Bensulide
Analysis of Risks
to
Endangered and Threatened Salmon and Steelhead

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Summary

Bensulide is a pre-emergent herbicide used in agriculture on a variety of fruit and vegetable crops. It is also used on home lawns, and golf courses, but only on greens and tees in western states. Bensulide exhibits modest toxicity to fish, but relatively high application rates, and especially on the various types of turf can result in exposure that could be of concern. An endangered species risk assessment is developed for federally listed Pacific salmon and steelhead. This assessment applies the findings of the Environmental Risk Assessment developed for non-target fish and wildlife as part of the reregistration process to determine the potential risks to the 26 listed Evolutionarily Significant Units of Pacific salmon and steelhead. The use of bensulide may affect 17 of these ESUs, may affect but is not likely to adversely affect 2 ESUs, and will have no effect on 7 ESUs.

Introduction

Problem Formulation - The purpose of this analysis is to determine whether the registration of bensulide as an herbicide for use on various crops and noncrop areas may affect threatened and endangered (T&E or listed) Pacific anadromous salmon and steelhead and their designated critical habitat.

Scope - Although this analysis is specific to listed western salmon and steelhead and the watersheds in which they occur, it is acknowledged that bensulide is registered for uses that may occur outside this geographic scope and that additional analyses may be required to address other T&E species in the Pacific states as well as across the United States. I understand that any subsequent analyses, requests for consultation and resulting Biological Opinions may necessitate that Biological Opinions relative to this request be revisited, and could be modified.

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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. (Mayer, personal communication, 2002)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Table 2. Risk quotient criteria for fish and aquatic invertebrates

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

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

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

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

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

It would appear that the Scholz et al (2000) work contradicts the 6x hypothesis. 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 bensulide

Bensulide is an organophosphate herbicide used on a variety of weeds, first registered in 1964 for pre-emergence control of crabgrass and annual bluegrass in turf. In 1968 bensulide was registered for weed control in food crops. Use data from 1987 to 1996 indicate an average use in the United States of approximately 550,000 lbs a.i. per year.

Bensulide is used for preemergent control of annual grasses and broadleaf weeds in agricultural crops (60-65% of all use). Current registered use sites are: carrots (Texas only), fruiting vegetables, leafy vegetables (mostly head lettuce), dry bulb vegetables (onions), cucurbits (mostly melons), and cole crops (cauliflower, cabbage, broccoli, broccolini, broccoflower). It is also used on field grown herbaceous plants and field grown bulbs.

Non-agricultural uses of bensulide include outdoor homeowner use on lawns, application by professional lawn care operators to residential lawns, and use on golf course turf. Use on other turf (e.g., parks, recreation areas) or on residential ornamentals and ground covers is no longer allowed. Use on golf course fairways is permitted in some states, but in states with Pacific salmon and steelhead, golf course use of bensulide is permitted only on tees and putting greens. Use is allowed on field grown (commercial) ornamental herbaceous plants and bulbs, but not in residential areas. This latter is a very minor use.

Bensulide's mode of action is through the inhibition of cell division in the roots and shoots of plants. It is applied directly to the soil and has no foliar activity. Plants that have already emerged will not be affected. Bensulide must be incorporated into the soil by cultivation if applied at or before planting time or watered in through irrigation if applied after planting. It may be applied through irrigation systems in California, but not in Oregon, Washington, or Idaho. Aerial application is prohibited.

Formulations: Bensulide is sold in the United States primarily under the trade names Betasan® and Prefar®. There are two basic types of formulations: emulsifiable concentrates and granulars. In addition, for home and garden use, bensulide may be formulated with fertilizers.

Registrant: Gowan Company is the primary registrant for federal FIFRA section 3 registrations and the sole registrant for agricultural uses. Scott, PBI Gordon, Anderson, and Platte companies are additional registrants for golf course and home lawn uses. There are two FIFRA section 24c (Special Local Needs) registrations. Current representative section 3 and 24c labels are included in this package as Attachment 1. The 24c label for California does not add any uses or additional rates relative to ecological risks. The 24c label for onions in Washington does allow for a higher rate on onions than would be permitted under the section 3 (federal) label.

Methods of Application: Bensulide is only by ground application, through groundboom, tractor-drawn spreaders, in irrigation water, and by homeowner push-spreader and hand-held equipment. It must be soil incorporated or "watered-in" to get below the soil surface.

Use Rates: Bensulide for use on agricultural crops has a maximum use rate of 6 lb ai/A per year, except that 9 lb ai/A are allowed for use on onions in Washington. Although labels do not indicate alternatives, it is possible that this amount may be split into two applications, most likely in areas where a second crop could be grown; but it seems most likely that a single application would occur. The use rate for field grown (commercial) ornamentals is up to 9 lb ai/A. For both the agricultural and field grown ornamental uses, applications are made to bare ground prior to the emergence of the plants.

The rate for lawns and golf courses is 12.5 lb ai/A, and a second application at the same rate is permitted at the same rate 4-5 months after the first application for a total annual maximum of 25 lb ai/A. The second application is likely only in areas warm enough to have annual grasses or crabgrass germinate again late in the year.

Annual Poundage: According to the Interim Reregistration Eligibility Decision (IRED) (Attachment 2) issued in 2000, approximately 550,000 pounds of bensulide active ingredient are applied annually. This information is based upon use through 1996. I note that in California, about 94,000 pounds ai were used in 1996, but I further note that this has increased in more recent years (Table 3). The reported acreage treated in California (e.g., 72,886 acres in 2000) consistently indicates an average rate of approximately 3 lb ai/A, with about 1/3 used on broccoli, cabbage, and other cole crops, 1/3 used on lettuce, and 1/3 used on other crops. Very little was used on golf courses or for commercial treatment of home lawns; California does not require reporting of use by homeowners. There are no other reliable, appropriate data for use by homeowners.

Table 3. Reported use of bensulide in California, 1992-2001, in pounds of active ingredient

1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
57,944	55,639	64,796	69,271	94,587	129,784	192,136	242,388	217,111	188,854

The largest amount of bensulide use in California was in counties not part of salmon and steelhead watersheds. Approximately half of the 1999-2001 bensulide poundage in California was used in Imperial County. The inland southern counties from Fresno County south accounted for 144,804 pounds in 2000 and 122,515 pounds in 2001, or 67% and 65%, respectively, of the total California use.

Most of the bensulide use in the remainder of California was in coastal counties, with Monterey County having the highest amount, 42,106 pounds in 2000 and 37,402 pounds in 2001. Ventura, Santa Barbara, and San Benito counties all had more than 1000 pounds used in 2000 and 2001, while San Luis Obispo and Santa Clara counties had more than 1000 pounds used in 2001. Stanislaus County was the only Central Valley county with more than 1000 pounds of use, and this occurred in both 2000 and 2001. Nationally, agricultural food crops accounted for more than 95% of all bensulide use, other with use being approximately 2% each on nursery crops and for landscape maintenance, including golf courses.

In Oregon, Washington, and Idaho, information on the actual amount of bensulide used is rather limited. As a substitute for actual use data, OPP uses USDA's National Agricultural

Census information which indicates the acreage planted to particular crops. For ESUs in these three states, the actual 1997 county acreage planted to crops on which bensulide may be used is provided; if no acreage is indicated, this means that there were only 1-3 growers and USDA did not report acreage to protect privacy. In such cases, actual acreage is likely to be small, but I cannot be certain. The Qualitative Usage Analysis (QUA) (Attachment 3) prepared for use with the bensulide IRED indicates that usage nationwide averaged 700,000 pounds per year from 1987-1996 (more recent data are unavailable). For the Pacific Northwest, the QUA only highlights sugar beets in Oregon with average annual use of 5,000 lb, "other crops" in Oregon with average annual use of 1000 lb, and onions in Idaho and Oregon with average annual use for Idaho, Texas and Oregon of 99,000 lb.

More recent usage data than 1996 are not available for Oregon, Washington, or Idaho.

With some hesitation, I have attached a map of pesticide use for bensulide as developed by the USGS. (Attachment 4) This is included as a quick and easy visual depiction of where bensulide may have been used on agricultural crops, but it should not be used for any quantitative analysis because it is based on 1992 crop acreage data and was developed from 1990-1995 statewide estimates of use that were then applied to that county acreage without consideration of local practices and usage.

a. Aquatic toxicity of bensulide

The acute toxicity data for freshwater organisms (Table 4) indicate that bensulide is moderately to highly toxic. The single test on the formulated product shows an LC50 approximately one-half that of the tests with the technical material having approximately twice the percentage of active ingredient. Given that typical intralaboratory variation in acute toxicity test results is two-fold, the comparison indicates that ingredients other than active ones, provide no addition to the toxicity of the active ingredient. There are no aquatic toxicity data on the granular formulations, but most granular formulations contain primarily clay or other similarly non-toxic materials as inert ingredients. The test on the channel catfish is not useful for risk assessment purposes because the test material was not adequately identified. Therefore, the assessment of acute risk is based on the rainbow trout test with the LC50 of 720 ppb. Using the criterion of concern when the EEC exceeds 0.05 of the LC50, an EEC above 36 ppb would require further analysis for potential acute effects to listed Pacific salmon and steelhead..

With respect to indirect, acute effects on food supply, the aquatic invertebrate EC50 of 580 ppb is used, along with the criterion of concern for indirect effects when the EEC exceeds 0.5 of the EC/LC50. An EEC in excess of 290 ppb would be of concern for effects on food supply.

Waterflea	*Daphnia magna*	92.9	580 (48 hr EC50)	Highly toxic
Amphipod	*Gammarus fasciatus*	95	1400	Moderately toxic
Rainbow trout	*Oncorhynchus mykiss*	92.9	1100	Moderately toxic
Rainbow trout	*Oncorhynchus mykiss*	95	720	Highly toxic
Bluegill sunfish	*Lepomis macrochirus*	95	810	Highly toxic
Bluegill sunfish	*Lepomis macrochirus*	46[a]	1780	Moderately toxic
Channel catfish	*Ictalurus punctatus*	not rept	380	Highly toxic

a. Emulsifiable concentrate

Since the IRED was issued, the registrant has developed the required chronic/subchronic toxicity data for aquatic organisms on bensulide. These data indicate that aquatic invertebrates are considerably more sensitive to chronic exposure than are fish. (Table 5). If there is chronic exposure, then concerns would exist for chronic and reproductive direct effects on threatened and endangered fish, such as salmon and steelhead, when the chronic EEC exceeds the NOEC of 374 ppb.

Species	Scientific name	duration	% a. i.	Endpoints affected	NOEC (ppb)	
Waterflea	*Daphnia magna*	21 d	93.4	reproduction	<6.9	6.9
Waterflea	*Daphnia magna*	21 d	93.4	growth	<4.2	4.2
Waterflea	*Daphnia magna*	21 d	93.4	growth	4.2	10
Fathead minnow	*Pimephales promelas*	28 d	93.4	larval growth and survival	374	789

Estuarine fish and invertebrates exhibit acute toxicity similar to freshwater organisms (Table 6). The estuarine mysid shrimp is rather more sensitive than the freshwater *Daphnia*, but it is typical that mysid shrimp are an order of magnitude more sensitive than *Daphnia* for many pesticides.

Table 6. Aquatic organisms: acute toxicity of bensulide to estuarine fish and invertebrates.

Species	Scientific name	% a. i.	LC50/EC50	Toxicity Category
Sheepshead minnow	*Cyprinodon variegatus*	92	96-hr LC50=560 ppb	Highly toxic
Spot	*Leiostomus xanthurus*	95	96-hr LC50= 320 ppb	Highly toxic
Mysid shrimp	*Americamysis bahia*	92	96-hr EC50=62.4 ppb	Very highly toxic

Table 6. Aquatic organisms: acute toxicity of bensulide to estuarine fish and invertebrates.				
Brown shrimp	*Penaeus aztecus*	95	96-hr LC50>1000 ppb	not applicable
Eastern oyster	*Crassostrea virginica*	92	96-hr LC50=250 ppb	Highly toxic
Eastern oyster	*Crassostrea virginica*	92	96-hr LC50=450 ppb	Highly toxic

b. Environmental fate and transport

Although the environmental fate data base for bensulide is not complete, information from acceptable laboratory studies indicates bensulide is persistent. Neither abiotic hydrolysis nor photolysis are major degradation processes in water or on soil surfaces. The main route of dissipation of bensulide appears to be aerobic soil metabolism with a reported half-life of 1 year. Under aerobic conditions it appears that mineralization of bensulide to CO_2, and immobilization as unextractable residues are the major mechanisms of dissipation in the soil. Under anaerobic soil conditions bensulide did not degrade. Based on the lack of degradation under laboratory conditions, it is predicted that bensulide will be extremely persistent in anaerobic terrestrial ecosystems.

Bensulide has the potential to be transported dissolved in water and on suspended sediment in runoff to surface waters where, based on laboratory data, it is expected to persist. Bensulide has the persistence characteristics of chemicals found capable of leaching to ground water; however, based on other environmental fate characteristics (i.e., high sorption capacity) and supporting groundwater modeling, bensulide is not expected to leach to ground water. The degradates bensulide oxon (N-[(2-(diisopropoxyphosphinoylthio)-1-ethyl]- benzenesulfonamide) and benzenesulphonamide are mobile in various soils.

While the data are not acceptable because of insufficient reporting of test parameters in 8 different studies, the field dissipation half-life of bensulide was reported to range from 8-34 days in studies conducted in California and from 91-210 days in studies conducted in Mississippi. In none of the studies was a consistent decline of parent compound observed. In another unacceptable but upgradeable field dissipation study, calculated first-order half-lives for bensulide in the top 6 inches of soil were 106.8 days (registrant-calculated) and 80.4 days (EPA reviewer-calculated). Bensulide and its degradate bensulide oxon were found only in the top 6 inches of the soil. These field dissipation data contrast with the laboratory data but do indicate qualitatively that bensulide will be persistent, although not to the extent indicated in the laboratory. In the upgradeable field study with the 106.8 day half-life, the deficiencies were in reporting ancillary data and not in the conduct of the study. While the study cannot fulfill data requirements, for the purposes of this analysis, it may be as good data on field persistence as are available.

