Bromacil and Lithium Bromacil:
Analysis of Risks
from Herbicide Use
to Ten Evolutionarily Significant Units of
Pacific Salmon and Steelhead

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Summary

Bromacil is an herbicide registered for use on citrus, pineapple, rights-of-way and other non-crop uses, where it is used to control a wide spectrum of woody and herbaceous vegetation. Lithium bromacil is very similar but is registered for use only on rights-of-way and other non-crop sites. This analysis involves a risk assessment of the use of bromacil and lithium bromacil for their various herbicidal uses and its potential effects on listed salmon and steelhead ESUs that occur in California, including the portion of Southern Oregon/Northern California Coastal Coho Salmon ESU that reaches into Oregon. I conclude that there will be no direct effect of bromacil or lithium bromacil on any ESU. There is a slight concern for indirect effects on aquatic vascular plants that may provide cover for listed salmon and steelhead. I conclude that the citrus use of bromacil in accordance with label directions will have no effect on nine ESUs and may affect, but is not likely to adversely affect, one ESU. I conclude that the rights-of-way use of bromacil and lithium bromacil in accordance with label directions will have no effect on five ESUs and may affect, but is not likely to adversely affect, five ESUs.

Introduction

This analysis was prepared by the U.S. Environmental Protection Agency (EPA) Office of Pesticides (OPP) to evaluate the risks of bromacil and lithium bromacil to the certain salmon and steelhead in California and southern Oregon. The effort to review bromacil and lithium bromacil for the ten "species" at this time is based upon a Consent Decree with a coalition headed by the Californians for Alternatives to Toxics. The Consent Decree names only the Central Valley California Steelhead and only the rights-of-way uses for "bromacil". Because there are a number of commonalities with other listed salmon and steelhead ESUs in California, the analysis also includes a review and request for consultation for the Southern California Steelhead ESU, the South Central California Steelhead ESU, the Central California Coast Steelhead ESU, the Northern California Steelhead ESU, the Sacramento River Winter-run Chinook Salmon ESU, the Central Valley Spring-run Chinook Salmon ESU, the California Coastal Chinook Salmon ESU, the Central California Coast Coho Salmon ESU, the southern Oregon/Northern California Coho

Salmon ESU. In addition, it is efficient to also consider the limited other uses, especially citrus, of bromacil to these ESUs at the same time.

The format of this analysis is similar to previous analyses, except that it covers only the Evolutionarily Significant Units of listed Pacific salmon and steelhead that occur in California and far southern Oregon. The background section explaining the risk assessment process is the same as was presented in a previous assessment for diazinon.

Problem Formulation - The purpose of this analysis is to determine whether the registration of bromacil and lithium bromacil for use on rights-of-way, citrus and other uses may affect the Southern Oregon/Northern California Coho Salmon, the Central California Coast Steelhead, the Central Valley Steelhead, the Southern California Steelhead ESU, the South Central California Steelhead ESU, the Central California Coast Steelhead ESU, the Sacramento River Winter-run Chinook Salmon ESU, the Central Valley Spring-run Chinook Salmon ESU, the California Coastal Chinook Salmon ESU, and the Central California Coast Coho Salmon ESU or that may adversely modify their designated critical habitat, particularly through possible effects on the food and cover for these ESUs.

Scope - This analysis is specific to the western salmon and steelhead named above and the watersheds in which they occur. It is acknowledged that bromacil and lithium bromacil use also may occur outside this geographic scope of these ten ESUs. Additional analyses will be developed to address other salmon and steelhead ESUs and may also be required to address other T&E species in the Pacific states as well as across the United States.

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1. Background

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

It is also important to note that pesticides used in urban areas can be expected to transport considerable distances if they should run off on to concrete or asphalt, such as with streets (e.g., TDK Environmental, 1991). This makes any quantitative analysis very difficult to address aquatic exposure from home use. It also indicates that a no-use or no-spray buffer approach for protection, which we consider quite viable for agricultural areas, may not be particularly useful for urban areas.

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

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

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

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

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

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

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

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

Table 2. Risk quotient criteria for fish and aquatic invertebrates

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

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

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

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

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

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

2. Description of bromacil and lithium bromacil

a. Chemical Overview

Common Name: Bromacil
Chemical Name: 5-bromo-3-*sec*-butyl-6-methyluracil
CAS Registry Number: 314-40-9
OPP Chemical Code: 012301
Empirical Formula: $C_9 H_{13} Br N_2 O_2$
Trade and Other Names: Hyvar® X; Krovar® I DF; Krovar® II DF
Basic Manufacturer: DuPont

Common Name: Bromacil, lithium salt
Chemical Name: 5-bromo-3-*sec*-butyl-6-methyluracil, lithium salt
CAS Registry Number: 53404-19-6
OPP Chemical Code: 012302
Empirical Formula: $C_9 H_{12} Br N_2 O_2 Li$
Trade and Other Names: Hyvar® L; Hyvar® X-L
Basic Manufacturer: DuPont

b. Registered uses

Bromacil is an herbicide registered for use on citrus, pineapple, rights-of-way and other non-crop areas. It is used to control a wide variety of annual and perennial weeds, brush, woody plants and vines. It appears to be particularly effective against perennial grasses.

There are two registered bromacil compounds. Bromacil (5-bromo-3-*sec*-butyl-6-methyluracil) is the major compound, but the lithium salt (5-bromo-3-*sec*-butyl-6-methyluracil, lithium salt) is also formulated into herbicide products. The lithium salt promotes solubilization. Only the former may be used on citrus and pineapple crops, in addition to the rights-of-way and non-crop uses; the latter is limited to the non-agricultural uses. Pineapple is not further considered because it is not grown in California.

There are currently 51 nationally registered products containing bromacil, but only 6 of the end-use products are allowed for use in California, and only 3 of these are registered for use on rights-of-way. Hyvar X herbicide is the primary bromacil product. There are 10 nationally registered products containing lithium bromacil. Two of these are registered for use in California, and both are allowed for use on rights-of-way. Hyvar X-L is the primary lithium bromacil product. Details on these products are in Table 3.

Table 3. Formulations of bromacil and lithium bromacil registered for use in California (source: California DPR*)

Product	type	formulation (a.i.)	use
Hyvar X Herbicide 352-287	wettable powder	bromacil 80%	citrus rights-of-way non-crop
Krovar I DF Herbicide 352-505	dry flowable	bromacil 40% diuron 40%	citrus rights-of-way non-crop
Ureabor 33560-47	pelleted	bromacil 1.5% sodium chlorate 30% sodium metaborate 66.5%	non-crop
Misty WK-44 liquid weed killer 10807-99	soluble concentrate	bromacil 1.22%	rights-of-way non-crop
V-1500 weed killer 920 10292-29	"ready-to-use" liquid	bromacil 0.90%	non-crop
Non-Selective herbicide #2 (Barren) 10088-68	"ready-to-use" liquid	bromacil 1.09% 2,4-D, ethylhexyl 0.98%	non-crop
Hyvar X-L Herbicide 352-346	dry flowable	lithium bromacil 21.9%	rights-of-way non-crop
Weed Out non-select weed killer 11474-24	"ready-to-use" liquid	lithium bromacil 1.22%	rights-of-way non-crop

* http://www.cdpr.ca.gov/docs/label/chemcode.htm

The Krovar I DF product with bromacil and diuron was included previously in the analysis of the potential effects of diuron on listed salmon and steelhead. Diuron is approximately 50 times more toxic to fish than bromacil. In addition, as discussed below, usage of bromacil in California is typically under 100,000 pounds ai/year whereas usage of diuron is typically over 1,000,000 pounds ai. In the diuron analysis, we concluded that there were concerns for diuron, both alone and also in the combined product, but not for the bromacil component. Considering the relative toxicity, risks, and usage of diuron and bromacil, we believe that it is most appropriate for the Service to evaluate the risks and develop any RPAs or RPMs, as necessary, for the Krovar product based upon the diuron and not the bromacil. Sections below do include usage information for bromacil that may include use of the Krovar product because the available usage data do not specify the products from which the usage information is obtained.

