Acrolein
Analysis of Risks
from the Aquatic Herbicide Use in Irrigation Supply Canals
to Eleven Evolutionarily Significant Units of
Pacific Salmon and Steelhead

May 15, 2003

Larry Turner, Ph.D. and William Erickson, Ph. D.
Environmental Field Branch
Office of Pesticide Programs

Summary

Acrolein is a biocide currently registered as an herbicide to control aquatic weeds in irrigation canals, as a burrow fumigant to control rodents, and as a microbiocide to eliminate slime-forming microbes in oil drilling operations, pulp and paper mills, and in industrial cooling towers. It has activity as a molluscicide, but is not currently registered for use against mollusks. This analysis involves a risk assessment of the use of acrolein as an aquatic herbicide and its potential effects on listed salmon and steelhead ESUs that occur in California, including the portion of Southern Oregon/Northern California Coastal Coho Salmon ESU that reaches into Oregon. We conclude that the aquatic herbicide use of acrolein, in accordance with label directions, may affect but is not likely to adversely affect six Evolutionarily Significant Units (ESUs) of salmon and steelhead and will have no effect on five ESUs.

Introduction

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

It is our intent to develop similar analyses for listed salmon and steelhead ESUs that occur in Oregon, Washington, and Idaho. Additional data are being developed, compiled, and/or analyzed as a result of NPDES permits being issued for uses of acrolein in some of these Pacific Northwest ESUs. These data will be included in future analyses by OPP.

The format of this analysis is similar to previous analyses, except that it covers only the Evolutionarily Significant Units of listed Pacific salmon and steelhead that occur in California and far southern Oregon. The background section explaining the risk assessment process is the same as was presented in a previous assessment for diazinon. There is no existing aquatic risk assessment for acrolein in OPP files because the aquatic herbicide uses were registered prior to the inception of OPP's ecological risk assessments. Acrolein is not scheduled to be evaluated for a "Reregistration Eligibility Decision" (RED) document until after 2005. Because of acrolein's high volatility, waivers have been requested for various test data. The record is not clear on which data waivers have actually been granted; these will be re-evaluated and determined when acrolein undergoes a risk assessment for reregistration.

Problem Formulation - The purpose of this analysis is to determine whether the registration of acrolein for use in irrigation systems may affect the Southern Oregon/Northern California Coho Salmon, the Central California Coast Steelhead, the Central Valley Steelhead, the Southern California Steelhead ESU, the South Central California Steelhead ESU, the Central California Coast Steelhead ESU, the Sacramento River Winter-run Chinook Salmon ESU, the Central Valley Spring-run Chinook Salmon ESU, the California Coastal Chinook Salmon ESU, the Central California Coast Coho Salmon ESU, and the proposed Central Valley Fall/Late Fall-run Chinook Salmon ESU or that may adversely modify their designated critical habitat.

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

Contents

1. Background

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Table 2. Risk quotient criteria for fish and aquatic invertebrates

Test data	Risk quotient	Presumption
Acute LC50	>0.5	Potentially high acute risk

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

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

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

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

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

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

a. Registered uses

Acrolein is a biocide registered for use as an aquatic herbicide, as a rodenticide fumigant, and as a microbiocide in cooling towers, oil drilling operations, and pulp and paper mill systems for control of slime-forming and animal-pathogenic bacteria and fungi and sulfate-reducing bacteria,. The action under consideration in this analysis is the aquatic herbicide use. Acrolein was originally registered at least as early as 1959, and at that time Shell Chemical Corporation was the registrant.

Currently, there are five federally registered products, two of which can be used as aquatic herbicides in irrigation canals; the other three are the microbiocide uses. The registrant for all Federally registered products is Baker Petrolite Corporation. In addition, there are seven Special Local Needs (SLN) registrations for particular states. Four of the SLN registrations are in California and Oregon. Each state has an SLN registration to control rodents in burrows, using the acrolein as a fumigant, and each state has an SLN registration that allows acrolein to be used in "impounded waters." In OPP files on the first review in 1978 of this latter use is a statement that, according to California Department of Food and Agriculture, "...the reservoirs to be treated are essentially large farm ponds designed to hold run-off water. The water is used only for agricultural irrigation and generally doesn't leave the property of the reservoir owner. The reservoirs do not contain either fish or potable water intakes." This impounded water use appears to be rare, at least in California where the Department of Fish and Game must be notified before any acrolein herbicide use. No such notifications have been received "in recent years."[1]

Acrolein is apparently a good molluscicide and may be used to control mollusks in other countries. However, acrolein is not registered for use against mollusks in the U. S.

All of the products under consideration here are classified as "restricted use" pesticides, which means they can be applied only be certified applicators. In addition, Baker Petrolite Corporation has a manual relating to uses and applications and they train all applicators in the appropriate use of acrolein. A copy of the manual and label is included as Attachment 1.

The vast majority of acrolein use is non-pesticidal. Large quantities are used in making polymers and other industrial chemicals. In 1983, 216 000-242 000 metric tons of acrolein was reported to be used in the USA for this purpose (WHO, 1992). Much of the industrial use includes both production and use of acrolein in a single manufacturing process. It is also formed in the incomplete burning of fossil fuels and other organic material, including coal utility use, internal combustion engines, forest fires, tobacco smoke, deep fat frying, and many others (Eisler, 1994).

b. Acrolein usage

There are no generally available usage data for acrolein except for California. California requires full pesticide-use reporting by all applicators except homeowners and most industrial or institutional uses not performed by a licensed pest control applicator. The California Department of Pesticide Regulation provides the use information at the county level (www.cdpr.ca.gov/docs/pur/purmain.htm). In California, annual use of acrolein has varied between 204,000 lb ai and 351,000 lb ai from 1991 to 1992 (Table 3). Because of the unusual use of acrolein, there is not a great deal of consistency from county to county on the way that specific uses are being reported to the state. Uses reported as "vertebrate control" are clearly not the aquatic herbicide use, and it is almost as clear that "structural pest control" would be the rodent

[1] Personal Communication, Bob Hosea, California Department of Fish and Game, April 28, 2003.

use. Acrolein is not registered for crops, and therefore any uses reported for a crop seem likely to be for rodent control also. The use as an aquatic herbicide may be reported as a "water" use or as a rights-of-way use.[2] The "ditch bank" use would also seem to be the vertebrate use since the aquatic herbicide use involves directly injecting the acrolein into the water. Regardless of the reporting categories, it does appear that most of the use in California is for aquatic weed control; both Baker Petrolite Corporation[3] and California Department of Fish and Game[4] qualitatively agree. Total usage in California for both the aquatic herbicide and vertebrate control is presented in Table 3. Table 4 then provides two years of statewide data broken down by the reported use. Additional breakdowns by the reported uses in each of the counties where the 11 subject ESUs occur are presented in the discussions of the individual ESUs. In general, acrolein is used more in sunnier areas and in warmer areas, and as a result, there is low use along the southern coastal areas and essentially no use along northern coastal areas in California.

Table 3. Reported use of acrolein in California, 1991-2001, in pounds of active ingredient. (source: California DPR Pesticide Use Reports)

Yr	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Use	204625	227022	299910	336993	351660	322578	341245	264207	328238	290180	233928

Table 4. Uses of acrolein in California 1999-2001 (source: California DPR Pesticide Use Report)

Use site	1999		2000		2001	
	lb ai applied	acres treated[a]	lb ai applied	acres treated[a]	lb ai applied	acres treated[a]
Rights-of-way	294,447	nr	256,899	nr	206,610	nr
Water areas	23,653	1066	24,303	9566	14,513	5356
Landscape maintenance	5320	nr	2779	nr	4508	nr
Structural pest control	1725	nr	972	nr	6401	nr
Ditch banks	0		67	3	810	110
Vertebrate control	0		0		756	nr

---

[2] Personal Communication, Tehama County Agricultural Commissioner's Office, April 21, 2003

[3] Telephone communication, Bonnie Bonnivier, Acrolein Program Manager, Baker Petrolite Corporation, May 1, 2003.

