberries (1312), apples, cherries	1312	623,722 32,637 5.2%
OR	Umatilla	potatoes (15,003), apples (3927), onions (3914), watermelons (837), plums & prunes (365), cherries (349), peppers (121)tomatoes (27), apricots (14), strawberries, peaches, caneberries, pears, nectarines, blueberries cucumbers	24,584	2,057,809 1,466,580 71.3%
OR	Morrow	potatoes (17,030), onions (1284), apples	18,314	1,301,021 1,119,004 86%
OR	Gilliam	none	0	770,664 766,373 99.4%
OR	Sherman	none	0	526,911 487,534 92.5%
OR	Wasco	cherries (7342), apples (463), pears (385), apricots (32), peaches (30), plums & prunes, strawberries	8262	1,523,958 1,152,965 75.7%

OR	Hood River	pears (11,788), apples (2592), cherries (1081), blueberries (29), peaches (13), caneberries, broccoli	15,504	334,328 27,201 8.1%
OR	Multnomah	caneberries (814), cabbage (553), potatoes (336), cucumbers (297), strawberries (171), squash (163), endive (62), lettuce (62), blueberries (62), cauliflower (55), peaches (36), broccoli (29), pears (25), beets (21), tomatoes (20), cherries, peppers, plums & prunes, carrots	2772	278,570 31,294 11.2%
OR	Columbia	blueberries (101), apples (39), pears (12), cherries, strawberries, plums & prunes, caneberries, peaches, filberts	186	420,332 71,839 17.1%
OR	Clatsop	cranberries (32), apples, blueberries	32	529,482 24,740 4.7%

There is a fairly large amount acreage in Washington where diazinon can be used in the reproductive and growth areas of this ESU. I conclude that the use of diazinon may affect the Snake River fall run chinook salmon ESU, both through effects on olfaction and on the invertebrate food supply. These effects should be limited to tributaries of the Snake River.

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, I have excluded Umatilla and Baker counties in Oregon and Blaine County in Idaho because accessible river reaches are all well above areas where diazinon can be used. Counties with migratory corridors are all of those down stream from the confluence of the Snake and Columbia Rivers.

The USDA census indicates that there is limited acreage where diazinon can be used in Idaho counties within this ESU, nor in the Washington counties bordering on Idaho. There is moderate acreage in Walla Walla and Franklin counties along the lower Snake River within the reproductive and growth area of this ESU. There is also moderate acreage in several counties along the migratory corridor, but there would appear to be sufficient dilution for diazinon to not be a concern in the Columbia River.

Table 32 shows the crop-acreage information for Oregon and Washington counties where the Snake River spring/summer-run chinook salmon ESU occurs. The cropping information for the migratory corridors is the same as for the Snake River fall-run chinook salmon and is in table 31 above. If there is no acreage given for a specific crop in table 32, this means that there are too few growers in the area for USDA to make the data available.

Table32. Crops on which diazinon can be used in Idaho counties which provide spawning and rearing habitat for the Snake River spring/summer run chinook ESU

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
ID	Adams	apples	0	873,399 221,209 25.3%
ID	Idaho	apples, pears, tomatoes, filberts, plums	11	5,430,522 744,295 13.7%
ID	Nez Perce	peaches (22), apples, cherries, apricots, potatoes	66	543,434 477,839 87.9%

ID	Custer	potatoes (507)	507	3,152,382 140,701 4.5%
ID	Lemhi	cherries, apples, peaches, pears, apricots	20	2,921,172 193,908 6.6%
ID	Valley	potatoes (225), carrots	225	2,354,043 78,813 3.3%
ID	Lewis	none		306,601 211,039 68.8%
ID	Latah	cherries (19), apples, pears	22	689,089 347,293 50.4%
WA	Asotin	apples (24), peaches (18), cherries (17), pears, apricots	70	406,983 274,546 67.5%
WA	Garfield	none		454,744 325,472 84.3%
WA	Columbia	apples	0	556,034 304,928 54.8%
WA	Whitman	apples (19), pears	21	1,382,006 1,404,289 101.6%
WA	Franklin	potatoes (35,770), apples (9000), onions (4074), carrots (3574), cherries (2165), peaches (262), pears (156), nectarines (129) caneberries (70), apricots (68), plums & prunes (43), strawberries (17), cucumbers, tomatoes, peppers, watermelons	55,332	794,999 670,149 84.3%

WA	Walla Walla	potatoes (9256), apples (5222), onions (2172), endive (306), cherries (280), cucumbers (140), plums & prunes (22), cabbage, beets, radishes, lettuce	17,406	813,108 710,546 87.4%
OR	Wallowa	apples, peaches	8	2,013,071 694,304 34.5%
OR	Union	potatoes (660), cherries (596), apples (39), peaches (12), apricots, pears, carrots, plums & prunes	1307	1,303,476 473,316 36.3%

Because of the moderate potato acreage in the lower Snake River, I conclude that the use of diazinon may affect the Snake River spring/summer run chinook salmon ESU, both through effects on olfaction and on the invertebrate food supply. These effects should be limited to tributaries of the Snake River.

4. Central Valley Spring-run Chinook Salmon ESU

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

Hydrologic units and upstream barriers within this ESU are the Sacramento-Lower Cow-Lower Clear, Lower Cottonwood, Sacramento-Lower Thomes (upstream barrier - Black Butte Dam), Sacramento-Stone Corral, Lower Butte (upstream barrier - Centerville Dam), Lower Feather (upstream barrier - Oroville Dam), Lower Yuba, Lower Bear (upstream barrier - Camp Far West Dam), Lower Sacramento, Sacramento-Upper Clear (upstream barriers - Keswick Dam, Whiskeytown dam), Upper Elder-Upper Thomes, Upper Cow-Battle, Mill-Big Chico, Upper Butte, Upper Yuba (upstream barrier - Englebright Dam), Suisin Bay, San Pablo Bay, and San Francisco Bay. These areas are said to be in the counties of Shasta, Tehama, Butte, Glenn, Colusa, Sutter, Yolo, Yuba, Placer, Sacramento, Solano, Nevada, Contra Costa, Napa, Alameda, Marin, Sonoma, San Mateo, and San Francisco. However, with San Mateo County being well south of the Oakland Bay Bridge, it is difficult to see why this county was included.

Table 33 contains usage information for the California counties supporting the Central Valley spring-run chinook salmon ESU. As with the Central Valley steelhead, there is moderate orchard use of diazinon. And for the next several years, there could be residential uses of concern.

