Trifluralin
Analysis of Risks
to
Endangered and Threatened Pacific Salmon and Steelhead

April 1, 2004

Ann Stavola
Michael Patterson, Ph.D.
Environmental Field Branch
Office of Pesticide Programs

Summary

Trifluralin is a selective, preemergence herbicide used to control a wide range of annual grasses and broadleaf weeds. Under laboratory conditions it is non-toxic to animals by ingestion, inhalation, or dermal exposure. It is not dermally irritating, as demonstrated by rabbit eye testing. Long term, chronic exposure (dermal) may lead to an allergic response. It has not been demonstrated to be carcinogenic or mutagenic. Although toxic to aquatic fish and invertebrates, is typically soil incorporated, is highly absorbent to soil, and essentially non-soluble in water.

Introduction

Problem formulation: The purpose of this analysis is to determine whether the registration of trifluralin as an herbicide for use on various treatment sites may affect threatened and endangered (T&E or listed) Pacific anadromous salmon and steelhead and their designated critical habitat.

Scope: Although this analysis is specific to listed Pacific anadromous salmon and steelhead and the watersheds in which they occur, it is acknowledged that trifluralin 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.

Contents

d. Estimated and actual concentrations of trifluralin in water
e. General risk conclusions
f. Existing protective measures

4. Reference

5. Attachments:
a. Reregistration Decision for Trifluralin
b. Sample Label
c. EPA Estimated Usage of Trifluralin
d. California Reported Use of Trifluralin (by county)
e. Pacific Northwest Reported Use of Trifluralin (by county)
f. Washington State Department of Agriculture Reported Use of Trifluralin

1. Background

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The risk assessment process is described in "Hazard Evaluation Division - Standard Evaluation Procedure - Ecological Risk Assessment" by Urban and Cook (1986) (termed

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

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

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

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

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

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

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

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

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

2. Description and use of trifluralin

a. Description of chemical

- ❑ Specific Name: α,α,α-trifluro-2,6-dinitro-N,N-dipropuyl-p-toluidine
- ❑ Common Name: Trifluralin
- ❑ Empirical Formula: $C_{13}H_{16}F_3N_3O_4$
- ❑ Molecular Weight: 335.3
- ❑ CAS Registry: 158209-8
- ❑ Shaughnessy No: 03101
- ❑ Melting Point: 42-49° C
- ❑ Solubility: Insoluble in water; soluble in acetone, xylenes, and aromatic naphthas

Trifluralin is a selective preemergent dinitroaniline herbicide, first registered in 1963, used to control annual grasses and broadleaf weeds on a variety of food crops including tree fruits, nuts, vegetables, grains, cotton, soybeans, sunflowers, alfalfa, sugar beets and peanuts. It also has many non-food uses including rights-of-ways, ornamentals, cottonwood and poplar plantations, recreational lawns and turf. There are over 130 active products containing trifluralin.

Trifluralin is formulated as a liquid, emulsifiable concentrate (3.9% to 50.8%), granular (0.17% to 10%), flowable concentrate(10.9%), impregnated material (18.9%), soluble concentrate/liquid (43.8%), soluble concentrate/solid (14%) and water dispersible granules (dry flowable) (0.75% to 80%). The major registrant is Dow AgroSciences. Trifluralin is also formulated with several other herbicides including triallate, benfluralin, alachlor, clomazone, isoxaben, imazaquin, clopyralid, oxadiazon, imazethapyr and flumetsulam. It can be applied by air and ground equipment including aircraft, boom sprayer, low pressure ground sprayer, center pivot irrigation, drip irrigation, overhead sprinkler irrigation, granule applicator, hand - held sprayers, shaker cans, sprinkler cans and spreaders. The timing of application is very variable depending on the target weed and the crop or site being treated. The timing includes, at-planting, bearing, dormant, semi-dormant, early preplant, established plantings, layby, nonbearing, post-emergence, post-harvest, preemergence, preharvest. These applications can occur in spring, summer, fall and winter, depending on the location of the site and targeted pest. The number of treatments varies according to use site, but for many of the agricultural uses, it is applied once per season. Trifluralin is soil-incorporated after it is applied.

b. Summary of labeled uses

Registered forestry, rangeland, right-of-way uses: for use on ornamental trees, rights of way, domestic outdoor and industrial sites. The principal agriculture uses are soybeans (66.10%) and cotton (23.84%). Other crops, which account for5% or less of total usage, are alfalfa for hay, sunflower, wheat and other grains, barley, tomatoes, and green peas.

Target Plants: Trifluralin is used to control annual grasses and certain broadleaf weeds.

Mode of action: Trifluralin applied to the soil kills weed seeds as they germinate. It does not control established weeds.

Method of application: Trifluralin is applied by low pressure ground spraying equipment, subsurface layering equipment, irrigation systems, aerial equipment, or granular applicators. Soil incorporation within 4 to 24 hours after application is recommended for most uses. For some products, surface application followed by irrigation is recommended. Do not apply to muck soils or to soils containing more than 10% organic matter.

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

a. Aquatic toxicity

The acute toxicity data indicate that technical grade trifluralin is moderately toxic to very highly toxic to freshwater fish and invertebrates and highly toxic to estuarine fish and invertebrates. There is limited formulated product testing with trifluralin. The data we have indicates that a 46% formulation is highly to very highly toxic to freshwater fish and highly toxic to estuarine invertebrates.

Adverse effects measured in chronic freshwater fish studies indicated that survival and length were affected at concentrations of 1.9 ppb and 2.18 ppb, respectively. Fecundity was affected in a chronic estuarine fish study at 1.3 ppb. A chronic study conducted with a freshwater invertebrate showed that survival is adversely affected at 7.2 ppb.

The data from the RED and the EFED database are presented in Tables 4 through 9 and the data from the AQUIRE database are presented in Table 10.

Table 4. Acute toxicity of trifluralin to freshwater fish (source: EFED Pesticide Ecotoxicity Database and Trifluralin RED)

Species	Scientific Name	% ai	96-h LC 50 (ppb)	Toxicity Category
Technical				
Rainbow trout	*Oncorhynchus mykiss*	95.9	22	Very highly toxic
Rainbow trout	*Oncorhynchus mykiss*	95.9	41	Very highly toxic
Bluegill sunfish	*Lepomis macrochirus*	95.9	8.4	Very highly toxic
Bluegill sunfish	*Lepomis macrochirus*	95.9	58	Very highly toxic
Largemouth bass	*Micropterus salmoides*	95.9	75	Very highly toxic
Fathead minnow	*Pimephales promelas*	95.9	105	Highly toxic
Channel catfish	*Ictalurus punctatus*	95.9	210	Highly toxic
Channel catfish	*Ictalurus punctatus*	95.9	2200	Moderately toxic
Formulated Products				
Rainbow trout	*Oncorhynchus mykiss*	46	10	Very highly toxic
Goldfish	*Carassius auratus*	46	145	Highly toxic

Table 5. Acute toxicity of trifluralin to freshwater invertebrates (source: EFED Pesticide Ecotoxicity Database and Trifluralin RED)

Species	Scientific Name	% ai	48-h LC 50 (ppb)	Toxicity Category
Technical				
Waterflea	*Daphnia pulex*	95.9	625	Highly toxic
Waterflea	*Daphnia magna*	95.9	560	Highly toxic
Sowbug	*Asellus brevicaudus*	95.9	>1000 (96-h)	Moderately toxic
Scud	*Gammarus fasciatus*	95.9	2200 (96-h)	Moderately toxic
Waterflea	*Simocephalus serrulatus*	95.9	900	Highly toxic
Stonefly	*Pteronarcys californica*	95.9	2800 (96-h)	Moderately toxic
Grass shrimp	*Paleamonetes kadiakensis*	95.9	37 (96-h)	Very highly toxic

Table 7. Acute toxicity of trifluralin to estuarine fish and invertebrates (source: EFED Pesticide Ecotoxicity Database and Trifluralin RED)

Species	Scientific Name	% ai	96-h LC 50 (ppb)	Toxicity Category
Technical				
Sheepshead minnow	*Cyprinodon variegatus*	99	190	Highly toxic
Sheepshead minnow	*Cyprinodon variegatus*	96	160	Highly toxic
Grass shrimp	*Palaemonetes pugio*	96.4	638.5	Highly toxic
Bay mussel	*Mytilus edulis*	99	240 -mortality 96-shell growth	Highly toxic
Formulated Products				
Dungeness crab	*Cancer magister*	44.5	330 (96-h)	Highly toxic

Table 8. Chronic toxicity of trifluralin to fish and invertebrates (source: EFED Pesticide Ecotoxicity Database and Trifluralin RED)