[4] Personal Communication, Bob Hosea, California Department of Fish and Game, April 28, 2003.

Use site	1999		2000		2001	
	lb ai applied	acres treated[a]	lb ai applied	acres treated[a]	lb ai applied	acres treated[a]
Uncultivated non-agriculture	518	38	2478	253	277	21
Mint			0	0	53	16
Oranges			5	1	0	0

[a] nr - not reported; please note that even when acreage is reported, it generally does not cover all of the applications

In southern Oregon, where the Southern Oregon/Northern California Coastal Coho Salmon ESU occurs in Curry, Josephine and Jackson counties, there has been significant historical usage of acrolein. In the Talent Irrigation District, Jackson County, and in the Grants Pass Irrigation District, Josephine County, there have been several significant incidents involving fish kills (see section 3c). There have been no sales of acrolein in any of these three counties in 2001 or 2002, apparently as a result of legal action or concern over further legal action. The last sale of acrolein to the Talent Irrigation District was in 2000 and was for 1110 pounds. There have been more recent sales in other southern Oregon areas (e.g., Klamath Irrigation District) outside the Critical Habitat of this coho ESU[5].

This recent usage data is not likely to accurately reflect what will be happening in the future. In 2001, a court case heard on appeal[6] required that NPDES permits be obtained prior to herbicide treatment of irrigation canals. As a result, acrolein was not allowed to be used without such a permit after the court decision. However, this lack of recent use is likely to change as irrigation districts work through the process and obtain appropriate permits, and as other actions occur. We believe that the 1999-2000 data for California is more likely to reflect future usage than the 2001 data. Similarly, although there have been no sales in the last two years to the Talent Irrigation District and others within the Southern Oregon/Northern California Coastal Coho salmon ESU, this district does intend to use acrolein.[7]

c. Application sites and methods

---

[5] Telephone communication, Bonnie Bonnivier, Acrolein Program Manager, Baker Petrolite Corporation, May 1, 2003.

[6] Headwaters, Inc. et al. v. Talent Irrigation District, No 99-35373. Opinion by the Appellate Court, filed March 12, 2001.

[7] Telephone communication, Jim Pendleton, Manager, Talent Irrigation District, May 7, 2003.

Information on how acrolein is used in irrigation systems was obtained from product labels and the application and safety manual for Magnacide H Herbicide (Attachment 1) and an SLN label. Acrolein is applied by injection from metered, pressurized containers into flowing water at a point of good mixing, such as downstream of a weir or siphon. The material is forced from the container using nitrogen gas and is introduced directly into the water for anywhere from 15 minutes to 8 hours. The acrolein travels downstream as a wave of treated water, and the concentration of herbicide drops to zero after the wave has passed. The amount of material required depends on the amount of water flow and weed density in the canal. Concentrations in the range of 1 to 15 ppm are needed for effective control. Where weed growth has "choked" the canal, as much as 1.5 gallons of product is needed per cubic foot per second of water flow. Water temperature affects efficacy, and the amount of product used may need to be increased as much as 100% when water temperature is at or below 50ºF and up to 50% when temperature is between 50 to 55ºF. The concentration of acrolein in the water should never exceed 15 ppm. According to the product label, water treated with Magnacide H Herbicide can be used to irrigate fields or, if not, must be held for 6 days before being released into fish-bearing waters or where it will drain into them.

The actual amount used in any application will depend both on the degree to which weeds occur in the canal and the size of the canal. Baker Petrolite Corporation indicated that application amounts range from 1 gallon (6.7 pounds ai) for a very small canal to as much as 400 gallons (2680 pounds ai) for a large canal.

The Federal label allows use only in irrigation supply canals. Irrigation drain canals are not to be treated. Thus, there would be no use in waters draining into fish-bearing waters. There are SLN labels that allow for use in "impounded waters" for both California and Oregon. These are not to be drained into fish bearing waters.

Baker Petrolite Corporation[8] indicated that acrolein is not really effective for aquatic weeds unless it can be well mixed. Therefore, it would not be efficacious in impounded waters with no flow. The nature of use is that typically the reservoirs are drawn down and used for irrigation, then the acrolein is added while they are being refilled. The refilling causes sufficient turbulence in the water to spread the acrolein around so that it comes in good contact with most surfaces of the target weeds. In irrigation supply canals, the water flow provides for sufficient mixing.

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

a. Aquatic toxicity of acrolein

There is a surprisingly large amount of aquatic toxicity data on acrolein. The quality of these data is highly variable; most data, even in OPP's one-liner database, are old and were not developed

---

[8] Telephone communication, Bonnie Bonnivier, Acrolein Program Manager, Baker Petrolite Corporation, May 1, 2003.

according to current methodology. The exceedingly high volatility of acrolein would result in dissipation from the test equipment unless it is controlled, and such control was seldom indicated, or not indicated in most cases. Tables 5 and 6 below present the typical kind of test data available for acrolein from EFED files and from other secondary sources.

(1) Acute toxicity to aquatic animals

Table 5 presents the acute toxicity data in OPP's files for aquatic animals. Because of the volatility of acrolein, waivers have been requested for several ecological tests. These waivers were denied, but because of the processing time, many of the tests have not yet been submitted. Waivers were requested and granted on aquatic toxicity testing of the formulation, which is typically required for a product to be applied directly to water. The basis of granting the waiver is that the formulated product is the same as the technical grade, although it is not clear if the "technical product testing" included the hydroquinone inhibitor. There are acceptable data that indicate that acrolein is very highly toxic to freshwater fish and aquatic invertebrates. Acrolein is highly toxic to estuarine fish and arthropods, but it is very highly toxic in one study on oysters. The 22 ppb LC50 for bluegill sunfish is the lowest LC50 value established in testing done to support registration, but test data from the literature (Table 6) indicate LC50 values of 14 ppb for the white sucker and the fathead minnow.

Table 5. Acute toxicity of acrolein to aquatic organisms (from EFED files).

Species	Scientific name	% a.i.	96-hour LC50 (ppb)	Toxicity Category	Guide-eline[a]
		Freshwater fish			
Bluegill sunfish	*Lepomis macrochirus*	96.4%	22	very highly toxic	Y
Rainbow trout	*Oncorhynchus mykiss*	96.4%	<31	very highly toxic	S
		Freshwater invertebrates			
Water flea	*Daphnia magna*	96.4%	<31	very highly toxic	S
		Estuarine Fish			
Sheepshead minnow	*Cyprinodon variegatus*	85.2	430	highly toxic	S
Longnose killifish	*Fundulus similis*	100	240	highly toxic	Y
		Estuarine invertebrates			
Eastern oyster	*Crassostrea virginica*	100	55	very highly toxic	Y
Eastern oyster	*Crassostrea virginica*	94.7	106	highly toxic	S
Brown shrimp	*Penaeus aztecus*	100	100	highly toxic	Y
Mysid shrimp	*Americamysis bahia*	94.7	500	highly toxic	S

[a] Y = fulfills guideline requirements; S = supplemental; N = not validated

Table 6 below presents additional data on the aquatic toxicity of acrolein. These were extracted from secondary sources (see footnotes to table). Only selected data of a semi-standardized nature are included in the table. Non-standard data include:

1. at 10,000 ppb, 98% of adult snails, *Australorbis glabratus*, and 100% of embryo snails died in 24 hours (Ferguson et al., 1971)[b];
2. 32% mortality of rainbow trout occurred when exposed to 48 ppb for 48 hours (Bartley and Hattrup, 1975)[a];
3. the incipient LC50 for six days in fathead minnow was 84 ppb (Macek et al., 1976)[a];

4. avoidance by rainbow trout fry occurred in 1 hour at 100 ppb; this was above the median lethal concentration (Folmar, 1976)[a];
5. less than 50% mortality of the snail, *Aplexa hypnorum*, and the midge, *Tanytarsus dissimilis*, occurred at 151 ppb for 96 hrs (Holcombe et al. 1987[b]);
6. there was 100% mortality of 3 species of freshwater snails *(Physa, Biomphalaria, Bulinus)* after exposure at 25,000 ppb for 3.5-4 h (Folmar, 1977[b]);
7. 100% of the common mussels *(Mytilus edulis)* detached from cooling water systems of power plants after 29 hr of exposure at 600 ppb (Rijstenbil and van Galen 1981[b]).

Table 6. Acute toxicity of acrolein to aquatic organisms from other sources.

Species	Scientific name	96-hour LC50 (ppb)	Reference
	Freshwater fish		
Bluegill sunfish	*Lepomis macrochirus*	100	Louder & McCoy, 1972[a]
Bluegill sunfish	*Lepomis macrochirus*	90	U. S. EPA, 1978[a]
Bluegill sunfish	*Lepomis macrochirus*	79 (24 hr)	Burdick et al. 1964[b]
Brown trout	*Salmo trutta*	46 (24 hr)	Burdick et al. 1964[b]
Largemouth bass	*Micropterus salmoides*	160	Louder & McCoy, 1972[a]
Bowfin	*Amia calva*	62 (24 hr)	Folmar, 1977[ab]
Mosquitofish	*Gambusia affinis*	61 (48 hr)	Louder & McCoy, 1972[a]
Fathead minnow	*Pimephales promelas*	115 (48 hr)	Louder & McCoy, 1972[a]
Fathead minnow	*Pimephales promelas*	14	Folmar, 1977[b]
Chinook salmon	*Oncorhynchus tshawytscha*	80 (24 hr)	Bond et al., 1960[a]
Coho salmon	*Oncorhynchus kisutch*	68 ppb	Lorz et al, 1979
Rainbow trout	*Oncorhynchus mykiss*	65 (24 hr)	Bond et al., 1960[a]
White sucker	*Catostomus commersoni*	14	Holcombe et al. 1987[b]
Harlequin fish	Rasbora heteromorpha	130 (48 hr)	Folmar, 1977[b]
	Freshwater invertebrates		
Water flea	*Daphnia magna*	57	Macek et al., 1976[a]
Water flea	*Daphnia magna*	80	U. S. EPA, 1978[a]
Water flea	*Daphnia magna*	51	Holcombe et al. 1987[b]
	Estuarine invertebrates		
Barnacles	*Balanus eburneus*	2100 (48 hr)	Dahlberg, 1971[b]
Barnacles	*Balanus eburneus*	1600 (48 hr)	Dahlberg, 1971[b]

[a] As cited in U. S. EPA, 1980
[b] As cited in Eisler, 1994

The toxicity of acrolein is not in doubt except to the degree that it occurs. It can be expected that acrolein will kill target plants and non-target animals, both vertebrate and invertebrate, that are exposed in aquatic treatment sites. Given that acrolein is very highly toxic, the question of risk for a chemical of this nature relates far more to exposure than to determining an exact LC50 for the most sensitive species.

Acrolein was included in a series of smoltification tests with coho salmon (Lorz et al., 1979). They found no apparent effect on sodium or potassium ion stimulated ATPase activity of the gills, and little effect on seawater tolerance following significant exposure below lethal levels. Some dose-related, detrimental histological effects were noted in gills, kidneys, and livers.

Because acrolein appears to be of comparable toxicity to fish and to aquatic invertebrates, it does not appear that indirect effects on the invertebrate food supply of fish are of as much concern as the direct toxicity to the fish.

(2) Chronic toxicity to freshwater fish and invertebrates

There are no chronic toxicity data in EFED files for acrolein and aquatic organisms. WHO (1991) cites a study by Macek et al., 1976 presenting MATCs (i.e., NOEC to LOEC) for fathead minnows and water fleas. The 3-generation (21-day) MATC for *Daphnia magna* was 17-34 ppb. The 60-day partial life cycle MATC for fathead minnows was 11-42 ppb. In both cases, the “effect” was mortality; no effect was observed on the reproductive parameters of survivors.

(3) Toxicity to aquatic plants and algae

Required aquatic vascular plant and algae data for acrolein are presented in Table 7. There are additional data in the literature, most of which are oriented towards the efficacy of acrolein as an aquatic herbicide. These data (see Eisler, 1994 and WHO, 1991 for discussions) indicate that effect levels for many aquatic plants are actually at higher concentrations than the effect levels for many aquatic animals. The attached label & manual developed by the registrant indicates that efficacy is excellent for submerged algae and vascular plants, is good, albeit at higher levels, for floating vegetation, and that emergent vegetation is not controlled; this is consistent with discussions in Eisler (1994). Terrestrial plants do not seem to be affected much by acrolein (Eisler, 1994; attached label and manual).

Table 7. Acute toxicity of acrolein to aquatic plants and algae (from EFED files).

Species	Scientific name	% a.i.	5-d EC50 (ppb)	Guideline[a]
Blue-green alga	*Anabaena flos-aquae*	95%	36 (33-40)	Y
Freshwater diatom	*Navicula pelliculosa*	95%	47 (43-52)	Y
Marine diatom	*Skeletonema costatum*	95%	28 (26-31)	Y
Green algae	*Selanastrum capicornutum*	95%	50 (45-55)	Y
Duckweed	*Lemna gibba*	95%	75 (67-73) (14-day)	S

[a] Y = fulfills guideline requirements; S = supplemental

(4) Field studies

There are no known field studies on the biological effects of acrolein. It is assumed that aquatic animals and most plants in treatment areas will be killed. See section xxx below with regard to field monitoring studies for the presence of acrolein.

(5) Toxicity of degradates

The major hydration product of acrolein is 3-hydroxypropanal, with other aldehydes also being formed (WHO, 1991). No toxicity data could be located. Studies cited in WHO (1991) indicate that these aldehydes are short-lived.

(6) Toxicity of inerts

There are several "inert" ingredients in acrolein formulations. However, all except one are impurities in the manufacturing process and are therefore part of the technical material. Thus, testing of the technical acrolein incorporates the toxic effects of these impurities. The only added "inert" ingredient is hydroquinone, which is added at 0.25% to inhibit spontaneous reactivity of acrolein. Hydroquinone is a "list one" ingredient, which means that it is of toxicological concern and is required to be listed on the label (and is therefore not "confidential"). De Graeve et al. (1980) reported that the 96-hour LC50 for hydroquinone was 97 ppb for rainbow trout and 44 ppb for fathead minnows; the 48-hour LC50 for Daphnia magna was 162 ppb. These were calculated values; the authors noted that 52% of the hydroquinone had hydrolyzed to *p*-benzoquinone in the high concentration. Thus the test incorporates the toxicity of both the hydroquinone and the degradate *p*-benzoquinone that formed during the test. The authors also noted, without providing quantitative data, that the *p*-benzoquinone apparently degrades rapidly to unidentified, less toxic compounds.