Table 33. Use of diazinon in counties with the Central Valley spring run chinook salmon ESU.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated
Alameda	landscape maintenance	1146	nr
	structural pest control	4153	nr
	county total	5303	
Butte	**almond**	**1222**	**632**
	peach	**1178**	**672**
	prune	**3825**	**1865**
	structural pest control	1664	nr
	county total	8081	
Colusa	**prune**	**348**	**175**
	tomatoes	**246**	**713**
	walnut	469	159
	county total	1411	
Contra Costa	**apple**	**1104**	**648**
	apricot	**226**	**122**
	landscape maintenance	8325	nr
	peach	**186**	**106**
	structural pest control	5404	nr
	walnut	105	114
	county total	15,592	
Glenn	**almond**	**5480**	**3165**
	prune	**5210**	**3010**
	structural pest control	212	nr
	walnut	522	232
	county total	11,425	

Marin	landscape maintenance	133	nr
	structural pest control	838	nr
	county total	972	
Napa	structural pest control	110	nr
	county total	186	
Nevada	structural pest control	492	nr
	county total	517	
Placer	landscape maintenance	272	nr
	peach	**123**	**91**
	plum	**134**	**121**
	structural pest control	2628	nr
	county total	3332	
Sacramento	**apple**	**262**	**161**
	cherry	**159**	**95**
	landscape maintenance	622	nr
	pear	**3603**	**1931**
	structural pest control	9673	nr
	tomatoes	**439**	**388**
	county total	14,780	
San Mateo	**brussel sprouts**	**568**	**806**
	landscape maintenance	270	nr
	nursery	**314**	**221**
	structural pest control	3530	nr
	county total	4695	
San Francisco	structural pest control	578	nr
	county total	582	

Shasta	structural pest control	2112	nr
	county total	2217	
Solano	**prune**	**279**	**156**
	structural pest control	1175	nr
	tomatoes	**402**	**1329**
	county total	2864	
Sonoma	grapes	159	154
	landscape maintenance	414	nr
	mushrooms	640	nr - indoor?
	structural pest control	3009	nr
	county total	4651	
Sutter	**almond**	**1206**	**524**
	corn	176	94
	peach	**4617**	**2426**
	prune	**7822**	**4000**
	structural pest control	560	nr
	tomatoes	**2933**	**4443**
	walnut	1440	528
	county total	19,561	
Tehama	**almond**	**674**	**541**
	prune	**2942**	**2309**
	structural pest control	584	nr
	county total	4314	
Yolo	**apple**	**126**	**126**
	landscape maintenance	565	nr
	pear	**102**	**60**

	prune	**433**	**291**
	structural pest control	782	nr
	tomatoes	**1249**	**1518**
	uncultivated agriculture	109	136
	watermelon	168	128
	county total	3712	
Yuba	**peach**	**1935**	**981**
	prune	**1787**	**1023**
	structural pest control	172	nr
	walnut	1209	496
	county total	5135	

Based primarily upon the orchard use, and currently on residential uses, I conclude that the use of diazinon may affect the Central Valley spring run chinook salmon ESU, both through effects on olfaction and on the invertebrate food supply.

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

Table 34 contains usage information for the California counties supporting the California coastal chinook salmon ESU. There is currently a moderate amount of diazinon use that will not be continued. But it is possible that until these uses are phased out, there may be diazinon exposures of concern.

Table 34. Use of diazinon in counties with the California coastal chinook salmon ESU.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated
Humboldt	county total	43	
Mendocino	county total	124	
Sonoma	grapes	159	154
	landscape maintenance	414	nr
	mushrooms	640	nr - indoor?
	structural pest control	3009	nr
	county total	4651	
Marin	landscape maintenance	133	nr
	structural pest control	838	nr
	county total	972	
Trinity	county total	10	
Lake	structural pest control	445	nr
	county total	535	

Based upon the current uses of diazinon, I conclude that it may affect the California coastal chinook salmon ESU, both through effects on olfaction and upon the food sources. These uses will be phased out, and this finding could warrant being re-evaluated in several years.

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 35 shows the acreage information for Washington counties where the Puget Sound chinook salmon ESU is located. Most of these counties have fairly low acreage of crops where diazinon could be used, but Skagit and Whatcom counties have high acreage, and Pierce County has moderate acreage. In addition, King and Pierce counties, in particular, are heavily urban and suburban where residential use of diazinon. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 35. Crops and acreage where diazinon can be used in counties that are in the Critical Habitat of the Puget Sound chinook salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Skagit	potatoes (6948), cucumbers (2540), caneberries (1094), carrots (555), apples (357), blueberries (330), strawberries (281), squash (61), beets (48), filberts (12), pears, onions, broccoli, cherries	12,232	1,110,583 92,074 8.3%
WA	Whatcom	caneberries (5255), potatoes (1585), blueberries (482), strawberries (297), filberts (206), apples (174), pears (15), tomatoes, cherries, endive, beets, lettuce, cabbage, broccoli, cucumbers, carrots, plums & prunes	8032	1,356,835 118,136 8.7%
WA	San Juan	apples (64), pears, caneberries, strawberries, filberts, plums & prunes, cherries, potatoes, lettuce, endive, peaches, carrots,	86	11,963 20,529 18.3%
WA	Island	pears, beets, squash, strawberries, blueberries	1	133,499 19,526 14.6%

WA	Snohomish	strawberries (81), caneberries (75), apples (47), pears (27), filberts (11), squash, broccoli, cabbage, cherries, plums & prunes, carrots, beets, cauliflower, cucumbers, lettuce	291	<u>1,337,728</u> 74,153 5.5%
WA	King	endive (146), cabbage (110), lettuce (89), apples (64), squash (56), strawberries (42), blueberries (32), caneberries 26, beets (20), cucumbers (19), pears (19), onions (14), carrots (10), broccoli, cherries, plums & prunes, tomatoes, onions, filberts, peppers, turnips, potatoes, apricots, peaches, ginseng, radishes, cauliflower	688	<u>1,360,705</u> 42,290 3.1%
WA	Pierce	endive (1025), lettuce (607), cabbage (242), caneberries (135), strawberries (125), blueberries (70), celery (64), apples (61), potatoes, pears, cherries, cucumbers, peppers, radishes, carrots, filberts, squash	2345	<u>1,072,350</u> 58,750 5.5%
WA	Thurston	blueberries (96), strawberries (74), caneberries (29), apples (23), cucumbers, squash, cherries, filberts, cabbage, endive, tomatoes, onions, radishes, peppers cauliflower, potatoes, lettuce, carrots, broccoli, beets	262	<u>465,322</u> 59,890 12.9%
WA	Lewis	blueberries (137), apples (77), filberts (25), cherries (10), pears, plums & prunes, strawberries	260	<u>1,540,991</u> 112,263 7.3%
WA	Grays Harbor	cranberries (240), blueberries, apples, filberts, cherries, pears	255	<u>1,227,045</u> 44,742 3.6%
WA	Mason	squash, apples, cucumbers, tomatoes, cherries, pears, blueberries	18	<u>615,108</u> 10,965 1.8%
WA	Clallam	apples (29), strawberries (13), cherries (11), pears, plums & prunes, carrots	55	<u>1,116,900</u> 24,253 2.2%

WA	Jefferson	apples, caneberries	7	<u>1,157,642</u> 9,603 0.8%
WA	Kitsap	caneberries (21), apples (21), strawberries, blueberries, pears, plums & prunes, cherries, lettuce, endive, potatoes, beets, squash, carrots, peppers, tomatoes,	81	<u>253,436</u> 10,302 4.1%

Based upon the moderate to high agricultural acreage within the Puget Sound chinook salmon ESU, along with the current residential usage, I conclude that the use of diazinon may affect the Puget Sound chinook salmon ESU, both through effects on olfaction and on the invertebrate food supply. These effects would not be expected to occur in Puget Sound itself.