Bensulide does not appear to have a large potential to bioaccumulate in fish with a reported whole body bioconcentration factor of 550X and a whole body elimination of 98% after

14 days depuration in clean water.

A more complete analysis of environmental fate and transport data is contained on pages 7-15 of the attached revised Environmental Risk Assessment.

c. Incidents

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

There are no reported incidents of bensulide involving terrestrial or aquatic animals. There are two incidents where non-target terrestrial plants were adversely affected. One of these incidents was reported in the Environmental Risk Assessment, while the other occurred subsequent to that time.

d. Estimated and actual concentrations of bensulide in water.

The attached revised Environmental Risk Assessment (Attachment 5) includes surface water modeling for estimated environmental concentrations (EECs). The inputs and results are presented and discussed on pages 19-24, and summarized below. There are two “tiers” of models (see background section above for more details). The first tier, based on the GENEEC program, is a screening tool. If concentrations predicted from the GENEEC screen warrant further investigation, then a more sophisticated PRZM-EXAMS model is used to estimate environmental concentrations. For bensulide, an addendum to the revised environmental risk assessment (Attachment 5) reanalyzes the turf use.

The GENEEC model for bensulide indicates that the peak surface water concentration following a single application at the maximum label rate of 6 lb ai/A for agricultural crops would be 36 ppb. The GENEEC model for one application of bensulide to golf courses at 12.5 lb ai/A resulted in an EEC of 42 ppb if applied as the granular formulation; applications to established turf are ‘watered in,’ not mechanically incorporated into the soil.

Normally, when there is a concern with the EECs identified in GENEEC model, a more sophisticated PRZM-EXAMS model is run to refine the EECs. For bensulide, tier 2 modeling was initially done, but after reconsideration (see Attachment 6: Addendum to the Bensulide RED: Revised Risk Assessment and Risk Characterization for Risk to Aquatic Organisms from Use on Turf, May 10, 2000) it was determined that PRZM-EXAMS models of that time did not appropriately represent turf uses and therefore, the tier 1 GENEEC EECs were used to characterize risk from turf uses. However, even this model is not applicable to bensulide use on golf courses in salmon and steelhead areas, because bensulide is now allowed only for use on tees and greens in states with Pacific anadromous salmonids. On page 12 of Attachment 6, it is stated, "...greens and tees represent relatively small and widely dispersed treatment areas. Therefore, treatment of only greens and tees would be expected to produce aquatic residues much less than those predicted by this model. Furthermore, the untreated areas that surround the greens will serve as a buffer zone, reducing the amount of bensulide that will reach the surface water. Use on greens and tees only therefore is not expected to result in significant risk to fish or aquatic invertebrates." EFED considers that tees and greens represent 4% of the treatable area of a golf course. Thus, the EECs for golf course use in the Pacific states would only be 4% of those indicated in the revised environmental risk assessment.

Finally, the revised environmental risk assessment used an application rate of 3 lb ai/A for onions and garlic. This may be common practice, but current labels allow up to 6 lb ai/A to be used and up to 9 lb ai/A in Washington. Thus, my depiction of GENEEC EECs for onion and garlic doubles those used in the revised environmental risk assessment, making them equivalent to the other vegetable crops.

Table 7. Adjusted EECs and risk quotients for bensulide uses based on GENEEC models and modifications as described in above text. Acute risk quotients are based on the rainbow trout LC50 of 720 ppb and chronic risk quotients are based upon the fathead minnow NOEC of 374 ppb.

use site	method	max rate (lb ai/A)	num ber	initial peak EEC (ppb)	acute risk quotient	21-day average EEC (ppb)	chronic risk quotient
vegetables (onions, cole crops, cucurbits)	ground spray (watered in) or chemigation	6	1	36	0.05	24	0.064
	incorporated ground spray	6	1	19	0.026	13	0.035
onions (Washington only)	ground spray (watered in) or chemigation	9	1	54	0.075	36	0.096
	incorporated ground spray	9	1	28	0.039	17	0.047
vegetables (onions, cole crops, cucurbits)	banded, ground spray (watered in)	6	1	27	0.038	12	0.032

use site	method	max rate (lb ai/A)	num ber	initial peak EEC (ppb)	acute risk quotient	21-day average EEC (ppb)	chronic risk quotient
	banded, incorporated ground spray	6	1	15	0.021	6.5	0.017
onions (Washington only)	banded, ground spray (watered in)	9	1	40	0.051	18	0.043
	banded, incorporated ground spray	9	1	23	0.032	9.7	0.026
turf[a] - golf course greens and tees	unincorporated granular broadcast	12.5	2	180 x .04 = 7.2	0.01	98 x .04 = 3.9	0.01
	unincorporated ground spray	12.5	1	100 x .11 = 4	0.006	55 x .04 = 2.2	0.005
turf - golf courses including fairways to mimic home lawns[b]	unincorporated granular broadcast	12.5	2	180	0.25	98	0.26
	unincorporated ground spray	12.5	1	100	0.14	55	0.15

a. Turf use EECs are from the revised turf assessment (Attachment 6) and are further modified by adjusting for use only on tees and greens which are estimated to comprise a maximum of 4% of the treated fairways, tees, and greens.
b. Speculative scenario for home lawns; *see discussion in background section above.*

The registrant has provided comments to OPP indicating that the modeled EECs are too high because of the requirement for soil incorporation or “watering-in”. The ecological risk assessment did consider both of these factors and I have, therefore, made no further adjustments.

It should be noted that while they are useful for comparative purposes, neither of the GENEEC or PRZM-EXAMS models is appropriate for a pesticide such as bensulide in considering the risks to salmon and steelhead. The primary difficulty relates to the use of the 10 hectare pond with no outflow as the receiving water and the long persistence of bensulide. Repeated use of bensulide over a number of years would result in an accumulation in a pond with no outflow, and the PRZM-EXAMS model using a high rainfall year could include many years of accumulation and yield unrealistically high EECs. In such circumstances, the GENEEC model is a more appropriate model for developing EECs. The GENEEC model is too conservative for moderate to large size streams, but is reasonably representative of first-order streams for single applications.

While the turf uses may not be adequately represented by the PRZM-EXAMS models, it is still appropriate as a second tier model for other use sites with a valid scenario. For bensulide, the crop scenario used in the revised Environmental Risk Assessment was for the Central Valley of California. The results of this model, along with the resulting risk quotients from comparisons with toxicity data, are presented in Table 8. I did not add the 50% higher application rate for Washington onions

Table 8. EECs and risk quotients for bensulide uses based on PRZM-EXAMS models. Acute risk quotients are based on the rainbow trout LC50 of 720 ppb and chronic risk quotients are based upon the fathead minnow NOEC of 374 ppb.

use site	method	max rate (lb ai/A)	num ber	initial peak EEC (ppb)	acute risk quotient	56-day average EEC (ppb)	chronic risk quotient
vegetables (onions, cole crops, cucurbits)	unincorporated ground spray	6	1	93	0.13	88	0.24
	incorporated ground spray	6	1	60	0.083	55	0.15
onions (Washington only)	unincorporated ground spray	9	1	140	0.19	132	0.35
	incorporated ground spray	9	1	90	0.125	83	0.22
vegetables (onions, cole crops, cucurbits)	banded, unincorporated ground spray	6	1	42	0.058	40	0.11
	banded, incorporated ground spray	6	1	30	0.042	28	0.075
onions (Washington only)	unincorporated ground spray	9	1	63	0.088	60	0.16
	incorporated ground spray	9	1	45	0.063	42	0.11

The endangered fish criterion (RQ> 0.05) for acute risks are exceeded for most agricultural uses of bensulide. Table 7 (turf) indicates that a “no effect” exists for use on golf courses since only greens and tees may be treated. But the agricultural crops exceed acute concern levels for all 6 lb ai/A applications except when banded and incorporated and for all 9 lb ai/A applications whether incorporated, banded, or not. The unincorporated banded sprays barely exceed our fish criteria; it may be that there are no concerns for fish in streams not adequately represented by the farm pond scenario. Even if the farm pond is representative of listed salmon and steelhead habitat, such as in first order streams, a reduction in the banded application rate to 5 lb ai/A would result in EECs below our level of concern. For the broadcast incorporated application, lowering the application rate to 3.5 lb ai/A would result in EECs below the level of concern. We cannot quantitate the reduction in bensulide residues that would occur in second order or larger streams, but qualitatively, reduction of bensulide residues would be expected to occur, relative to the farm pond/first order stream model because of both the water movement and the amount of water. Certainly if split applications were made, i.e., 3 lb ai/A twice and separated by time, the movement of the water would be expected to transport sufficient amounts of bensulide away that exposures of concern would be unlikely. Such split applications may not be appropriate or efficacious in some areas, especially where a single crop is grown in a year and the primary target plants (crabgrass and bluegrass) are likely to germinate only once in a year.

Tables 7 and 8 (both) indicate that a “no effect” exists for chronic risk to endangered fish, where the criterion is the RQ>1.

There are no standard models and no usage data that relate to use on lawns by homeowners. In such areas, bensulide would most likely be used for crabgrass control in the spring; because bensulide persists in the soil, applications may actually be made in the late fall or winter. I can speculate that some homeowners would not control crabgrass, others would not use herbicides, and others would use different herbicides, but I cannot quantify this. The lawn scenarios should resemble golf course scenarios (see discussion in background section above). Table 7 above indicates that if fairways of a golf course are treated in addition to tees and greens, the 180 ppb and 100 ppb EECs would exceed our levels of concern, if all of the lawns in an area were treated before the same runoff event. This is conceivable but unlikely. It is more likely that only 10 % of the homes in an area would use bensulide prior to a particular runoff event. In this latter case, the models suggest that 10% of the full treatment EECs (18 and 10 ppb) would be below our concern levels, and therefore would have no effect. I must reiterate the lack of exposure and usage data and state that we have exceedingly large uncertainty regarding home lawn use of bensulide. The uncertainties are so large that there are no technically valid scenarios or quantitative measures used by OPP for aquatic exposures from home lawns, even though this use cannot be ignored for listed aquatic species.

Although the amount of bensulide used for lawns in an area is unknown, I can back-calculate, from table 7, the amount of area to be treated that would relate to our criteria. Based on two applications per year, our concerns would be exceeded if more than 20% of the treatable area had applications of bensulide at the maximum rate. For one application, our criteria would be exceeded if bensulide was used on more than 36% of the treatable area. Again, it should be noted that this does not take into account that watering-in after applications will reduce runoff and it assumes that the farm pond model is appropriate. The former would be dependent upon soil type, with more runoff from clay soils, and the amount of water used by the homeowner after application. The latter seems rather unlikely in urban areas since most cities, perhaps excepting Seattle, are not on first order streams, but rather on larger bodies of water that would provide for more dilution. I must also note again that proximity to a stream is only marginally relevant in urban areas because material can transport across asphalt and concrete surfaces from considerable distances after it leaves a lawn. This may also be a factor in more populated suburban areas, but is probably not particularly relevant in more rural residential areas. Rural residential areas also would have a much smaller proportion of unpaved land in lawns that could be treated with bensulide.

It does not appear the bensulide was a pesticide for which the National Water Quality Assessment monitoring program analyzed. I could find no USGS reports indicating either positive or negative results. Thus, actual, measured concentrations in water are unknown.

Indirect effects

The risks of bensulide exceed levels of concern for threatened or endangered aquatic plants, based upon toxicity data for the duckweed, *Lemna gibba* and the 10 hectare farm pond model. This is based upon the *Lemna* no-observed-effect-level of 17 ppb and the EECs for various uses and rates, as identified in addendum 1 of the revised bensulide ecological risk assessment. This criterion is intended to be protective of individual *Lemna*. It is not necessary to protect individual Lemna plants as potential cover for T&E fish; rather, protection of populations of species with respect to indirect effects is appropriate. The risks of bensulide do not exceed the levels of concern for populations of *Lemna*, based upon our criterion of one-half the median EC50 of 140 ppb value for the species and the EECs that would result after the deletion of western golf course fairways from registered use. In addition, bensulide is active only at the root tips and does not have activity on plants that have already emerged. There would be no effect on rooted aquatic vegetation. Therefore, there would be no effect on salmon and steelhead as a result of effects on aquatic plants.

The risks of bensulide exceed levels of concern for threatened or endangered aquatic invertebrates, based upon the *Daphnia magna* EC50 of 580 ppb and the 10 hectare farm pond model. Applying the standard uncertainty/safety factor would mean that environmental concentrations above 29 ppb would be a concern for T&E aquatic arthropods. This criterion is intended to be protective of individual organisms. It is not necessary to protect individual organisms that may serve as food for T&E species; rather protection of populations of these food sources is appropriate. For aquatic arthropods, our criterion for protecting populations that may serve as a food source for endangered species is ½ the EC50 or 290 ppb for bensulide. EECs for all uses are well below 290 ppb and therefore there is no concern for this indirect effect.

Bensulide does exhibit chronic effects to aquatic arthropods based upon life-cycle tests with Daphnia magna. If there were chronic exposure, this could be a concern for the food supply of listed salmon and steelhead. However, based on very low use, there would be no exposure of concern in the lakes where the sockeye salmon occur. For those salmon and steelhead that live in streams and rivers, there may be acute exposure of aquatic invertebrates to bensulide, but there would not be a chronic exposure in flowing waters. In addition, one would expect that if there were a temporary disruption of aquatic arthropods in streams and rivers, there would be rapid replenishment to serve as a food source for the salmon and steelhead. Therefore, there would be no indirect effect of bensulide on Pacific salmon and steelhead as a result of impairing their food supply.

e. Changes in registration status

The development of a Reregistration Eligibility Decision (RED) document is a step in the process of reregistering existing pesticide products. The Environmental Risk Assessment used and referred to throughout much of this analysis provides an assessment at the point in time at which it is developed. Subsequent to the development of the RED, changes in uses may occur, label changes may be required, and additional data may be requested. As a result, there are nearly always changes in certain aspects of the registration that occur after the development of the RED.