Species	Scientific Name	% ai	Duration	Endpoints affected	NOEC (ppb)	LOEC (ppb)
Technical						
Fathead minnow	*Pimephales promelas*	97	61 weeks	survival	1.9	5.1
Fathead minnow	*Pimephales promelas*	99	35 days	N.R.**	0.3	0.7
Sheepshead minnow	*Cyprinodon variegatus*	Form*	N.R.**	fecundity	1.3	4.8

Rainbow trout	*Oncorhynchus mykiss*	99.9	48 days	larval fish length	1.14	2.18
Waterflea	*Daphnia magna*	97	64 days	survival	2.4	7.2

* The study was conducted on a formulation, but the percent active ingredient is not given.
** N.R. = Not reported

OPP does not categorize toxicity to plants. However, the data indicate that trifluralin is more toxic to aquatic vascular plants than to algae. Diatoms are the most sensitive of the tested aquatic plant species to trifluralin

Table 9. Acute toxicity of trifluralin to aquatic plants (source: EFED Pesticide Ecotoxicity Database and Trifluralin RED)

Species	**Scientific Name**	**% ai**	**NOEC (ppb)**	**EC50 (ppb)**
Duckweed	*Lemna gibba*	97.9	N.R.*	43.5 (14-D)
Freshwater diatom	*Navicula pelliculosa*	97.9	N.R.	15.3 (5-D)
Blue-green algae	*Anabaena flos-aquae*	97.9	N.R.	>339 (5-D)
Marine diatom	*Skeletonema costatum*	97.9	N.R.	28 (5-D)
Algae	*Isochrysis galbana*	96	N.R.	2500 (240-h)
Green algae	*Chloroccum sp.*	96	N.R.	2500 (240-h)
Green algae	*Dunaliella tertiolecta*	96	N.R.	5000 (240-h)
Marine diatom	*Phaeodactylum tricornutum*	96	N.R.	2500 (24-h)

* N.R. = The value was not reported.

There are some aquatic toxicity data for trifluralin from EPA's AQUIRE database (http://www.epa.gov/ecotox/). We did not look at the original papers but report the toxicity values for the toxicity test periods that are analogous to the those required by OPP testing requirements as a means of comparison. The AQUIRE reference numbers for each reported value are provided. In addition to the studies listed below there were additional studies that were taken from the EFED Pesticide Toxicity Database that are listed in tables 4 through 9 above, and, therefore, are not included in Table 10. Also many of the fish toxicity values listed in AQUIRE were based on 24-hour exposure periods, instead of the standard 96-hour period used by the Agency. These values were not included in Table 10..

Table 10. Summary of acute toxicity data from the EPA AQUIRE database.

Species	**Scientific Name**	**Test Chemical***	**96-h LC 50 (ppb)**	**Reference**

Freshwater Fish				
Common carp	*Cyprinus carpio*	Active	660	11531
Common carp	*Cyprinus carpio*	Form.	45	20430
Bluegill sunfish	*Lepomis macrochirus*	Form.	18, 47, 68, 120, 190	2085, 2871
Bluegill sunfish	*Lepomis macrochirus*	Form.	18.5 - 400	6797
Rainbow trout	*Oncorhynchus mykiss*	Form.	10 - 160, 1600	6797
Rainbow trout	*Oncorhynchus mykiss*	Form.	10, 86, 42, 152, 210	2085, 2871
Western mosquitofish	*Gambusia affinis*	Form.	12000	10092
Channel catfish	*Ictalurus punctatus*	Form.	330, 417, 440, 660	858, 6797
Fathead minnow	*Pimephales promelas*	Form.	124, 160	6797
Estuarine Fish				
Porgy	*Acanthopagrus schlegeli*	Active	>56	17085
Green fish	*Girella punctata*	Active	110	17085
Freshwater Invertebrates				
Waterflea	*Alonella*	Form.	60 (48-h)	11476
Waterflea	*Daphnia magna*	Active	193 (48-h)	632
Waterflea	*Simocephalus serrulatus*	Form.	450	10337
Waterflea	*Daphnia pulex*	Form.	240 (48-h)	888
Cyclopoid copepod	*Eucyclops*	Form.	50	11476
Scud	*Gammarus fasciatus*	Form.	1000, 2200	886, 885
Stonefly	*Pteronarcys californicus*	Form.	3000	889, 2871
Red swamp crayfish	*Procambarus clarkii*	Form.	12000, 13000, 26000	10092, 12802
Oligochaete, worm	*Lumbriculus variegatus*	Active	>300	6502
Estuarine Invertebrates				
Opossum shrimp	*Americamysis bahia*	Active	>136.4	4891
Bay mussel	*Mytilus edulis*	Active	350	8127
Dungeness crab	*Cancer magister*	Form.	250, 300	6793, 8280

Dungeness crab	*Cancer magister*	Active	>110, >1000, >9300	6793

* Form. = Test was conducted with formulated products. The product composition and percent active ingredient were not given.
Active = Test was conducted with the active ingredient, but the percent dichlobenil was not given.

The AQUIRE data corroborate the toxicity values reported in EFED's database and the trifluralin RED. Most of the data in AQUIRE are reported from studies conducted with formulated products, however, the types of formulations and percents active ingredient were not reported. Therefore, it is difficult to compare these data with those reported by OPP. The AQUIRE database is not always reliable regarding the test being with the formulation or the active ingredient; unless the test indicates an active ingredient, it is put into AQUIRE as formulation testing. However, we have seen values reported for the technical material in Mayer & Ellersieck (1986) to be reported in AQUIRE as a formulation test. We report the information on formulation versus active ingredient, but we need to note that it is not completely reliable.

b. Vertebral lesions in fish

Trifluralin has been observed to cause vertebral dysplasia in young fish exposed to trifluralin. The dysplasia consisted of semi-symmetrical hypertrophy of the vertebrae so they were three to twenty times their normal size. The end result was longitudinal fusion of the vertebrae and damage to the spinal column such that the affected fish are noticeably shorter than normal fish. A study conducted by EPA's Environmental Research Laboratory in Gulf Breeze, Florida, ["Vertebral Dysplasia in Young Fish Exposed to the Herbicide Trifluralin", J.A. Couch, et .al., *Journal of Fish Diseases,* 1979, 35-42] documents this effect in a standard fish early-life stage study. Sheepshead minnow were exposed to trifluralin throughout the first 28 days of their lives. The authors reported that the effect occurred at exposure concentrations of 5.5 ppb and higher.

c. Toxicity of multiple active ingredients

There are no known fish toxicity data on trifuralin products that contain other active pesticide ingredients. The 1996 RED listed a number of herbicides and insecticides with which trifluralin was combined. However, a search of EPA's Pesticide Product Label System (PPLS) for this consultation could not find combined multiples with four of the active pesticide ingredients listed in the RED (metribuzin, tebuthiuron, chlorpyrifos and disulfoton), but it found trifluralin products combined with two other pesticides, clopyralid and oxadiazon, that were not listed in the RED. Benfluralin is the most common pesticide contained in trifluralin products containing other actives. Table 11 presents freshwater fish toxicity data on all ingredients that were indicated as formulated with trifluralin. Of the ten active ingredients that we found in PPLS, nine are less toxic than trifluralin, and only one, benfluralin, is equivalent in toxicity to trifluralin. The highest percentage of benfluralin found in any trifluralin product was 1.33%, with most of the mixtures of these two actives containing less than one percent. The low percentage of benfluralin in these products leads us to conclude that there is no basis for considering that the toxicity will be any greater than for the trifluralin ingredient alone.

Table 11. Freshwater fish toxicity of other pesticide active ingredients in trifluralin products. Source: EFED Pesticide Ecotoxicity Database)

Pesticide	Most sensitive species	Lowest 96-h LC50 value for technical material
triallate	rainbow trout	1.2 ppm
benfluralin	bluegill	65 ppb
alachlor	rainbow trout	2.4 ppm
clomazone	rainbow trout	19 ppm
isoxaben	bluegill	>1.1 ppm
imazaquin	rainbow trout	280 ppm
imazethapyr	channel catfish	240 ppm
flumetsulam	fathead minnow	>293 ppm
oxadiazon	bluegill	880 ppb
clopyralid	rainbow trout	103.5 ppm
metribuzin	rainbow trout	42 ppm
tebuthiuron	bluegill	106 ppm
disulfoton	bluegill	300 ppb
chlorpyrifos	bluegill	1.7 ppb

b. Environmental fate and transport

The available information on the properties of trifluralin in the environment suggest that the chemical is expected to be moderately persistent. It is not expected to be mobile, as a consequence of adsorption to soil. Risks to water resources, ground water and surface water are discussed in detail in Section "c." below. Trifluralin may contaminate surface water by spray drift, and under some circumstances by runoff. Despite the low mobility of trifluralin, the USEPA Pesticides in Ground Water Data Base indicates detections in 10 states. However, the validity and significance of the detections is questionable on several grounds which are discussed below in section c.(1). The available data, represented by supplemental and acceptable studies, suggest the following conclusions regarding mechanisms of dissipation in the field. Although trifluralin is volatile, in the field it dissipates primarily by soil binding and (secondarily) by biotic degradation. For trifluralin to be effective, it has to be incorporated into the soil at the time of application. Incorporation limits dissipation via surface active processes, primarily volatilization and photodegradation. Once incorporated, soil binding is the initial route of dissipation. This is followed by biotic degradation processes with a half life of 116 to 201 days. A number of transitional degradates have been identified.