<u>7. Lower Columbia River Chinook Salmon ESU</u>

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

The hydrologic units and upstream barriers are the Middle Columbia-Hood (upstream barriers - Condit Dam, The Dalles Dam), Lower Columbia-Sandy (upstream barrier - Bull Run Dam 2), Lewis (upstream barrier - Merlin Dam), Lower Columbia-Clatskanie, Upper Cowlitz, Lower Cowlitz, Lower Columbia, Clackamas, and the Lower Willamette. Spawning and rearing habitat would be in the counties of Hood River, Wasco, Columbia, Clackamas, Marion, Multnomah, and Washington in Oregon, and Klickitat, Skamania, Clark, Cowlitz, Lewis, Wahkiakum, Pacific, Yakima, and Pierce in Washington. Clatsop County appears to be the only county in the critical habitat that does not contain spawning and rearing habitat, although there is only a small part of Marion County that is included as critical habitat. I have excluded Pierce County, Washington because the very small part of the Cowlitz River watershed in this county is at a high elevation where diazinon would not be used.

Tables 36 shows the cropping information for Oregon and Washington counties where the Lower Columbia River chinook salmon ESU occurs. Potential acreage for diazinon use is moderate to high in several of these counties and significant residential use may occur for several years. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 36. Crops and acreage where diazinon can be used in counties that are in the Critical Habitat of the Lower Columbia River chinook salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Wasco	cherries (7342), apples (463), pears (385), apricots (32), peaches (30), plums & prunes, strawberries	8262	1,523,958 1,152,965 75.7%
OR	Hood River	pears (11,788), apples (2592), cherries (1081), blueberries (29), peaches (13), caneberries, broccoli	15,504	334,328 27,201 8.1%
OR	Marion	filberts (7061), cabbage (4210), caneberries (4182), broccoli (2548), onions (2036), strawberries (1858), cherries (1568), cauliflower (1505), squash (1281), cucumbers (993), apples (555), blueberries (545), beets (184), peaches (179), pears (150), plums & prunes (145), carrots (76), celery (32), peppers (33), tomatoes (16), watermelons, nectarines, potatoes, lettuce	29,159	758,394 302,462 39.9%
OR	Clackamas	filberts (3994), caneberries (2409), cucumbers (830), strawberries (608), cabbage (593), endive (512), squash (380), blueberries (334), cauliflower (319), broccoli (184), apples (167), radishes (144), onions (140), lettuce (132), beets (80), peaches (78), cherries (53), pears (37), plums & prunes (37), peppers (29), tomatoes (21), potatoes	11,082	1,195,712 148,848 12.4%
OR	Multnomah	caneberries (814), cabbage (553), potatoes (336), cucumbers (297), strawberries (171), squash (163), endive (62), lettuce (62), blueberries (62), cauliflower (55), peaches (36), broccoli (29), pears (25), beets (21), tomatoes (20), cherries, peppers, plums & prunes, carrots	2772	278,570 31,294 11.2%

OR	Washington	filberts (5595), caneberries (2227), strawberries (1257), blueberries (654), broccoli (400), cabbage (400), plums & prunes (358), apples (279), cherries (211), onions (196), cucumbers (188), beets (168), peaches (168), squash (82), endive (75), pears (69), tomatoes (27), lettuce, watermelons, peppers, carrots, potatoes, cauliflower	12,362	<u>463,231</u> 139,820 30.2%
OR	Columbia	blueberries (101), apples (39), pears (12), cherries, strawberries, plums & prunes, caneberries, peaches, filberts	186	<u>420,332</u> 71,839 17.1%
OR	Clatsop	cranberries (32), apples, blueberries	32	<u>529,482</u> 24,740 4.7%
WA	Pacific	cranberries (1312), apples, cherries	1312	<u>623,722</u> 32,637 5.2%
WA	Wahkiakum	none	0	<u>169,125</u> 12,611 7.5%
WA	Clark	caneberries (642), strawberries (162), filberts (87), blueberries (85), pears (75), peaches (46), apples (33), tomatoes (10), plums & prunes (10), squash, lettuce, cucumbers, cherries	1152	<u>401,850</u> 82,967 20.6
WA	Cowlitz	caneberries (439), apples (14), pears, cherries, filberts, tomatoes, blueberries, carrots	460	<u>728,781</u> 35,678 4.9%
WA	Lewis	blueberries (137), apples (77), filberts (25), cherries (10), pears, plums & prunes, strawberries	260	<u>1,540,991</u> 112,263 7.3%
WA	Klickitat	pears (923), apples (516), cherries (457), peaches (199), apricots (18), peppers (12), tomatoes, plums & prunes, squash, cucumbers, potatoes	2135	<u>1,198,385</u> 689,639 57.5%

WA	Skamania	pears (477), apples (75)	552	1,337,179 4043 0.4%

Based upon the moderate to high agricultural acreage where diazinon can be used, along with the significant amount of potential residential use for several years, I conclude that the use of diazinon may affect the Lower Columbia River chinook salmon ESU, both through effects on olfaction and on the invertebrate food supply. Effects are unlikely in the Columbia River.

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 diazinon would not be used. Salmon habitat for this ESU is exceedingly limited in Douglas County also, but we cannot rule out future diazinon use on a small amount of acreage in Douglas County.