Changes that may alter the aquatic risk analysis for bensulide since the Environmental Risk Assessment was completed are:

- Section 3 labels are in the process of being changed (most have been changed) to delete the use of bensulide on golf courses, other than on tees and greens in the western United States. In certain mid-continental and eastern states, bensulide may be used on fairways of bentgrass only.
- Home residential uses will no longer include use on ornamental plants or ground covers. Most labels have already incorporated this change.
- Additional label directions regarding droplet size, wind speed and direction, application height, and a prohibition of applications during temperature inversions should also reduce drift into aquatic habitats.

Incorporation of the golf course provision ought to reduce the aquatic risks. However, there was not much risk to Pacific salmon and steelhead before this provision because bensulide use on golf courses in the western United States was low (see, for example, landscape usage in tables 9-13 below).

f. General risk conclusions

There are concerns for acute risk to fish, including endangered and threatened salmon and steelhead, based upon the revised Environmental Risk Assessment and my modification of it to represent western salmon states. Both of these analyses use a “worst-case” scenario where

OPP uses the highest application rates, shortest application intervals, lowest toxicity values, longest degradation rates, the farm pond model for EECs, and a very conservative criterion of concern. These risks exceed our criteria for the protection of individuals, but are not high enough to expect population effects. It is relevant that no fish kills have been reported for bensulide in over 30 years of use. I cannot discount the worst-case scenario presented above. However, I believe that there is a low likelihood that it will occur, and it is almost certain that it will not occur widely. However, I cannot identify very well those areas where it could occur.

Concerns were identified for chronic risk to fish from use on golf courses and crops in the revised Environmental Risk Assessment. Bensulide is persistent and could be a chronic concern in lentic waters. However, the turf addendum to the Environmental Risk Assessment (Attachment 6) indicates that the prior analysis was excessively cautious, and the addendum indicates that EECs would be below the concern levels for chronic risk even if there were chronic exposure. There are no agricultural use sites where bensulide may be used within the reproductive areas of the sockeye salmon that may be found in lentic waters.

g. Existing protective measures

Nationally, there are no specific protective measures for endangered and threatened species beyond the generic statements on the current bensulide labels. As stated on all pesticide labels, it is a violation of Federal law to use this product in a manner inconsistent with its labeling. There are a variety of measures on bensulide labels for the protection of agricultural workers and other humans, which are not discussed here, but which may be seen on the attached labels. The Environmental Hazards section, for section 3 labels for bensulide products that may be applied to the various use sites, state: “This pesticide is toxic to fish and aquatic invertebrates. Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater or rinsate. Do not apply when weather conditions favor drift from the treated area.” The environmental hazards section also contains a warning regarding bee toxicity and concerns for effects on avian reproduction.

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

In California, the Department of Pesticide Regulation (DPR) in the California Environmental Protection Agency creates county bulletins consistent with those developed by OPP. However, California also has a system of County Agricultural Commissioners responsible for pesticide regulation, and all commercial applicators must get a permit for the use of any restricted use pesticide and must report all pesticide use, restricted or not. The California bulletins for protecting endangered species have been in use for about 5 years. Although they are “voluntary” in nature, the Agricultural Commissioners strongly promote their use by pesticide applicators. Bensulide is currently included in these bulletins only for protection of listed plants, but it could be listed for aquatic species should the results of the consultation so specify. Agricultural and other commercial applicators are well sensitized to the need for protecting endangered and threatened species. DPR believes that the vast majority of agricultural applicators in California are following the limitations in these bulletins (Richard Marovich, Endangered Species Project, DPR, telephone communication, July 19, 2002).

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

In Oregon, Washington, and Idaho, information on the actual amount of bensulide used is rather limited. For ESUs in these three states, I have indicated the amount of acreage, by county, where bensulide could be used according to the labels. The actual 1997 acreage is provided; if no acreage is indicated, this means that there were only 1-3 growers and USDA did not report acreage to protect privacy. In such cases, actual acreage is likely to be small, but I cannot be certain.

The sources of data available on bensulide use are considerably different for California than for other states. California has full pesticide use reporting by all applicators except homeowners; commercial applications in residential areas do have to be reported. Oregon has initiated a process for full use reporting, but it is not in place yet. Washington and Idaho do not have such a mechanism to my knowledge.

The latest information for California pesticide use is for the year 2001 [URL: http://www.cdpr.ca.gov/docs/pur/purmain.htm]. The reported information to the County Agricultural Commissioners includes pounds used, acres treated (for agricultural uses), and the specific location treated. The pounds and acres are reported to the state, but the specific location information is retained at the county level and is not readily available to EPA. For the non-agricultural uses in California, a "research" use typically involves efficacy testing or perhaps testing to satisfy a data requirement for registration, e.g., for "tolerances" in human food items. Landscape maintenance could possibly mean use by commercial applicators in residential sites, but for bensulide, this term most likely means use on golf course greens and tees. Structural pest control usually involves termites or rodents; when herbicides are involved, it is likely to mean removing rodent cover around buildings.

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

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 for 1.5 to 4 months before hatching as alevins. Following yolk sac absorption, alevins emerge as fry and begin actively feeding. Juveniles rear in fresh water from 1 to 4 years, then migrate to the ocean as ‘‘smolts.’’

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

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

1. Southern California Steelhead ESU

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

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

Within San Diego County, the San Mateo Creek runs through Camp Pendleton Marine Base and into the Cleveland National Forest. While there are agricultural uses of pesticides in other parts of California within the range of this ESU, it would appear that there are no such uses in the vicinity of San Mateo Creek. Within Los Angeles County, this steelhead occurs in Malibu Creek and possibly Topanga Creek. Neither of these creeks drain agricultural areas. But both may be associated with residential areas, and bensulide may be used on home lawns. There is a potential for steelhead waters to drain agricultural areas in Ventura, Santa Barbara, and San Luis Obispo counties; agricultural bensulide usage is moderate in these counties. In all of these counties, there may be unquantified use of bensulide on home lawns. Usage of bensulide in counties where this ESU occurs are presented in Table 9.

Table 9. Use of bensulide in counties with the Southern California steelhead ESU. Data do not include homeowner use on lawns.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated	Non-agricultural uses	Non-Ag usage pounds
San Diego	Lettuce, broccoli, cauliflower, onions	19	5	Landscape	134
Los Angeles	Endive	89	46	Landscape, structural	376
Ventura	Cabbage, cucumbers, pumpkins, lettuce, flowers, kale, bok choy, peppers	2526	564	Landscape, rights of way	69
San Luis Obispo	Cabbage, peppers, bok choy, lettuce, broccoli, kale	1317	471	Landscape	113
Santa Barbara	Lettuce, broccoli, nursery, endive, cabbage, pumpkin, squash, parsley, peppers	3213	2333	Landscape	36

I conclude that there is sufficient agricultural use of bensulide within the freshwater range and critical habitat of the southern California steelhead ESU that it may affect this ESU. It is also possible, but we have inadequate use data for a sound conclusion, that the home lawn use may affect this ESU, especially in Los Angeles County. Levels of concern are exceeded, but not by a large amount. I believe that adding an aquatic hazard designation to California DPR's county bulletins would reduce aquatic exposures below levels of concern for the agricultural uses, but these bulletins do not address homeowner uses of pesticides. Unless NMFS considers that the risks from lawn use of bensulide are discountable either because the steelhead do not inhabit first order streams in this ESU or because it would require more than 20% of the lawns to be treated twice (or 36% treated once) to exceed our criteria, taking into account the conservativeness of our farm pond model and the extra concerns for urban uses to transport readily across paved surfaces, then I recommend that NMFS and OPP work with California DPR to determine ways of reducing bensulide exposure from lawn use to acceptable levels.

2. South Central California Steelhead ESU

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

This ESU includes the hydrologic units of Pajaro (upstream barriers - Chesbro Reservoir, North Fork Pachero Reservoir), Estrella, Salinas (upstream barriers - Nacimiento Reservoir, Salinas Dam, San Antonio Reservoir), Central Coastal (upstream barriers - Lopez Dam, Whale Rock Reservoir), Alisal-Elkhorn Sloughs, and Carmel. Counties of occurrence include Santa Cruz, San Benito, Monterey, and San Luis Obispo. There are agricultural areas in these counties, and these areas would be drained by waters where steelhead critical habitat occurs. Again, there could be unspecified use of bensulide on home lawns. Table 10 shows that agricultural bensulide use may be very high in two of the counties where this ESU occurs.

Table 10. Use of bensulide in counties with the South Central California steelhead ESU. Data do not include homeowner use on lawns.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated	Non-agricultural uses	Non-Ag usage pounds
Santa Cruz	Lettuce, mustard, leafy vegetables, collards, cabbage, broccoli	665	253	none	
San Benito	Lettuce, mustard, mizuna, chicory, chinese greens, endive, broccoli, pepper, pumpkin, kale, celery, bok choy, collards, cucumbers	11,980	3588	Research, rights of way	15
Montere y	Lettuce, Broccoli, Cabbage, Rappini, Cauliflower, Kale, Mustard, Endive, Squash, Chicory, Pepper, Spinach, Bok choy, Chervil, Radish, Cucumber, Pumpkin, Arrugula	37,257	16,733	Landscape, research	145

San Luis Obispo	Cabbage, peppers, bok choy, lettuce, broccoli, kale	1317	471	Landscape	113

The past and potential future agricultural use of bensulide is more pronounced within this ESU than any other Pacific salmon or steelhead ESU. I conclude that the high agricultural use of bensulide within the freshwater range and critical habitat of the south central California steelhead ESU may affect this ESU. It is also possible, but we have inadequate use data for a sound conclusion, that the home lawn use may affect this ESU. I note that there are considerable residential areas, and if bensulide may be used twice in one year on residential lawns to control crabgrass, it would require that less than 20% of an area near this ESU be treated to result in concentrations below our level of concern, or less than 36% to be treated if there is only one application per year. Despite the high amount of usage within this ESU, the levels of concern for agricultural use are not exceeded by a large amount. I believe that adding an aquatic hazard designation to California DPR's county bulletins would reduce aquatic exposures below levels of concern for the agricultural uses, but these bulletins do not address homeowner uses of pesticides. If the risks from lawn use of bensulide are of concern to NMFS, as above, I again recommend that NMFS and OPP work with California DPR to determine ways of reducing bensulide exposure to acceptable levels.

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. Bensulide use is very low or none in most of the counties associated with this ESU. There is low agricultural use of bensulide in Santa Cruz County; the only moderate usage is in Santa Clara County. We cannot be certain, but it appears that Santa Clara County is largely outside the Critical Habitat for this ESU. Again, there could be unspecified use of bensulide on home lawns. This ESU is associated with significantly large urban and suburban areas. Within a county, crops are listed in order from greatest bensulide use to smallest.

Table 11. Use of bensulide in counties with the Central California Coast steelhead ESU. Data do not include homeowner use on lawns.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated	Non-agricultural uses	Non-Ag usage pounds
Santa Cruz	Lettuce, mustard, leafy vegetables, collards, cabbage, broccoli	665	253	none	
San Mateo	Chinese greens	6	1	none	
San Francisco	none			none	
Marin	none			none	
Sonoma	pumpkin	14	14	none	
Mendocino	none			none	
Napa	none			none	
Alameda	none			Landscape, structural	387
Contra Costa	none			Landscape	124
Solano	none			Landscape, research, rights of way	79
Santa Clara	Lettuce, pepper, squash	2878	729	none	

There is not a lot of agricultural bensulide use in the area where the Central California Coast steelhead occurs. However, much of this area is strongly urban and suburban where bensulide lawn use may occur. Given the relatively low agricultural use along the coast, and the limited parts of Santa Clara County within the ESU, I would expect that bensulide would not be likely to adversely affect this ESU. But in combination with a very high level of uncertainty regarding lawn use, I conclude that bensulide may affect the California Central Coast steelhead. I would expect that the potential for effects would be low because I doubt that more than 20% of the lawns would be treated twice, or 36% treated once. But the “may affect” conclusion does not relate to how much effect but rather whether there is an adverse effect.

Because I believe the most likely concern within this ESU is from home lawn use, making an aquatic hazard designation for bensulide in California DPR’s county bulletins would not seem to provide sufficient protection. Unless NMFS considers that the risks from lawn use of bensulide are discountable because it would require more than 20% of the lawns to be treated twice (or 36% treated once) to exceed our criteria, taking into account the conservativeness of our farm pond model and the extra concerns for urban uses to transport readily across paved surfaces, then I recommend that NMFS and OPP work with California DPR to determine ways of reducing bensulide exposure to acceptable levels.

4. California Central Valley Steelhead ESU

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

This ESU includes populations ranging from Shasta, Trinity, and Whiskeytown areas, along with other Sacramento River tributaries in the North, down the Central Valley along the San Joaquin River to and including the Merced River in the South, and then into San Pablo and San Francisco Bays. Counties at least partly within this area are Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Glenn, Marin, Merced, Nevada, Placer, Sacramento, San Francisco, San Joaquin, San Mateo, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tuloumne, Yolo, and Yuba. A large proportion of this area is heavily agricultural, but there are also large amounts of urban and suburban areas that may have lawns. Usage of bensulide in counties where the California Central Valley steelhead ESU occurs is presented in Table 12, and is surprisingly small in most counties. Within a county, crops are listed in order from greatest bensulide use to smallest.

Table 12. Use of bensulide in counties with the California Central Valley steelhead ESU. Data do not include homeowner use on lawns.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated	Non-agricultural uses	Non-Ag usage pounds
Alameda	none			Landscape, structural	387

Amador	none			none	
Butte	Squash, unidentified vegetable	47	8	Landscape	132
Calaveras	none			none	
Colusa	none			Landscape, rights of way	22
Contra Costa	none			Landscape	124
Glenn	none			none	
Marin	none			none	
Merced	none			Landscape	151
Nevada	none			Landscape	20
Placer	none			Landscape	3
Sacramento	Melons, squash, pumpkin, cucumbers, nursery container plants	577	118	Landscape	262
San Joaquin	unidentified	1		Landscape	175
San Mateo	Chinese greens	6	1	none	
San Francisco	none			none	
Shasta	none			Landscape	150
Solano	none			Landscape, research, rights of way	79
Sonoma	Pumpkin	14	14	none	
Stanislaus	Mustard, lettuce, collards, bok choy, cabbage, kale, watermelon, kohlrabi, fennel	3277	598	rights of way	7
Sutter	Pumpkin	24	4	none	
Tehama	Pumpkin	15	9	Landscape	38

Tuolumne	none			Landscape	31
Yolo	Watermelon	<1	<1	Landscape, research	85
Yuba	none			none	

Except in Stanislaus and Sacramento counties, there is quite low use of concern for bensulide within this ESU. Even in those counties, there is limited agricultural acreage treated. It is possible that some of this could occur near smaller water bodies, although designating bensulide as an aquatic hazard in DPR's county bulletins would provide more than adequate protection for the agricultural uses.