Because we have requested consultation for diuron products for all uses and all listed Pacific salmon and steelhead for the Washington Toxics Coalition litigation, and because the broader scope of that effort includes all of the various uses and ESUs specified in the consent decree with the Californians for Alternatives to Toxics, we are not requesting consultation on the Krovar I DF product in conjunction with this bromacil analysis.

c. Bromacil and lithium bromacil usage

The best available data on usage of the bromacils are for California, which requires full pesticide-use reporting by all outdoor applicators except homeowners, with a few other exceptions. Institutional and industrial applications that are not performed by a licensed pest control applicator are also not reported, nor is the use of chlorine for water treatment. The California Department of Pesticide Regulation provides the use information at the county level (www.cdpr.ca.gov/docs/pur/purmain.htm).

In California, total annual use of bromacil has varied between 55,000 lb ai and 117,000 lb ai from 1992 to 2001 (Table 4). Use of lithium bromacil has been considerably less at 3,000 lb ai to 17,000 lb ai. There is a clear downward trend in the total use of bromacil, which appears to be primarily associated with reductions in use on citrus. The trend is not evident in the rights-of-way and landscape maintenance uses, the two largest non-crop use of bromacil, nor is it evident for lithium bromacil. Table 5 provides data on the various grouped uses of bromacil and lithium bromacil over the last 3 years for which reports are available. Additional breakdowns by use in each of the counties where the 11 subject ESUs occur are presented in the discussions of the individual ESUs.

Table 4. Usage of bromacil and lithium bromacil in California, 1992-2001, in pounds a.i. for total use (all), citrus, rights-of-way (ROW), and landscape maintenance (LM) . (source: California DPR Pesticide Use Report)

use	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
bromacil										
all	112,160	117,848	192,406*	96,772	98,293	82,424	84,645	75,513	67,753	55,857
citrus	90,051	91,801	158,511*	72,635	69,714	60,126	61,038	52,896	43,453	33,774
ROW	18,886	21,831	28,553	18,175	22,597	18,560	16,328	15,849	18,419	16,408
LM	1,619	3,235	3,421	4,838	4,023	2,035	4,579	3,083	3,583	4,274
lithium bromacil										
all	4,837	7,045	11,065	6,517	17,381	9,141	4,686	4,162	4,478	3,217
ROW	4,790	6,965	10,082	6,517	17,380	9,134	4,547	4,090	4,444	3,214
LM	20	71	989	0	1	6	6	21	11	3

* There is a discrepancy between the 1994 report and the annual summaries from 1997 onward that provide summary data for certain pesticides for all reporting years. These more recent summaries indicate that "probable" errors have been removed, and they indicate that the annual bromacil use for 1994 was 104,052 lb ai; but they do not break out the uses. The 1994 report indicated 103,128 lbs ai for lemon to treat 12,602 acres. This appears to be a decimal error, and if so, I would estimate the actual citrus use in 1994 at 65,696 lb ai.

Table 5. Uses of bromacil and lithium bromacil in California 1999-2001 (source: California DPR Pesticide Use Report)

Use site	1999	2000	2001
	lb ai applied	lb ai applied	lb ai applied
Citrus	52,897	43,143	32,774
Rights-of-way	15,849	18,419	16,408
Rights-of-way (Lithium salt)	4,090	4,444	3,214
Landscape maintenance	3,083	3,583	4,274
Landscape maintenance (Lithium salt)	21	11	3
Other non-crop sites[a]	2,599	1,451	1,224
Other crops[b]	66	88	197

[a] Includes structural pest control, ditch banks, vertebrate control, "uncultivated non-agriculture", animal premises, industrial site, water areas, rangeland, nursery crops, public health use, regulatory pest control
[b] Primarily "uncultivated agriculture" which is presumed to be fallow land

In southern Oregon, where the Southern Oregon/Northern California Coastal Coho Salmon ESU occurs in Curry, Josephine and Jackson counties, information on usage of bromacil and lithium bromacil is not available. Citrus is not grown in this area. It is not feasible to determine the extent of rights-of-way in those areas where it is possible that bromacil and lithium bromacil may be used. The bromacil RED indicates that 2-3% of rights-of-way are treated on a national basis.

d. Application sites and methods

Bromacil and lithium bromacil are applied by ground application only for all uses except aerial application is allowed on one military firing range. Fixed boom sprayers are typically used for broadcast treatment of perennial and annual weeds; for brush control, basal spot applications are made to the specific shrubs and trees to be controlled. In citrus groves, it is often applied only in bands between the tree rows. Bromacil needs to be watered in to the soil to be effective, and it is best applied to soil that is already damp. For rights-of-way use, which is not amenable to irrigation, and for unirrigated citrus applications, this generally means that bromacil and lithium bromacil would be applied during the rainy season in the winter.

e. Application rates

In California, applications may occur on citrus or on rights-of-way and other non-crop sites. Citrus applications are not to exceed 6.4 lb ai/A; this may be done in a single application or split between two applications in fall and spring. All of the non-crop uses, including rights-of-way, have a maximum label rate of 12 lb ai/A. The 2001 usage reporting data from California indicates that the citrus use does not average as high as 2 lb ai/A/yr for any county except San Diego, where the average rate is slightly over 4 lb ai/A.

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

a. Aquatic toxicity of bromacil and lithium bromacil

Although bromacil is a relatively old chemical, there is not a large body of aquatic toxicity data. The fairly low toxicity to fish and aquatic invertebrates has not triggered high concerns, even though the application rates have been quite high. The surprisingly moderate amount of old data on the aquatic toxicity of formulated products suggests that bromacil may have been once used, or at least considered, for use as an aquatic herbicide. However, currently available information in OPP data systems do not indicate that it has been registered for such uses.

(1) Acute toxicity to aquatic animals

Table 6 presents the acute toxicity data for aquatic animals that were used in the RED. These data indicate that bromacil is slightly toxic to practically non-toxic to various fish species, and practically non-toxic to aquatic invertebrates. The lowest fish LC50 is 36 ppm for bluegill. All data were considered core and acceptable to support reregistration.

Table 6. Acute toxicity of technical bromacil to aquatic organisms (from RED).

Species	Scientific name	% a.i.	96-hour LC50 (ppm)	Toxicity Category
Freshwater fish				
Bluegill sunfish	*Lepomis macrochirus*	95%	127	practically non-toxic
Rainbow trout	*Oncorhynchus mykiss*	96.6%	36	slightly toxic
Freshwater invertebrates				
Water flea	*Daphnia magna*	96.6%	121	practically non-toxic
Estuarine Fish				
Sheepshead minnow	*Cyprinodon variegatus*	95.1%	162	practically non-toxic
Estuarine invertebrates				
Eastern oyster -embryo-larvae	*Crassostrea virginica*	95.1%	130	practically non-toxic
Mysid shrimp	*Americamysis bahia*	95.1%	112.9	practically non-toxic

Additional data on formulations exist in EFED files. It should be noted that many of these data are very old. They were considered valid when reviewed, but I note that some of the products tested have changed. For example, the “Weed Broom” product tested contained ingredients that are not in the currently registered Weed Broom formulations. Even the major products that have the same percentage of active ingredient, such as “Hyvar X”, may have different inert ingredients than those tested in the 1960s and 1970s. However, the low to very low toxicity of both bromacil technical material in Table 6 above and all tested formulations in Tables 7 and 8 below indicates that neither the technical material nor formulations are of significant toxicological concern to fish and aquatic invertebrates. Data for bromacil are presented in Table 7 and for lithium bromacil in Table 8.