Tables 37 and 38 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. There is a high amount of acreage where diazinon may be used in several counties within the spawning and growth areas, and also in Multnomah County, along with the residential uses. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 37. Crops on which diazinon can be used that are part of the spawning and rearing habitat of the Upper Willamette River chinook salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Douglas	plums & prunes (305), apples (148), blueberries (108), pears (105), cherries (64), filberts (55), peaches (53), watermelons (52), tomatoes (41), peppers (29), caneberries (28), strawberries (24), squash (17), cucumbers, cabbage, broccoli, onions, apricots, lettuce, endive, beets, carrots, cauliflower, nectarines	1052	3,223,576 402,023 12.5%
OR	Lane	filberts (3677), carrots (270), cherries (249), beet (223), apples (174), caneberries (122), strawberries (74), blueberries (74), tomatoes (55), peaches (54), pears (51), plums & prunes (34), squash (27), cucumbers (21), cabbage (20), peppers (17), endive (16), lettuce (15), potatoes, broccoli, cauliflower, onions, nectarines	5196	2,914,656 242,121 8.3%
OR	Benton	squash (881), filberts (493), beets (202), blueberries (109), apples (62) cherries (18) strawberries (17), endive (10), lettuce (10), pears, peaches, tomatoes, plums & prunes, caneberries, peppers, onions, cucumbers, potatoes, watermelon, broccoli	1848	432,961 118,818 27.4%
OR	Linn	filberts (1820), squash (479), cabbage (431), caneberries (422), broccoli (267), cauliflower (164), cherries (157), apples (133), beets (78), peaches (73), blueberries (58), strawberries (52), pears (26), plums & prunes (14), tomatoes, cucumbers, nectarines, onions, peppers, carrots	4190	1,466,507 380,464 25.9%

OR	Polk	filberts (2394), cherries (1888), plums & prunes (595), caneberries (157), apples (157), pears (63), peaches (51), strawberries (22), blueberries (21), tomatoes, beets, squash, peppers, watermelons, carrots, broccoli	5355	474,296 167,880 35.4%
OR	Clackamas	filberts (3994), caneberries (2409), cucumbers (830), strawberries (608), cabbage (593), endive (512), squash (380), blueberries (334), cauliflower (319), broccoli (184), apples (167), radishes (144), onions (140), lettuce (132), beets (80), peaches (78), cherries (53), pears (37), plums & prunes (37), peppers (29), tomatoes (21), potatoes	11,082	1,195,712 148,848 12.4%
OR	Marion	filberts (7061), cabbage (4210), caneberries (4182), broccoli (2548), onions (2036), strawberries (1858), cherries (1568), cauliflower (1505), squash (1281), cucumbers (993), apples (555), blueberries (545), beets (184), peaches (179), pears (150), plums & prunes (145), carrots (76), celery (32), peppers (33), tomatoes (16), watermelons, nectarines, potatoes, lettuce	29,159	758,394 302,462 39.9%
OR	Yamhill	filberts (7110), cherries (1693), caneberries (453), plums & prunes (369), blueberries (324), apples (310), cabbage (308), broccoli (308), strawberries (265), beets (176), squash (133), peaches (104), pears (54), peppers (13), tomatoes, potatoes	11,630	457,986 179,787 39.3%

OR	Washington	filberts (5595), caneberries (2227), strawberries (1257), blueberries (654), broccoli (400), cabbage (400), plums & prunes (358), apples (279), cherries (211), onions (196), cucumbers (188), beets (168), peaches (168), squash (82), endive (75), pears (69), tomatoes (27), lettuce, watermelons, peppers, carrots, potatoes, cauliflower	12,362	463,231 139,820 30.2%

Table 38. Crops on which diazinon can be used that are part of the migration corridors of the Upper Willamette River chinook salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Clark	caneberries (642), strawberries (162), filberts (87), blueberries (85), pears (75), peaches (46), apples (33), tomatoes (10), plums & prunes (10), squash, lettuce, cucumbers, cherries	1152	401,850 82,967 20.6
WA	Cowlitz	caneberries (439), apples (14), pears, cherries, filberts, tomatoes, blueberries, carrots	460	728,781 35,678 4.9%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
WA	Pacific	cranberries (1312), apples, cherries	1312	623,722 32,637 5.2%
OR	Multnomah	caneberries (814), cabbage (553), potatoes (336), cucumbers (297), strawberries (171), squash (163), endive (62), lettuce (62), blueberries (62), cauliflower (55), peaches (36), broccoli (29), pears (25), beets (21), tomatoes (20), cherries, peppers, plums & prunes, carrots	2772	278,570 31,294 11.2%

OR	Columbia	blueberries (101), apples (39), pears (12), cherries, strawberries, plums & prunes, caneberries, peaches, filberts	186	420,332 71,839 17.1%
OR	Clatsop	cranberries (32), apples, blueberries	32	529,482 24,740 4.7%

Based upon the moderate to high acreage where diazinon can be used, I conclude that the use of diazinon may affect the Upper Willamette River chinook salmon ESU, both through effects on olfaction and on the invertebrate food supply. These effects are likely to be limited to tributaries of the Willamette River.

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 39), with the lower river reaches being migratory corridors (Table 40).

Tables 39 and 40 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. There is considerable acreage of potatoes, where diazinon may be used, in several counties. There is also a significant amount of apple acreage where diazinon could be used if the woolly apple aphid is a pest in these areas. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 39. Crops on which diazinon can be used in Washington counties where there is spawning and rearing habitat for the Upper Columbia River chinook salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed

WA	Benton	potatoes (25,317), apples (18,245), onions (3398), pears (472), plums & prunes (180), apricots (174), peaches (149) nectarines (106), tomatoes, peppers, cucumbers, squash	51,445	<u>1,089,993</u> 640,370 58.7%
WA	Kittitas	apples (1859), potatoes (442), pears (331), filberts, peaches, plums & prunes,	2625	<u>1,469,862</u> 355,360 24.2%
WA	Chelan	apples (17,096), pears (8298), cherries (3704), apricots (81), nectarines (22), peaches (21), plums & prunes, cucumbers	29,225	<u>1,869,848</u> 112,085 6%
WA	Douglas	apples (14,383), cherries (1842), pears (1104), apricots (315), peaches (167), nectarines (91), tomatoes	17,902	<u>1,165,168</u> 918,033 78.8%
WA	Okanogan	apples (24164), pears (3280), cherries (1003), peaches (67), nectarines (38), apricots (13), filberts (10), peppers, broccoli, caneberries, carrots, plums & prunes, squash, cabbage, tomatoes	28,582	<u>3,371,698</u> 1,291,118 38.3%
WA	Grant	potatoes (44,263), apples (33,615), onions (6214), cherries (3470), carrots (2207), pears (998), apricots (266), peaches (261), nectarines (163), tomatoes, plums & prunes, squash, peppers, strawberries, caneberries, cucumbers, filberts, watermelons	91,958	<u>1,712,881</u> 1,086,045 63.4%

Table 40. Crops on which diazinon can be used that are migration corridors for the Upper Columbia River chinook salmon ESU.