While these values certainly demonstrate the high toxicity of the hydroquinone, it is less toxic than the acrolein and is present in only very small amounts. Therefore, it should not contribute meaningfully to the aquatic risk posed by acrolein.

b. Environmental fate and transport

The environmental fate and transport of acrolein are poorly known, except that acrolein is highly volatile and the major routes of loss appear to be hydration and volatilization. OPP has only one acceptable environmental fate study on acrolein. In a hydrolysis study using buffered aqueous solutions containing 10 ppm acrolein, half-lives were 92 hours at pH 5, 37 hours at pH 7, and 19 hours at pH 9.

Because of its prominent use as an industrial chemical, fate and transport data do exist even if these data were not developed in accordance with pesticide practices. All of the following is from WHO (1991) except where specifically attributed otherwise; the double indented paragraph is a quote, and the remaining discussion summarizes (without further attribution) key fate and transport factors:

> "Acrolein is a volatile, highly flammable, lacrimatory liquid at ordinary temperature and pressure. Its odour is described as burnt sweet, pungent, choking, and disagreeable. The compound is highly soluble in water and in organic solvents such as ethanol and diethylether. The extreme reactivity of acrolein can be attributed to the conjugation of a carbonyl group with a vinyl group within its structure. Reactions shown by acrolein include Diels-Alder condensations, dimerization and polymerization, additions to the carbon-carbon double bond, carbonyl additions, oxidation, and reduction. In the absence of an inhibitor, acrolein is subject to highly exothermic polymerization catalysed by light and air at room temperature to an insoluble, cross-linked solid. Highly exothermic polymerization also occurs in the presence of traces of acids or strong bases even when an inhibitor is present."

Acrolein does not contain hydrolysable groups but it does react with water in a reversible hydration reaction to 3-hydroxypropanal. The rate constant for this hydration corresponds to a half-life of 46 h. At equilibrium, laboratory experiments indicate that 8% of the material is acrolein and 85% aldehydes. But the aldehydes "do not persist in river waters so that other methods of dissipation must exist." EPA (1980) indicated that in natural waters, no equilibrium was reached and dissipating reactions occurred to completion.

In field experiments, dissipation was faster than could be predicted assuming hydration alone. Half-lives were calculated from degradation rate constants in irrigation canals to be 3-7 hours. WHO cited studies in which aged acrolein solutions become biocidally inactive after approximately 120 to 180 h at a pH of 7. It was suggested that catalysis, adsorption, and volatilization contributed significantly to acrolein dissipation in addition to the hydration. Other studies indicate a low potential for adsorption to soil.

Eisler (1994) summarizes the half-time persistence of acrolein in freshwater as usually less than 50 h; in seawater it is less than 20 h and in the atmosphere less than 3 h.

In waters where microbes are not acclimated to acrolein, negligible biological degradation occurs, apparently due to toxicity of acrolein to the microbes. However, in waters where acrolein is used routinely or periodically, some microbial components apparently acclimate to the acrolein toxicity, and biodegradation occurs. The rates were equivocal, with 100% degradation in 7 days in one study, and with 30-42% degradation in two other studies. The initial concentrations appear to be very important in acclimating the microbial populations, and this factor may account for the different results.

There is a statement in a press release by the Oregon Natural Resources Council (ORNC), entitled "Summary of evidence from 1989 to 2002 of acrolein use and harm to fish & wildlife in the Klamath Basin of southern Oregon and northern California", and posted at http://www.onrc.org/lawsuits/acrolein/acroleinuse.html that Dr. Glenn Miller testified that acrolein could remain toxic for as long as 22 days, depending upon a number of variables. Therefore, ORNC claims that the six day holding period required on the label is inadequate. This is not consistent with other information that we have found on the persistence of acrolein, and no data were provided to support the statement. It is not included in the claim made in ORNC et al., v. Keys, posted at URL: http://www.pestlaw.com/x/courts/ORNatRes20021021.html. This comment is included in the interest of being complete, but we believe that the preponderance of other data indicating considerably shorter persistence warrants more consideration.

c. Incidents

A number of fish kills have been reported for acrolein. Where sufficient information has been provided, it appears that the fish incidents are as a result of misuse. The form of misuse is that water was released from the irrigation canals too early. In some cases this was because the gate valves were not properly closed or that they leaked, in other cases the applicator opened them intentionally, but too soon. In one case, boards that helped contain the irrigation canal water may have been removed by children playing. In some cases, there was insufficient information to indicate whether the use was in accordance with labels or was a misuse. While some have occurred in Colorado and Nebraska, more have been reported for California and southern Oregon, including in areas where listed salmon and steelhead occur. Fish kills in our Ecological Incident Information System (EIIS) are listed in Table 8. It should be noted that acrolein was, about 15-20 years ago, registered for use in irrigation return canals. In general, we are not able to determine if the older incidents resulted from use in irrigation drainage canals, which is no longer allowed, or in irrigation supply canals, as currently registered

Table 8. Fish kills reported in EFED's Ecological Incident Information System.

Location	date	number	species	reporter[a]
Siskiyou County, CA	8/1/1976	200	"fish"	CDFG
Siskiyou County, CA	5/26/1976	1000	"fish" - mostly steelhead	CDFG
Nevada County, CA	9/9/1994	not reported	6 catfish, 50 sunfish, unknown number of largemouth bass	CDFG
Tehama County, CA	6/22/1988	8000	salmon were being raised in the treated irrigation canal	CDFG
Tehama County, CA	8/24/1976	11000	mostly sticklebacks; about 1000 "game fish"	CDFG
Yolo County, CA	8/27/1971	thousands	not reported	CDFA
Bear Creek Jackson County, OR (Talent District)	5/8/1976-5/9/1976	5000 (initial report)	many species of fish, invertebrates, worms, etc	ODFW
		92,000 (subsequent estimate)	juvenile steelhead	ODFW
Josephine County, OR (Grants Pass District)	1977	238,000	salmon, trout, suckers, cottids, minnows	ODFW

[a.] CDFG = California Department of Fish and Game; CDFA = California Department of Food and Agriculture; ODFW - Oregon Department of Fish and Wildlife

In addition, some reports provided to EPA have too little information to be entered into the EIIS. Mostly these are summary reports of what are considered "minor" incidents, and most of them are annual reports from California's Department of Fish and Game. In addition to the incidents listed above, these include:

1. 45 fish and wildlife incidents in 1994 & 1995 in California; no details on how many were fish and how many were wildlife
2. 5 "fish losses" in California in 1999; no additional details
3. in 1972-73, "many fish" died in two incidents; no additional details
4. 19 incidents in 2001 in Merced County, CA involving a variety of birds, along with carp and trout; no additional details
5. 21 fish kill reports from 1993 for Nebraska; details are available on one incident where the estimate was 50,000 dead fish; apparently the fish killed were living in the treated irrigation canal.
6. about 200 fish, including 1395 German brown trout, died when treated canal water was discharged directly into a creek after application. A neutralizing compound was used to supposedly render the acrolein harmless.
7. Snyder-Conn (1997) references two unpublished fish kill incidents at Tule Lake National Wildlife Refuge along the California-Oregon border. These are not in our files, and we have no details.