Laboratory data indicate that trifluralin is not mobile in sandy loam, loam, and clay loam soils. Surface volatilization of trifluralin is controlled by soil moisture and temperature. Results based on laboratory data appear to be confirmed by supplemental field data which indicate trifluralin dissipates with a field half life of 29 to 149 days with no detection of trifluralin below six inches depth.

In order for the submitted studies to fulfill guideline data requirements, confirmation of analytical procedures has been requested to be submitted. It is not likely that the additional information requested will change the overall qualitative assessment. However, the additional information may bear on the confidence in the data, and is expected to provide a better understanding of the environmental fate properties of the chemical. Also, the additional information could be relevant for a quantitative assessment of trifluralin exposure.

b. Environmental Fate and Transport

In order for the submitted laboratory and field studies to be acceptable to fulfill the data requirements, confirmatory analysis (preferably MS) is needed. Separations such as those based on TLC should be confirmed by another analytical method.

(1) Degradation

Hydrolysis: The data requirement is not fulfilled at this time. The registrant is supporting a study (MRID 00131135) that was found to be acceptable in 1984-1985. Comparison of that study to a study of photodegradation in water (MRID 40560101) indicates a discrepancy. Trifluralin was reported to be substantially more stable in the hydrolysis study than for the dark controls in the study of photodegradation in water. In order to fully understand the degradation and dissipation of trifluralin, this apparent discrepancy needed to be addressed. The registrant has submitted information addressing the discrepancy which is currently under review.

Photodegradation in Water: The submitted study supplies supplemental data and is scientifically valid. However, it cannot be used to fulfill the data requirement at this time, but may be upgradable when the following points are adequately addressed:

As described for the hydrolysis data requirement, there is a discrepancy between the dark control half life (about 20 days) and the relative stability reported for the hydrolysis study. The reason for the difference is not apparent at this time.

Trifluralin appears to volatilize in preliminary testing. For a complete environmental fate assessment, measurements are needed of the fractions of volatile and nonvolatile parent and degradates over the course of the test.

The study reports that trifluralin degraded with a half-life of 8.93 hours in a sterile pH 7 aqueous buffer solution when exposed to a light source. In the dark control, trifluralin degraded with a half-life of 485 hours (or about 20 days). The major degradates identified in the samples exposed to light (with maximum percent of applied) were: (47.4%) 2-ethyl-7-nitro-5-trifluoromethylbenzimidazole; (9.6%) 5-trifluoromethyl3-nitro-1,2-benzene diamine; and (53.8%) 2-ethyl-7-nitro-1-propyl-5-trifluoromethylbenzimidazole.

The fraction of applied radioactivity recovered as volatile residue was about 55% for control samples and about 70% for light-exposed samples. The registrant has submitted information to address the cited deficiencies that is currently under review (MRID 40560101).

Photodegradation on Soil: The available study of photodegradation on soil is scientifically valid and can be used as supplemental data, but cannot be used to fulfill the data requirement. In order to validate the analytical data, a confirmatory analysis (preferably MS) is needed in addition to comparison to the Rf of reference standards. There are guideline concerns [soil moisture and sieve size were not furnished and a discrepancy in the half-life for photodegradation on soil control samples (66 days) and for aerobic soil metabolism data (189 days)] in the study methodology, as well. However, the Agency believes that repeating this study will not provide significant new information. If information is furnished to the Agency confirming the analytical procedures the study can be used to fulfill the data requirement. The study reports that trifluralin degraded with a reported half-life of 41 days when exposed to a light source on sandy loam soil. The half-life of dark control samples of trifluralin was reported to be 66 days. Two degradates, 2,6-dinitro-N-propyl-4-trifluoromethylbenzenamine, and 2-ethyl-7nitro-5-trifluoromethylbenzimidazole-3-oxide, were identified in the light exposed samples at maximum concentrations of 6.0% and 7.1% of applied radioactivity in the soil extract, respectively. Unidentified residues made up a maximum of <9.6% of soil extract at 29.8-day following treatment. At 29.8 days following treatment, 11.2% of the applied radioactivity was not extracted. Also, carbon dioxide was reported to reach 5.79% of applied radioactivity in the exposed samples and 0% for the dark control samples during the testing period. The Agency is currently reviewing information submitted by the registrant to fulfill this requirement (MRID 40597801, 40751301).

Aerobic Soil Metabolism: The aerobic soil metabolism study is scientifically valid and can be used for supplemental data but cannot be used to fulfill the data requirement. A complete environmental fate assessment of the degradation of trifluralin under aerobic conditions cannot be made at this time for the following reason: Degradates present in the organic extracts at up to 7.6% of the applied (0.119 ppm) and in the aqueous extracts at up to 6.9% of the applied (0.108 ppm) were not characterized.

Trifluralin degraded with registrant-calculated half-lives of 189, 201, and 116 days in sandy loam, clay loam, and loam soils, respectively, when incubated aerobically in the dark at 22 C for 364 days. Seven degradates were identified. With maximum percentages of applied radioactivity in the test samples, the seven degradates are:

1) , , -trifluoro-2,6-dinitro-N-propyl-p-toluidine
2) , , -trifluoro-5-nitro-4-propyl-toluene- 3,4-diamine
3) 2-ethyl-7-nitro-1-propyl-5-(trifluoromethyl) benzimidazole-3-oxide
4) 2-ethyl-7-nitro-1-propyl-5-(trifluoromethyl) benzimidazole
5) 2-ethyl-7-nitro-5-(trifluoromethyl)benzimidazole
6) , , -trifluoro-2,6-dinitro-p-cresol
7) 2,2'azoxybis(, , -trifluoro-6-nitro-N-propyl-p- toluidine

These degradates were identified in test samples at maximum concentrations (% applied radioactivity) 2.8 to 4.6%, 1.5 to 2.1%, 0.1 to 0.3%, 0.5 to 1.0%, 2.1 to 2.6%, 0.1 to 2.7%, and 0.8 to 3.0%. During the testing period of about one year trifluralin parent declined to less than 25% of applied radioactivity in all soils. At the same time volatile and unextractable residues increased to 21.7% and about 45% of applied radioactivity. The registrant has submitted degradate information that is currently under Agency review (MRID 41240501).

Anaerobic Soil Metabolism: The anaerobic soil metabolism study is scientifically valid and can be used as supplemental data. The data cannot be used to fulfill the guideline requirement but may be upgradable. A complete assessment of trifluralin degradation under anaerobic conditions cannot be made at this time because important degradates were not identified: Degradates were not characterized that were present in organic extracts at up to 6.1% of applied radioactivity (0.099 ppm) and in aqueous extracts at up to 12.1% of applied (0.182 ppm).

Based on the study available, trifluralin degraded with registrant-calculated half-lives of 25-59 days in sandy loam, loam, and clay loam soils incubated anaerobically in the dark at 22 C for 60 days following an aerobic incubation period of 30 days. The major degradates identified were:

1) , , -trifluoro-5-nitro-N4,N4-dipropyl-toluene- 3,4-diamine (which reached a maximum concentration of 5.4% and 13.2% of the applied radioactivity in the sandy loam soil and clay loam soil, respectively, at Day 60 following flooding, and 11.6% in the loam soil at Day 30 following flooding);
2) 7-amino-2-ethyl-1-propyl-5-(trifluoromethyl) benzimidazole (which reached 7.3% in the sandy loam soil and 8.3% in the loam and clay loam soils at Day 60 following flooding);
3) , , -trifluoro-N4,N4-dipropyltoluene-3,4,5-triamine (which reached 0.3% in the sandy loam soil, 4.1% in the loam soil, and 2.6% in the clay loam soil).

Four other degradates identified were:

1) , , -trifluoro-2,6-dinitro-N-propyl-p-toluidine;
2) , , -trifluoro-5-nitro-N4-propyl-toluene-3,4-diamine;
3) 2-ethyl-7-nitro-1- propyl-5-(trifluoromethyl) benzimidazole;
4) 2,2'-azoxybis (, , -trifluoro-6-nitro-N-propyl- p-toluidine)
each present at concentrations up to 2.1% of the initial radioactivity.