Table 7. Formulation toxicity data for bromacil (from EFED files)

Species	Scientific name	% a.i.	96-hour LC50 (ppm)	Toxicity Category	Formulation
Freshwater fish					
Bluegill sunfish	*Lepomis macrochirus*	80%	>32	slightly toxic	Hyvar X Weed Killer
Rainbow trout	*Oncorhynchus mykiss*	1.5% bromacil 30% sodium chlorate 66.5% sodium metaborate	>180	practically non-toxic	Weedgard G*
Bluegill sunfish	*Lepomis macrochirus*	1.5% bromacil 30% sodium chlorate 66.5% sodium metaborate	>180	practically non-toxic	Weedgard G*
Rainbow trout	*Oncorhynchus mykiss*	1.5% bromacil 30% sodium chlorate 66.5% sodium metaborate	>100	practically non-toxic	"New Improved Ureabor"
Bluegill sunfish	*Lepomis macrochirus*	1.5% bromacil 30% sodium chlorate 66.5% sodium metaborate	>180	practically non-toxic	"New Improved Ureabor"
Bluegill sunfish	*Lepomis macrochirus*	80%WP	>71	slightly toxic	Hyvar X Bromacil Weed Killer
Bluegill sunfish	*Lepomis macrochirus*	80% WP	71 (48 hr)	practically non-toxic	Hyvar X Bromacil Weed Killer
Bluegill sunfish	*Lepomis macrochirus*	80% WP	75 (48 hr)	practically non-toxic	Hyvar X Bromacil Weed Killer
Rainbow trout	*Oncorhynchus mykiss*	80% WP	>100	practically non-toxic	Hyvar X Bromacil Weed Killer

* no longer registered or no longer registered with these ingredients

Table 8. Formulation data for lithium bromacil (from EFED files)

Species	Scientific name	% a.i.	96-hour LC50 (ppm)	Toxicity Category	Formulation
Freshwater fish					
Bluegill sunfish	*Lepomis macrochirus*	31.7%	>100	practically non-toxic	Hyvar X-L Weed Killer
Bluegill sunfish	*Lepomis macrochirus*	27.75%	>100	practically non-toxic	Chapman Weed Free LB*
Bluegill sunfish	*Lepomis macrochirus*	0.47% lithium bromacil 0.8% disodium methanearsonate 0.39% sodium 2,4-D	approx 700 ppm (EEB calculated at 661 ppm)	practically non-toxic	Weed Broom*
Rainbow trout	*Oncorhynchus mykiss*	same as above	approx 700 ppm	practically non-toxic	Weed Broom*

* no longer registered or no longer registered with these ingredients

(2) Chronic toxicity to freshwater fish and invertebrates

There are no chronic toxicity data in EFED files for bromacil or lithium bromacil and aquatic organisms. Call, et al (1987) conducted tests on fathead minnow where eggs, fry, and juveniles were continuously exposed for 64 days. The results indicate a significant effect on mean weight and length at the lowest test concentration of 1 ppm ($p < 0.01$). Effects were not significant on length at 1.9 ppm ($p < 0.05$), and were significant on weight at $p < 0.05$ at 1.9 ppm, whereas the latter was significant at 1.0 ppm at $p < 0.01$. Effects on both parameters were more pronounced at test concentrations of 4.4 ppm and higher. Although a no-observed-effect-concentration (NOEC) was not established, the p values and percentage of effects at the concentrations tested suggest that a NOEC would not be much below 1 ppm. There were no significant effects, relative to controls, on percent hatched, percent dead or abnormal, and number of 60-day survivors post hatch, even at concentrations up to 29 ppm.

No information could be found that addresses the chronic toxicity of bromacil or lithium bromacil to aquatic invertebrates.

(3) Toxicity to aquatic plants and algae

Required aquatic vascular plant and algae data for bromacil are presented in Table 9. Only the *Selanastrum* study was reported in the RED. Additional algae studies have been submitted and validated. The aquatic vascular plant study on *Lemna gibba* has not yet been validated by EFED, but an initial review suggests that it is a sound study. No data were found for lithium bromacil.

Table 9. Acute toxicity of bromacil to aquatic plants and algae (from EFED files).

Species	Scientific name	% a.i.	5-d EC50 (ppb)	Guideline[a]
Blue-green alga	*Anabaena flos-aquae*	97%	69.9 (54.2-90.1)	not in RED - core (recent)
Marine diatom	*Skeletonema costatum*	97%	12.1(8.3-17.6)	not in RED - core (recent)
Green algae	*Selanastrum capicornutum*	96.5%	6.8 (5.9-7.8)	core in RED
Duckweed	*Lemna gibba*	97%	45.1 (34-60)* (14-day)	just submitted not yet validated

* EC50 based upon frond count; EC50 for biomass was 47.5 ppb

(4) Field studies

We are unaware of any field studies on the biological effects of bromacil or lithium bromacil.

(5) Toxicity of degradates

Under aerobic conditions, carbon dioxide appears to be the major degradate. None of the other aerobic degradates occurred in sufficient quantity (i.e., >10%) to be considered "major." However, under anaerobic conditions, 3-sec-butyl-6-methyluracil was identified as a major degradate, comprising over 80% of the radiolabeled residues. There are no toxicity data available on any of the organic degradates.

(6) Toxicity of inerts

There are several "inert" ingredients in bromacil formulations. Testing on various formulated products indicates that they are all slightly to practically non-toxic to fish, which indicates that inert ingredients are not of toxicological concern.

b. Environmental fate and transport

Bromacil is a persistent compound, consistent with its use as an herbicide to prevent vegetation in rights-of-way and other non-crop sites, as well as between orchard rows. It is stable to hydrolysis and also to photolysis except in aqueous solutions under alkaline conditions. The photolysis half life at pH 9 was 4-7 days. It is fairly stable to aerobic field dissipation, but appears to be subject to more rapid degradation under anaerobic conditions. The available anaerobic degradation data indicated that only 1.3% of the parent bromacil remained after 93 days, but the study was inadequate to calculate a half life. The registrants calculation of a half life of 39 days was rejected by the Agency. Additional data have been required.

In water, lithium bromacil rapidly dissociates. As a result, aquatic concentrations can be determined for bromacil, but not for lithium bromacil, *per se.* I do not try to distinguish between bromacil and lithium bromacil throughout the remainder of this environmental fate section and most of the rest of the document, except in a few identified areas (e.g., incidents, California usage, conclusions).

Bromacil is considered a mobile compound based on laboratory studies, and it has been detected in groundwater. Field dissipation studies suggest that it is less mobile than indicated by the laboratory or groundwater data. It was not found below 40 cm in two such field studies, but that limited mobility may have been due to timing of precipitation or irrigation. Because of the numerous groundwater detections, which have been determined to result form normal agricultural use, the crop use of bromacil is classified as "restricted use" in California. There are limited data on groundwater detection from non-agricultural uses, but in California the non-crop uses are not permitted in areas determined to be sensitive to ground water contamination. The highest ground water detection reported in the RED for California was a well in Tulare county with 20 ppb detected. Ground water detections have been more prominent in Florida, where the weather and soils tend to favor movement of mobile chemicals to ground water.

The bioaccumulation potential is very low, with a bioaccumulation factor of 2.5x for whole fish.

c. Incidents

Four fish incidents are known where bromacil was involved; none are known for lithium bromacil. One involved illegal dumping into a drain and another was from a spill. Two were from actual applications. One of these was an illegal application to a stream bank where the bromacil and 2,4-D (not known whether it was an ester, salt or amine) went right into the stream. The 2,4-D esters are toxic to fish, but the amines and salts are of comparably low toxicity to bromacil. It is considered "probable" that the cause was bromacil, or 2,4-D, or the combination. There were no residue measurements that would further clarify the incident, but it was a misuse. The other application was of Krovar I DF, which contains 40% diuron and 40% bromacil, to an electrical substation site and was included in our request for consultation for diuron. Copper sulfate was also applied in the vicinity earlier. Residues in the water were 1 ppm for copper, 5.5 ppb for diuron, and 0.47 ppb for bromacil. The probable cause was most likely the copper. But if not copper, then diuron was most likely as it was found at 10x the bromacil and is approximately 50 times more toxic than bromacil.

d. Estimated and actual concentrations of bromacil in water

(1) EECs based upon application rates and methods

Discussion of rights-of-way scenarios

OPP classifies three specific kinds of rights-of-way: highway, railroad, and utility (including pipeline). It is important to note that there is no quantitative scenario that can be applied to rights-of-way to enhance an aquatic risk assessment. In the bromacil RED, an EEC for the rights-of-way use was based on GENEEC, with the typical farm pond model of a 10 Ha watershed draining into a 1 Ha pond. Even though this is obviously an inappropriate spatial model for a rights-of-way use, it does provide a comparative estimate that can be used to assess risks. It may be too conservative or not conservative enough depending upon the nature of the right-of-way.