Finally we note that the EIIS incident report for 5/8-9/96 in Jackson County, Oregon has one report (as in Table 8) indicating 5000 were killed and another report that 92,000 steelhead were killed on the same date in the same location. A court opinion and order from a lawsuit[9] indicated that there was one incident, stating that the application was made on May 8, 1996, and the incident was discovered on May 9, 1996. This court document refers to the 92,000 steelhead..

d. Estimated and actual concentrations of acrolein in water

(1) EECs based upon application rate

Unlike typical pesticides, there is no way of modeling estimated environmental concentrations for acrolein. However, the nature of the use and the label provide for an intended environmental concentration in the water. The maximum label concentration will be 15 ppm. The concentration used in any particular application may be lower if the weeds are relatively small and mostly submerged. The concentration may also be lower if the acrolein is put into the water over a longer period of time. And to be efficacious, the concentration needs to be proportionately higher at lower water temperatures. The attached Magnacide H manual indicates that a longer treatment period, albeit at a lower concentration, would be necessary in fast moving canals to ensure that there is sufficient duration of contact to control weeds. Under no circumstances may the concentration exceed the 15 ppm.

---

[9] Headwaters and Oregon Natural Resources Council versus Talent Irrigation District, Civil No. 98-6004-AA, United States District Court for the District of Oregon. February 1, 1999

Baker Petrolite Corporation[10] indicated that most applications are at considerably lower concentrations than the 15 ppm maximum. The reason for this is that the preventative maintenance approach of treating the weeds and algae before they grow too much is more efficient and economical than waiting until there is sufficient growth to warrant using the higher concentrations.

(2) Measured residues in the environment

During the summer of 1986, the registrant conducted a field monitoring study to determine the lifetime of acrolein in four canal systems selected by the Washington State Water Resources Association (Caravello, 1988). Canals were monitored for Magnacide H at several locations as the wave of treated water arrived, peaked, and passed by sampling points. Lifetimes of acrolein, determined by comparing the peak concentrations versus time, ranged from 27 to 46 hours for the various application rates (Table 9). We note that there are uncertainties in evaluating the applicability of this study, which was not reviewed and validated by OPP. The application rate was well below the maximum label rate of 15 ppm, and there is no indication in the report that treated water was held for 6 days before being released into untreated waters. Indeed, the report was used as a basis for a Special Local Needs registration for acrolein by Washington state which included only a two-day holding period before release into untreated waters.

Table 9. Lifetimes of acrolein (Magnacide H Herbicide) within four treated canal systems in Washington in 1986.

Site/ water conditions	appl. rate (ppm)	appl. period (hours)	lifetime (hours)
East Low Canal flow (cfs): 2050 temp. (°F): 61-66 pH: 7.5	1.5	3	39
Potholes East Canal flow (cfs): 1780 temp. (°F): 70-74 pH: 7.9	1.4	4	35
Roza Main Canal flow (cfs): 990 temp. (°F): 62-67 pH: 7.7	0.77	6	46

[10] Telephone communication, Bonnie Bonnivier, Acrolein Program Manager, Baker Petrolite Corporation, May 1, 2003.

Site/ water conditions	appl. rate (ppm)	appl. period (hours)	lifetime (hours)
Town Ditch Canal flow (cfs): 82 temp. (°F): 55-58 pH: 7.1	3	4	27

A monitoring study also was conducted in California in 1994. We have not seen the results of this study, but it is mentioned in the U. S. Fish and Wildlife Service's 1995 "Biological Opinion on the Use of Pesticides and Fertilizers on Federal Lease Lands and Acrolein and Herbicide Use on the Klamath Project Rights-of-way located on the Klamath Project (reinitiation of consultation on the use of acrolein for Aquatic Weed Control in Bureau Canals and Drains)". Few details are provided on the treatment application or lifetime of acrolein in this canal; but, according to Service's review of the study, acrolein did not reach natural receiving waters from the three different flow regimes tested. However, leakages in the system were a frequent problem, and acrolein concentrations of 5.9 ppb, 16-17 ppb, and 120-160 ppb were measured in leakage waters.

Acrolein is not a pesticide included in the NAWQA monitoring programs.

e. Recent changes in acrolein registrations

There are no recent changes in the acrolein registrations as an aquatic herbicide with respect to salmon and steelhead areas. About 15-20 years ago, acrolein could also be used in drainage canals as well as irrigation supply canals.

f. Existing protections

The primary protective measure for the use of acrolein as an aquatic herbicide is that it is a restricted use herbicide and can only be used by certified applicators. In addition, Baker Petrolite Corporation requires users to be trained by Baker in the use of acrolein. A second *de facto* protection measure is that the equipment and nature of application is so specialized, and also cumbersome according to some that we have talked to, that its use is very unlikely except when and where appropriate.

The current label statement on acrolein products for use in irrigation canals states:

> "This product is toxic fish and wildlife. Keep out of lakes, streams, or ponds. Fish, shrimp and crabs will be killed at application rates recommended. Do not apply where they are important resources. Do not apply to water drainage areas where runoff or flooding will contaminate ponds, lakes, streams, tidal marshes and estuaries. Do not contaminate water by

cleaning of equipment or disposal of wastes. Notify your state Fish and Game Agency before applying this product. Use only as specified."

In addition, the "DIRECTIONS FOR USE" for Magnacide H Herbicide stipulate that:

"Water treated with Magnacide H Herbicide must be used for irrigation of fields, either crop bearing, fallow or pasture, where the treated water remains on the field OR held for 6 days before being released into fish bearing waters or where it will drain into them."

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. Acrolein has not been included in these bulletins, but if there were a need to communicate specific restrictions to protect listed species, the use of a label statement on the product referring to specific limitations on use in county bulletins would be the most likely approach. Bulletin development is an ongoing process. At present, 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 agricultural and commercial applicators must get a permit for the use of any restricted use pesticide, such as acrolein, 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 currently "voluntary " in nature, the Agricultural Commissioners strongly promote their use by pesticide applicators. Acrolein is not currently included in these bulletins, but it could be if warranted. 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).

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

g. Water quality criteria

Toxicity data available to the Office of Water when the ambient water quality criteria were established did not include the studies currently available within OPP, which were all conducted after 1980. As a result, the criteria were based on the then-available LC50 values that were higher than are included in this current analysis.

“The available data for acrolein indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 68 and 21 µg/l, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

“The available data for acrolein indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 55 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of acrolein to sensitive saltwater aquatic life.” (EPA, 1980)

h. Discussion and general risk conclusions

Acrolein is very highly toxic to fish, and listed aquatic species in treated areas could be at risk from even low concentrations of acrolein. The LOC for endangered fish is exceeded when the risk quotient (RQ = EEC/LC50) exceeds 0.05. Assuming that the bluegill LC50 of 22 ppb is representative of endangered steelhead and salmon, the LOC would be exceeded when the concentration of acrolein in the water exceeds 1.1 ppb. Based upon the most sensitive fish in the literature, the fathead minnow and white sucker with LC50 values of 14 ppb, the LOC would be exceeded at 0.7 ppb. Aquatic invertebrates are sensitive, but based upon the limited data available, they are no more sensitive than fish. Therefore, there would be less concern for indirect effects on food supply for listed fish than for direct effects on the fish

Applications of up to 15 ppm are allowed by the product label and would definitely pose an acute risk to any fish in the treatment area; RQs based on the bluegill LC50 and the maximum concentration would be (15 ppm/1.1 ppb) =13,636. Even the lowest efficacious rates would pose serious risk to fish in the treated canals. However, effective persistence of acrolein in water appears to be up to 50 hours in fresh water (Eisler, 1994; Caravello, 1988), with hydration and volatilization being the primary routes of dissipation. The six-day holding period for acrolein-treated waters is almost three times as long as this dissipation time. There are a number of incidents in which fish have been killed from acrolein treatments, but we know of none when the treated water was held for six days before discharge. Most or all fish kills occurred when treated water was discharged without a holding period or when fish were inhabiting the treated irrigation canals.