The following three degradates:

1) 2-ethyl-7-nitro-1-propyl-5-(trifluoromethyl);
2) benzimidazole-3-oxide;
3) 7-amino-2-ethyl-5-(trifluoromethyl)benzimidazole;

were each present at up to 1% of the initial radioactivity
.

Uncharacterized degradates in the organic extracts were at maximum concentrations of 6.1% (0.099 ppm) of the initial radioactivity in the sandy loam soil, 6.2% (0.093 ppm) in the loam soil, and 6.3% (0.090 ppm) in the clay loam soil. Uncharacterized degradates in the aqueous extracts were maximums of 6.4% (0.104 ppm) of applied radioactivity in the sandy loam soil, 12.1% (0.182 ppm) in the loam soil, and 9.6% (0.138 ppm) in the clay loam soil. An increase of unextractable trifluralin residues (9.4 to 60%) indicated that binding of residues to soil organic matter is the major route of anaerobic dissipation for trifluralin. The registrant has submitted degradate information that is currently under Agency review (MRID 41240502)
.

(2) Mobility

Leaching and Adsorption-Desorption: The mobility study, an unaged batch equilibrium and aged column study, is scientifically valid and can be used as supplemental data. It cannot be used to fulfill the data requirement. Degradates that were detected in the soil segments extracts and the leachate were not quantified and characterized, as needed to predict the leaching of trifluralin residues.

Unaged trifluralin appears not to be mobile in sandy loam, loam, and clay loam soils (Freundlich K , values of 54.8-155.6). However, aged trifluralin residues appear to be slightly mobile in columns of sand and loam soils: About 90% of the applied radioactivity remained in the upper 6 cm; 0.65-2.57% leached from the column. The degradates identified were:

1) , , -trifluoro-2,6-dinitro-N-propyl-toluidine (TR-2) (present at 3.01-3.05% of the extracted radioactivity);

2) 2-ethyl-7-nitro-1-propyl-5-(trifluoromethyl)-benzimidazole (present at 0.77-0.87% of extracted radioactivity);

3) 2,2'-azoxybis(, , -trifluoro-6-nitro-N-propyl-p- toluidine) (present at 0.38-0.40% of extracted radioactivity).

Degradates remaining at the TLC origin were 0.88 to 1.31% of the extracted radioactivity. Also, radioactivity in other TLC zones ranged from 0.01 to 0.54% of extracted radioactivity. Uncharacterized residues in the aqueous extract averaged 0.76% of the applied radioactivity with unextracted residues averaging 6.79% of the applied radioactivity. Volatile residues extracted from the charcoal trap averaged 3.40% of the applied radioactivity. The extracted radioactivity in the charcoal trap was identified as essentially all trifluralin with some TR-2, and residues remaining at the TLC origin. The registrant has responded to the study deficiencies and this submission is currently under Agency review (MRID 40673501).

Laboratory Volatility: Three laboratory volatility studies were submitted and provide supplemental data. They cannot be used to fulfill the data requirement. These data were taken from published articles and were not originally designed to satisfy Subdivision N data requirements. Therefore, it is difficult to draw conclusions needed for an environmental fate assessment. However, published laboratory and field volatility data submitted (MRID 40673601A-G) do indicate the following:

1) Volatility may be a major route of dissipation for trifluralin above the soil surface.

2) Trifluralin appears to volatilize (25 to 60% of applied in 11 days).

3) Data are needed to determine relative rate of dissipation due to volatility in relation to other routes of dissipation.

In the data submitted, the concentration of trifluralin in air and soil was not reported. Also, application rate and material balances could not be confirmed, and the concentration of trifluralin residues in the air could not be related to the concentration of trifluralin residues in the soil. Furthermore, the study was terminated before the pattern of decline of the test substance was established. The registrant has committed to conduct a new laboratory field volatility study (MRID 40673601A, 40673601B, 40673601C).

Field Volatility: Four field volatility studies were submitted and provide supplemental data. They cannot be used to fulfill the data requirement.

These data were taken from published articles and were not originally designed to satisfy Subdivision N data requirements. Therefore, it is difficult to draw the conclusions needed for an environmental fate assessment. However, published volatility data submitted do indicate the following:

1) Volatility may be a major route of dissipation for trifluralin above the soil surface.

2) Trifluralin appears to volatilize: 25% to 60% of applied trifluralin volatilizes in 11 days).

3) Laboratory volatility data are needed to determine the contribution of volatilization to dissipation, relative to other dissipation mechanisms.

4) No further field volatility data are needed until evaluation of acceptable laboratory volatility data are completed.

In the data submitted the concentration of trifluralin in the soil immediately following treatment was not reported. Therefore, the application rate was not confirmed and the concentration of trifluralin in the air could not be related to the amount of trifluralin in the soil. Furthermore, the study was terminated before the pattern of decline of the test substance was established. The registrant has requested that the need for a new study be determined upon receipt and review of the laboratory volatility study (MRID 40673601D, 40673601E, 40673601F, 40673601G).

(3) Accumulation

Bioaccumulation in Fish: A single study submitted was determined to be scientifically valid and to provide supplemental information. That study cannot be used to fulfill the data requirement. Accumulation and depuration in fish cannot be fully assessed because radioactive residues in the fish tissues were not completely characterized. Radioactivity attributed to a total of 10 metabolites at a maximum of 0.804 ppm was not identified; up to 1.273 ppm was described only as polar radioactivity. Also, up to 1.8% of the total radioactivity in the aqueous phase of the tissue extracts was not characterized. Trifluralin residues accumulated in bluegill sunfish exposed to 0.0059 ppm of trifluralin, with maximum mean bioconcentration factors of 2041x, 9586x, and 5674x for edible, nonedible, and whole fish tissues, respectively. Depuration occurred with 86.34-88.01% of the [C]residues eliminated from the fish tissues after 14 days of exposure to pesticide free water.
The registrant has responded to the study deficiencies. This submission is currently under Agency review (MRID 40673801)
.
(4) Field Dissipation

Terrestrial Field Dissipation: The submitted studies of terrestrial field dissipation are scientifically valid and can be used as supplemental data. However, they cannot be used to fulfill the data requirement because degradates identified in laboratory data were not analyzed for in field samples, and the degradation pathway of trifluralin in the field could not be determined from this study.

In order to fulfill the data requirement, acceptable data must be submitted for two sites treated at the maximum registered application rate for each trifluralin formulation type.

Granular trifluralin dissipated with a reported half-life of 49 days in the top 6 inches of soil when applied to loamy sand soil in California. Pretreatment sample analysis indicated there were low levels (0.07-0.16 ppm) of trifluralin present at depths less than 6 inches. Immediately following treatment, concentrations ranged from 1.30 to 6.30 ppm and from 1.80 to 5.00 ppm for applications 1 and 2, respectively. By days 14 and 42 following treatment the average recovery was 1.14 ppm (range of 0.88-1.30 ppm) and 0.74 ppm (range of 0.38-1.90), respectively. With the exception of one sample, trifluralin was not detected at depths greater than 6 inches (MRID 41781901).
Trifluralin (EC formulations) dissipated with reported half-lives of 149 days from California loam soil and 93 days from Alabama clay soil. Immediately following treatment, the recoveries on 8 samples ranged from 2.10 to 6.70 ppm and from 1.40 to 2.90 ppm at depths to 6

inches for the CA and AL sites, respectively. By termination of the study (Day 494 following treatment for CA site and day 482 following treatment for AL site) the recovery of applied material had declined to 0.22 and 0.04 ppm, respectively. Trifluralin did not appear to leach to below 6 inches depth. However, one sample at 24 to 30 inches depth did contain trifluralin at 0.06 ppm, 494 days following treatment at the California site (MRID 41661101).

Emulsifiable concentrate trifluralin formulations were reported to dissipate with a half-life ranging from 29 to 35 days when applied to coarse (sandy loam soil at Shellman, GA site) and fine (silty clay loam soil at Mansfield, IL site) soils, respectively. However, granular trifluralin formulation was reported to dissipate with a half-life ranging from 15-to 86 days when applied to sandy loam soil in Shellman, GA. These half-lives were calculated from nonlinear dissipation curves. Furthermore, since trifluralin was not discernible in soil segments below the top 6 inches of soil, trifluralin did not demonstrate any leaching potential.