The "landscape" use is most likely golf course use on greens and tees where exposure does not exceed our criteria of concern. As everywhere, we cannot quantify the likely use of bensulide on home lawns. While there is considerable population throughout this ESU, the density to the point of expecting more than 20% or 36% of the area to be in once or twice treated lawns is likely only in the immediate vicinity of Sacramento.

I conclude that there is a remote, but not discountable, possibility that agricultural uses of bensulide may affect the Central Valley steelhead ESU, but that there would be no effect from these uses if bensulide were in the DPR county bulletins for aquatic species. Because of very high uncertainty, I conclude that there is also a possibility that the home lawn use may affect this ESU. But as with other salmon and steelhead ESUs in highly populated areas, I have no suggestions on how to mitigate the exposure sufficiently. Again, I recommend a dialogue with the appropriate agencies.

5. Northern California Steelhead ESU

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

This Northern California coastal steelhead ESU occupies river basins from Redwood Creek in Humboldt County, CA to the Gualala River, inclusive, in Mendocino County, CA. River entry ranges from August through June and spawning from December through April, with peak spawning in January in the larger basins and in late February and March in the smaller coastal basins. The Northern California ESU has both winter and summer steelhead, including what is presently considered to be the southernmost population of summer steelhead, in the Middle Fork Eel River. Counties included appear to be Humboldt, Mendocino, Trinity, and Lake. Table 13 shows no reportable use of bensulide in these counties. These counties are also not strongly urban and suburban with respect to homeowner use of bensulide.

Table 13. Use of bensulide in counties with the Northern California steelhead ESU. Data do

not include homeowner use on lawns.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated	Non-agricultural uses	Non-Ag usage pounds
Humboldt	none			none	
Mendocino	none			none	
Trinity	none			none	
Lake	none			none	

Based upon the lack of agricultural use of bensulide and the lack of high density housing with associated lawns, I conclude there will be no effect of bensulide on the Northern California steelhead ESU.

6. Upper Columbia River steelhead ESU

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

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

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

There is a moderate amount of acreage, primarily onions, where bensulide may be used with the reproductive area of this ESU. OPP's Quantitative Use Assessment indicates that nationally, an average of 11% of the onion crop is treated with bensulide. However, the QUA also indicates that 100% of the bensulide use on onions occurs in Texas, Idaho, and Oregon. There is no explanation as to why bensulide would be used on onions in Oregon and Idaho, but not in Washington. I suspect there is use of bensulide on Washington onions.

Except for the moderate acreage of onions in Walla Walla and Benton counties, WA and Umatilla County, OR, there are few acres of crops where bensulide may be used in the migratory corridors for this ESU.

Other than the Portland area, neither the reproductive areas nor the migratory areas are heavily urbanized. Some bensulide home lawn use may occur above Portland, but is probably insignificant relative to the size of the water into which the bensulide could run off.

Tables 14 and 15 show the cropping information, where bensulide can be used for Washington counties where the Upper Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 14. Crops on which bensulide can be used in Washington counties where there is spawning and growth of the Upper Columbia River steelhead ESU

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Benton	Dry onions 3398 Peppers 2 Cucurbits	3400	1,089,993 640,370 58.7%
WA	Franklin	Dry onions 4074 Cucurbits 7 Peppers	4081	794,999 670,149 84.3%
WA	Kittitas	none	0	1,469,862 355,360 24.2%
WA	Yakima	Cucurbits 817 Peppers 439 Cabbage 144 Eggplant 5 Dry onions Garlic	1405	2,749,514 1,639,965 59.6%
WA	Chelan	none	0	1,869,848 112,085 6%
WA	Douglas	none	0	1,165,168 918,033 78.8%

WA	Okanogan	Garlic 5 Cabbage 1 Cucurbits 1 Broccoli 1	8	3,371,698 1,291,118 38.3%
WA	Grant	Dry onions 6214 Cucurbits 133	6347	1,712,881 1,086,045 63.4%

Table 15. Crops on which bensulide can be used in Oregon and Washington counties that are migration corridors for the Upper Columbia River steelhead ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Walla Walla	Dry onions 2172 Endive 306 Cucurbits 140 Cabbage 6 Lettuce	2624	813,108 710,546 87.4%
WA	Klickitat	Peppers 12 Garlic 1	13	1,198,385 689,639 57.5%
WA	Skamania	none	0	1,337,179 4043 0.4%
WA	Clark	Cucurbits 2 Lettuce	2	401,850 82,967 20.6
WA	Cowlitz	none	0	728,781 35,678 4.9%
WA	Wahkiakum	none	0	169,125 12,611 7.5%

WA	Pacific	none	0	<u>623,722</u> 32,637 5.2%
OR	Gilliam	none	0	<u>770,664</u> 766,373 99.4%
OR	Umatilla	Dry onions 3914 Cucurbits 1037 Peppers 121 Garlic 9 Buckwheat	5081	<u>2,057,809</u> 1,466,580 71.3%
OR	Sherman	none	0	<u>526,911</u> 487,534 92.5%
OR	Morrow	Dry onions	NS	<u>1,301,021</u> 1,119,004 86%
OR	Wasco	Garlic	NS	<u>1,523,958</u> 1,152,965 75.7%
OR	Hood River	Broccoli Cucurbits	NS	<u>334,328</u> 27,201 8.1%
OR	Multnomah	Cucurbits 877 Cabbage 553 Endive 62 Lettuce 62 Cauliflower 55 Broccoli 29 Mustard greens 10 Peppers 4 Eggplant Garlic	1652	<u>278,570</u> 31,294 11.2%
OR	Columbia	none	0	<u>420,332</u> 71,839 17.1%

OR	Clatsop	none	0	529,482 24,740 4.7%

Based upon the 11% average, and noting that it is an average, the potential acreage that would be treated with bensulide within the spawning and rearing habitat of the Upper Columbia River steelhead ESU would be no more than 700 acres treated in any county. I would expect no concerns in the Columbia River and high volume tributaries, but should a moderate portion of those acres be located next to or near a small tributary where the steelhead could occur, then there could be a concern. I conclude that bensulide's agricultural use may affect this ESU, even though I do not think it very likely. The likelihood of home lawn use in sufficient quantities to be a concern is so low that I believe there will be no effect from this use. Similarly, I believe there will be no effect in the migratory corridors. I recommend that a buffer be used to mitigate exposure so that it is below our concern levels. Alternatively, the Washington State Department of Agriculture's task force may provide more focused protective measures that would be acceptable to NMFS.

7. Snake River Basin steelhead ESU

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

Spawning and early growth areas of this ESU consist of all areas upstream from the confluence of the Snake River and the Columbia River as far as fish passage is possible. Hells Canyon Dam on the Snake River and Dworshak Dam on the Clearwater River, along with Napias Creek Falls near Salmon, Idaho, are named as impassable barriers. These areas include the counties of Wallowa, Baker, Union, and Umatilla (northeastern part) in Oregon; Asotin, Garfield, Columbia, Whitman, Franklin, and Walla Walla in Washington; and Adams, Idaho, Nez Perce, Blaine, Custer, Lemhi, Boise, Valley, Lewis, Clearwater, and Latah in Idaho. I have excluded Baker County, Oregon, which has a tiny fragment of the Imnaha River watershed. While a small part of Rock Creek extends into Baker County, this occurs at 7200 feet in the mountains (partly in a wilderness area) and is of no significance with respect to bensulide use in agricultural or residential areas. I have similarly excluded the Upper Grande Ronde watershed tributaries (e.g., Looking Glass and Cabin Creeks) that are barely into higher elevation forested areas of Umatilla County. However, crop areas of Umatilla County are considered in the migratory routes. In Idaho, Blaine and Boise counties technically have waters that are part of the steelhead ESU, but again, these are tiny areas which occur in the Sawtooth National Recreation Area and/or National Forest lands. I have excluded these areas because they are not relevant to use of bensulide. The agricultural areas of Valley County, Idaho, appear to be primarily associated with the Payette River watershed, but there is enough of the Salmon River watershed in this county that I was not able to exclude it.

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

The USDA Agricultural Census indicates there are no crops on which bensulide can be used in Idaho counties within this ESU, nor in the Washington counties bordering on Idaho. There is moderate acreage in Walla Walla and Franklin counties along the lower Snake River. Except for the moderate acreage of onions in Walla Walla and Benton counties, WA and Umatilla County, OR, crops where bensulide may be used are generally very low in the migratory corridors for this ESU.

Tables 16 and 17 show the cropping information for the Pacific Northwest counties where the Snake River Basin steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 16. Crops on which bensulide can be used in Pacific Northwest counties which provide spawning and rearing habitat for the Snake River Basin steelhead ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
ID	Adams	none	0	873,399 221,209 25.3%
ID	Idaho	none	0	5,430,522 744,295 13.7%
ID	Nez Perce	none	0	543,434 477,839 87.9%
ID	Custer	none	0	3,152,382 140,701 4.5%
ID	Lemhi	none	0	2,921,172 193,908 6.6%

ID	Valley	none	0	2,354,043 78,813 3.3%
ID	Lewis	none	0	306,601 211,039 68.8%
ID	Clearwater	none	0	1,575,396 103,246 6.6%
ID	Latah	none	0	689,089 347,293 50.4%
WA	Adams	Dry onions	NS	1,231,999 996,742 80.9%
WA	Asotin	none	0	406,983 274,546 67.5%
WA	Garfield	none	0	454,744 325,472 84.3%
WA	Columbia	none	0	556,034 304,928 54.8%
WA	Whitman	none	0	1,382,006 1,404,289 101.6%
WA	Franklin	Dry onions 4074 Cucurbits 7 Peppers	4081	794,999 670,149 84.3%
WA	Walla Walla	Dry onions 2172 Endive 306 Cucurbits 140 Cabbage 6 Lettuce	2624	813,108 710,546 87.4%

OR	Wallowa	none	0	2,013,071 694,304 34.5%
OR	Union	none	0	1,303,476 473,316 36.3%

Table 17. Crops on which bensulide can be used in Washington and Oregon counties through which the Snake River Basin steelhead ESU migrates

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Walla Walla	Dry onions 2172 Endive 306 Cucurbits 140 Cabbage 6 Lettuce	2624	813,108 710,546 87.4%
WA	Benton	Dry onions 3398 Peppers 2 Cucurbits	3400	1,089,993 640,370 58.7%
WA	Klickitat	Peppers 12 Garlic 1	13	1,198,385 689,639 57.5%
WA	Skamania	none	0	1,337,179 4043 0.4%
WA	Clark	Cucurbits 2 Lettuce	2	401,850 82,967 20.6
WA	Cowlitz	none	0	728,781 35,678 4.9%
WA	Wahkiakum	none	0	169,125 12,611 7.5%

WA	Pacific	none	0	623,722 32,637 5.2%
OR	Umatilla	Dry onions 3914 Cucurbits 1037 Peppers 121 Garlic 9 Buckwheat	5081	2,057,809 1,466,580 71.3%
OR	Morrow	Dry onions	NS	1,301,021 1,119,004 86%
OR	Gilliam	none	0	770,664 766,373 99.4%
OR	Sherman	none	0	526,911 487,534 92.5%
OR	Wasco	Garlic	NS	1,523,958 1,152,965 75.7%
OR	Hood River	Broccoli Cucurbits	NS	334,328 27,201 8.1%
OR	Multnomah	Cucurbits 877 Cabbage 553 Endive 62 Lettuce 62 Cauliflower 55 Broccoli 29 Mustard greens 10 Peppers 4 Eggplant Garlic	1652	278,570 31,294 11.2%
OR	Columbia	none	0	420,332 71,839 17.1%

OR	Clatsop	none	0	529,482 24,740 4.7%

As with the Upper Columbia steelhead, there is a slight chance for agricultural exposure of concern to the Snake River Basin steelhead ESU in Franklin and Walla Walla counties in smaller tributaries to the Snake River, although I would not expect any risk in larger streams and rivers. On that basis, I conclude that bensulide may affect this ESU. I also conclude no effect from lawn use or from any use in the migratory corridor. Again, I recommend a buffer or alternatives that may be developed by WSDA's task force.

8 Upper Willamette River steelhead ESU

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

Spawning and rearing areas are river reaches accessible to listed steelhead in the Willamette River and its tributaries above Willamette Falls up through the Calapooia River. This includes most of Benton, Linn, Polk, Clackamas, Marion, Yamhill, and Washington counties, and small parts of Lincoln and Tillamook counties. However, the latter two counties are small portions in forested areas where bensulide would not be used, and these counties are excluded from my analysis. While the Willamette River extends upstream into Lane County, the final Critical Habitat Notice does not include the Willamette River (mainstem, Coastal and Middle forks) in Lane County or the MacKenzie River and other tributaries in this county that were in the proposed Critical Habitat.

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

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

Acreage where agricultural bensulide use may occur is low in some counties in this ESU, but is moderate in Clackamas, Linn and Washington counties and high in Marion County. Urban and suburban areas where home lawn use could occur would be most pronounced in Portland, which is in the migratory corridor, and its surrounding suburbs of Washington and Clackamas counties. However, the Willamette Valley may have moderate amounts of home lawns throughout.