Two basic scenarios for aquatic risk assessment can be identified for rights-of-way. The first is where a rights-of-way crosses a water body, typically a stream or river. In such cases, there is very often a slope associated with the approach to the bridge crossing the stream. The length and slope of the approach determine the amount of a rights-of-way herbicide that could move down the approach and run into the water, and of course, the fate and transport characteristics of the particular herbicide are important.

To provide some perspective on the treated area for a stream-crossing right-of-way, one can assume, for example, an eight foot wide strip treated on both sides of a road would mean that one treated acre would be a strip approximately 0.5 miles long. In other words, if a road starts a downward slope 0.5 mile from a bridge, then there is a potential for the amount of herbicide on one treated acre to be available for runoff into the water. Obviously, if the treated strip is wider or narrower the amount of herbicide that is available for runoff is proportionately greater or smaller, respectively. If the right-of-way slopes down on both sides of the crossing, then the treated area is double. OPP considers that the typical pond scenario for estimated environmental concentrations does represent first order streams. But the pond scenario has a 10-acre treated area for the one acre pond (or 10 hectares for a 1-hectare pond). To mimic the pond scenario, and assuming that a right-of-way goes down hill on both sides of the crossing, it would require that the downhill slope be 2.5 miles long on each side of the crossing, or 5 miles long if the slope is on only one side of the crossing. Rights-of-way can vary hugely, but this scenario does seem plausible, in general, for a pesticide that is applied continuously along the right-of-way. Directed or spot treatments would result in considerably less pesticide applied.

A second type of right-of-way exposure would occur when a right-of-way follows a stream, such as through a narrow valley, rather than crossing the stream. This approach would apply to roads and railroads, but would be unlikely for utilities or pipelines except for very brief stretches. This initially appears to provide a much higher potential for stream exposure. But using the same kind of calculations as above would result in mimicking the farm pond model by treating a long stretch along the stream, 5 miles for the 8-foot wide treatment. The potential would be higher for runoff from applications to the stream side of the right-of-way, but would be lower from the away side of the right-of-way. But there would also be 5 miles of stream into which the runoff could flow, whereas on the crossing scenario above, almost all of the runoff would flow into a very small portion of the stream at the crossing.

The intent of the above discussion is to provide some perspective on rights-of-way uses. It must be reiterated that there is no model for such areas. Railroads, and many roads, are often well-bermed when they follow a stream. Whether a road is banked or crowned, and how a shoulder is constructed can make a significant difference in the manner that runoff occurs and the quantity that will run off. Slopes can be steep or shallow, long or short. And, of course, the climate and soils are very important, as well as the nature of the particular pesticide being used. Bromacil, for example, needs to be activated by moisture. Therefore, it is likely to be applied to such sites when rain is expected. Light to moderate rain can result in the bromacil being activated in place; heavy rain can cause runoff.

Calculated EECs

In the RED (table 25, page 53) EECs are presented for the uses and application rates registered at that time. The rights-of-way and other non-crop uses were modeled on the basis of application rates of 24 lb ai/A for liquid formulations and 32 lb ai/A for granular applications. Other application and fate parameters for the model were not clear in the RED, nor was information found in EFED files. Rates have been reduced and aerial application has been eliminated for rights-of-way and other non-crop uses. Consequently, we ran the newer GENEEC2 model using current label rates and methods[1]. For the current 12 lb ai/A maximum application rate and ground application methods (including "watering in" to the soil after application), the EEC was calculated as 675 ppb for spray applications. For granular applications the EEC was calculated at an almost identical 672 ppb.

The GENEEC2 model is used even though it represents a high runoff (10%) scenario based on southeastern United States because there is no PRZM-EXAMS model scenario that is available for rights-of-way uses. Consequently, the model significantly overestimates the likelihood of aquatic exposure for more arid areas such as most of California, but we have no basis to quantify the differences. The 675 ppb EEC is used for calculations of non-crop risk quotients.

The citrus EEC used for calculations of risk quotients is the 264 ppb value reported in the RED. This value is also based upon the conservative GENEEC model and is considered an overestimate for California even if the maximum rate of 6.4 lb ai/A/yr is applied. As noted above, the maximum rate is more than 3 times the average rate used in most California counties.

(2) Measured surface water residues in the environment

We checked the U. S. Geological Survey's "Data Warehouse" for bromacil monitoring data: http://infotrek.er.usgs.gov/servlet/page?_pageid=543&_dad=portal30&_schema=PORTAL30. There have been 6459 surface water samples analyzed for bromacil nationwide and 200 of these samples detected bromacil. The detection level is 0.035 ppb. Of the 200 detects, 13 were over 1 ppb. The highest was 5 ppb in Georgia. In California, 313 surface water samples were taken; bromacil was detected in 18, with 3 of these being over 1 ppb, all in Merced County. The highest was 1.9 ppb, and was most likely from a dormant orchard spray in citrus.

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[1] Environmental fate parameters used in the model include solubility=815 ppm, terrestrial metabolic field dissipation half-life=155 days, aquatic aerobic field dissipation half-life=275 days, stable to photolysis and hydrolysis, and default (high) mobility absent a K_d value.

In addition, California EPA's Department of Pesticide Regulation has monitored for bromacil in surface water in the San Joaquin River and Orestimba Creek in Merced County. In the 1997-98 winter season, there were 3 detects in 18 samples from Orestimba Creek and 3 detects in 30 samples in the San Joaquin River. The highest reported residue was 0.066 ppb. In the winter of 1998-99, there were 3 detects of 20 samples in Orestimba Creek, and 1 detect in 30 samples in the San Joaquin River. The highest residue was 0.89 ppb (DPR, 1999).

Braun and Hawkins (1991) sampled 14 sites, mostly citrus, in Tulare County for bromacil, diuron, and simazine in runoff water following rainfall, and 6 sites for runoff following irrigation. They sampled only the runoff water, not as might be diluted by receiving water. It appears that each site was sampled once, although for some sites, samples were split and analyzed in two different laboratories. Bromacil was found in 9 samples with rain runoff, with the highest amount being 47.2 ppb. Another sample had 46.6 ppb and the remainder ranged between 1.2 and 8.1 ppb. Where runoff resulted from irrigation two sites had residues of 0.6 and 4.7 ppb.

e. Recent changes in bromacil registrations

Since the ecological risk assessment was developed for the RED, there have been several changes that relate to potential aquatic exposure in salmon and steelhead areas. The ditch bank treatment no longer exists, and therefore none of the current labeled uses would result in direct application to water. Uses in recreation areas have been deleted. Maximum rates have been reduced from 32 lb ai/A for non-crop uses to 12 lb ai/A.

f. Existing protections

As noted above, bromacil use on crops has been classified by California for "restricted use" only by trained, certified applicators. California also does not permit non-crop uses at all in "Pesticide Management Zones" designated as ground water sensitive areas.

In California, the Department of Pesticide Regulation (DPR) in the California Environmental Protection Agency creates county bulletins which provide information to pesticide users on steps that would be appropriate for protecting endangered or threatened species. California's approach to pesticide regulation occurs largely through a system of County Agricultural Commissioners, and all agricultural and commercial applicators must get a permit for the use of any restricted use pesticide, such as is the case with bromacil in California. The California bulletins for protecting endangered species have been in use for about 5 years. Although they are currently "voluntary " in nature, the Agricultural Commissioners strongly promote their use by pesticide applicators. Bromacil is included in these bulletins with use limitations intended for the protection of endangered plants, but not for endangered animals.