Mean recoveries immediately following treatment for the emulsifiable concentrate at the Georgia and Illinois sites were 0.94 ppm (132% of applied) and 0.99 ppm (200% of applied) at depths less than 6 inches, respectively. For the granular formulation the mean recoveries immediate following treatment at the Georgia and Illinois sites were 0.85 ppm (113% of applied) and 0.67 ppm (134% of applied), respectively. By termination of study, the mean recoveries for the emulsifiable concentrate were 0.04 ppm at 398 following treatment at the Illinois site and 0.09 ppm at Day 193 following treatment at the Georgia sites. For the granular formulation, at termination of study the mean recoveries were 0.04 ppm (Day 573 posttreatment) and 0.10 ppm (Day 549 posttreatment) for the Illinois and Georgia sites, respectively. There was an increase in the mean at Day 7 posttreatment at the Georgia site for the emulsifiable concentrate formulation (1.91 ppm which is 400% of applied) and at the Illinois site for the granular formulation (1.01 ppm which is 135% of applied)(MRID 42309101).

(5) Spray Drift

No studies have been submitted to the Agency for spray drift droplet size (201-1) or field drift (202-1). These studies are held in reserve pending the results of work currently being conducted by the Spray Drift Task Force. Registrants who are not members of Task Force or do not have the permission to cite Task Force data will have to independently develop these data.

c. Incidents

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

The results of this review indicate several incidents involving aquatic organisms between 1991 and 1997. Two of these events, 6/12/91, IA; 5/26/95, LA; were considered to be due to trifluralin related with high probability. One (LA) resulted directly from an accidental spill. A total of five events related to fish kills were recorded, with mortality in Bass, Bluegill, Catfish, Crappie, Eel, Gar, Shad, and Minnows.

d. Estimated and measured concentrations of trifluralin in surface waters

Measured concentrations in surface water

California's Department of Pesticide Regulation has a surface water database that contains data from a wide variety of environmental monitoring studies that test for the presence or absence of pesticides in the state's surface waters. The data were updated in January 2002 and reflect the contents of the database as of April 2003. There are a total of 204 monitoring sites statewide at the present time. The information is available at http://www.cdpr.ca.gov/docs/sw/surfdata.htm. The data indicated that trifluralin was routinely sampled for at many of the collection sites, but it was not always detected. Table 12 lists the counties, and sites within each county where it was detected, the number of detections at the site, and the range of measured concentrations, and the dates trifluralin was detected.

Table 12. Measured concentrations of trifluralin in surface waters in California (Source: California Department of Pesticide Regulation)

County	Site Number and Location	Range of Measured Concentrations (ppb)	Number of Detections	Dates of Detections
Imperial	13-4-Alamo River	0.10	1	12/13/93
Merced	24-7 Merced River	0.003 - 0.057	12	2/8/93-7/10/01
Merced	24-12 trib. to S.J. River	0.010 - 0.102	2	4/11/01-6/12/01
Merced	24-13 trib. to S.J. River	0.003 - 0.110	36	2/11/93-8/21/01
Sacramento	34-15 Arcade Creek	0.005 - 0.020	5	1/29/97-3/9/98

San Joaquin	39-17 San Joaquin R.	0.006 - 0.011	6	2/15/95-5/16/01
Stanislaus	50-2 San Joaquin R.	0.009 - 0.017	10	4/11/01-7/31/01
Stanislaus	50-3 Sonoma storm drain	0.016	1	2/13/95
Stanislaus	50-4 Dry Creek	0.007 - 0.008	3	2/13/95-3/11/95
Stanislaus	50-5 McHenry storm drain	0.010 - 0.018	2	2/13/95-2/14/95
Stanislaus	50-6 Ninth St. storm drain	0.013	1	2/13/95
Stanislaus	50-8 Dry Creek	0.006 - 0.015	4	2/13/95-3/10/95
Stanislaus	50-9 Farabuindo storm drain	0.024	1	2/13/95
Stanislaus	50-15 San Joaquin R.	0.010 - 0.052	17	4/11/01-8/7/01
Stanislaus	50-17 Tuolumne R.	0.006	1	3/11/95
Stanislaus	50-21 Westside storm drain	0.013	1	2/13/95
Stanislaus	50-22 Turlock Irr.Dist.	0.007	1	2/14/95
Stanislaus	50-28 Orestimba Creek	0.003 - 0.152	46	1/8/93-8/21/01
Stanislaus	50-32 Del Puerto Creek	0.011 - 1.74	19	4/11/01-8/21/01
Stanislaus	50-33 San Joaquin R.	0.011 - 0.064	17	4/11/01-8/14/01
Yolo	57-2 Colusa Basin Drain	0.004 - 0.023	10	2/8/94-2/26/98

The data indicate that 21 sites out of 204 sites statewide (10.3%) had measurable residues of trifluralin, with the greatest number of detections occurring in Merced and Stanislaus counties. The rates of detections of trifluralin in these two counties are equivalent to 23% and 42% of the monitoring sites in each county. The range of residues that were measured at all sites is fairly consistent, except for the maximum levels measure at sites 50-28 and 50-32 in Stanislaus County.

Estimated environmental concentrations

The EEC calculations, based on PRZM/EXAMS scenarios, in the RED were not adequate for this consultation as they were based on an older version of the PRZM/EXAMS model and older scenarios. Therefore, EFED provided us with new EEC calculations specific to this consultation. The 2002 use data from California DPR and the use information from BEAD were used as the basis of selecting the scenarios to be modeled. The rationale was to choose crops with the greater amount of acreage treated, tempered by the modeling scenarios currently available. The California scenarios that were selected are alfalfa, carrots, cotton, grapes, safflower and tomatoes. Carrots is also applicable to sugar beets and safflower is also applicable to corn.

The input parameters for the PRZM/EXAMS models are listed in Table 13.

Table 13: Input Parameters for Trifluralin

Parameters	Input Value and Unit	Source of Info/Reference
Application Rate	Carrots (1.12 kg/ha) Alfalfa (2.24 kg/ha) Cotton (2.24 kg/ha) Grapes (2.24 kg/ha) Safflower (1.12 kg/ha) Tomatoes (1.12 kg/ha)	Cornbelt Label (EPA Reg No. 11773-17) Cornbelt Label (EPA Reg No. 11773-17) Cornbelt Label (EPA Reg No. 11773-17) Cornbelt Label (EPA Reg No. 11773-17) Cornbelt Label (EPA Reg No. 11773-17) Cornbelt Label (EPA Reg No. 11773-17)
Soil Partition Coefficient, Kd	52.5 L/Kg (Lowest nonsand Kd) sandy loam	MRID 40673501
Molecular Weight	335.28	
Solubility in Water	0.3 ppm at 25 ºC	
Vapor Pressure	1.10E-4 Torr	(RED)
Henry's Law Constant	1.62E-4 atm m3/mole	(RED)
Hydrolysis $T_{1/2}$	Stable at pH 5, pH 7, pH 9	MRID 00131135
Aqueous Photolysis (pH 5) $T_{1/2}$	0.371 days (Parent) 9.43 days (Parent and degradates, TR-6,TR-15)	MRID 40560101
Aerobic Soil Metabolism $T_{1/2}$	219 days (90% upper confidence bound on the mean metabolism half-lives, 189, 201, 116 days)	MRID: 41240501
Anaerobic Soil Metabolism $T_{1/2}$	59 days (Parent) (90% upper confidence bound on the mean metabolism half-lives, 59, 25, 35 days) 68 days (Parent and degradate, TR-4) (90% upper confidence bound on the mean metabolism half-lives, 63, 31, 55 days)	MRID 41240502
Aerobic aquatic metabolism $T_{1/2}$	438 days (2x aerobic soil metabolism input value when no data available)	Guidance Manual (Feb 28, 2002)

The environmental fate modeling was conducted to assess relative impact of runoff and spray drift on trifluralin loading into the standard water body. This process was accomplished using a fixed exposure scenario except for spray drift assumptions. The drift scenarios include a no drift scenario (assumes 100% application efficiency and zero drift), aerial application drift scenario (assumes 95% application efficiency and a drift of 5% of the application rate), and ground application drift scenario (assumes 99% application efficiency and a drift of 1% of the application rate).

Trifluralin application was simulated as preplant herbicide. Crop planting dates were estimated from www.fsa.usda.gov/pas/publications/reports/2002/ loancommerical.htm, 3/4/04 and Toulumne County Vegetable Planting Dates, University of California Cooperative Extension. The application method simulated soil incorporated to a depth of 5 cm using the PRZM chemical application method (CAM) of 4. Additionally, trifluralin application rates were adjusted to account for soil texture and organic carbon content label restrictions.

Due to the complexity of the modeling results, they are presented in individual tables for each crop scenario.