Tables 18 and 19 show the cropping information for Oregon counties where the Upper Willamette River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 18. Crops on which bensulide can be used that are part of the spawning and rearing habitat of the Upper Willamette River steelhead ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Benton	Cucurbits 891 Endive 10 Lettuce 10 Peppers 4 Dry onions 3 Garlic 3 Broccoli Eggplant	921	432,961 118,818 27.4%
OR	Linn	Cucurbits 494 Cabbage 431 Broccoli 267 Cauliflower 164 Dry onions 1 Peppers Garlic	1357	1,466,507 380,464 25.9%
OR	Polk	Cucurbits 17 Garlic 7 Broccoli Peppers	24	474,296 167,880 35.4%

OR	Clackamas	Cucurbits 1296 Cabbage 593 Endive 512 Cauliflower 319 Broccoli 184 Lettuce 132 Peppers 29 Mustard Greens 12 Kale 6 Dry onions Garlic	3083	1,195,712 148,848 12.4%
OR	Marion	Cabbage 4210 Cucurbits 2556 Broccoli 2548 Dry onions 2036 Cauliflower 1505 Garlic 556 Celery 32 Peppers 31 Lettuce	13,474	758,394 302,462 39.9%
OR	Yamhill	Broccoli 308 Cabbage 308 Cucurbits 275 Sweet peppers 13 Eggplant Dry onions	904	457,986 179,787 39.3%
OR	Washington	Broccoli 400 Cabbage 400 Cucurbits 321 Dry onions 196 Endive 75 Garlic 13 Lettuce 3 Peppers 2 Eggplant 1 Cauliflower	1411	463,231 139,820 30.2%

Table 19. Crops on which bensulide can be used in Oregon and Washington counties that are part of the migration corridors of the Upper Willamette River steelhead ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Clark	Cucurbits 2 Lettuce	2	401,850 82,967 20.6
WA	Cowlitz	none	0	728,781 35,678 4.9%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
WA	Pacific	none	0	623,722 32,637 5.2%
OR	Multnomah	Cucurbits 877 Cabbage 553 Endive 62 Lettuce 62 Cauliflower 55 Broccoli 29 Mustard greens 10 Peppers 4 Eggplant Garlic	1652	278,570 31,294 11.2%
OR	Columbia	none	0	420,332 71,839 17.1%
OR	Clatsop	none	0	529,482 24,740 4.7%

Based upon the moderate acreage in most counties and high acreage in Marion County, I conclude that agricultural use of bensulide may affect the Upper Willamette River steelhead ESU, although I believe this would apply only in the smaller tributaries. While I suspect that bensulide use on home lawns would not exceed the 20% and 36% levels calculated above, I cannot be sufficiently certain to discount this concern for the Portland metropolitan area. Therefore, it is possible that the home lawn use of bensulide may affect this ESU also. I would expect no effect in the migratory corridor below Portland.

I believe that a buffer would provide appropriate protection from the agricultural use of bensulide. But if enough lawns in the urban/suburban areas are treated to be of concern, a buffer might not be adequate for the lawn use. I have no alternative recommendations for the lawn use, but suggest working with the Oregon Department of Agriculture to see what might be done.

9. Lower Columbia River steelhead ESU

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

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

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

Only Clackamas and Multnomah counties have moderate acreage where bensulide may be used within this ESU. Both of these counties and Washington County, OR are urban/suburban where bensulide may be used on lawns. The migratory corridors for this ESU have no acreage where bensulide can be used and generally have very low density housing, at least below Portland.

Tables 20 and 21 show the cropping information for Oregon and Washington counties where the Lower Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 20. Crops and acreage where bensulide can be used in counties that provide spawning and rearing habitat for the Lower Columbia River Steelhead ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Hood River	Broccoli Cucurbits	NS	334,328 27,201 8.1%
OR	Clackamas	Cucurbits 1296 Cabbage 593 Endive 512 Cauliflower 319 Broccoli 184 Lettuce 132 Peppers 29 Mustard Greens 12 Kale 6 Dry onions Garlic	3083	1,195,712 148,848 12.4%
OR	Multnomah	Cucurbits 877 Cabbage 553 Endive 62 Lettuce 62 Cauliflower 55 Broccoli 29 Mustard greens 10 Peppers 4 Eggplant Garlic	1652	278,570 31,294 11.2%
WA	Clark	Cucurbits 2 Lettuce	2	401,850 82,967 20.6
WA	Cowlitz	none	0	728,781 35,678 4.9%
WA	Skamania	none	0	1,337,179 4043 0.4%

Table 21. Crops and acreage where bensulide can be used in counties that are migratory corridors for the Lower Columbia River Steelhead ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Columbia	none	0	420,332 71,839 17.1%
OR	Clatsop	none	0	529,482 24,740 4.7%
WA	Pacific	none	0	623,722 32,637 5.2%
WA	Wahkiakum	none	0	169,125 12,611 7.5%

Based upon the uncertainties of home lawn use, and in conjunction with the modest, but not insignificant agricultural acreage and potential use in Clackamas and Multnomah counties, I conclude that bensulide may affect the Lower Columbia River steelhead ESU. I consider the probability low but not discountable. I would expect no effect on migratory corridors. To mitigate exposure, I recommend a buffer. Alternatively, the Oregon Department of Agriculture may know of or be able to develop measures that would provide sufficient protection.

10. Middle Columbia River Steelhead ESU

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

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

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

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

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

The acreage where bensulide can be used is moderate in several counties within this ESU and is mostly onions. As noted above, a national average of 11% of the onion crop is treated with bensulide. Residential lawn use could be scattered throughout the ESU, but could be pronounced in the Portland area.

Tables 22 and 23 show the cropping information for Oregon and Washington counties where the Middle Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 22. Crops and acreage where bensulide can be used in counties that provide spawning and rearing habitat for the Middle Columbia River Steelhead ESU.

St	County	Crops and acres planted	Acres	<u>total acreage</u> land in farms % farmed
OR	Gilliam	none	0	<u>770,664</u> 766,373 99.4%

OR	Morrow	Dry onions	NS	1,301,021 1,119,004 86%
OR	Umatilla	Dry onions 3914 Cucurbits 1037 Peppers 121 Garlic 9 Buckwheat	5081	2,057,809 1,466,580 71.3%
OR	Sherman	none	0	526,911 487,534 92.5%
OR	Wasco	Garlic	NS	1,523,958 1,152,965 75.7%
OR	Crook	Garlic	NS	1,906,892 894,853 46.9%
OR	Grant	none	0	2,898,444 1,154,399 39.8%
OR	Wheeler	none	0	1,097,601 728,131 66.3%
OR	Jefferson	Garlic	NS	1,139,744 530,960 46.6%
WA	Benton	Dry onions 3398 Peppers 2 Cucurbits	3400	1,089,993 640,370 58.7%
WA	Columbia	none	0	556,034 304,928 54.8%
WA	Franklin	Dry onions 4074 Cucurbits 7 Peppers	4081	794,999 670,149 84.3%

WA	Kittitas	none	0	1,469,862 355,360 24.2%
WA	Klickitat	Peppers 12 Garlic 1	13	1,198,385 689,639 57.5%
WA	Skamania	none	0	1,337,179 4043 0.4%
WA	Walla Walla	Dry onions 2172 Endive 306 Cucurbits 140 Cabbage 6 Lettuce	2624	813,108 710,546 87.4%
WA	Yakima	Cucurbits 817 Peppers 439 Cabbage 144 Eggplant 5 Dry onions Garlic	1405	2,749,514 1,639,965 59.6%

Table 23. Crops on which bensulide can be used in Washington and Oregon counties through which the Middle Columbia River steelhead ESU migrates

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Skamania	none	0	1,337,179 4043 0.4%
WA	Clark	Cucurbits 2 Lettuce	2	401,850 82,967 20.6
WA	Cowlitz	none	0	728,781 35,678 4.9%

WA	Pacific	none	0	623,722 32,637 5.2%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
OR	Hood River	Broccoli Cucurbits	NS	334,328 27,201 8.1%
OR	Multnomah	Cucurbits 877 Cabbage 553 Endive 62 Lettuce 62 Cauliflower 55 Broccoli 29 Mustard greens 10 Peppers 4 Eggplant Garlic	1652	278,570 31,294 11.2%
OR	Columbia	none	0	420,332 71,839 17.1%
OR	Clatsop	none	0	529,482 24,740 4.7%

There is moderate acreage where bensulide could be used in several counties throughout the Middle Columbia River steelhead ESU. I would expect a low, but not discountable, probability that agricultural use next to smaller tributaries may affect this ESU. I believe there would be no effect from the home lawn use or along the migratory corridors. I recommend a buffer as an alternative or again, I would welcome acceptable protective measures that may be developed by the Oregon Department of Agriculture or the WSDA task force.

B. Chinook salmon

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

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

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

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

1. Sacramento River Winter-run Chinook Salmon ESU

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

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

Table 24 shows the bensulide usage in California counties supporting the Sacramento River winter-run chinook salmon ESU. In these tables, crops are listed in order of the greatest use of bensulide to the smallest. In general, the agricultural uses of bensulide within this ESU are low to very low. In addition to the reportable use sites, some of these areas are heavily urban and suburban where bensulide could be used on home lawns.

Table 24. Use of bensulide in counties with the Sacramento River winter-run Chinook salmon ESU. Spawning areas are primarily in Shasta and Tehama counties above the Red Bluff diversion dam.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated	Non-agricultural uses	Non-Ag usage pounds
Alameda	none			Landscape, structural	387
Butte	Squash, unidentified vegetable	47	8	Landscape	132
Colusa	none			Landscape, rights of way	22
Contra Costa	none			Landscape	124
Glenn	none			none	
Marin	none			none	
Sacramento	melons, squash, pumpkin, cucumbers, nursery container plants	577	118	Landscape	262
San Mateo	Chinese greens	6	1	none	
San Francisco	none			none	
Shasta	none			Landscape	150
Solano	none			Landscape, research, rights of way	79
Sonoma	Pumpkin	14	14	none	
Tehama	Pumpkin	15	9	Landscape	38

Yolo	Watermelon	<1	<1	Landscape, research	85

As with the Central Valley steelhead ESU, I believe there is such low use of bensulide except in Sacramento County as to be discountable. Even in Sacramento County, there is limited agricultural acreage treated. Again, the “landscape” use is most likely golf course use on greens and tees where exposure does not exceed our criteria of concern. And as before, we cannot quantify the likely use of bensulide on home lawns. While there is considerable population throughout this ESU, the density to the point of expecting more than 20% or 36% of the area to be in once or twice treated lawns is likely only in the immediate vicinity of Sacramento.

The spawning area for this ESU is the Sacramento River. It is my understanding that the young chinook of this ESU are likely to stay in the river, and because our concerns for bensulide relate only to ponds and small tributaries, I conclude that bensulide may affect, but is not likely to adversely affect the Sacramento River Run chinook ESU. On that basis, I do not believe that any measures to mitigate exposure are necessary.

If the young of this ESU do get into first order streams in Sacramento County, the only county where lawn or agricultural use is enough to cause even a small concern, I would have to reconsider my finding.

2. Snake River Fall-run Chinook Salmon ESU

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

In 1998, NMFS proposed to revise the Snake River fall-run chinook to include those stocks using the Deschutes River (63FR11482-11520, March 9, 1998). The John Day, Umatilla, and Walla Walla Rivers would be included; however, fall-run chinook in these rivers are believed to have been extirpated. It appears that this proposal has yet to be finalized. I have not included these counties here; however, I would note that the Middle Columbia River steelhead ESU encompasses these basins, and crop information is presented in that section of this analysis.

Hydrologic units with spawning and rearing habitat for this fall-run chinook are the Clearwater, Hells Canyon, Imnaha, Lower Grande Ronde, Lower North Fork Clearwater, Lower

Salmon, Lower Snake-Asotin, Lower Snake-Tucannon, and Palouse. These units are in Baker, Umatilla, Wallowa, and Union counties in Oregon; Adams, Asotin, Columbia, Franklin, Garfield, Lincoln, Spokane, Walla Walla, and Whitman counties in Washington; and Adams, Benewah, Clearwater, Idaho, Latah, Lewis, Nez Perce, Shoshone, and Valley counties in Idaho. I note that Custer and Lemhi counties in Idaho are not listed as part of the fall-run ESU, although they are included for the spring/summer-run ESU. Because only high elevation forested areas of Baker and Umatilla counties in Oregon are in the spawning and rearing areas for this fall-run chinook, I have excluded them from consideration because bensulide would not be used in these areas. I have, however, kept Umatilla County as part of the migratory corridor.

The USDA census indicates that there are no crops where bensulide can be used in Idaho counties within this ESU, nor in the Washington counties bordering on Idaho. Within the spawning and rearing habitat of this ESU, there is moderate acreage of onions in Walla Walla and Franklin counties along the lower Snake River. Except for the moderate acreage of onions in Walla Walla and Benton counties, WA and Umatilla County, OR, crops where bensulide may be used are generally very low in the migratory corridors for this ESU. Residential lawn use could be scattered throughout the ESU, but could be pronounced in the Portland area.