OPP currently has proposed (67 *Federal Register* 231, 71549-71561, December 2, 2002) a final implementation program that includes labeling products to require pesticide applicators to follow provisions in county bulletins. The comment period has closed; comments are being evaluated; and a final *Federal Register* Notice is anticipated, most likely by the end of 2003, perhaps considerably earlier. If this notice becomes final as it was proposed, pesticide registrants will be required to put on their products label statements mandating that applicators follow the label and county bulletins, including those in California. These will be enforceable under FIFRA.

g. Water quality criteria

We are not aware of any water quality criteria for bromacil in the U. S. or elsewhere for the protection of aquatic organisms.

h. Discussion and general risk conclusions

Bromacil has low toxicity to fish and aquatic invertebrates. Tables 25-27 in the RED (pages 53-54) show that rates up to and including 16 lb ai/A do not exceed the criteria for direct acute effects on fish. The very high, former rates of 24-32 pounds ai/A for non-crop uses, along with the use of a high runoff EEC model based upon crops resulted in a concern for aquatic organisms expressed in RED. In addition, the ditch bank use and rice use were modeled appropriately as direct applications to water, but the former is no longer allowed anywhere and the latter is not allowed in California.

With the current rates and methods, the EEC has been calculated as 675 ppb for rights-of-way. Although this is considered to be a significant overestimate (see above discussions), we have no basis on which to quantitatively determine a more appropriate value. With an acute fish LC50 of 36 ppm, the resulting risk quotient (EEC/LC50) is 0.02, which is below the 0.05 concern level for direct acute effects. Therefore, there will be no effect from acute exposure of listed salmon and steelhead from bromacil at any current labeled application rate.

The chronic risk quotient for fish cannot be calculated because a complete NOEC was not established. However, based upon the discussion of the chronic toxicity data in section 3a(2) above and the exceedingly conservative EEC, it is my best professional judgement that there is no direct chronic risk of bromacil to fish.

The freshwater aquatic invertebrate LC50 is 121 ppm. Estuarine invertebrates are comparable. With less toxicity to aquatic invertebrates than to fish, there is no concern for potential effects on populations of aquatic invertebrates that may serve as a food source for listed salmon and steelhead.

The aquatic vascular plant toxicity data on the duckweed, *Lemna gibba*, has an EC50 of 41.5 ppb. Concerns for populations of aquatic vascular plants that may serve as cover for listed salmon and steelhead exist when the risk quotient exceeds 1. Based upon the EEC of 675 ppb, the risk quotient would be 16.3 for non-crop uses and 6.4 for crop uses, and therefore there is concern for this indirect effect. These values of 16.3 and 6.4 are excessively high due to the overestimate of the EEC. It is possible that the most appropriate EEC, such as would be based on a western climate and tier 2 PRZM-EXAMS models, if available, would be result in a risk quotient less than one; certainly the risk quotient would be well below 16.3. But there are inadequate data to reach such a conclusion, and therefore it is my professional judgement that criteria of concern are exceeded for indirect effects on cover, at least at the screening level. Back-calculating from the application rates and risk quotients, it can be seen that even at this conservative screening level, it would require an average application rate of 1 lb ai/A to exceed the criteria. I would note that while the number of acres treated is available from DPR for crop uses, it is rarely available for non-crop uses.

It is important to note, however, that the models are for pond scenarios where all of a small watershed is treated. Unlike direct effects, where even a fairly small amount of a pesticide exceeding criteria could be a concern if it were applied right next to a fish, the indirect effects are considered on a broader scale. When only a lower percentage of an area is treated, the potential effects are reduced. Also, unlike ponds, stream habitats also carry pesticide away and further diminish the potential for indirect effects. Finally, I note that the available surface water monitoring data in California found only 3 samples of 313 in the NAWQA program that exceeded 1 ppb, with a maximum of 1.9 ppb; DPR monitoring did not report over 1 ppb; and even in runoff water before dilution, the maximum bromacil residues found by Braun and Hawkins (1991) were only 46 ppb. While the criteria are theoretically exceeded based upon screening level models, it seems highly unlikely that actual exposures in California will be high enough to pose a true risk.

The findings for individual salmon and steelhead ESUs will be discussed in section 4 below, taking into account the usage information in addition to the theoretical risk information. Some perspective on the amount of bromacil usage at high application rates may be provided by looking at EEC pond scenario. Although the model now uses a 10-hectare watershed draining into a 1-hectare pond, a 10-acre watershed draining into a 1-acre pond provides the same ratios and can be matched with the English units that correspond to DPR use of pounds and acres. If a 10 acre watershed is treated with the maximum rate, then there would be 160 pounds of bromacil used in that area for a non-crop site and 64 pounds of bromacil used for a citrus site. Put slightly differently, if 16 pounds were used in the watershed, and if the high runoff occurred as predicted by the model, then the criteria for indirect effects on cover would be barely exceeded in a 1-acre pond.

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

(a) Steelhead

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

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

Depending on water temperature, steelhead eggs may incubate in redds (spawning beds) for 1.5 to 4 months before hatching as alevins. Following yolk sac absorption, alevins emerge as fry and begin actively feeding. Juveniles rear in fresh water from 1 to 4 years, then migrate to the ocean as “smolts.”

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

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

1. Southern California Steelhead ESU

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

Within San Diego County, the San Mateo Creek runs through Camp Pendleton Marine Base and into the Cleveland National Forest. While there are agricultural uses of pesticides in other parts of California within the range of this ESU, it would appear that there are no such uses in the vicinity of San Mateo Creek; it is possible that rights-of-way chemicals could be used. Within Los Angeles County, this steelhead occurs in Malibu Creek and possibly lower Topanga Creek; these could be subject to rights-of-way pesticide use and there is broader potential for steelhead to occur in rights-of-way areas in Ventura, Santa Barbara, and San Luis Obispo counties.

Usage of bromacil in counties where this ESU occurs is presented in Table 10.

Table 10. Use of bromacil in counties with the Southern California steelhead ESU.

County	Crop or other use site	Usage (pounds)	Acres treated
San Diego	Landscape Maintenance	234	NR
	Lemon	34	145
	Orange	59	145
	Rights of Way	60	NR
	Structural Pest Control	<1	NR
	Tangerine	29	20
Los Angeles	Landscape Maintenance	181	NR
	Rights of Way	2,229	NR
	Lithium Salt		
	Rights of Way	1,852	NR
Ventura	Avocado	32	20
	Landscape Maintenance	23	NR
	Lemon	2,993	2,052
	Orange	749	823
	Rights of Way	168	NR
San Luis Obispo	Landscape Maintenance	12	NR
	Lemon	320	230
	Orange	67	80
	Rights of Way	99	99
Santa Barbara	Landscape Maintenance	12	NR
	Lemon	877	540
	Rights of Way	77	NR

The total amount of bromacil used on rights-of-way in this ESU is 4485 lb ai, with over 90% of that occurring in Los Angeles county. The total amount used on citrus is 5128 lb ai to treat 4035 acres, with almost 75% occurring in Ventura County, where there was an average rate of 1.3 lb ai/A on citrus. The bulk of remaining use (17%) is in Santa Barbara County where the average application rate was 1.6 lb ai/A

The only reported location for this steelhead in Los Angeles County in recent times is lower Topanga Creek, where it was thought that the observed fish had not been spawned there, due in part to habitat conditions of Topanga Creek. (65FR79328-79336, December 19, 2000). It seems rather unlikely that bromacil used on rights-of-way throughout Los Angeles would end up going down Topanga Creek in enough quantity to affect cover for the steelhead that may not even be there as young fish. Bromacil use on rights-of-way in the rest of this ESU is minimal.

In Ventura and Santa Barbara counties, Critical Habitat for this steelhead does appear to include areas where citrus is grown and may be treated with bromacil. Bromacil use on lemons and other citrus is 3742 lb ai in Ventura county and 877 lb ai in Santa Barbara County and is considerably less in other counties.

Based upon the conservative EEC model including 10% runoff, the pond scenario which is not representative of the more transient exposure in coastal streams within this ESU, the citrus application rates being considerably lower than modeled, along with the relatively low rights-of-way use over the total area in the ESU, I expect that there will be no effect, but I can only reach a conclusion that bromacil may affect, but is not likely to adversely affect, the southern California steelhead ESU. This conclusion applies both to the rights-of-way and citrus uses.