St	County	Crops and acres planted	Acres	<u>total acreage</u> land in farms % farmed

WA	Franklin	potatoes (35,770), apples (9000), onions (4074), carrots (3574), cherries (2165), peaches (262), pears (156), nectarines (129) caneberries (70), apricots (68), plums & prunes (43), strawberries (17), cucumbers, tomatoes, peppers, watermelons	55,332	<u>794,999</u> 670,149 84.3%
WA	Yakima	apples (75264), pears (10,190), cherries (6129), potatoes (1929), peaches (1438), nectarines (605), plums & prunes (478), peppers (480), tomatoes (293), squash (292), apricots (285), watermelons (151), cabbage (144), turnips (40), caneberries (10), filberts, onions,	97,928	<u>2,749,514</u> 1,639,965 59.6%
WA	Walla Walla	potatoes (9256), apples (5222), onions (2172), endive (306), cherries (280), cucumbers (140), plums & prunes (22), cabbage, beets, radishes, lettuce	17,406	<u>813,108</u> 710,546 87.4%
WA	Klickitat	pears (923), apples (516), cherries (457), peaches (199), apricots (18), peppers (12), tomatoes, plums & prunes, squash, cucumbers, potatoes	2135	<u>1,198,385</u> 689,639 57.5%
WA	Skamania	pears (477), apples (75)	552	<u>1,337,179</u> 4043 0.4%
WA	Clark	caneberries (642), strawberries (162), filberts (87), blueberries (85), pears (75), peaches (46), apples (33), tomatoes (10), plums & prunes (10), squash, lettuce, cucumbers, cherries	1152	<u>401,850</u> 82,967 20.6
WA	Cowlitz	caneberries (439), apples (14), pears, cherries, filberts, tomatoes, blueberries, carrots	460	<u>728,781</u> 35,678 4.9%
WA	Wahkiakum	none	0	<u>169,125</u> 12,611 7.5%

WA	Pacific	cranberries (1312), apples, cherries	1312	623,722 32,637 5.2%
OR	Gilliam	none	0	770,664 766,373 99.4%
OR	Umatilla	potatoes (15,003), apples (3927), onions (3914), watermelons (837), plums & prunes (365), cherries (349), peppers (121)tomatoes (27), apricots (14), strawberries, peaches, caneberries, pears, nectarines, blueberries cucumbers	24,584	2,057,809 1,466,580 71.3%
OR	Sherman	none	0	526,911 487,534 92.5%
OR	Morrow	potatoes (17,030), onions (1284), apples	18,314	1,301,021 1,119,004 86%
OR	Wasco	cherries (7342), apples (463), pears (385), apricots (32), peaches (30), plums & prunes, strawberries	8262	1,523,958 1,152,965 75.7%
OR	Hood River	pears (11,788), apples (2592), cherries (1081), blueberries (29), peaches (13), caneberries, broccoli	15,504	334,328 27,201 8.1%
OR	Multnomah	caneberries (814), cabbage (553), potatoes (336), cucumbers (297), strawberries (171), squash (163), endive (62), lettuce (62), blueberries (62), cauliflower (55), peaches (36), broccoli (29), pears (25), beets (21), tomatoes (20), cherries, peppers, plums & prunes, carrots	2772	278,570 31,294 11.2%
OR	Columbia	blueberries (101), apples (39), pears (12), cherries, strawberries, plums & prunes, caneberries, peaches, filberts	186	420,332 71,839 17.1%

OR	Clatsop	cranberries (32), apples, blueberries	32	529,482 24,740 4.7%

There is a fairly large amount of potato and apple acreage where diazinon can be used in the reproductive and growth areas of this ESU. I conclude that the use of diazinon may affect the Upper Columbia River chinook salmon ESU, both through effects on olfaction and on the invertebrate food supply. These effects should be limited to tributaries of the Snake and Columbia Rivers.

C. Coho Salmon

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

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

After spawning in late fall and early winter, eggs incubate in redds for 1.5 to 4 months, depending upon the temperature, before hatching as alevins. Following yolk sac absorption, alevins emerge and begin actively feeding as fry. Juveniles rear in fresh water for up to 15 months, then migrate to the ocean as ‘‘smolts’’ in the spring. Coho salmon typically spend two growing seasons in the ocean before returning to their natal stream. They are most frequently recovered from ocean waters in the vicinity of their spawning streams, with a minority being recovered at adjacent coastal areas, decreasing in number with distance from the natal streams. However, those coho released from Puget Sound, Hood Canal, and the Strait of Juan de Fuca are caught at high levels in Puget Sound, an area not entered by coho salmon from other areas.

1. Central California Coast Coho Salmon ESU

The Central California Coast Coho Salmon ESU includes all coho naturally reproduced in streams between Punta Gorda, Humboldt County, CA and San Lorenzo River, Santa Cruz County, CA, inclusive. This ESU was proposed in 1995 (60FR38011-38030, July 25, 1995) and listed as threatened, with critical habitat designated, on May 5, 1999 (64FR24049-24062).

Critical habitat consists of accessible reaches along the coast, including Arroyo Corte Madera Del Presidio and Corte Madera Creek, tributaries to San Francisco Bay.

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

Table 41 contains usage information for the California counties supporting the Central California coast coho salmon ESU. Except for moderate use in Santa Cruz County, there is very little agricultural diazinon use within this ESU. Housing density where residential use of diazinon may continue for several years may be high in San Mateo County and moderate in Santa Cruz and Marin counties.

Table 41. Use of diazinon in counties with the Central California Coast coho ESU.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated
Santa Cruz	**blackberries**	**395**	**215**
	brussel sprouts	**748**	**1461**
	landscape maintenance	1020	nr
	lettuce	**3367**	**5946**
	nursery	**290**	**263**
	spinach	**781**	**449**
	strawberry	**129**	**160**
	county total	8371	
San Mateo	**brussel sprouts**	**568**	**806**
	landscape maintenance	270	nr
	nursery	**314**	**221**
	structural pest control	3530	nr
	county total	4695	
Marin	landscape maintenance	133	nr

	structural pest control	838	nr
	county total	972	
Sonoma	grapes	159	154
	landscape maintenance	414	nr
	mushrooms	640	nr - indoor?
	structural pest control	3009	nr
	county total	4651	
Mendocino	county total	124	
Napa	structural pest control	110	nr
	county total	186	

There is a moderate amount of diazinon use, especially on lettuce in Santa Cruz County, and potentially a moderate amount of residential use for the next several years. I conclude that the use of diazinon may affect the Central California Coast coho salmon ESU, both through effects on olfaction and on the invertebrate food supply.

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, Klamath, and Douglas, in Oregon. However, I have excluded Glenn County, California from this analysis because the salmon habitat in this county is not near areas where diazinon can be used.

Tables 42 shows that there is only a small amount of reportable diazinon usage in the California counties supporting the Southern Oregon/Northern California coastal coho salmon ESU, and none of these uses will be continued. Table 43, however, shows that the acreage where diazinon may be used on orchard crops could be significant in the Oregon counties where the Southern Oregon/Northern California coastal coho salmon ESU occurs. In Table 43, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available. Residential use would be generally low throughout both states within this ESU.

Table 42. Use of diazinon in California counties with the Southern Oregon/Northern California coastal coho salmon ESU.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated
Humboldt	county total	43	
Mendocino	county total	124	
Del Norte	county total	15	
Siskiyou	county total	56	
Trinity	county total	10	
Lake	structural pest control	445	nr
	county total	535	

Table 43. Diazinon acreage in Oregon counties where there is habitat for the Southern Oregon/Northern California coastal coho salmon ESU.