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

Table 25. Crops on which bensulide can be used in Pacific Northwest counties which provide spawning and rearing habitat for the Snake River fall-run chinook ESU

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
ID	Adams	none	0	873,399 221,209 25.3%
ID	Idaho	none	0	5,430,522 744,295 13.7%
ID	Nez Perce	none	0	543,434 477,839 87.9%
ID	Valley	none	0	2,354,043 78,813 3.3%

ID	Lewis	none	0	306,601 211,039 68.8%
ID	Benewah	none	0	496,662 111,510 22.5%
ID	Shoshone	none	0	1,685,770 4,428 0.3%
ID	Clearwater	none	0	1,575,396 103,246 6.6%
ID	Latah	none	0	689,089 347,293 50.4%
WA	Adams	Dry onions	NS	1,231,999 996,742 80.9%
WA	Lincoln	none	0	1,479,196 1,465,788 99.1%
WA	Spokane	Cucurbits 208 Peppers 7 Endive 1 Lettuce 1 Garlic Dry onions	217	1,128,835 625,769 55.4%
WA	Asotin	none	0	406,983 274,546 67.5%
WA	Garfield	none	0	454,744 325,472 84.3%
WA	Columbia	none	0	556,034 304,928 54.8%

WA	Whitman	none	0	1,382,006 1,404,289 101.6%
WA	Franklin	Dry onions 4074 Cucurbits 7 Peppers	4081	794,999 670,149 84.3%
WA	Walla Walla	Dry onions 2172 Endive 306 Cucurbits 140 Cabbage 6 Lettuce	2624	813,108 710,546 87.4%
OR	Wallowa	none	0	2,013,071 694,304 34.5%
OR	Union	none	0	1,303,476 473,316 36.3%

Table 26. Crops on which bensulide can be used in Washington and Oregon counties through which the Snake River fall-run chinook and the Snake River spring/summer-run chinook ESUs migrate.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Walla Walla	Dry onions 2172 Endive 306 Cucurbits 140 Cabbage 6 Lettuce	2624	813,108 710,546 87.4%
WA	Benton	Dry onions 3398 Peppers 2 Cucurbits	3400	1,089,993 640,370 58.7%
WA	Klickitat	Peppers 12 Garlic 1	13	1,198,385 689,639 57.5%
WA	Skamania	none	0	1,337,179 4043 0.4%

WA	Clark	Cucurbits 2 Lettuce	2	401,850 82,967 20.6
WA	Cowlitz	none	0	728,781 35,678 4.9%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
WA	Pacific	none	0	623,722 32,637 5.2%
OR	Umatilla	Dry onions 3914 Cucurbits 1037 Peppers 121 Garlic 9 Buckwheat	5081	2,057,809 1,466,580 71.3%
OR	Morrow	Dry onions	NS	1,301,021 1,119,004 86%
OR	Gilliam	none	0	770,664 766,373 99.4%
OR	Sherman	none	0	526,911 487,534 92.5%
OR	Wasco	Garlic	NS	1,523,958 1,152,965 75.7%
OR	Hood River	Broccoli Cucurbits	NS	334,328 27,201 8.1%

OR	Multnomah	Cucurbits 877 Cabbage 553 Endive 62 Lettuce 62 Cauliflower 55 Broccoli 29 Mustard greens 10 Peppers 4 Eggplant Garlic	1652	278,570 31,294 11.2%
OR	Columbia	none	0	420,332 71,839 17.1%
OR	Clatsop	none	0	529,482 24,740 4.7%

There is a slight chance for agricultural exposure of concern to the Snake River fall-run chinook ESU in Franklin and Walla Walla counties in smaller tributaries to the Snake River. On that basis, I conclude that bensulide may affect this ESU. I also conclude no effect from lawn use or from any use in the migratory corridor. Again, I recommend a buffer or alternatives that may be developed by WSDA's task force.

3. Snake River Spring/Summer-run Chinook Salmon

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

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

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

The USDA census indicates that there are no crops where bensulide can be used in Idaho counties within this ESU, nor in the Washington counties bordering on Idaho. There is moderate acreage in Walla Walla and Franklin counties along the lower Snake River. Except for the moderate acreage of onions in Walla Walla and Benton counties, WA and Umatilla County, OR, crops where bensulide may be used are generally very low in the migratory corridors for this ESU. Residential lawn use could be scattered throughout the ESU, but could be pronounced in the Portland area.

Table 27 shows the crop-acreage information for Oregon and Washington counties where the Snake River spring/summer-run chinook salmon ESU occurs. The cropping information for the migratory corridors is the same as for the Snake River fall-run chinook salmon and is in table 26 above. If there is no acreage given for a specific crop in table 24, this means that there are too few growers in the area for USDA to make the data available.

Table 27. Crops on which bensulide can be used in Idaho counties which provide spawning and rearing habitat for the Snake River spring/summer run chinook ESU

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
ID	Adams	none	0	873,399 221,209 25.3%
ID	Idaho	none	0	5,430,522 744,295 13.7%
ID	Nez Perce	none	0	543,434 477,839 87.9%

ID	Custer	none	0	3,152,382 140,701 4.5%
ID	Lemhi	none	0	2,921,172 193,908 6.6%
ID	Valley	none	0	2,354,043 78,813 3.3%
ID	Lewis	none	0	306,601 211,039 68.8%
ID	Latah	none	0	689,089 347,293 50.4%
WA	Asotin	none	0	406,983 274,546 67.5%
WA	Garfield	none	0	454,744 325,472 84.3%
WA	Columbia	none	0	556,034 304,928 54.8%
WA	Whitman	none	0	1,382,006 1,404,289 101.6%
WA	Franklin	Dry onions 4074 Cucurbits 7 Peppers	4081	794,999 670,149 84.3%
WA	Walla Walla	Dry onions 2172 Endive 306 Cucurbits 140 Cabbage 6 Lettuce	2624	813,108 710,546 87.4%

OR	Wallowa	none	0	2,013,071 694,304 34.5%
OR	Union	none	0	1,303,476 473,316 36.3%

As with the Snake River fall-run chinook, there is a slight chance for agricultural exposure of concern to the Snake River spring/summer run chinook ESU in Franklin and Walla Walla counties in smaller tributaries to the Snake River. On that basis, I conclude that bensulide may affect this ESU. I also conclude no effect from lawn use or from any use in the migratory corridor. Again, I recommend a buffer or alternatives that may be developed by WSDA's task force.

4. Central Valley Spring-run Chinook Salmon ESU

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

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

Table 28 contains usage information for the California counties supporting the Central Valley spring-run chinook salmon ESU. Within a county, crops are listed from the most bensulide use to the least. As with the Central Valley steelhead, there is only low or very low reportable use of bensulide, but some areas are heavily urban/suburban where home lawn use could occur.

Table 28. Use of bensulide in counties with the Central Valley spring run chinook salmon ESU.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated	Non-agricultural uses	Non-Ag usage pounds
Alameda	none			Landscape, structural	387
Butte	Squash, unidentified vegetable	47	8	Landscape	132
Colusa	none			Landscape, rights of way	22
Contra Costa	none			Landscape	124
Glenn	none			none	
Marin	none			none	
Napa	none			none	
Nevada	none			Landscape	20
Placer	none			Landscape	3
Sacramento	melons, squash, pumpkin, cucumbers, nursery container plants	577	118	Landscape	262
San Mateo	Chinese greens	6	1	none	
San Francisco	none			none	
Shasta	none			Landscape	150
Solano	none			Landscape, research, rights of way	79
Sonoma	Pumpkin	14	14	none	
Sutter	Pumpkin	24	4	none	
Tehama	Pumpkin	15	9	Landscape	38
Yolo	Watermelon	<1	<1	Landscape, research	85
Yuba	none			none	

As with the Central Valley steelhead ESU, I believe there is such low use of bensulide except in Sacramento County as to be discountable. Even in Sacramento County, there is limited agricultural acreage treated. Again, I note that the “landscape” use is most likely golf course use on greens and tees where exposure does not exceed our criteria of concern. And as before, we cannot quantify the likely use of bensulide on home lawns. While there is considerable population throughout this ESU, the density to the point of expecting more than 20% or 36% of the area to be in once or twice treated lawns is likely only in the immediate vicinity of Sacramento.

Unlike the Sacramento River winter run chinook, for the Central Valley spring run chinook it is my understanding that this ESU does get into a number of tributaries to the Sacramento River. Many of these tributaries may be large up to the impassable barriers or dams that preclude further movement. I do not know if there are first order streams in Sacramento County where young chinook from this ESU may occur. Because of that uncertainty, I conclude that bensulide may affect the Central Valley spring run chinook salmon. If this the young of this ESU do not occur in small streams in Sacramento County, I would further conclude that bensulide would be not likely to adversely affect this ESU.

I believe that adding an aquatic hazard designation to California DPR’s county bulletins would reduce aquatic exposures below levels of concern for the agricultural uses, but these bulletins do not address homeowner uses of pesticides. Unless NMFS considers that the risks from lawn use of bensulide are discountable either because the chinook do not inhabit first order streams in Sacramento County or because it would require more than 20% of the lawns to be treated twice (or 36% treated once) to exceed our criteria, taking into account the conservativeness of our farm pond model and the extra concerns for urban uses to transport readily across paved surfaces, then I recommend that NMFS and OPP work with California DPR to determine ways of reducing bensulide exposure to acceptable levels.

5. California Coastal Chinook Salmon ESU

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

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

Table 29 contains usage information for the California counties supporting the California coastal chinook salmon ESU. Reportable usage of bensulide is essentially none, excepting for 14 acres in Sonoma County. Housing density where home lawn use could occur may be moderate on the San Francisco Bay side of Marin County, but should be low in the other counties.

Table 29. Use of bensulide in counties with the California coastal chinook salmon ESU.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated	Non-agricultural uses	Non-Ag usage pounds
Humboldt	none			none	
Mendocino	none			none	
Sonoma	pumpkin	14	14	none	
Marin	none			none	
Trinity	none			none	
Lake	none			none	

Based upon the low agricultural use, I conclude no effect from agricultural use of bensulide on the California coastal chinook ESU. Also, because the only moderate density housing where bensulide could be used on lawns would expose the bay areas where dilution would be significant enough to reduce concentrations below levels of concern, I conclude no effect from use on home lawns.

6. Puget Sound Chinook Salmon ESU

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

The hydrologic units and upstream barriers are the Strait of Georgia, San Juan Islands, Nooksack, Upper Skagit, Sauk, Lower Skagit, Stillaguamish, Skykomish, Snoqualmie (upstream barrier - Tolt Dam), Snohomish, Lake Washington (upstream barrier - Landsburg Diversion), Duwamish, Puyallup, Nisqually (upstream barrier - Alder Dam), Deschutes, Skokomish, Hood Canal, Puget Sound, Dungeness-Elwha (upstream barrier - Elwha Dam). Affected counties in Washington, apparently all of which could have spawning and rearing habitat, are Skagit, Whatcom, San Juan, Island, Snohomish, King, Pierce, Thurston, Lewis, Grays Harbor, Mason, Clallam, Jefferson, and Kitsap.

Table 30 shows the acreage information for Washington counties where the Puget Sound chinook salmon ESU is located. Most of these counties have very low acreage of crops where bensulide could be used, but Skagit and Pierce counties have moderate acreage, and King County has low acreage. In addition, King and Pierce counties, in particular are heavily urban and suburban where home use could occur. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 30. Crops and acreage where bensulide can be used in counties that are in the Critical Habitat of the Puget Sound chinook salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Skagit	Cucurbits 3086 Garlic 1 Broccoli	3087	1,110,583 92,074 8.3%
WA	Whatcom	Endive 3 Lettuce 2 Broccoli 1 Garlic 1 Cabbage 1 Cucurbits	8	1,356,835 118,136 8.7%
WA	San Juan	Endive 1 Lettuce 1 Garlic 1	3	11,963 20,529 18.3%
WA	Island	Cucurbits	NS	133,499 19,526 14.6%
WA	Snohomish	Cucurbits 82 Broccoli 4 Cabbage 4 Lettuce Cauliflower Mustard greens	90	1,337,728 74,153 5.5%

WA	King	Cucurbits 220 Endive 146 Cabbage 110 Lettuce 89 Mustard greens 14 Broccoli 8 Dry onions 4 Peppers 3 Garlic 3 Eggplant 1 Cauliflower	598	1,360,705 42,290 3.1%
WA	Pierce	Endive 1025 Lettuce 607 Cucurbits 410 Cabbage 242 Celery 64 Garlic 2 Peppers	2350	1,072,350 58,750 5.5%
WA	Thurston	Cucurbits 34 Cabbage 2 Garlic 2 Endive 2 Dry onions 1 Cauliflower 1 Peppers 1 Broccoli	43	465,322 59,890 12.9%
WA	Lewis	none	0	1,540,991 112,263 7.3%
WA	Grays Harbor	none	0	1,227,045 44,742 3.6%
WA	Mason	Cucurbits	36	615,108 10,965 1.8%
WA	Clallam	none	0	1,116,900 24,253 2.2%

WA	Jefferson	none	0	1,157,642 9,603 0.8%
WA	Kitsap	Cucurbits 9 Lettuce 3 Endive 3 Peppers 1 Garlic 1	17	253,436 10,302 4.1%

There is enough agricultural acreage in Skagit, Pierce, and perhaps King counties where bensulide could be used to be of minor, but not discountable, concern. In addition, there is a potential for considerable lawn use in the Seattle, Tacoma, and Olympia areas, although we have a very high degree of uncertainty about the lawn use of bensulide in this area. In addition, it appears likely that there are first order streams around Puget Sound where this ESU could occur. Therefore, I conclude that bensulide may affect the Puget Sound chinook ESU. I believe a buffer would be appropriate for the agricultural use sites for bensulide. But if enough lawns in the urban/suburban areas are treated to be of concern, a buffer might not be adequate for the lawn use. The Washington State Department of Agriculture's task force may provide more focused protective measures for the agricultural use that would be acceptable to NMFS, and they may have ideas of how to treat the lawn use of bensulide.