As best as we can tell, there should be no effect of acrolein on fish and other aquatic species, unless they are in the treated canals. The Talent Irrigation District, and presumably others in the subject area, have had fish screens to keep fish out for many decades, and at least the Talent District has upgraded those screens recently to meet NMFS standards.[11] We do not have information indicating if fish, in particular the listed Southern Oregon/Northern California Coho Salmon ESU, are actually being kept out of the canals.

---

[11] Telephone communication, Jim Pendleton, Manager, Talent Irrigation District, May 7, 2003.

Fish not in the canals should not be affected from legal registered uses. The US FWS (1995) issued a final "Biological Opinion on the Use of Pesticides and Fertilizers on Federal Lease Lands and Acrolein and Herbicide Use on the Klamath Project Rights-of-way located on the Klamath Project (reinitiation of consultation on the use of acrolein for Aquatic Weed Control in Bureau Canals and Drains)" on February 9, 1995 (Attachment 2). This Biological Opinion addresses possible effects of acrolein on several endangered plants and animals, including the Lost River sucker (*Deltistes luxatus*) and the shortnose sucker (*Chasmistes brevirostris*). The Service determined that "If acrolein is applied to portions of the irrigation system that do not contain sucker populations, these applications are not likely to adversely affect the suckers provided that the label restrictions are followed. The label specifies 'do not release treated water for 6 days after application into any fish bearing waters or where it will drain into them.' Therefore, all treated irrigation waters must be held for six days or applied to cropland." The label restrictions also require that the concentration of acrolein in treated waters can not exceed 15 ppm.

After the issuance of this biological opinion, US FWS contaminants specialist Snyder-Conn (1997) conducted a study on acrolein, relative to the Tule Lake National Wildlife Refuge. She found no acrolein residues in water coming into the refuge from irrigation canals that had been treated with acrolein. She also found no evidence of acrolein-related mortality among fathead minnows (*Pimephales promelas*), *Daphnia magna*, and the snail, *Planorvella pierosoma subcrenaum.* There were difficulties with the maintenance of the minnows, but these difficulties were not related to the treatment, and it was noted that the minnows did not exhibit more mortality closer to the edge of the refuge where they would be more likely to encounter acrolein than sites further from the treatment area. No specific conclusions were stated, but the discussion clearly indicates that no effects could be attributed to acrolein use.

There are and always will be uncertainties in risk conclusions. Our information used in making the determinations is existing data generated in the past. We can make projections for the future but we can provide little assurance that something will not change to render our projections into the future moot. Our intent is to use the best available scientific and commercial data and then to apply our best professional judgement. On this basis, we conclude that the use of acrolein as an aquatic herbicide is not likely to adversely affect certain salmon and steelhead ESUs. It seems most likely that acrolein will have no effect on these salmon and steelhead, but given the history of incidents in the areas occupied by some salmon and steelhead ESUs, along with uncertainties regarding the systems in which acrolein is used, we cannot reach a "no effect" determination. In some areas acrolein is not used or is not used in canals where there is a potential to connect with salmon and steelhead waters, and we have reached a no effect determination in these cases. The determinations for the individual ESUs is presented below in section 4.

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

(a) Steelhead

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

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

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

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

1. Southern California Steelhead ESU

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

Within San Diego County, the San Mateo Creek runs through Camp Pendleton Marine Base and into the Cleveland National Forest. While there are agricultural uses of pesticides in other parts of California within the range of this ESU, it would appear that there are no such uses in the vicinity of San Mateo Creek. Within Los Angeles County, this steelhead occurs in Malibu Creek and possibly Topanga Creek. Neither of these creeks drain agricultural areas. There is also a potential for steelhead to occur in agricultural areas in Ventura, Santa Barbara, and San Luis Obispo counties.

Usage of acrolein in counties where this ESU occurs is presented in Table 10. According to Baker Petrolite Corporation, all of the use of acrolein in San Luis Obispo and Santa Barbara counties is for the "impounded waters" use where there is no connection with any stream or river.[12]

Table 10. Use of acrolein in counties within the Southern California steelhead ESU

County	site	2001 lb ai	2000 lb ai	1999 lb ai	1998 lb ai	1997 lb ai
San Diego		0	0	0	0	0
Los Angeles		0	0	0	0	0
Ventura		0	0	0	0	0
San Luis Obispo	rights-of-way	99	961		439	78
	landscape maintenance	537	42			
	water area	170	418	564	633	375
	vertebrate pest control					67
Santa Barbara	rights-of-way	105	51			
	uncult non-agricultural	193				
	landscape maintenance				322	327
	water area	75		990	484	

With no acrolein use that could reach moving waters where this ESU occurs, we conclude that there will be no effect on the Southern California Steelhead ESU.

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-

[12] Telephone communication, Bonnie Bonnivier, Acrolein Program Manager, Baker Petrolite Corporation, May 13, 2003.

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 there is steelhead critical habitats in these areas.

Table 11 shows the acrolein usage in the counties where there is critical habitat for the South Central California steelhead ESU. According to Baker Petrolite Corporation, all of the use of acrolein in these coastal counties is in the "impounded waters" category of use where there is no connection with any stream or river.[13]

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

County	site	2001 lb ai	2000 lb ai	1999 lb ai	1998 lb ai	1997 lb ai
Santa Cruz		0	0	0	0	0
San Benito		0	0	0	0	0
Monterey	rights-of-way uncult. non-agriculture	412 84	 669	 518	1005 	2286 1106
San Luis Obispo	rights-of-way landscape maintenance water area vertebrate pest control	99 537 170 	961 42 418 	 564 	439 633 	78 375 67

With no acrolein use that could reach moving waters where this ESU occurs, we conclude that there will be no effect on the South Central California Steelhead ESU.

3. Central California Coast Steelhead ESU

[13] Telephone communication, Bonnie Bonnivier, Acrolein Program Manager, Baker Petrolite Corporation, May 13, 2003.

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).

There is no usage of acrolein along the coastal portions of this ESU. However, there is some usage in the inland counties of Contra Costa and Solano.

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

County	site	2001 lb ai	2000 lb ai	1999 lb ai	1998 lb ai	1997 lb ai
Alameda		0	0	0	0	0
Contra Costa	rights-of-way commodity fumig	3,969	3815	6806 818	8063	8903
Mendocino		0	0	0	0	0
Marin		0	0	0	0	0
Napa		0	0	0	0	0
San Francisco		0	0	0	0	0
San Mateo		0	0	0	0	0
Santa Clara		0	0	0	0	0

Santa Cruz		0	0	0	0	0
Solano	rights-of-way ditch bank	2051 702	7928	7165	7390	9680
Sonoma		0	0	0	0	0

It is very unlikely that acrolein would affect the Central California Coast Steelhead ESU if it is used in accordance with all label requirements, specifically the six-day holding period before release into natural fish-bearing waters. However, we have insufficient information to ascertain that young steelhead cannot get into canals where it is used, and we note that there have been incidents. At the same time, it appears that in most areas within this ESU there is no acrolein usage at all. Given the current label requirements and the specialized training required, we conclude that the use acrolein in accordance with label directions may affect, but is not likely to adversely affect, the Central California Coast Steelhead ESU.

4. California Central Valley Steelhead ESU

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

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

There is considerable use of acrolein within the range of this ESU. Merced and Stanislaus counties in the southern portion of this ESU have particularly high usage of acrolein, but there is also moderate usage of acrolein in the Sacramento Valley.