St	County	Crops and acres planted	Acres	<u>total acreage</u> land in farms % farmed
OR	Curry	cranberries (581), apples (27), plums & prunes, cherries, pears, endive, lettuce, strawberries, broccoli, blueberries	624	<u>1,041,557</u> 74,375 7.1%

OR	Jackson	pears (9387), apples (360), peaches (198), onions (40), cherries (27), tomatoes (26), strawberries (18), plums & prunes (15), squash (15), nectarines (14), caneberries (13), blueberries (11), apricots (10), peppers, endive, lettuce, watermelon, cabbage, beets, carrots, broccoli, filberts, cucumbers	10,168	<u>1,782,633</u> 262,251 14.7%
OR	Josephine	apples (181), peaches (29), cherries, potatoes, caneberries, tomatoes, carrots, cabbage, squash, strawberries, watermelon, broccoli, plums & prunes, peppers, endive, cucumbers, lettuce, onions, cauliflower, blueberries, pears,	267	<u>1,049,308</u> 31,249 3.0%
OR	Douglas	plums & prunes (305), apples (148), blueberries (108), pears (105), cherries (64), filberts (55), peaches (53), watermelons (52), tomatoes (41), peppers (29), caneberries (28), strawberries (24), squash (17), cucumbers, cabbage, broccoli, onions, apricots, lettuce, endive, beets, carrots, cauliflower, nectarines	1052	<u>3,223,576</u> 402,023 12.5%
OR	Klamath	potatoes (8951), onions (278), strawberries (17), apples	9254	<u>3,804,552</u> 720,153 18.9%

Based upon the potential orchard uses of diazinon in Oregon, I conclude that the use of diazinon may affect the Northern California/Southern Oregon coastal coho salmon ESU, both through effects on olfaction and on the invertebrate food supply. Effects would seem to be limited and temporary, if any, in the California portion of 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 are primarily forested areas where diazinon cannot be used, and I have eliminated them in this analysis.

Table 44 show the acreage where diazinon can be used for Oregon counties where the Oregon coast coho salmon ESU occurs. There is essentially no relevant acreage, other than cranberries, in the strictly coastal counties. Douglas, Lane, and Benton counties have low acreage, but it is very likely that most of this acreage occurs in the Willamette River watershed portions of these counties rather than along the coastal stream portions of these counties. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 44. Crops on which diazinon can be used that are in counties where there is habitat for the Oregon coast coho salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Curry	cranberries (581), apples (27), plums & prunes, cherries, pears, endive, lettuce, strawberries, broccoli, blueberries	624	1,041,557 74,375 7.1%
OR	Coos	cranberries (1499), apples (28), cherries (11), blueberries, pears, plums & prunes, peaches, nectarines, caneberries, filberts	1558	1,024,346 174,872 17.1%
OR	Douglas	plums & prunes (305), apples (148), blueberries (108), pears (105), cherries (64), filberts (55), peaches (53), watermelons (52), tomatoes (41), peppers (29), caneberries (28), strawberries (24), squash (17), cucumbers, cabbage, broccoli, onions, apricots, lettuce, endive, beets, carrots, cauliflower, nectarines	1052	3,223,576 402,023 12.5%

OR	Lane	filberts (3677), carrots (270), cherries (249), beet (223), apples (174), caneberries (122), strawberries (74), blueberries (74), tomatoes (55), peaches (54), pears (51), plums & prunes (34), squash (27), cucumbers (21), cabbage (20), peppers (17), endive (16), lettuce (15), potatoes, broccoli, cauliflower, onions, nectarines	5196	<u>2,914,656</u> 242,121 8.3%
OR	Lincoln	apples (22), caneberries, lettuce, cabbage, broccoli, cucumbers, endive, pears, squash, blueberries	34	<u>626,976</u> 34,292 5,5%
OR	Benton	squash (881), filberts (493), beets (202), blueberries (109), apples (62) cherries (18) strawberries (17), endive (10), lettuce (10), pears, peaches, tomatoes, plums & prunes, caneberries, peppers, onions, cucumbers, potatoes, watermelon, broccoli	1848	<u>432,961</u> 118,818 27.4%
OR	Polk	filberts (2394), cherries (1888), plums & prunes (595), caneberries (157), apples (157), pears (63), peaches (51), strawberries (22), blueberries (21), tomatoes, beets, squash, peppers, watermelons, carrots, broccoli	5355	<u>474,296</u> 167,880 35.4%
OR	Tillamook	blueberries	0	<u>705,417</u> 39,559 5.6%
OR	Clatsop	cranberries (32), apples, blueberries	32	<u>529,482</u> 24,740 4.7%

Based almost solely on diazinon use on cranberries, I conclude that diazinon may affect the Oregon Coast coho salmon ESU. I acknowledge that the cranberry use may not occur where it would result in exposure of this ESU, but I have inadequate knowledge to rule it out.

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’.

Table 45 shows that the acreage where diazinon can be used is very low in the Washington counties where the Hood Canal summer-run chum salmon ESU occurs. Some residential use could occur but housing density is generally low throughout the ESU, although it could be moderate along Hood Canal itself, which would provide for substantial dilution. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 45. Crops on which diazinon can be used that are in counties where there is habitat for the Hood Canal Summer-run chum salmon ESU

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Mason	squash, apples, cucumbers, tomatoes, cherries, pears, blueberries	18	615,108 10,965 1.8%
WA	Clallam	apples (29), strawberries (13), cherries (11), pears, plums & prunes, carrots	55	1,116,900 24,253 2.2%
WA	Jefferson	apples, caneberries	7	1,157,642 9,603 0.8%
WA	Kitsap	caneberries (21), apples (21), strawberries, blueberries, pears, plums & prunes, cherries, lettuce, endive, potatoes, beets, squash, carrots, peppers, tomatoes,	81	253,436 10,302 4.1%
WA	Island	pears, beets, squash, strawberries, blueberries	1	133,499 19,526 14.6%

Based upon the low crop acreage and low residential density, I conclude that the use of diazinon may affect, but is not likely to affect, the Hood Canal summer run chum salmon 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 46 shows the cropping information for Oregon and Washington counties where the Columbia River chum salmon ESU occurs. There is a moderate amount of acreage where diazinon could be used and a moderate to high amount of residential areas in Multnomah and Washington counties, but essentially none elsewhere within this ESU. There is essentially no acreage and very little housing in Grays River and Hardy and Hamilton Creeks, but there is a moderate amount of cranberries in Pacific County. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 46. Crops on which diazinon can be used that are in counties where there is habitat for the Columbia River chum salmon ESU