7. Lower Columbia River Chinook Salmon ESU

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

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

Tables 31 shows the cropping information for Oregon and Washington counties where the Lower Columbia River chinook salmon ESU occurs. Marion County has high acreage where bensulide could be used, but is only marginally within the Critical Habitat of this ESU. Clackamas, Washington, and Multnomah counties have moderate acreage where bensulide can be used, and these counties also are heavily urban and suburban where home lawn use is possible. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 31. Crops and acreage where bensulide can be used in counties that are in the Critical Habitat of the Lower Columbia River chinook salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Wasco	Garlic	NS	1,523,958 1,152,965 75.7%
OR	Hood River	Broccoli Cucurbits	NS	334,328 27,201 8.1%
OR	Marion	Cabbage 4210 Cucurbits 2556 Broccoli 2548 Dry onions 2036 Cauliflower 1505 Garlic 556 Celery 32 Peppers 31 Lettuce	13,474	758,394 302,462 39.9%
OR	Clackamas	Cucurbits 1296 Cabbage 593 Endive 512 Cauliflower 319 Broccoli 184 Lettuce 132 Peppers 29 Mustard Greens 12 Kale 6 Dry onions Garlic	3083	1,195,712 148,848 12.4%

OR	Multnomah	Cucurbits 877 Cabbage 553 Endive 62 Lettuce 62 Cauliflower 55 Broccoli 29 Mustard greens 10 Peppers 4 Eggplant Garlic	1652	278,570 31,294 11.2%
OR	Washington	Broccoli 400 Cabbage 400 Cucurbits 321 Dry onions 196 Endive 75 Garlic 13 Lettuce 3 Peppers 2 Eggplant 1 Cauliflower	1411	463,231 139,820 30.2%
OR	Columbia	none	0	420,332 71,839 17.1%
OR	Clatsop	none	0	529,482 24,740 4.7%
WA	Pacific	none	0	623,722 32,637 5.2%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
WA	Clark	Cucurbits 2 Lettuce	2	401,850 82,967 20.6
WA	Cowlitz	none	0	728,781 35,678 4.9%

WA	Lewis	none	0	1,540,991 112,263 7.3%
WA	Klickitat	Peppers 12 Garlic 1	13	1,198,385 689,639 57.5%
WA	Skamania	none	0	1,337,179 4043 0.4%

Based upon the moderate acreage in Clackamas, Multnomah, Washington and Marion counties, Oregon (even though most of Marion County is outside the area of this ESU), I conclude that agricultural use of bensulide may affect the Lower Columbia River chinook ESU, although I believe this would apply only in the smaller tributaries. While I suspect that bensulide use on home lawns would not exceed the 20% and 36% levels calculated above, I cannot be sufficiently certain to discount this concern for the Portland metropolitan area. Therefore, it is possible that the home lawn use of bensulide may affect this ESU also. I would expect no effect for the Washington counties due to negligible acreage and lower housing density, and no effect in the migratory corridor below Portland.

I believe that a buffer would provide appropriate protection for the agricultural use of bensulide. But if enough lawns in the urban/suburban areas are treated to be of concern, a buffer might not be adequate for the lawn use. I have no alternative recommendations for the lawn use, but suggest working with the Oregon Department of Agriculture to see what might be done.

8. Upper Willamette River Chinook Salmon ESU

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

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

Tables 32 and 33 show the cropping information for Oregon counties where the Upper Willamette River chinook salmon ESU occurs and for the Oregon and Washington counties where this ESU migrates. There is a high amount of acreage where bensulide may be used in Marion County, and a moderate amount of acreage in Linn, Clackamas, and Washington counties within the spawning and growth areas and in Multnomah County in the migratory corridor. Again, the Willamette Valley can have moderate amounts of homes throughout, and the Portland area is heavily urban and suburban. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 32. Crops on which bensulide can be used that are part of the spawning and rearing habitat of the Upper Willamette River chinook salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Douglas	Cucurbits 235 Peppers 28 Garlic 18 Cabbage 7 Broccoli 3 Eggplant 3 Endive 1 Lettuce 1 Cauliflower	296	3,223,576 402,023 12.5%
OR	Lane	Cucurbits 206 Cabbage 20 Endive 16 Peppers 15 Lettuce 15 Broccoli 5 Cauliflower 4 Dry Onions 3 Garlic 3	288	2,914,656 242,121 8.3%

OR	Benton	Cucurbits 891 Endive 10 Lettuce 10 Peppers 4 Dry onions 3 Garlic 3 Broccoli Eggplant	921	432,961 118,818 27.4%
OR	Linn	Cucurbits 494 Cabbage 431 Broccoli 267 Cauliflower 164 Dry onions 1 Peppers Garlic	1357	1,466,507 380,464 25.9%
OR	Polk	Cucurbits 17 Garlic 7 Broccoli Peppers	24	474,296 167,880 35.4%
OR	Clackamas	Cucurbits 1296 Cabbage 593 Endive 512 Cauliflower 319 Broccoli 184 Lettuce 132 Peppers 29 Mustard Greens 12 Kale 6 Dry onions Garlic	3083	1,195,712 148,848 12.4%
OR	Marion	Cabbage 4210 Cucurbits 2556 Broccoli 2548 Dry onions 2036 Cauliflower 1505 Garlic 556 Celery 32 Peppers 31 Lettuce	13,474	758,394 302,462 39.9%

OR	Yamhill	Broccoli 308 Cabbage 308 Cucurbits 275 Sweet peppers 13 Eggplant Dry onions	904	457,986 179,787 39.3%
OR	Washington	Broccoli 400 Cabbage 400 Cucurbits 321 Dry onions 196 Endive 75 Garlic 13 Lettuce 3 Peppers 2 Eggplant 1 Cauliflower	1411	463,231 139,820 30.2%

Table 33. Crops on which bensulide can be used that are part of the migration corridors of the Upper Willamette River chinook salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Clark	Cucurbits 2 Lettuce	2	401,850 82,967 20.6
WA	Cowlitz	none	0	728,781 35,678 4.9%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
WA	Pacific	none	0	623,722 32,637 5.2%

OR	Multnomah	Cucurbits 877 Cabbage 553 Endive 62 Lettuce 62 Cauliflower 55 Broccoli 29 Mustard greens 10 Peppers 4 Eggplant Garlic	1652	278,570 31,294 11.2%
OR	Columbia	none	0	420,332 71,839 17.1%
OR	Clatsop	none	0	529,482 24,740 4.7%

Based upon the moderate acreage in most counties and high acreage in Marion County, I conclude that agricultural use of bensulide may affect the Upper Willamette River chinook ESU, although I believe this would apply only in the smaller tributaries. While I suspect that bensulide use on home lawns would not exceed the 20% and 36% levels calculated above, I cannot be sufficiently certain to discount this concern for the Portland metropolitan area. Therefore, it is possible that the home lawn use of bensulide may affect this ESU also. I would expect no effect in the migratory corridor below Portland.

I believe that a buffer would provide appropriate protection for the agricultural use of bensulide. But if enough lawns in the urban/suburban areas are treated to be of concern, a buffer might not be adequate for the lawn use. I have no alternative recommendations for the lawn use, but suggest working with the Oregon Department of Agriculture to see what might be done.

9. Upper Columbia River Spring-run Chinook Salmon ESU

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

Columbia-Clatskanie, Lower Columbia, and Lower Willamette. Counties in which spawning and rearing occur are Chelan, Douglas, Okanogan, Grant, Kittitas, and Benton (Table 34), with the lower river reaches being migratory corridors (Table 35).

Tables 34 and 35 show the cropping information for Washington counties that support the Upper Columbia River chinook salmon ESU and for the Oregon and Washington counties where this ESU migrates. Grant and Benton counties have moderate acreage where bensulide can be used on onions, for which the QUA estimates a national average of 11% is treated with bensulide. There is also moderate onion acreage along the migration corridor although the size of the Columbia River should provide more than adequate dilution. Houses would be likely to be of low density except in the Portland and surrounding area. In these tables, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 34. Crops on which bensulide can be used in Washington counties where there is spawning and rearing habitat for the Upper Columbia River chinook salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Benton	Dry onions 3398 Peppers 2 Cucurbits	3400	1,089,993 640,370 58.7%
WA	Kittitas	none	0	1,469,862 355,360 24.2%
WA	Chelan	none	0	1,869,848 112,085 6%
WA	Douglas	none	0	1,165,168 918,033 78.8%
WA	Okanogan	Garlic 5 Cabbage 1 Cucurbits 1 Broccoli 1	8	3,371,698 1,291,118 38.3%
WA	Grant	Dry onions 6214 Cucurbits 133	6347	1,712,881 1,086,045 63.4%

Table 35. Crops on which bensulide can be used that are migration corridors for the Upper

Columbia River chinook salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Franklin	Dry onions 4074 Cucurbits 7 Peppers	4081	794,999 670,149 84.3%
WA	Yakima	Cucurbits 817 Peppers 439 Cabbage 144 Eggplant 5 Dry onions Garlic	1405	2,749,514 1,639,965 59.6%
WA	Walla Walla	Dry onions 2172 Endive 306 Cucurbits 140 Cabbage 6 Lettuce	2624	813,108 710,546 87.4%
WA	Klickitat	Peppers 12 Garlic 1	13	1,198,385 689,639 57.5%
WA	Skamania	none	0	1,337,179 4043 0.4%
WA	Clark	Cucurbits 2 Lettuce	2	401,850 82,967 20.6
WA	Cowlitz	none	0	728,781 35,678 4.9%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
WA	Pacific	none	0	623,722 32,637 5.2%

OR	Gilliam	none	0	770,664 766,373 99.4%
OR	Umatilla	Dry onions 3914 Cucurbits 1037 Peppers 121 Garlic 9 Buckwheat	5081	2,057,809 1,466,580 71.3%
OR	Sherman	none	0	526,911 487,534 92.5%
OR	Morrow	Dry onions	NS	1,301,021 1,119,004 86%
OR	Wasco	Garlic	NS	1,523,958 1,152,965 75.7%
OR	Hood River	Broccoli Cucurbits	NS	334,328 27,201 8.1%
OR	Multnomah	Cabbage 553 Cucurbits 877 Endive 62 Lettuce 62 Cauliflower 55 Broccoli 29 Mustard greens 10 Peppers 4 Eggplant Garlic	1652	278,570 31,294 11.2%
OR	Columbia	none	0	420,332 71,839 17.1%
OR	Clatsop	none	0	529,482 24,740 4.7%

Based upon the 11% average, and noting that it is an average, the potential onion acreage that would be treated with bensulide within the spawning and rearing habitat of the Upper Columbia River chinook salmon ESU would be no more than 700 acres treated in any county. I would expect no concerns in the Columbia River and high volume tributaries, but should a moderate portion of those acres be located next to or near a small tributary where the chinook could occur, then there could be a concern. I conclude that bensulide's agricultural use may affect this ESU, even though I do not think it very likely. The likelihood of home lawn use in sufficient quantities to be a concern is so low that I believe there will be no effect from this use. Similarly, I believe there will be no effect in the migratory corridors. I recommend that a buffer be used to mitigate exposure so that it is below our concern levels. Alternatively, the Washington State Department of Agriculture's task force may provide more focused protective measures that would be acceptable to NMFS.

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.

Table 36 contains usage information for the California counties supporting the Central California coast coho salmon ESU. Except for low use in Santa Cruz County, there is very little reportable bensulide use within this ESU. Housing density where lawn use could occur may be high in San Mateo County and moderate in Santa Cruz and Marin counties.

Table 36. Use of bensulide in counties with the Central California Coast coho ESU.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated	Non-agricultural uses	Non-Ag usage pounds
Santa Cruz	Lettuce, mustard, leafy vegetables, collards, cabbage, broccoli	665	253	none	
San Mateo	Chinese greens	6	1	none	
San Francisco	none			none	
Marin	none			none	
Sonoma	pumpkin	14	14	none	
Mendocino	none			none	
Napa	none			none	

There is not a lot of agricultural bensulide use, only 268 acres in 2001, in the area where the Central California Coast coho salmon occurs. However, much of this area is strongly urban and suburban where bensulide lawn use may occur. Given the relatively low agricultural use along the coast, I would expect that bensulide would not be likely to adversely affect this ESU. But in combination with very high level of uncertainty regarding lawn use, I conclude that bensulide may affect the California Central Coast coho salmon. I would expect that the potential for effects would be low because I doubt that more than 20% of the lawns would be treated twice, or 36% treated once. But the “may affect” conclusion does not relate to how much effect but rather whether there is an adverse effect.

Because I believe the most likely concern within this ESU is from home lawn use, making an aquatic hazard designation for bensulide in California DPR's county bulletins would not seem to provide sufficient protection. Unless NMFS considers that the risks from lawn use of bensulide are discountable because it would require more than 20% of the lawns to be treated twice (or 36% treated once) to exceed our criteria, taking into account the conservativeness of our farm pond model and the extra concerns for urban uses to transport readily across paved surfaces, then I recommend that NMFS and OPP work with California DPR to determine ways of reducing bensulide exposure to acceptable levels.

2. Southern Oregon/Northern California Coast Coho Salmon ESU

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

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

Tables 37 shows that there is no reportable usage of bensulide in the California counties supporting the Southern Oregon/Northern California coastal coho salmon ESU. Table 38 shows the acreage where bensulide may be used on crops is very low in the Oregon counties where the Southern Oregon/Northern California coastal coho salmon ESU occurs. In Table 38 if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available. Housing density would be generally low throughout both states within this ESU.

Table 37. Use of bensulide in California counties with the Southern Oregon/Northern California coastal coho salmon ESU.

County	Agricultural Crop(s)	Ag usage pounds	Ag Acres treated	Non-agricultural uses	Non-Ag usage pounds
Humboldt	none			none	
Mendocino	none			none	
Del Norte	none			none	
Siskiyou	none			none	
Trinity	none			none	
Lake	none			none	

Table 38. Bensulide use in Oregon counties where there is habitat for the Southern Oregon/Northern California coastal coho salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Curry	Endive 1 Lettuce 1 Broccoli	2	1,041,557 74,375 7.1%
OR	Jackson	Cucurbits 46 Dry onions 40 Lettuce 8 Peppers 8 Endive 8 Eggplant 3 Garlic 2 Cabbage 1 Broccoli 1	117	1,782,633 262,251 14.7%

OR	Josephine	Cucurbits 17 Garlic 5 Cabbage 4 Broccoli 2 Cauliflower 1 Peppers 1 Dry onions 1 Endive 1 Lettuce 1	33	<u>1,049,308</u> 31,249 3.0%
OR	Douglas	Cucurbits 235 Peppers 28 Garlic 18 Cabbage 7 Broccoli 3 Eggplant 3 Endive 1 Lettuce 1 Cauliflower	296	<u>3,223,576</u> 402,023 12.5%
OR	Klamath	Dry onions	NS	<u>3,804,552</u> 720,153 18.9%

Because there is no agricultural use of bensulide in California, and because of the quite limited acreage where bensulide could be used in the Oregon counties, and because of the low density of housing where lawn use could occur, it would seem most likely that there would be no effect. But I cannot be certain that the limited agricultural acreage is not next to first order streams where coho from this ESU might occur. Therefore, I conclude that bensulide may affect, but is not likely to adversely affect, the Southern Oregon/Northern California coastal coho salmon.