(2) South Central California Steelhead ESU

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

This ESU includes the hydrologic units of Pajaro (upstream barriers - Chesbro Reservoir, North Fork Pachero Reservoir), Estrella, Salinas (upstream barriers - Nacimiento Reservoir, Salinas Dam, San Antonio Reservoir), Central Coastal (upstream barriers - Lopez Dam, Whale Rock Reservoir), Alisal-Elkhorn Sloughs, and Carmel. Counties of occurrence include Santa Cruz, Santa Clara, San Benito, Monterey, and San Luis Obispo.

There is considerable agricultural use in most counties within this ESU. There is a potential for steelhead waters to drain agricultural areas. Reportable usage of bromacil in counties where this ESU occurs are presented in Table 11.

Table 11. Use of bromacil in counties with the South Central California steelhead ESU.

County	Crop or other use site	Usage (pounds)	Acres treated
Santa Cruz	Landscape Maintenance Rights of Way	2 18	NR NR
San Benito	Landscape Maintenance Rights of Way	24 14	NR NR
Monterey	Landscape Maintenance Lemon Rights of Way Uncultivated Non-ag	42 108 98 28	NR 70 NR 18
San Luis Obispo	Landscape Maintenance Lemon Orange Rights of Way	12 320 67 99	NR 230 80 99

Total bromacil use in this ESU was only 832 lb ai, with 495 lb being used on 380 acres of citrus at an average rate of 1.3 lb ai/A.

Based upon the conservative EEC model including 10% runoff, the pond scenario which is not representative of the more transient exposure in coastal streams within this ESU, the citrus application rates being considerably lower than modeled, along with the minimal rights-of-way use over the total area in the ESU, I conclude that there will be no effect of bromacil on the south-central California steelhead ESU.

(3) Central California Coast Steelhead ESU

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

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

Counties of occurrence for this ESU are Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Mendocino, Napa, Alameda, Contra Costa, Solano, and Santa Clara counties (Table 12).

Table 12. Use of bromacil in counties with the Central California Coast steelhead ESU.

County	Crop or other use site	Usage (pounds)	Acres treated
Santa Cruz	Landscape Maintenance Rights of Way	2 18	NR NR
San Mateo	None		
San Francisco	Landscape Maintenance Structural Pest Control	27 <1	NR NR
Marin	None		

County	Crop or other use site	Usage (pounds)	Acres treated
Sonoma	Landscape Maintenance	<1	NR
Mendocino	Landscape Maintenance	3	NR
Napa	Rights of Way	84	NR
Alameda	Landscape Maintenance	35	NR
	Rights of Way	436	NR
	Uncultivated Non-ag	30	30
	Lithium Salt		
	Rights of Way	3	NR
Contra Costa	Landscape Maintenance	1,317	NR
	Rights of Way	383	NR
	Uncultivated Non-ag	64	NR
	Lithium Salt		
	Rights of Way	3	NR
Solano	Landscape Maintenance	31	NR
	Rights of Way	122	NR
	Uncultivated Non-ag	8	5
	Lithium Salt		
	Rights of Way	57	NR
Santa Clara	None		

Total bromacil usage in the counties where this ESU has Critical Habitat is 2623 lb ai, all of which is used on rights-of-way and other non-crop sites. It is unclear what the large landscape management use in Contra Costa County was for. While OPP believes that the amounts reported for non-crop sites are accurate, there does appear to be considerable variability in the non-crop categories designated by those applicators making the reports. Landscape maintenance is quite often golf courses or commercial treatment of residential sites, but bromacil tends to be used where total vegetation control is desired, which does not fit those two kinds of sites. *Federal Register* Notices indicate that, while Critical Habitat may occur in Napa, Contra Costa, Alameda, Santa Clara, and Solano counties, the steelhead may be extirpated from tributaries to San Pablo and San Francisco Bays. Usage in the coastal counties where the steelhead does occur is only 50 lb ai.

Based upon the conservative EEC model including 10% runoff, the pond scenario which is not representative of the more transient exposure in coastal streams within this ESU, the lack of any citrus use within the ESU, the negligible use on rights-of-way in coastal counties, the likelihood that this steelhead may be extirpated from the inland counties where most of the bromacil use is within this ESU, along with the likelihood that any effects on cover in these inland areas would be ephemeral, I conclude that there will be no effect of bromacil on the central California coastal steelhead ESU.

(4) California Central Valley Steelhead ESU

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

This ESU includes populations ranging from Shasta, Trinity, and Whiskeytown areas, along with other Sacramento River tributaries in the North, down the Central Valley along the San Joaquin River to and including the Merced River in the South, and then into San Pablo and San Francisco Bays. Counties at least partly within this area are Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Glenn, Marin, Merced, Napa, Nevada, Placer, Sacramento, San Benito, San Francisco, San Joaquin, San Mateo, San Francisco, Santa Clara, Shasta, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tuloumne, Yolo, and Yuba.

A large proportion of this area is heavily agricultural, but there are also large amounts of urban and suburban areas. Usage of bromacil in counties where the California Central Valley steelhead ESU occurs is presented in Table 13.

Table 13. Use of bromacil in counties with the California Central Valley steelhead ESU.

County	Crop or other use site	Usage (pounds)	Acres treated
Alameda	Landscape Maintenance	35	NR
	Rights of Way	436	NR
	Uncultivated Non-ag	30	30
	Lithium Salt		
	Rights of Way	3	NR
Amador	Rights of Way	32	NR
Butte	Citrus	12	22
	Landscape Maintenance	5	NR
	Orange	60	92
	Rights of Way	29	NR
Calaveras	Rights of Way	7	NR
Colusa	Rights of Way	1,290	NR
Contra Costa	Landscape Maintenance	1,317	NR
	Rights of Way	383	NR
	Uncultivated Non-ag	64	NR
	Lithium Salt		
	Rights of Way	3	NR
Glenn	Orange	14	17
	Rights of Way	1,252	NR

County	Crop or other use site	Usage (pounds)	Acres treated
Marin	None		
Merced	Animal Premise Rights of Way	16 1,111	5 NR
Nevada	None		
Placer	None		
Sacramento	Landscape Maintenance Rights of Way Structural Pest Control	22 459 2	NR NR NR
San Joaquin	Animal Premise Landscape Maintenance Rights of Way Structural Pest Control Uncultivated Ag Uncultivated Non-ag **Lithium Salt** Rights of Way	24 96 549 29 105 76 31	14 NR NR NR 53 93 NR
San Francisco	Landscape Maintenance Structural Pest Control	27 <1	NR NR
San Mateo	None		
Shasta	Rights of Way	199	NR
Solano	Landscape Maintenance Rights of Way Uncultivated Non-ag **Lithium Salt** Rights of Way	31 122 8 57	NR NR 5 NR
Sonoma	Landscape Maintenance	<1	NR
Stanislaus	Citrus Landscape Maintenance N-outdr Plants in Containers Rights of Way Structural Pest Control **Lithium Salt** Rights of Way	233 197 12 1,856 30 12	284 NR 30 NR NR NR

County	Crop or other use site	Usage (pounds)	Acres treated
Sutter	Landscape Maintenance Pistachio Rights of Way	4 23 965	NR 22 NR
Tehama	Rights of Way	407	NR
Tuloumne	None		
Yolo	Landscape Maintenance Rights of Way	13 422	NR NR
Yuba	Rights of Way	30	NR

There was a total of 12,140 lb ai of bromacil used in 2001 within this ESU, most on rights-of-way (9655 lb ai) and other non-crop sites (2026 lb ai). Citrus and other agricultural use is minimal. Although the rights-of-way may have the appearance of being considerable, the total area within the ESU extends from Shasta County in the north to Merced County in the south. Only four counties have more than 1000 lb ai of use on rights-of-way, although Contra Costa County also has significant use that might be on rights-of-way even though not reported as such.

Based upon the conservative EEC model, including 10% runoff which is very unlikely in the arid Central Valley, along with the pond scenario which is not representative of the typical stream habitat of the steelhead, and the relatively low rights-of-way use over the total area in the ESU, I expect that there will be no effect, but I can only reach a conclusion that bromacil use on rights-of-way may affect, but is not likely to adversely affect, the California Central Valley steelhead ESU.