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Skamania	pears (477), apples (75)	552	1,337,179 4043 0.4%
WA	Clark	caneberries (642), strawberries (162), filberts (87), blueberries (85), pears (75), peaches (46), apples (33), tomatoes (10), plums & prunes (10), squash, lettuce, cucumbers, cherries	1152	401,850 82,967 20.6
WA	Lewis	blueberries (137), apples (77), filberts (25), cherries (10), pears, plums & prunes, strawberries	260	1,540,991 112,263 7.3%
WA	Cowlitz	caneberries (439), apples (14), pears, cherries, filberts, tomatoes, blueberries, carrots	460	728,781 35,678 4.9%

WA	Pacific	cranberries (1312), apples, cherries	1312	623,722 32,637 5.2%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
OR	Multnomah	caneberries (814), cabbage (553), potatoes (336), cucumbers (297), strawberries (171), squash (163), endive (62), lettuce (62), blueberries (62), cauliflower (55), peaches (36), broccoli (29), pears (25), beets (21), tomatoes (20), cherries, peppers, plums & prunes, carrots	2772	278,570 31,294 11.2%
OR	Columbia	blueberries (101), apples (39), pears (12), cherries, strawberries, plums & prunes, caneberries, peaches, filberts	186	420,332 71,839 17.1%
OR	Washington	filberts (5595), caneberries (2227), strawberries (1257), blueberries (654), broccoli (400), cabbage (400), plums & prunes (358), apples (279), cherries (211), onions (196), cucumbers (188), beets (168), peaches (168), squash (82), endive (75), pears (69), tomatoes (27), lettuce, watermelons, peppers, carrots, potatoes, cauliflower	12,362	463,231 139,820 30.2%
OR	Clatsop	cranberries (32), apples, blueberries	32	529,482 24,740 4.7%

Based upon the uncertainty of where cranberry use could expose the Lower Columbia River chum salmon ESU, I conclude that diazinon may affect this ESU. If it can be determined that cranberries and chum salmon are not associated, then no effect would occur in the currently occupied areas for this ESU. Reintroduction into some of the upper reaches of this ESU could result in diazinon exposure.

E. Sockeye Salmon

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

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

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

1. Ozette Lake Sockeye Salmon ESU

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

While Lake Ozette, itself, is part of Olympic National Park, its tributaries extend outside park boundaries, much of which is private land. There is limited agriculture in the whole of Clallam County. Table 47 shows that there is only a small amount of agricultural acreage where diazinon can be used within the county, and the residential uses of diazinon would be quite small.

Table 47. Crops on which diazinon can be used that are in Clallam County where there is habitat for the Ozette Lake sockeye salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Clallam	apples (29), strawberries (13), cherries (11), pears, plums & prunes, carrots	55	1,116,900 24,253 2.2%

Based upon the low acreage where diazinon can be used, along with the quite sparse residential areas, conclude that the use of diazinon may affect, but is not likely to affect, the Ozette Lake sockeye salmon 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. Diazinon 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 diazinon in the lower and larger river reaches during its juvenile or adult migration, but considering that the migratory corridors are larger rivers any exposure should be well below levels of concern.

Table 48 shows that there is only a small acreage of potatoes in Idaho counties where this ESU reproduces or migrates. Table 49 shows that only in the migratory corridor from the lower Snake River downstream would there be any acreage where diazinon can be used. In table 49, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 48. Crops on which diazinon can be used that are in Idaho counties where there is spawning and rearing habitat for the Snake River sockeye salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
ID	Custer	potatoes (507)	507	3,152,382 140,701 4.5%
ID	Blaine	potatoes (848)	848	1,692,735 266,293 15.7%

Table 49. Crops on which diazinon can be used that are in Oregon and Washington counties that are in the migratory corridors for the Snake River sockeye salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
ID	Idaho	apples, pears, tomatoes, filberts, plums	11	5,430,522 744,295 13.7%
ID	Lemhi	cherries, apples, peaches, pears, apricots	20	2,921,172 193,908 6.6%
ID	Lewis	none		306,601 211,039 68.8%
ID	Nez Perce	peaches (22), apples, cherries, apricots, potatoes	66	543,434 477,839 87.9%
WA	Asotin	apples (24), peaches (18), cherries (17), pears, apricots	70	406,983 274,546 67.5%
WA	Garfield	none		454,744 325,472 84.3%
WA	Whitman	apples (19), pears	21	1,382,006 1,404,289 101.6%

WA	Columbia	apples	0	<u>556,034</u> 304,928 54.8%
WA	Walla Walla	potatoes (9256), apples (5222), onions (2172), endive (306), cherries (280), cucumbers (140), plums & prunes (22), cabbage, beets, radishes, lettuce	17,406	<u>813,108</u> 710,546 87.4%
WA	Franklin	potatoes (35,770), apples (9000), onions (4074), carrots (3574), cherries (2165), peaches (262), pears (156), nectarines (129) caneberries (70), apricots (68), plums & prunes (43), strawberries (17), cucumbers, tomatoes, peppers, watermelons	55,332	<u>794,999</u> 670,149 84.3%
WA	Benton	potatoes (25,317), apples (18,245), onions (3398), pears (472), plums & prunes (180), apricots (174), peaches (149) nectarines (106), tomatoes, peppers, cucumbers, squash	51,445	<u>1,089,993</u> 640,370 58.7%
WA	Klickitat	pears (923), apples (516), cherries (457), peaches (199), apricots (18), peppers (12), tomatoes, plums & prunes, squash, cucumbers, potatoes	2135	<u>1,198,385</u> 689,639 57.5%
WA	Skamania	pears (477), apples (75)	552	<u>1,337,179</u> 4043 0.4%
WA	Clark	caneberries (642), strawberries (162), filberts (87), blueberries (85), pears (75), peaches (46), apples (33), tomatoes (10), plums & prunes (10), squash, lettuce, cucumbers, cherries	1152	<u>401,850</u> 82,967 20.6
WA	Cowlitz	caneberries (439), apples (14), pears, cherries, filberts, tomatoes, blueberries, carrots	460	<u>728,781</u> 35,678 4.9%

WA	Wahkiakum	none	0	169,125 12,611 7.5%
WA	Pacific	cranberries (1312), apples, cherries	1312	623,722 32,637 5.2%
OR	Wallowa	apples, peaches	8	2,013,071 694,304 34.5%
OR	Umatilla	potatoes (15,003), apples (3927), onions (3914), watermelons (837), plums & prunes (365), cherries (349), peppers (121)tomatoes (27), apricots (14), strawberries, peaches, caneberries, pears, nectarines, blueberries cucumbers	24,584	2,057,809 1,466,580 71.3%
OR	Morrow	potatoes (17,030), onions (1284), apples	18,314	1,301,021 1,119,004 86%
OR	Gilliam	none	0	770,664 766,373 99.4%
OR	Sherman	none	0	526,911 487,534 92.5%
OR	Wasco	cherries (7342), apples (463), pears (385), apricots (32), peaches (30), plums & prunes, strawberries	8262	1,523,958 1,152,965 75.7%
OR	Hood River	pears (11,788), apples (2592), cherries (1081), blueberries (29), peaches (13), caneberries, broccoli	15,504	334,328 27,201 8.1%