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

County	site	2001 lb ai	2000 lb ai	1999 lb ai	1998 lb ai	1997 lb ai
Alameda		0	0	0	0	0
Amador		0	0	0	0	0

Butte		0	0	0	0	0
Calaveras		0	0	0	0	0
Colusa	rights-of-way structural pest ctrl	670	1421	744 1696	196	2018 171
Contra Costa	rights-of-way commodity fumig	3,969	3815	6806 818	8063	8903
El Dorado		0	0	0	0	0
Glenn	rights-of-way structural pest ctrl	9,255	3326 972	6514	4221	7815
Marin		0	0	0	0	0
Merced	rights-of-way structural pest ctrl almonds[a]	56,737	28,435	40,259	25,472	33,221 35 10
Napa		0	0	0	0	0
Nevada	rights-of-way structural pest ctrl	3,240 807	3775	4465	3054	4888
Placer	rights-of-way	3,718	5593	5118	4397	7127
Sacramento	rights-of-way	0	123	304	0	12
San Joaquin	rights-of-way	0	851	2855	773	2048
San Francisco		0	0	0	0	0
San Mateo		0	0	0	0	0
Shasta	rights-of-way mint vertebrate control	758 53 53	770	963	725	791
Solano	rights-of-way ditch bank	2051 702	7928	7165	7390	9680
Sonoma		0	0	0	0	0
Stanislaus	rights-of-way structural pest ctrl vertebrate control	38,459	58,503	46,707	43,873 3339 2898	67,109
Sutter	rights-of-way	0	526	710	0	0

Tehama	rights-of-way aquatic-industrial	3,371	316 2677	2674	2838	4948
Tuloumne		0	0	0	0	0
Yolo	rights-of-way aquatic-unspecified aquatic-industrial	0	2326 2677 904	16,905	0	0
Yuba	rights-of-way structural pest ctrl	105	142	248 29	86	371

[a] Acrolein is not registered on crops; presumably this was for vertebrate control

It is unlikely that acrolein would affect the Central California Valley Steelhead ESU if it is used in accordance with all label requirements, specifically the six-day holding period before release into natural fish-bearing waters. However, we have insufficient information to ascertain that young steelhead cannot get into canals where it is used, and we note that there have been incidents, including one where salmon in an irrigation canal within this ESU were killed. This incident may have occurred when acrolein could be used to treat drainage canals also, but we do not have good information. Given the current label requirements and the specialized training required, we conclude that the use acrolein in accordance with label directions may affect, but is not likely to adversely affect, the Central California Valley Steelhead ESU.

5. Northern California Steelhead ESU

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

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

There has been no acrolein use in these north coastal counties in the last five years (Table 14).

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

County	site	2001 lb ai	2000 lb ai	1999 lb ai	1998 lb ai	1997 lb ai
Humboldt		0	0	0	0	0

Mendocino		0	0	0	0	0
Trinity		0	0	0	0	0
Lake		0	0	0	0	0

We conclude that acrolein has no effect on the Northern California steelhead ESU, because acrolein is not used in any county within this ESU.

B. Chinook salmon

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

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

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).

There is a moderate amount of acrolein used in the Sacramento River Valley.

Table 15. Use of acrolein 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	site	2001 lb ai	2000 lb ai	1999 lb ai	1998 lb ai	1997 lb ai
Alameda		0	0	0	0	0
Butte		0	0	0	0	0
Colusa	rights-of-way structural pest ctrl	670	1421	744 1696	196	2018 171
Contra Costa	rights-of-way commodity fumig	3,969	3815	6806 818	8063	8903
Glenn	rights-of-way structural pest ctrl	9,255	3326 972	6514	4221	7815
Marin		0	0	0	0	0
Sacramento	rights-of-way	0	123	304	0	12
San Mateo		0	0	0	0	0
San Francisco		0	0	0	0	0

Shasta	rights-of-way mint vertebrate control	758 53 53	770	963	725	791
Solano	rights-of-way ditch bank	2,051 702	7928	7165	7390	9080
Sonoma		0	0	0	0	0
Sutter	rights-of-way	0	526	710	0	0
Tehama	rights-of-way aquatic-industrial	3,371	316 2677	2674	2838	4948
Yolo	rights-of-way aquatic-unspecified aquatic-industrial	0	2326 2677 904	16,905	0	0

It is unlikely that acrolein would affect the Sacramento River Winter-run Chinook Salmon ESU if it is used in accordance with all label requirements. Although we cannot be certain, it appears that this ESU exists almost exclusively within the Sacramento River, and if that is true, then there should be no effect at all. Even if stray fish move up into agricultural drains, the use of acrolein only in irrigation supply canals would preclude effects. Because we cannot be certain that this ESU occurs only in the Sacramento River, we cannot completely preclude potential effects. Therefore, we conclude that the use acrolein in accordance with label directions may affect, but is not likely to adversely affect, the Sacramento River Winter-run Chinook Salmon ESU.

2. Central Valley Spring-run Chinook Salmon ESU

The Central valley Spring-run chinook salmon ESU was proposed as threatened in 1998 (63FR11482-11520, March 9, 1998) and listed on September 16, 1999 (64FR50393-50415). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches accessible to listed chinook salmon in the Sacramento River and its tributaries in California, along with the 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 16 contains usage information for the California counties supporting the Central Valley spring-run chinook salmon ESU.

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

County	site	2001 lb ai	2000 lb ai	1999 lb ai	1998 lb ai	1997 lb ai
Alameda		0	0	0	0	0
Butte		0	0	0	0	0
Colusa	rights-of-way structural pest ctrl	670	1421	744 1696	196	2018 171
Contra Costa	rights-of-way commodity fumig	3,969	3815	6806 818	8063	8903
Glenn	rights-of-way structural pest ctrl	9,255	3326 972	6514	4221	7815
Marin		0	0	0	0	0
Napa		0	0	0	0	0
Nevada	rights-of-way structural pest ctrl	3,240 807	3775	4465	3054	4888
Placer	rights-of-way	3,718	5593	5118	4397	7127
Sacramento	rights-of-way	0	123	304	0	12
San Francisco		0	0	0	0	0
San Mateo		0	0	0	0	0
Shasta	rights-of-way mint vertebrate control	758 53 53	770	963	725	791
Solano	rights-of-way ditch bank	2051 702	7928	7165	7390	9680
Sonoma		0	0	0	0	0
Sutter	rights-of-way	0	526	710	0	0

Tehama	rights-of-way aquatic-industrial	3,371	316 2677	2674	2838	4948
Trinity		0	0	0	0	0
Tuloumne		0	0	0	0	0
Yolo	rights-of-way aquatic-unspecified aquatic-industrial	0	2326 2677 904	16,905	0	0
Yuba	rights-of-way structural pest ctrl	105	142	248 29	86	371

It is unlikely that acrolein would affect the Central Valley Spring-run Chinook Salmon ESU if it is used in accordance with all label requirements, specifically the six-day holding period before release into natural fish-bearing waters. However, we have insufficient information to ascertain that young steelhead cannot get into canals where it is used, and we note that there have been incidents, including one where salmon in an irrigation canal within this ESU were killed. This incident may have occurred when acrolein could be used to treat drainage canals also, but we do not have good information. Given the current label requirements and the specialized training required, we conclude that the use acrolein in accordance with label directions may affect, but is not likely to adversely affect, the Central Valley Spring-run Chinook Salmon ESU.

3. California Coastal Chinook Salmon ESU

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

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

Table 17 indicates that there is no usage of acrolein in the California counties supporting the California coastal chinook salmon ESU.