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

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

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

Table 39 show the acreage where bensulide can be used for Oregon counties where the Oregon coast coho salmon ESU occurs. There is essentially no relevant acreage in the strictly coastal counties. Douglas, Lane, and Benton counties have low acreage, but from personal experience, I believe that nearly all, or at least most of this acreage occurs in the Willamette River watershed portions of these counties rather than along the coastal stream portions of these counties. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available. Housing density is low enough that lawn use would not be a concern.

Table 39. Crops on which bensulide can be used that are in counties where there is habitat for the Oregon coast coho salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
OR	Curry	Endive 1 Lettuce 1 Broccoli	2	1,041,557 74,375 7.1%
OR	Coos	none	0	1,024,346 174,872 17.1%
OR	Douglas	Cucurbits 235 Peppers 28 Garlic 18 Cabbage 7 Broccoli 3 Eggplant 3 Endive 1 Lettuce 1 Cauliflower	296	3,223,576 402,023 12.5%

OR	Lane	Cucurbits 206 Cabbage 20 Endive 16 Peppers 15 Lettuce 15 Broccoli 5 Cauliflower 4 Dry Onions 3 Garlic 3	288	2,914,656 242,121 8.3%
OR	Lincoln	Cucurbits 2 Lettuce 1 Cabbage 1 Endive 1 Broccoli 1 Garlic	6	626,976 34,292 5,5%
OR	Benton	Cucurbits 891 Endive 10 Lettuce 10 Peppers 4 Dry onions 3 Garlic 3 Broccoli Eggplant	921	432,961 118,818 27.4%
OR	Polk	Cucurbits 17 Garlic 7 Broccoli Peppers	24	474,296 167,880 35.4%
OR	Tillamook	none	0	705,417 39,559 5.6%
OR	Clatsop	none	0	529,482 24,740 4.7%

Based upon the very high likelihood that the agricultural use of bensulide in counties associated with this ESU does not occur to any significant degree in the coastal watersheds, and because of the low housing density, I conclude there is no effect of bensulide on the Oregon coast coho salmon ESU.

D. Chum Salmon

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

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

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

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

1. Hood Canal Summer-run chum salmon ESU

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

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

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

Table 40 shows that the acreage where bensulide can be used is very low in the Washington counties where the Hood Canal summer-run chum salmon ESU occurs. Housing density as relates to home lawn use is generally low throughout the ESU, especially in the vicinity of first order streams. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 40. Crops on which bensulide can be used that are in counties where there is habitat for the Hood Canal Summer-run chum salmon ESU

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Mason	Cucurbits	36	615,108 10,965 1.8%
WA	Clallam	none	0	1,116,900 24,253 2.2%
WA	Jefferson	none	0	1,157,642 9,603 0.8%
WA	Kitsap	Cucurbits 9 Lettuce 3 Endive 3 Peppers 1 Garlic 1	17	253,436 10,302 4.1%
WA	Island	Cucurbits	NS	133,499 19,526 14.6%

Based on the low agricultural acreage for bensulide use and the low housing density, I conclude that there is no effect of bensulide on the Hood Canal chum salmon ESU.

2. Columbia River Chum Salmon ESU

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

Critical habitat for the Columbia River chum salmon ESU encompasses all accessible reaches and adjacent riparian zones of the Columbia River (including estuarine areas and tributaries) downstream from Bonneville Dam, excluding Oregon tributaries upstream of Milton Creek at river km 144 near the town of St. Helens. These areas are the hydrologic units of

Lower Columbia - Sandy (upstream barrier - Bonneville Dam, Lewis (upstream barrier - Merlin Dam), Lower Columbia - Clatskanie, Lower Cowlitz, Lower Columbia, Lower Willamette in the counties of Clark, Skamania, Cowlitz, Wahkiakum, Pacific, Lewis, Washington and Multnomah, Clatsop, Columbia, and Washington, Oregon. It appears that there are three extant populations in Grays River, Hardy Creek, and Hamilton Creek.

Table 41 shows the cropping information for Oregon and Washington counties where the Columbia River chum salmon ESU occurs. There is a moderate amount of acreage where bensulide could be used and a moderate to high amount of housing in Multnomah and Washington counties, but potential use would be negligible elsewhere within this ESU. There is essentially no acreage and very little housing in Grays River and Hardy and Hamilton Creeks which are the locations of existing populations within this ESU. In this table, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 41. Crops on which bensulide can be used that are in counties where there is habitat for the Columbia River chum salmon ESU

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
WA	Skamania	none	0	1,337,179 4043 0.4%
WA	Clark	Cucurbits 2 Lettuce	2	401,850 82,967 20.6
WA	Lewis	none	0	1,540,991 112,263 7.3%
WA	Cowlitz	none	0	728,781 35,678 4.9%
WA	Pacific	none	0	623,722 32,637 5.2%

WA	Wahkiakum	none	0	169,125 12,611 7.5%
OR	Multnomah	Cucurbits 877 Cabbage 553 Endive 62 Lettuce 62 Cauliflower 55 Broccoli 29 Mustard greens 10 Peppers 4 Eggplant Garlic	1652	278,570 31,294 11.2%
OR	Columbia	none	0	420,332 71,839 17.1%
OR	Washington	Broccoli 400 Cabbage 400 Cucurbits 321 Dry onions 196 Endive 75 Garlic 13 Lettuce 3 Peppers 2 Eggplant 1 Cauliflower	1411	463,231 139,820 30.2%
OR	Clatsop	none	0	529,482 24,740 4.7%

Based upon the exceedingly low acreage where bensulide can be used and the very low housing density, I conclude that bensulide will have no effect on the Columbia River chum salmon ESU. I further conclude that the use of bensulide in unoccupied portions of the Critical Habitat will not adversely modify the Critical Habitat longer than in the year which it is used. Should any populations of this ESU be found or re-established in first order streams in Multnomah or Washington counties, Oregon, we should re-evaluate our finding to ensure that adequate protection, if necessary, can be developed.

E. Sockeye Salmon

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

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

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

<u>1. Ozette Lake Sockeye Salmon ESU</u>

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

While Lake Ozette, itself, is part of Olympic National Park, its tributaries extend outside park boundaries, much of which is private land. There is limited agriculture in the whole of Clallam County. Table 42 shows that there is no acreage where bensulide can be used within the county, and there is limited housing where bensulide could be used on lawns within this ESU.

Table 42. Crops on which bensulide can be used that are in Clallum County where there is habitat for the Ozette Lake sockeye salmon ESU.

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

WA	Clallam	none	0	1,116,900 24,253 2.2%

Because there is no agricultural acreage where bensulide can be used within this ESU and because of the very low density of housing in areas around Ozette Lake and its tributaries, I conclude that there will be no effect of bensulide on the Ozette Lake sockeye salmon ESU.

2. Snake River Sockeye Salmon ESU

The Snake River sockeye salmon was the first salmon ESU in the Pacific Northwest to be listed. It was proposed and listed in 1991 (56FR14055-14066, April 5, 1991 & 56FR58619-58624, November 20, 1991). Critical habitat was proposed in 1992 (57FR57051-57056, December 2, 1992) and designated a year later (58FR68543-68554, December 28, 1993) to include river reaches of the mainstem Columbia River, Snake River, and Salmon River from its confluence with the outlet of Stanley Lake down stream, along with Alturas Lake Creek, Valley Creek, and Stanley, Redfish, Yellow Belly, Pettit, and Alturas lakes (including their inlet and outlet creeks).

Spawning and rearing habitats are considered to be all of the above-named lakes and creeks, even though at the time of the critical habitat Notice, spawning only still occurred in Redfish Lake. These habitats are in Custer and Blaine counties in Idaho. However, the habitat area for the salmon is high elevation areas in a National Wilderness area and National Forest. Bensulide cannot be used on such a site, and therefore there will be no exposure in the spawning and rearing habitat. There is a possibility that this salmon ESU could be exposed to bensulide in the lower and larger river reaches during its juvenile or adult migration, but considering that the migratory corridors are larger rivers where bensulide could be used, concentrations would be well below our criteria of concern.

Table 43 shows that there is no acreage of crops in Idaho counties where this ESU reproduces or migrates. Table 44 shows that only in the migratory corridor from the lower Snake River downstream would there be any acreage where bensulide can be used. In addition, there is scattered potential housing except where around Portland. In table 44, if there is no acreage given for a specific crop, this means that there are too few growers in the area for USDA to make the data available.

Table 43. Crops on which bensulide can be used that are in Idaho counties where there is spawning and rearing habitat for the Snake River sockeye salmon ESU.

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

ID	Custer	none	0	3,152,382 140,701 4.5%
ID	Blaine	none	0	1,692,735 266,293 15.7%

Table 44. Crops on which bensulide can be used that are in Oregon and Washington counties that are in the migratory corridors for the Snake River sockeye salmon ESU.

St	County	Crops and acres planted	Acres	total acreage land in farms % farmed
ID	Idaho	none	0	5,430,522 744,295 13.7%
ID	Lemhi	none	0	2,921,172 193,908 6.6%
ID	Lewis	none	0	306,601 211,039 68.8%
ID	Nez Perce	none	0	543,434 477,839 87.9%
WA	Asotin	none	0	406,983 274,546 67.5%
WA	Garfield	none	0	454,744 325,472 84.3%
WA	Whitman	none	0	1,382,006 1,404,289 101.6%
WA	Columbia	none	0	556,034 304,928 54.8%

WA	Walla Walla	Dry onions 2172 Endive 306 Cucurbits 140 Cabbage 6 Lettuce	2624	813,108 710,546 87.4%
WA	Franklin	Dry onions 4074 Cucurbits 7 Peppers	4081	794,999 670,149 84.3%
WA	Benton	Dry onions 3398 Peppers 2 Cucurbits	3400	1,089,993 640,370 58.7%
WA	Klickitat	Peppers 12 Garlic 1	13	1,198,385 689,639 57.5%
WA	Skamania	none	0	1,337,179 4043 0.4%
WA	Clark	Cucurbits 2 Lettuce	2	401,850 82,967 20.6
WA	Cowlitz	none	0	728,781 35,678 4.9%
WA	Wahkiakum	none	0	169,125 12,611 7.5%
WA	Pacific	none	0	623,722 32,637 5.2%
OR	Wallowa	none	0	2,013,071 694,304 34.5%

OR	Umatilla	Dry onions 3914 Cucurbits 1037 Peppers 121 Garlic 9 Buckwheat	5081	2,057,809 1,466,580 71.3%
OR	Morrow	Dry onions	NS	1,301,021 1,119,004 86%
OR	Gilliam	none	0	770,664 766,373 99.4%
OR	Sherman	none	0	526,911 487,534 92.5%
OR	Wasco	Garlic	NS	1,523,958 1,152,965 75.7%
OR	Hood River	Broccoli Cucurbits	NS	334,328 27,201 8.1%
OR	Multnomah	Cucurbits 877 Cabbage 553 Endive 62 Lettuce 62 Cauliflower 55 Broccoli 29 Mustard greens 10 Peppers 4 Eggplant Garlic	1652	278,570 31,294 11.2%
OR	Columbia	none	0	420,332 71,839 17.1%
OR	Clatsop	none	0	529,482 24,740 4.7%

Based upon the lack of agriculture and housing in the spawning and rearing areas of this

ESU, and because bensulide concentrations in the migratory corridors would be well below levels of concern, I conclude there will be no effect on the Snake River sockeye salmon ESU.

5. Specific conclusions for Pacific salmon and steelhead

1. There is no known or very limited use associated with several salmon and steelhead ESUs. Therefore, I conclude that there is “no effect” from the registration of bensulide on the Northern California steelhead ESU, the California coastal chinook salmon ESU, the Hood Canal chum salmon ESU, the Lower Columbia River chum salmon ESU, and the Ozette Lake sockeye salmon ESU.

2. There is no known use of bensulide associated with the spawning and rearing habitat of the Snake River sockeye salmon, and there would be sufficient dilution in the migratory corridors to be of no consequence. Therefore, I conclude that there is “no effect” from the registration of bensulide on the Snake River sockeye salmon ESU.

3. The potential use of bensulide in counties for the Oregon Coast coho salmon ESU is low to very low, but where it is only “low”, nearly all of the acreage is in the Willamette Valley rather than in the coastal watershed of this ESU. I conclude there is no effect on this ESU.

4. For the Sacramento River run chinook salmon ESU, I conclude that there will be sufficient dilution of bensulide in the Sacramento River that while bensulide may affect, it is not likely to adversely affect this ESU.

5. There is limited acreage where bensulide can be used in the areas where the Southern Oregon/Northern California coho salmon ESU occurs. Effects would occur only if bensulide is used on much of this acreage and if this acreage is next to first order streams. I consider this likelihood so low that, while bensulide may affect, it is not likely to affect this ESU.

6. There is considerable use of bensulide in the South Central California steelhead ESU. Bensulide may affect this ESU.

7. There is low to moderate agricultural use, and very often uncertain home use of bensulide in other ESUs. In general, I would expect effects to be unlikely, but I cannot discount them. Therefore, I must consider that bensulide may affect the Upper Columbia, Snake River spring/summer-run, Snake River fall-run, Upper Willamette, Lower Columbia, Puget Sound, and Central Valley spring-run chinook ESUs, the Central California Coastal coho salmon ESU, and the Snake River Basin, Upper Columbia River, Middle Columbia River, Lower Columbia River, Upper Willamette River, Central California Coast, Southern California, and Central Valley, California steelhead ESUs.

Table 45. Summary conclusions on specific ESUs of salmon and steelhead for bensulide.

Species	ESU	finding

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

Steelhead	Central Valley, California	may affect

6. References

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

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

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

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

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

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

McCorkle FM, Chambers JE, and Yarbrough JD. 1977. Acute toxicities of selected herbicides to fingerling channel catfish, *Ictalurus punctatus*. Bull. Environ. Contam. Toxicol. 18: 267-270.

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

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

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

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

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

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

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

Attachments

1. Representative Labels
2. Interim Reregistration Eligibility Decision for Bensulide
3. Qualitative Use Assessment for Bensulide
4. USGS map of Bensulide Use Areas
5. Revised Environmental Fate and Effects Division's Ecological Risk Assessment
6. Memorandum: Addendum to bensulide RED: Revised Risk Assessment and Risk Characterization for Risk to Aquatic Organisms from Use on Turf