Table 14: **1 in 10 year Estimated Environmental Concentrations of Trifluralin for Carrots in California**

Drift Scenarios	Loading Contribution	Estimated Environmental Concentration (µg/L)			
		Peak	4 day average	21 day average	60 day average
No Drift	runoff only	0.17	0.13	0.08	0.04
Ground Spray	runoff +1%drift	0.56	0.46	0.28	0.12
Aerial Spray	runoff + 5% drift	2.80	2.30	1.17	0.49

Table 15: **1 in 10 year Estimated Environmental Concentrations of Trifluralin for Alfalfa in California**

Drift Scenarios	Loading Contribution	Estimated Environmental Concentration (µg/L)			
		Peak	4 day average	21 day average	60 day average
No Drift	runoff only	0.06	0.05	0.03	0.02
Ground Spray	runoff +1%drift	1.12	0.90	0.43	0.17
Aerial Spray	runoff + 5% drift	5.59	4.48	2.13	0.87

Table 16: **1 in 10 year Estimated Environmental Concentrations of Trifluralin for Cotton in California**

Drift Scenarios	Loading Contribution	Estimated Environmental Concentration (µg/L)			
		Peak	4 day average	21 day average	60 day average
No Drift	runoff only	0.04	0.03	0.01	0.01
Ground Spray	runoff +1%drift	1.12	0.89	0.42	0.17
Aerial Spray	runoff + 5% drift	5.59	4.44	2.07	0.83

Table 17: **1 in 10 year Estimated Environmental Concentrations of Trifluralin for Grapes in California**

Drift Scenarios	Loading Contribution	Estimated Environmental Concentration (µg/L)			
		Peak	4 day average	21 day average	60 day average
No Drift	runoff only	0.001	0.001	0.0006	0.0002
Ground Spray	runoff +1%drift	1.12	0.86	0.39	0.16
Aerial Spray	runoff + 5% drift	5.59	4.38	1.97	0.78

Table 18: **1 in 10 year Estimated Environmental Concentrations of Trifluralin for Safflower in California**

Drift Scenarios	Loading Contribution	Estimated Environmental Concentration (µg/L)			
		Peak	4 day average	21 day average	60 day average
No Drift	runoff only	0.95	0.79	0.49	0.27
Ground Spray	runoff +1%drift	0.94	0.78	0.49	0.27
Aerial Spray	runoff + 5% drift	2.38	2.27	1.09	0.45

Table 19: **1 in 10 year Estimated Environmental Concentrations of Trifluralin for Tomatoes in California**

Drift Scenarios	Loading Contribution	Estimated Environmental Concentration (µg/L)			
		Peak	4 day average	21 day average	60 day average
No Drift	runoff only	0.47	0.40	0.25	0.12
Ground Spray	runoff +1%drift	0.57	0.45	0.26	0.13
Aerial Spray	runoff + 5% drift	2.80	2.22	1.04	0.42

e. General risk conclusions

Trifluralin is moderately to highly toxic to freshwater and marine fish and invertebrates. The Risk Quotients exceeded the Endangered Species Levels of Concern for freshwater fish with ground applications to carrots, alfalfa, cotton, grapes, safflower, and tomatoes in the California model. Similar findings were seen with aerial applications. Invertebrate Endangered species LOCs were exceeded with aerial application on carrots and cotton. These findings suggest trifluralin may have an effect in the ESUs under review, particularly when applied by aerial methods.

Table 20: Risk Quotients for the Species of Concern

Crops and Application Rates	Species	Acute RQ (96 hours)
Carrots, Ground Spray + 1% Drift (CA)	Bluegill Rainbow Trout Flathead Minnow	0.07 0.03 0.01
Carrots, Aerial (CA)	Bluegill Rainbow Trout Flathead Minnow	0.33 0.13 0.03
Carrots, Ground Spray + 1% Drift (CA)	Sheepshead Minnow Bay Mussel Grass Shrimp	0.004 0.002 0.009
Carrots, Aerial (CA)	Sheepshead Minnow Bay Mussel	0.02 0.01
Carrots, Ground Spray + 1% Drift (CA)	*Daphnia magna* Grass Shrimp	0.001 0.009
Carrots, Aerial (CA)	*Daphnia magna* Grass Shrimp	0.005 0.08
Alfalfa, Ground Spray + 1% Drift (CA)	Bluegill Rainbow Trout Flathead Minnow	0.13 0.05 0.006
Alfalfa,. Aerial (CA)	Bluegill Rainbow Trout Flathead Minnow	0.68 0.25 0.05
Alfalfa, Ground Spray + 1% Drift (CA)	Sheepshead Minnow Bay Mussel Grass Shrimp	0.0001 0.0003 0.0001
Alfalfa,. Aerial (CA)	Sheepshead Minnow Bay Mussel	0.04 0.02
Alfalfa, Ground Spray + 1% Drift (CA)	*Daphnia magna* Grass Shrimp	0.002 0.03
Alfalfa,. Aerial (CA)	*Daphnia magna* Grass Shrimp	0.01 0.15
Cotton, Ground Spray + 1% Drift (CA)	Bluegill Rainbow Trout Flathead Minnow	0.13 0.05 0.01

Cotton,. Aerial (CA)	Bluegill Rainbow Trout Flathead Minnow	0.67 0.25 0.05
Cotton, Ground Spray + 1% Drift (CA)	Sheepshead Minnow Bay Mussel	0.007 0.005
Cotton,. Aerial (CA)	Sheepshead Minnow Bay Mussel	0.04 0.02
Cotton, Ground Spray + 1% Drift (CA)	*Daphnia magna* Grass Shrimp	0.002 0.03
Cotton,. Aerial (CA)	*Daphnia magna* Grass Shrimp	0.01 0.15
Grapes, Ground Spray + 1% Drift (CA)	Bluegill Rainbow Trout Flathead Minnow	0.13 0.05 0.01
Grapes,. Aerial (CA)	Bluegill Rainbow Trout Flathead Minnow	0.67 0.25 0.05
Grapes, Ground Spray + 1% Drift (CA)	Sheepshead Minnow Bay Mussel Grass Shrimp	0.007 0.005 0.002
Grapes,. Aerial (CA)	Sheepshead Minnow Bay Mussel	0.04 0.02
Grapes, Ground Spray + 1% Drift (CA)	*Daphnia magna* Grass Shrimp	0.01 0.03
Grapes,. Aerial (CA)	*Daphnia magna* Grass Shrimp	0.01 0.15
Safflower, Ground Spray + 1% Drift (CA)	Bluegill Rainbow Trout Flathead Minnow	0.11 0.04 0.009
Safflower,. Aerial (CA)	Bluegill Rainbow Trout Flathead Minnow	0.28 0.11 0.02
Safflower, Ground Spray + 1% Drift (CA)	Sheepshead Minnow Bay Mussel	0.006 0.004

Safflower,. Aerial (CA)	Sheepshead Minnow Bay Mussel	0.02 0.001
Safflower, Ground Spray + 1% Drift (CA)	*Daphnia magna* Grass Shrimp	0.002 0.002
Safflower,. Aerial (CA)	*Daphnia magna* Grass Shrimp	0.004 0.004
Tomatoes, Ground Spray + 1% Drift (CA)	Bluegill Rainbow Trout Flathead Minnow	0.07 0.03 0.005
Tomatoes,. Aerial (CA)	Bluegill Rainbow Trout Flathead Minnow	0.33 0.13 0.03
Tomatoes, Ground Spray + 1% Drift (CA)	Sheepshead Minnow Bay Mussel	0.004 0.0004
Tomatoes,. Aerial (CA)	Sheepshead Minnow Bay Mussel	0.02 0.004
Tomatoes, Ground Spray + 1% Drift (CA)	*Daphnia magna* Grass Shrimp	0.001 0.0001
Tomatoes,. Aerial (CA)	*Daphnia magna* Grass Shrimp	0.005 0.004

f. Existing protective measures

Specific guidelines to control spray drift have been included in the RED. These instructions include limits on the boom length, a limit of 45 degrees for nozzle downward direction, specific pressure requirements (maximum pressure), and maximum wind velocities. Typical worker protection instructions are also in place to prevent inhalation or dermal exposure to this pesticide.

g. Specific Analysis of Evolutionarily Significant Units (ESUs)

In the discussion of specific ESUs below, tables referred to as D-# or E-# can be in Appendices D and E, respectively.

A. Steelhead

Steelhead, *Oncorhynchus mykiss*, exhibit one of the most complex suite of life history traits of any salmonid species. Steelhead may exhibit anadromy or freshwater residency.

Resident forms are usually referred to as ‘‘rainbow’’ or ‘‘redband’’ trout, while anadromous life forms are termed ‘‘steelhead.’’ The relationship between these two life forms is poorly understood, however, the scientific name was recently changed to represent that both forms are a single species.