OR	Multnomah	caneberries (814), cabbage (553), potatoes (336), cucumbers (297), strawberries (171), squash (163), endive (62), lettuce (62), blueberries (62), cauliflower (55), peaches (36), broccoli (29), pears (25), beets (21), tomatoes (20), cherries, peppers, plums & prunes, carrots	2772	278,570 31,294 11.2%
OR	Columbia	blueberries (101), apples (39), pears (12), cherries, strawberries, plums & prunes, caneberries, peaches, filberts	186	420,332 71,839 17.1%
OR	Clatsop	cranberries (32), apples, blueberries	32	529,482 24,740 4.7%

The chances of exposure of this sockeye ESU to diazinon are quite small, but I cannot them out completely. In addition, this is a very precarious ESU. Therefore, I conclude that diazinon may affect, but is not likely to adversely affect, the Snake River sockeye salmon ESU.

5. Specific conclusions for Pacific salmon and steelhead

1. There is no likely or very limited use of diazinon associated with several salmon and steelhead ESUs, but it cannot be completely ruled out, at least during the period when residential and certain other uses are being phased out. Therefore, I conclude that diazinon "may affect, but is not likely to adversely affect the Northern California steelhead ESU, the Hood Canal chum salmon ESU, the Snake River sockeye salmon ESU, and the Ozette Lake sockeye salmon ESU.

2. There is considerable use of diazinon in Monterey County and adjacent areas; the use on lettuce, in particular is likely to continue, at least through the five year adjustment period for that crop. Diazinon may especially affect the South Central California Coast steelhead ESU.

3. There are varying degrees of agricultural use, and very often potential moderate (but uncertain) residential use of diazinon in other ESUs. Therefore, I must consider that diazinon may affect all other listed salmon and steelhead ESUs along the Pacific coast. For several of these ESUs, a re-evaluation of potential effects may be warranted after the phase out of certain diazinon uses occurs.

Table 50. Summary conclusions on specific ESUs of salmon and steelhead for diazinon.

Species	ESU	finding
Chinook Salmon	Upper Columbia	may affect

Chinook Salmon	Snake River spring/summer-run	may affect
Chinook Salmon	Snake River fall-run	may affect
Chinook Salmon	Upper Willamette	may affect
Chinook Salmon	Lower Columbia	may affect
Chinook Salmon	Puget Sound	may affect
Chinook Salmon	California Coastal	may affect
Chinook Salmon	Central Valley spring-run	may affect
Chinook Salmon	Sacramento River winter-run	may affect
Coho salmon	Oregon Coast	may affect
Coho salmon	Southern Oregon/Northern California Coast	may affect
Coho salmon	Central California	may affect
Chum salmon	Hood Canal summer-run	may affect, but not likely to adversely affect
Chum salmon	Columbia River	may affect
Sockeye salmon	Ozette Lake	may affect, but not likely to adversely affect
Sockeye salmon	Snake River	may affect, but not likely to adversely affect
Steelhead	Snake River Basin	may affect
Steelhead	Upper Columbia River	may affect
Steelhead	Middle Columbia River	may affect
Steelhead	Lower Columbia River	may affect
Steelhead	Upper Willamette River	may affect
Steelhead	Northern California	may affect, but not likely to adversely affect
Steelhead	Central California Coast	may affect
Steelhead	South-Central California	may affect

Steelhead	Southern California	may affect
Steelhead	Central Valley, California	may affect

6. References

Allison DT, Hermanutz, RO. 1977. Toxicity of Diazinon to Brook Trout and Fathead Minnows Ecol.Res.Ser., EPA-600/3-77-060, Environ.Res.Lab., U.S.EPA, Duluth, MN: 69 p.

Arthur, J. W., J. A. Zischke, K. N. Allen, and R. O. Hermanutz. 1983. Effects of diazinon on macroinvertebrates and insect emergence in outdoor experimental channels. Aquat. Toxicol. 4:283-301.

Beyers DW, Keefe TJ, Carlson CA. 1994. Toxicity of carbaryl and malathion to two federally endangered fishes, as estimated by regression and ANOVA. Environ. Toxicol. Chem. 13:101-107.

Dileanis PD, Bennett KP, Domagalski JL. 2002. Occurrence and transport of diazinon in the Sacramento River basin, California, and selected tributaries during three winter storms, January-February, 2000. Water-Resources Investigations Report 02-4101. U. S. Geological Survey, Sacramento, California. 71 p.

Dwyer FJ, Hardesty DK, Henke CE, Ingersoll CG, Whites GW, Mount DR, Bridges CM. 1999. Assessing contaminant sensitivity of endangered and threatened species: Toxicant classes. U.S. Environmental Protection Agency Report No. EPA/600/R-99/098, Washington, DC. 15 p.

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

Eisler R. 1986. Diazinon hazards to fish, wildlife, and invertebrates: A synoptic review. U. S. Fish and Wildlife Service Biol. Rept 85(1.9) 37 p.

Fujii, Y. and S. Asaka. 1982. Metabolism of diazinon and diazoxon in fish liver preparations. Bull. Environ. Contam. Toxicol., 29:453-460.

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

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

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

Meier, E. P., W. H. Dennis, A. B. Rosencrance, W. F. Randall, W. J. Cooper, and M. C. Warner. 1979. Sulfotepp, a toxic impurity in formulations of diazinon. Bull. Environ. Contam. Toxicol. 23(½): 158-164.

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

NRA Australia (National Registration Authority for Agricultural and Veterinary Chemicals, Australia). 2002. The NRA Review of Diazinon. Public Review Draft, September, 2002. Canberra, Australia. 94 p.

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

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

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

Tsuda, T., M. Kojima, H. Harada, A. Nakajima, and S. Aoki. 1997. Acute toxicity, accumulation and excretion of organophosphorous insecticides and their oxidation products in killifish. Chemosphere 35(5): 939-949.

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

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

WQCB (Central Valley Region, Water Quality Control Board, California). 2001. Sacramento/Feather River Water Quality Management Strategy for Diazinon: Potential Targets, Draft, May 2001.

WHO/FAO. 1971. 1970 Evaluations of Some Pesticide Residues in Food: The Monographs, Issued Jointly by the World Health Organization and the Food and Agriculture Organization of the United Nations, Rome 1971.

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

Attachments
1. Interim Reregistration Eligibility Decision document (with Appendix A only)
2. Selected labels
3. Qualitative Use Assessment
4. USGS map of diazinon use
5. Revised Environmental Risk Assessment for Diazinon, October 2000