(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, Glenn, Lake, and Sonoma. Glenn and Lake counties are excluded from this particular analysis because the hydrologic units in these counties are entirely within the Mendocino National Forest, where there will be no bromacil usage. Table 14 shows the reported use of bromacil in these counties.

Table 14. Use of bromacil in counties with the Northern California steelhead ESU.

County	Crop or other use site	Usage (pounds)	Acres treated
Humboldt	Landscape Maintenance	24	NR

County	Crop or other use site	Usage (pounds)	Acres treated
Mendocino	Landscape Maintenance	3	NR
Trinity	None		
Lake	Landscape Maintenance	10	NR

There was only 37 lb ai of bromacil used within this ESU. Even if our assessment was not very conservative for nearly all parameters, there is essentially no probability that this amount of bromacil would result in a loss of cover that would affect this ESU. There is no effect of bromacil on the Northern California steelhead ESU.

(b) Chinook salmon

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

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

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

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

(1) Sacramento River Winter-run Chinook Salmon ESU

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

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

Table 15 shows the bromacil usage in California counties supporting the Sacramento River winter-run chinook salmon ESU.

Table 15. Use of bromacil in counties with the Sacramento River winter-run Chinook salmon ESU. Spawning areas are primarily in Shasta and Tehama counties above the Red Bluff diversion dam.

County	Crop or other use site	Usage (pounds)	Acres treated
Alameda	Landscape Maintenance	35	NR
	Rights of Way	436	NR
	Uncultivated Non-ag	30	30
	Lithium Salt		
	Rights of Way	3	NR
Amador	Rights of Way	32	NR
Butte	Citrus	12	22
	Landscape Maintenance	5	NR
	Orange	60	92
	Rights of Way	29	NR
Colusa	Rights of Way	1,290	NR
Contra Costa	Landscape Maintenance	1,317	NR
	Rights of Way	383	NR
	Uncultivated Non-ag	64	NR
	Lithium Salt		
	Rights of Way	3	NR

County	Crop or other use site	Usage (pounds)	Acres treated
Glenn	Orange Rights of Way	14 1,252	17 NR
Marin	None		
Sacramento	Landscape Maintenance Rights of Way Structural Pest Control	22 459 2	NR NR NR
San Joaquin	Animal Premise Landscape Maintenance Rights of Way Structural Pest Control Uncultivated Ag Uncultivated Non-ag **Lithium Salt** Rights of Way	24 96 549 29 105 76 31	14 NR NR NR 53 93 NR
San Francisco	Landscape Maintenance Structural Pest Control	27 <1	NR NR
San Mateo	None		
Shasta	Rights of Way	199	NR
Solano	Landscape Maintenance Rights of Way Uncultivated Non-ag **Lithium Salt** Rights of Way	31 122 8 57	NR NR 5 NR
Sonoma	Landscape Maintenance	<1	NR
Tehama	Rights of Way	407	NR
Yolo	Landscape Maintenance Rights of Way	13 422	NR NR

There was a total of 7,664 lb ai of bromacil used in 2001 within this ESU, most on rights-of-way (5774 lb ai) and other non-crop sites (1799 lb ai). Citrus and other agricultural use is negligible. Although the rights-of-way may have the appearance of being considerable, the total area within the ESU extends throughout the entire Sacramento River Valley. Only Glenn, Colusa, and possibly Contra Costa counties have more than 1000 lb ai of use on rights-of-way.

Based upon the conservative EEC model, including 10% runoff which is very unlikely in the Sacramento Valley, along with the pond scenario which is not representative of the Sacramento River, which is the primary habitat of this chinook, and the relatively low rights-of-way use over the total area in the ESU, most of which is probably away from the Sacramento River, I expect that there will be no effect, but I can only reach a conclusion that bromacil use on rights-of-way may affect, but is not likely to adversely affect, the Sacramento River Winter-run chinook salmon ESU.

(2) Central Valley Spring-run Chinook Salmon ESU

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

Hydrologic units and upstream barriers within this ESU are the Sacramento-Lower Cow-Lower Clear, Lower Cottonwood, Sacramento-Lower Thomes (upstream barrier - Black Butte Dam), Sacramento-Stone Corral, Lower Butte (upstream barrier - Centerville Dam), Lower Feather (upstream barrier - Oroville Dam), Lower Yuba, Lower Bear (upstream barrier – Camp Far West Dam), Lower Sacramento, Sacramento-Upper Clear (upstream barriers – Keswick Dam, Whiskeytown dam), Upper Elder-Upper Thomes, Upper Cow-Battle, Mill-Big Chico, Upper Butte, Upper Yuba (upstream barrier - Englebright Dam), Suisin Bay, San Pablo Bay, and San Francisco Bay. These areas are in the counties of Shasta, Tehama, Butte, Glenn, Colusa, Sutter, Yolo, Yuba, Placer, Sacramento, Solano, Nevada, Contra Costa, Napa, Alameda, Marin, Sonoma, San Mateo, San Francisco, and Santa Clara. However, Santa Clara and San Mateo counties are south of the Oakland Bay Bridge and are not included in the analysis.

Table 16 contains usage information for the California counties supporting the Central Valley spring-run chinook salmon ESU.

Table 16. Use of bromacil in counties with the Central Valley spring run chinook salmon ESU.

County	Crop or other use site	Usage (pounds)	Acres treated
Alameda	Landscape Maintenance	35	NR
	Rights of Way	436	NR
	Uncultivated Non-ag	30	30
	Lithium Salt		
	Rights of Way	3	NR
Butte	Citrus	12	22
	Landscape Maintenance	5	NR
	Orange	60	92
	Rights of Way	29	NR
Colusa	Rights of Way	1,290	NR

County	Crop or other use site	Usage (pounds)	Acres treated
Contra Costa	Landscape Maintenance	1,317	NR
	Rights of Way	383	NR
	Uncultivated Non-ag	64	NR
	Lithium Salt		
	Rights of Way	3	NR
Glenn	Orange	14	17
	Rights of Way	1,252	NR
Marin	None		
Napa	Rights of Way	84	NR
Nevada	None		
Placer	None		
Sacramento	Landscape Maintenance	22	NR
	Rights of Way	459	NR
	Structural Pest Control	2	NR
San Francisco	Landscape Maintenance	27	NR
	Structural Pest Control	<1	NR
San Mateo	None		
Shasta	Rights of Way	199	NR
Solano	Landscape Maintenance	31	NR
	Rights of Way	122	NR
	Uncultivated Non-ag	8	5
	Lithium Salt		
	Rights of Way	57	NR
Sonoma	Landscape Maintenance	<1	NR
Sutter	Landscape Maintenance	4	NR
	Pistachio	23	22
	Rights of Way	965	NR
Tehama	Rights of Way	407	NR
Yolo	Landscape Maintenance	13	NR
	Rights of Way	422	NR
Yuba	Rights of Way	30	NR

There was a total of 7,808 lb ai of bromacil used in 2001 within this ESU, most on rights-of-way (6141 lb ai) and other non-crop sites (1558 lb ai). Citrus and other agricultural use is negligible.

Although the rights-of-way may have the appearance of being considerable, the total area within the ESU includes the entire Sacramento River Valley and the Delta.   Only Glenn, Colusa, and possibly Contra Costa counties have more than 1000 lb ai of use on rights-of-way.

Based upon the conservative EEC model, including 10% runoff which is rather unlikely in the Sacramento Valley and Delta, along with the pond scenario which is not representative of the typical stream habitat of the chinook salmon, and the relatively low rights-of-way use over the total area in the ESU, it seems most likely that there would be no effect. However, there is a low potential that there could be a fairly brief effect on cover. I conclude that bromacil use on rights-of-way may affect, but is not likely to adversely affect, the Central Valley spring run chinook salmon ESU

(3) California Coastal Chinook Salmon ESU

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

The hydrologic units and upstream barriers are Mad-Redwood, Upper Eel (upstream barrier - Scott Dam), Middle Fort Eel, Lower Eel, South Fork Eel, Mattole, Big-Navarro-Garcia, Gualala-Salmon, Russian (upstream barriers - Coyote Dam; Warm Springs Dam), and Bodega Bay. Counties with agricultural areas where pesticides could be used are Humboldt, Trinity, Mendocino, Sonoma, and Marin. A small portion of Glenn County is also included in the Critical Habitat, but bromacil would not be used in the forested upper elevation areas. A small portion of Lake County contains habitat for this ESU, but is entirely within the Mendocino National Forest.