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

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

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

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,but unlikely, Topanga Creek. Neither of these creeks drain agricultural areas and there are no residential uses for this pesticide. There is a potential for steelhead in waters that drain agricultural areas in Ventura, Santa Barbara, and San Luis Obispo. Usage of trifluralin in counties where this ESU occurs are presented in Table D-1.

Table D-1: Counties supporting the Southern California steelhead ESU

A total of 15,021 pounds of trifluralin is applied in the Southern California Steelhead ESU. In consideration of the size of this ESU, application will have no effect on the T&E species of concern.

<u>2. South Central California Steelhead ESU</u>

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

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

Table D-2: Counties supporting the South Central California steelhead ESU

Total usage of trifluralin in the South Central California Coast Steelhead ESU is modest. It will have no effect on the species of concern.

<u>3. Central California Coast Steelhead ESU</u>

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

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

Counties of occurrence for this ESU are Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Mendocino, Napa, Alameda, Contra Costa, Solano, and Santa Clara counties. Usage of trifluralin in the counties where the Central California coast steelhead ESU is presented in Table D-3.

Table D-3: Counties supporting the Central California Coast steelhead ESU

Use of trifluralin is very modest in the Central California Coast Steelhead ESU. It will have no effect on the T&E species under review.

4. California Central Valley Steelhead ESU

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

This ESU includes populations ranging from Shasta, Trinity, and Whiskeytown areas, along with other Sacramento River tributaries in the North, down the Central Valley along the San Joaquin River to and including the Merced River in the South, and then into San Pablo and San Francisco Bays. Counties at least partly within this area are Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Glenn, Marin, Merced, Nevada, Placer, Sacramento, San Francisco, San Joaquin, San Mateo, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tuloumne, Yolo, and Yuba. A large proportion of this area is heavily agricultural. Usage of trifluralin in counties where the California Central Valley steelhead ESU occurs is presented in Table D-4.

Table D-4: Counties supporting the Central Valley California steelhead ESU.

A total of 287,288 lbs a.i. is applied in the Central Valley California Steelhead ESU, a major agricultural area. This magnitude of application may affect the species of concern.

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 D-5 shows the use of trifluralin in the counties where the Northern California steelhead ESU occurs. There is almost negligible use of trifluralin.

Table D-5: Counties supporting the Northern California steelhead ESU

A total of 36 pounds a.i of trifluralin is applied in the Northern California Steelhead ESU. This will have no effect on the endangered steelhead present.

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.

Table E-1 shows the cropping information and maximum potential trifluralin use for Washington counties where the Upper Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. There are significant quantities of Trifluralin use for migration corridors (791,387 lbs) and spawning and growth (1,695,912 lbs).

Table E-1: Spawning and rearing areas supporting the Upper Columbia River steelhead ESU and **Oregon and Washington counties that are migration corridors for the Upper Columbia River steelhead ESU.**

A total of 83,351 lbs a.i trifluralin is applied within the migratory corridors of this ESU. An additional 127,005 pounds are applied in the spawning and rearing areas of the Upper Columbia River Steelhead ESU. This significant usage may affect the species of concern.

7. Snake River Basin steelhead ESU

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

Spawning and early growth areas of this ESU consist of all areas upstream from the confluence of the Snake River and the Columbia River as far as fish passage is possible. Hells Canyon Dam on the Snake River and Dworshak Dam on the Clearwater River, along with Napias Creek Falls near Salmon, Idaho, are named as impassable barriers. These areas include the counties of Wallowa, Baker, Union, and Umatilla (northeastern part) in Oregon; Asotin, Garfield, Columbia, Whitman, Franklin, and Walla Walla in Washington; and Adams, Idaho, Nez Perce, Blaine, Custer, Lemhi, Boise, Valley, Lewis, Clearwater, and Latah in Idaho. Baker County, Oregon, which has a tiny fragment of the Imnaha River watershed was excluded. While a small part of Rock Creek that extends into Baker County, this occurs at 7200 feet in the mountains (partly in a wilderness area) and is of no significance with respect to trifluralin use in agricultural areas. Similarly excluded are the Upper Grande Ronde watershed tributaries (e.g., Looking Glass and Cabin Creeks) that are barely into higher elevation forested areas of Umatilla County. However, crop areas of Umatilla County are considered in the migratory routes. In Idaho, Blaine and Boise counties technically have waters that are part of the steelhead ESU, but again, these are tiny areas which occur in the Sawtooth National Recreation Area and/or National Forest lands.

They have been excluded because they are not relevant to use of trifluralin. The agricultural areas of Valley County, Idaho, appear to be primarily associated with the Payette River watershed, but there is enough of the Salmon River watershed in this county that it was not able to exclude it.

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

Table E-2: Rearing/spawning areas supporting the Snake River Basin steelhead ESU and Washington and Oregon counties through which the Snake River Basin steelhead ESU migrates.

A total of 98,178 lbs a.i. are applied in the migratory corridors of the Snake River Basin Steelhead ESU. An additional 255,967 lbs a.i. are applied in the spawning and rearing areas. Trifluralin use in this ESU may affect the endangered steelhead population.

<u>8 Upper Willamette River steelhead ESU</u>

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 trifluralin would not be used, and these counties are excluded from my analysis. While the Willamette River extends upstream into Lane County, the final Critical Habitat Notice does not include the Willamette River (mainstem, Coastal and Middle forks) in Lane County or the MacKenzie River and other tributaries in this county that were in the proposed Critical Habitat.

Hydrologic units where spawning and rearing occur are Upper Willamette, North Santiam (upstream barrier - Big Cliff Dam), South Santiam (upstream barrier - Green Peter Dam), Middle Willamette, Yamhill, Molalla-Pudding, and Tualatin.

The areas below Willamette Falls and downstream in the Columbia River are considered migration corridors, and include Multnomah, Columbia and Clatsop counties, Oregon, and Clark, Cowlitz, Wahkiakum, and Pacific counties, Washington.

Table E-3: Spawning and rearing habitat of the Upper Willamette River steelhead ESU and Oregon and Washington counties that are part of the migration corridors of the Upper Willamette River steelhead ESU.

Significant application of trifluralin is present in the Upper Willamette River Steelhead ESU, and may affect the species of concern.

9. Lower Columbia River steelhead ESU

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

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

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

Table E-4: Spawning/rearing areas for the Lower Columbia steelhead ESU and Migratory corridors for the Lower Columbia River Steelhead ESU.

A moderate amount of trifluralin (<10,000 lbs a.i.) is applied in the Lower Columbia River Steelhead ESU. This may affect, but is unlikely to adversely affect, the T&E steelhead population.

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

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

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

Table E-5: Spawning/Rearing areas for the Middle Columbia Steelhead ESU and **Washington and Oregon counties through which the Middle Columbia River steelhead ESU migrates**

A total of 159,500 pounds a.i. of trifluralin is applied in the Middle Columbia River Steelhead ESU, with a majority in the spawning/rearing areas. This may affect the species of concern.

B. Chinook salmon

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

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

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

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

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

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

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

Table D-6: California counties supporting the Sacramento River, winter-run chinook ESU.

A significant amount (106,168 lbs a.i.) of trifluralin is applied in the Sacramento River, winter-run Chinook Salmon ESU. The northern location of this ESU suggests that the heaviest applications will be in the spring, however the potential long half life of this chemical suggests it may affect, but is unlikely to adversely affect, the species of concern.

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 the 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. Custer and Lemhi counties in Idaho are not listed as part of the fall-run ESU, although they are included for the spring/summer-run ESU. Because only high elevation forested areas of Baker and Umatilla counties in Oregon are in the spawning and rearing areas for this fall-run chinook, they were excluded them from consideration because trifluralin would not be used in these areas.

Table E-6 : Spawning/rearing areas supporting the Snake River Fall-run chinook salmon ESU.

98,178 lbs a.i is applied in the migratory pathways and an additional 318,659 lbs in the spawning and rearing areas of the Snake River fall-run Chinook salmon ESU. This may affect the endangered Chinook salmon population.

3. Snake River Spring/Summer-run Chinook Salmon

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

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

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

Table E-7: Spawning/rearing area supporting the Snake River spring/summer chinook ESU.

A total of 313,598 lbs a.i. of trifluralin is applied in the Snake River spring/summer run Chinook salmon ESU. This significant amount of chemical may affect the endangered salmon species present.

4. Central Valley Spring-run Chinook Salmon ESU

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

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

Table D-7: California counties supporting the Central Valley spring-run chinook salmon ESU.

A significant amount of trifluralin is applied in the Central Valley spring-run Chinook salmon ESU. Because of the quantity of chemical applied and the likely timing of use, trifluralin may affect the endangered salmon populations.

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 trifluralin 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 trifluralin would not be used in the forested upper elevation areas.

Table D-8: California counties supporting the California coastal chinook salmon ESU.

There is minimal application of trifluralin in the California Coastal Chinook Salmon ESU and it will have no effect on the species of concern.

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 E-8: Washington counties where the Puget Sound chinook salmon ESU is located.

A total of 11,203 lbs a.i. is applied in the Puget Sound Chinook salmon ESU. In consideration of the significant total circulation and extensive watershed, this will not affect the endangered salmon present.

7. Lower Columbia River Chinook Salmon ESU

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

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

Table E-9: Oregon and Washington counties where the Lower Columbia River chinook salmon ESU occurs.

Moderate amounts of trifluralin are applied in the Lower Columbia River Chinook Salmon ESU. The frequently large water flow rates indicate that while the chemical use may affect the ESU, it is not likely to adversely affect the species of concern.

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

Table E-11: Spawning/Rearing areas for the Upper Willamette River chinook ESU and Migration corridors of the Upper Willamette River chinook salmon ESU.

121,107 lbs a.i. are applied in the Upper Willamette Chinook salmon ESU. This significant application may affect the endangered Chinook salmon population.

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, with the lower river reaches being migratory corridors.

Most trifluralin usage occurs upstream from the confluence of the Snake River with the Columbia River, but not as far north as Chelan, and Okanogan counties, where there is limited acreage of potato, the only crop for trifluralin. However, a modest amount is used on potato below that confluence in counties on either side of the Columbia River, but all upstream of the John Day Dam.

Table E-12: Counties Supporting the Upper Columbia Chinook ESU Spawning/Rearing Area and **Migration corridors for the Upper Columbia River Chinook salmon ESU**.

Significant quantities of trifluralin a.i. are applied in the Upper Columbia River Chinook salmon ESU. This may affect the species of concern.

C. Coho Salmon

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

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

After spawning in late fall and early winter, eggs incubate in redds for 1.5 to 4 months, depending upon the temperature, before hatching as alevins. Following yolk sac absorption, alevins emerge and begin actively feeding as fry. Juveniles rear in fresh water for up to 15 months, then migrate to the ocean as ‘‘smolts’’ in the spring. Coho salmon typically spend two growing seasons in the ocean before returning to their natal stream. They are most frequently recovered from ocean waters in the vicinity of their spawning streams, with a minority being recovered at adjacent coastal areas, decreasing in number with distance from the natal streams.

However, those coho released from Puget Sound, Hood Canal, and the Strait of Juan de Fuca are caught at high levels in Puget Sound, an area not entered by coho salmon from other areas.

1. Central California Coast Coho Salmon ESU

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

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

Table D-9: California counties supporting the Central California coast Coho salmon ESU.

There is modest use of trifluralin in the Central California Coast Coho salmon ESU, and it will have no effect on the species.

2. Southern Oregon/Northern California Coast Coho Salmon ESU

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

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

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

Table E-10.: California Counties where the Southern Oregon/Northern California Coastal Coho Salmon ESU Occurs and **Oregon counties where there is habitat for the Southern Oregon/Northern California coastal coho salmon ESU.**

There is modest use of trifluralin in the Southern Oregon/Northern California Coastal Coho salmon ESU, and it will not affect the endangered populations of salmon.

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

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

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

Table E-13: Oregon counties where the Oregon coast coho salmon ESU occurs.

A total of 24, 370 lbs a.i. are applied in the Oregon Coast Coho salmon ESU. While this may affect the ESU, it is not likely to adversely affect the species of concern.

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 out migrate 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.

<u>1. Hood Canal Summer-run chum salmon ESU</u>

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 E-14: Washington counties where the Hood Canal summer-run chum salmon ESU Occurs.

A modest amount of trifluralin a.i. is applied in the Hood Canal summer-run Chum salmon ESU, and it will not affect the species of concern.

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 E-15: Oregon and Washington counties where the Columbia River chum salmon ESU occurs.

A modest amount of trifluralin is applied in the Columbia River Chum salmon ESU. In considering the large size of many waterways and high water flow rates, it will have no effect on the endangered Chum salmon population.

E. Sockeye Salmon

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

Growth is influenced by competition, food supply, water temperature, thermal stratification, and other factors, with lake residence time usually increasing the farther north a nursery lake is located. In Washington and British Columbia, lake residence is normally 1 or 2 years. Incubation, fry emergence, spawning, and adult lake entry often involve intricate patterns of adult and juvenile migration and orientation not seen in other *Oncorhynchus* species.

Upon emergence from the substrate, lake-type sockeye salmon juveniles move either downstream or upstream to rearing lakes, where the juveniles rear for 1 to 3 years prior to migrating to sea. Smolt migration typically occurs beginning in late April and extending through early July.

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

1. Ozette Lake Sockeye Salmon ESU

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

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

Table E-16: Clallum County where there is habitat for the Ozette Lake sockeye salmon ESU.

There is modest chemical application in the Ozette Lake Sockeye salmon ESU, and it will not affect the species of concern.

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 at high elevation, above the agriculture zone, and in protected areas of a National Wilderness area and National Forest. Trifluralin 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 trifluralin in the lower and larger river reaches during its juvenile or adult migration.

Table E-17: Idaho counties where there is spawning and rearing habitat for the Snake River sockeye salmon ESU and Oregon and Washington counties that are in the migratory corridors for the Snake River sockeye salmon ESU.

A total of 274,221 lbs a.i. of trifluralin is applied in the Snake River Sockeye Salmon ESU. This is a significant amount of chemical use and may affect the endangered species of concern.

5. Specific Conclusions for Pacific Salmon and Steelhead

Upon general review, it appears that the toxicity of trifluralin is sufficiently high to pose concern when present in high quantities. The Endangered Species Levels of Concern are exceeded for several registered crops for fish and, less frequently, for invertebrates. Aerial application appears to have more significant effects than ground application.

A major consideration in the conclusions listed below is the large quantity of chemical applied in several of the ESUs. Such significant use causes concern that trifluralin application in those ESUs may affect the endangered salmon and steelhead populations.

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, but Unlikely to Adversely Affect
Chinook Salmon	Puget Sound	No Effect
Chinook Salmon	California Coastal	No Effect
Chinook Salmon	Central Valley spring run	May Affect
Chinook Salmon	Sacramento River winter run	May Affect, but Unlikely to Adversely Affect

Coho Salmon	Oregon Coast	May Affect, but Unlikely to Adversely Affect
Coho Salmon	Southern Oregon/Northern California	No Effect
Coho Salmon	Central California	No Effect
Chum Salmon	Hood Canal summer run	No Effect
Chum Salmon	Columbia River	No Effect
Sockeye Salmon	Ozette Lake	No Effect
Sockeye Salmon	Snake River	May Affect
Steelhead	Snake River Basin	May Affect
Steelhead	Upper Columbia River	May Affect
Steelhead	Middle Columbia River	May Affect
Steelhead	Lower Columbia River	Mat Affect, but Unlikely to Adversely Affect
Steelhead	Upper Willamette River	May Affect
Steelhead	Northern California	No Effect
Steelhead	Central California Coast	No Effect
Steelhead	South-Central California Coast	No Effect
Steelhead	Southern California	No Effect
Steelhead	Central Valley California	May Affect

5. References

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.

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.

Gianessi LP and Marcelli MR, 2000. Pesticide use in US crop production: 1997. National Center fort Food and Agriculture Policy.

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

Hussain MA, Mohamad RB, Oloffs PC. 1985. Studies on the toxicity, metabolism, and anticholinesterase properties of methamidophos and methamidophos. J. Environ. Sci. Health, B20(1), p.129-147.

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

Juarez LM, Sanchez J. 1989. Toxicity of the organophosphous insecticide methamidophos to larvae of the freswater prawn, *Macobachium rosenbergii* and blue shrimp *Penaeus stylirostris*. bull. Environ. Cpontam. Toxicol. 43:302-309.

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.

Reimers PE, 1973. The length of residence of juvinile fall chinook salmon in the Sixes River, Oregon. Oregon Fish Comm., 4:2-43.

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.

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.

West Coast Chinook Salmon Biological Review Team, 1997. Review of the status of Chinook Salmon (*Oncorhynchus tshwawytscha*) from Washington, Oregon, California and Idaho under the US Endangered Species Act.

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

Attachment A
Reregistration Decision
Trifluralin

Attachment B
Sample Label
Trifluralin

Attachment C
Estimated National Use
Trifluralin

Attachment D
Trifluralin Use in California

Attachment E
Trifluralin Use in the Pacific Northwest

Attachment F
Washington State Department of Agriculture
Summary of Trifluralin Use