Table17 contains usage information for the California counties supporting the California coastal chinook salmon ESU.

Table 17. Use of bromacil in counties with the California coastal chinook salmon ESU.

County	Crop or other use site	Usage (pounds)	Acres treated
Humboldt	Landscape Maintenance	24	NR
Mendocino	Landscape Maintenance	3	NR
Sonoma	Landscape Maintenance	<1	NR
Marin	None		
Trinity	None		
Lake	Landscape Maintenance	10	NR

There were only 37 lb ai of bromacil used within this ESU in 2001.   Even if our assessment was not very conservative for nearly all parameters, there would still be essentially no probability that this amount of bromacil would result in a loss of cover that would affect this ESU. There is no effect of bromacil on the California coastal chinook salmon ESU.

(c) Coho Salmon

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

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

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

<u>(1) Central California Coast Coho Salmon ESU</u>

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. San Francisco County lies within the north-south boundaries of this ESU, but was not named in the Critical Habitat FR Notice, presumably because there are no coho salmon streams in the county; it is excluded.

Table 18 contains usage information for the California counties supporting the Central California coast coho salmon ESU.

Table 18. Use of bromacil in counties with the Central California Coast coho ESU.

County	Crop or other use site	Usage (pounds)	Acres treated
Santa Cruz	Landscape Maintenance Rights of Way	2 18	NR NR
San Mateo	None		
Marin	None		
Sonoma	Landscape Maintenance	<1	NR
Mendocino	Landscape Maintenance	3	NR
Napa	Rights of Way	84	NR

There were only 107 lb ai of bromacil used within this ESU, most of it in Napa County away from the coast. Even if our assessment was not very conservative for nearly all parameters, there is essentially no probability that this amount of bromacil would result in a loss of cover that would affect this ESU. There is no effect of bromacil on the Central California coast coho ESU.

(2) Southern Oregon/Northern California Coast Coho Salmon ESU

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

The Southern Oregon/Northern California Coast coho salmon ESU occurs between Punta Gorda, Humboldt County, California and Cape Blanco, Curry County, Oregon. Major basins with this salmon ESU are the Rogue, Klamath, Trinity, and Eel river basins, while the Elk River, Oregon, and the Smith and Mad Rivers, and Redwood Creek, California are smaller basins within the range. Hydrologic units and the upstream barriers are Mattole, South Fork Eel, Lower Eel, Middle Fork Eel, Upper Eel (upstream barrier - Scott Dam-Lake Pillsbury), Mad-Redwood, Smith, South Fork Trinity, Trinity (upstream barrier - Lewiston Dam-Lewiston Reservoir), Salmon, Lower Klamath, Scott, Shasta (upstream barrier - Dwinnell Dam-Dwinnell Reservoir), Upper Klamath (upstream barrier - Irongate Dam-Irongate Reservoir), Chetco, Illinois (upstream barrier - Selmac Dam-Lake Selmac), Lower Rogue, Applegate (upstream barrier – Applegate Dam-Applegate Reservoir), Middle Rogue (upstream barrier - Emigrant Lake Dam-Emigrant Lake), Upper Rogue (upstream barriers - Agate Lake Dam-Agate Lake; Fish Lake Dam-Fish Lake; Willow Lake Dam-Willow Lake; Lost Creek Dam-Lost Creek Reservoir), and Sixes. Related counties are Humboldt, Mendocino, Trinity, Glenn, Lake, Del Norte, and Siskiyou in California and Curry, Jackson, Josephine, Klamath, and Douglas in Oregon. The habitat in Glenn and Lake Counties, CA is within the Mendocino National Forest, and that in Douglas County, OR is entirely within the Rogue River and Umpqua National Forests, where bromacil would not be used; therefore, Glenn, Lake, and Douglas Counties were excluded from this analysis.

Note: We previously included Klamath County, OR in this ESU, but have now omitted it because it appears to be entirely above various named upstream barriers. Again we will submit more details in a separate transmittal to NMFS.

The reportable bromacil usage in the California counties supporting the Southern Oregon/Northern California coastal coho salmon ESU is shown in Table 19. We cannot reliably estimate the bromacil usage in the southern Oregon part of this ESU, nor even provide the acres that could be treated since the agricultural census does not include non-crop acreage and there is no citrus.

Table 19. Use of bromacil in California counties with the Southern Oregon/Northern California coastal coho salmon ESU.

County	Crop or other use site	Usage (pounds)	Acres treated
Humboldt	Landscape Maintenance	24	NR
Mendocino	Landscape Maintenance	3	NR
Del Norte	None		
Siskiyou	None		
Trinity	None		
Lake	Landscape Maintenance	10	NR

There were only 37 lb ai of bromacil used within the California portion of this ESU. Even if our assessment was not very conservative for nearly all parameters, there is essentially no probability that this amount of bromacil would result in a loss of cover that would affect the California part of this ESU. We have considerable uncertainty as to bromacil use in southern Oregon, although we have no reason to think it would be much more than in northern California where it is negligible. While it is exceedingly likely that there would be no effect, especially considering the conservative approach used in our analysis, uncertainty leads me to conclude that bromacil may affect, but is not likely to adversely affect, the Southern Oregon/Northern California coastal coho salmon ESU.

5. Specific conclusions for Pacific salmon and steelhead included in this analysis

1. Based upon the risk assessment models used in the RED, the deletion of any uses that could be considered direct application to water according to the label, and the reduced application rates since the RED was issued, there is no direct effect of bromacil on any salmon or steelhead ESU, nor on their aquatic invertebrate food supply even under the most conservative possible scenario.

2. There is very low use of bromacil in many ESUs. Even though the conservative screening criteria suggest an effect on aquatic vascular plants, there is insufficient bromacil used to warrant

any concern at all for the South Central California Steelhead ESU, the Central California Coast steelhead ESU, the Northern California Steelhead ESU, the California Coastal Chinook Salmon ESU, and the Central California Coast coho ESU.

3. There is negligible use of bromacil in California, but an uncertain amount of use in southern Oregon. Although an effect seems exceedingly unlikely, based upon uncertainty the use of bromacil may affect, but is not likely to adversely affect, aquatic cover of Southern Oregon/Northern California Coastal Coho Salmon ESU.

4. There is a moderate amount of use, although not heavily concentrated in any one area as best as can be determined, in the ESUs for the Southern California Steelhead ESU, the California Central Valley Steelhead ESU. the Sacramento River Winter-run Chinook Salmon ESU, and the California Central Valley Spring-run Chinook Salmon ESU. Although I consider the potential to be very low, the use of bromacil on rights-of-way within these ESUs may affect, but is not likely to adversely affect the aquatic cover of these ESUs. In addition, there is a similarly low potential for the citrus use of bromacil to be of concern to aquatic plant cover in Ventura and Santa Barbara counties, and I conclude that bromacil use on citrus may affect, but is not likely to adversely affect, aquatic plant cover of the Southern California Steelhead ESU.

Table 20. Summary conclusions on specific ESUs of salmon and steelhead for bromacil.

Species	ESU	rights-of-way finding	citrus finding
Chinook Salmon	California Coastal	No effect	No effect
Chinook Salmon	Central Valley spring-run	May affect, but is not likely to adversely affect	No effect
Chinook Salmon	Sacramento River winter-run	May affect, but is not likely to adversely affect	No effect
Coho salmon	Southern Oregon/Northern California Coast	May affect, but is not likely to adversely affect	No effect
Coho salmon	Central California	No effect	No effect
Steelhead	Northern California	No effect	No effect
Steelhead	Central California Coast	No effect	No effect
Steelhead	South-Central California	No effect	No effect
Steelhead	Southern California	May affect, but is not likely to adversely affect	May affect, but is not likely to adversely affect

Steelhead	Central Valley, California	May affect, but is not likely to adversely affect	No effect

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