Table 17. Use of acrolein in counties within the California coastal chinook salmon ESU

County	site	2001 lb ai	2000 lb ai	1999 lb ai	1998 lb ai	1997 lb ai
Humboldt		0	0	0	0	0
Mendocino		0	0	0	0	0
Sonoma		0	0	0	0	0
Marin		0	0	0	0	0
Trinity		0	0	0	0	0
Lake		0	0	0	0	0

We conclude that acrolein has no effect on the California coastal chinook salmon ESU, because acrolein is not used in any county within this ESU.

4. Central Valley Fall/Late Fall-run Chinook Salmon ESU (proposed for listing)

The Central Valley Fall/Late Fall-run chinook salmon ESU was proposed for listing in 1998 (63FR11482-11520, March 9, 1998). The National Marine Fisheries Service concluded at that time that "chinook salmon in this ESU are not presently in danger of extinction but are likely to become endangered in the foreseeable future." In a later reassessment (64FR50394-50415, September 16, 1999), NMFS stated that the populations had increased in abundance, and this ESU is not likely to become endangered in the foreseeable future. Critical habitat is still under development.

Hydrologic units and upstream barriers within this ESU are the San Pablo Bay (upstream barrier – San Pablo Reservoir), San Francisco Bay, Coyote (upstream barrier – Calaveras Reservoir), Suisun Bay, San Joaquin Delta, Middle San Joaquin-Lower Merced-Lower Stanislaus (upstream barrier – Crocker Diversion La Grange), Lower Calaveras-Mormon Slough (upstream barrier – New Hogan), Lower Consumnes-Lower Mokelumne (upstream barrier – Camanche Dam), Upper Consumnes, Lower Sacramento, Lower American (upstream barrier – Nimbus Dam), Upper Coon-Upper Auburn, Lower Bear (upstream barrier – Camp Far West Dam), Lower Feather (upstream barrier – Oroville Dam), Lower Yuba (upstream barrier – Englebright Dam), Lower Butte, Sacramento-Stone Corral, Upper Butte, Sacramento-Lower Thomes (upstream barrier – Black Butte Dam), Mill-Big Chico, Upper Elder-Upper Thomes, Cottonwood Headwaters, Lower Cottonwood, Sacrament-Lower Cow-Lower Clear (upstream barrier – Keswick Dam Shasta), Upper Cow-Battle (upstream barrier – Whiskeytown Dam), and Sacramento-Upper Clear.

These areas are in the counties of Shasta, Trinity, Tehama, Glenn, Butte, Colusa, Sutter, Yuba, Yolo, Placer, El Dorado, Amador, Sacramento, Solano, Napa, Marin, Sonoma, San Francisco, San Mateo, Santa Clara, Alameda, Contra Costa, San Joaquin, Calaveras, Stanislaus, and Merced.

As with the other Central Valley ESUs, we have omitted San Mateo and Santa Clara counties from the usage analysis because they are south of the Oakland Bay Bridge. There is no Critical Habitat FR Notice on this, but there is nothing we have seen that suggests this would be different from the other Central Valley ESUs.

Table 18 contains acrolein usage information for the California counties supporting the Central Valley Fall/Late Fall-run chinook salmon ESU.

Table 18. Use of acrolein in counties with the Central Valley Fall/Late Fall-run chinook salmon ESU.

County	site	2001 lb ai	2000 lb ai	1999 lb ai	1998 lb ai	1997 lb ai
Alameda		0	0	0	0	0
Amador		0	0	0	0	0
Butte		0	0	0	0	0
Calaveras		0	0	0	0	0
Colusa	rights-of-way structural pest ctrl	670	1421	744 1696	196	2018 171
Contra Costa	rights-of-way commodity fumig	3,969	3815	6806 818	8063	8903
El Dorado		0	0	0	0	0
Glenn	rights-of-way structural pest ctrl	9,255	3326 972	6514	4221	7815
Marin		0	0	0	0	0
Merced	rights-of-way structural pest ctrl almonds	56,737	28,435	40,259	25,472	33,221 35 10
Napa		0	0	0	0	0
Placer	rights-of-way	3,718	5593	5118	4397	7127
Sacramento	rights-of-way	0	123	304	0	12
San Joaquin	rights-of-way	0	851	2855	773	2048
San Francisco		0	0	0	0	0

Shasta	rights-of-way mint vertebrate control	758 53 53	770	963	725	791
Solano	rights-of-way ditch bank	2051 702	7928	7165	7390	9680
Sonoma		0	0	0	0	0
Stanislaus	rights-of-way structural pest ctrl vertebrate control	38,459	58,503	46,707	43,873 3339 2898	67,109
Sutter	rights-of-way	0	526	710	0	0
Tehama	rights-of-way aquatic-industrial	3,371	316 2677	2674	2838	4948
Trinity		0	0	0	0	0
Tuloumne		0	0	0	0	0
Yolo	rights-of-way aquatic-unspecified aquatic-industrial	0	2326 2677 904	16,905	0	0
Yuba	rights-of-way structural pest ctrl	105	142	248 29	86	371

It is unlikely that acrolein would affect the Central Valley Fall/Late Fall-run Chinook Salmon ESU if it is used in accordance with all label requirements, specifically the six-day holding period before release into natural fish-bearing waters. However, we have insufficient information to ascertain that young steelhead cannot get into canals where it is used, and we note that there have been incidents, including one where salmon in an irrigation canal within this ESU were killed. This incident may have occurred when acrolein could be used to treat drainage canals also, but we do not have good information. Given the current label requirements and the specialized training required, we conclude that the use acrolein in accordance with label directions may affect, but is not likely to adversely affect, the Central Valley Fall/Late Fall-run Chinook Salmon ESU.

C. Coho Salmon

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

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

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

1. Central California Coast Coho Salmon ESU

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

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

Table 19 indicates that there is no acrolein usage in the California counties supporting the Central California coast coho salmon ESU.

Table 19. Use of acrolein in counties with the Central California Coast coho ESU.

County	site	2001 lb ai	2000 lb ai	1999 lb ai	1998 lb ai	1997 lb ai
Santa Cruz		0	0	0	0	0
San Mateo		0	0	0	0	0
Marin		0	0	0	0	0
Sonoma		0	0	0	0	0
Mendocino		0	0	0	0	0
Napa		0	0	0	0	0

We conclude that acrolein has no effect on the Central California Coast coho ESU, because acrolein is not used in any county within this ESU.

2. Southern Oregon/Northern California Coast Coho Salmon ESU

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

The Southern Oregon/Northern California Coast coho salmon ESU occurs between Punta Gorda, Humboldt County, California and Cape Blanco, Curry County, Oregon. Major basins with this salmon ESU are the Rogue, Klamath, Trinity, and Eel river basins, while the Elk River, Oregon, and the Smith and Mad Rivers, and Redwood Creek, California are smaller basins within the range. Hydrologic units and the upstream barriers are Mattole, South Fork Eel, Lower Eel, Middle Fork Eel, Upper Eel (upstream barrier - Scott Dam-Lake Pillsbury), Mad-Redwood, Smith, South Fork Trinity, Trinity (upstream barrier - Lewiston Dam-Lewiston Reservoir), Salmon, Lower Klamath, Scott, Shasta (upstream barrier - Dwinnell Dam-Dwinnell Reservoir), Upper Klamath (upstream barrier - Irongate Dam-Irongate Reservoir), Chetco, Illinois (upstream barrier - Selmac Dam-Lake Selmac), Lower Rogue, Applegate (upstream barrier - Applegate Dam-Applegate Reservoir), Middle Rogue (upstream barrier - Emigrant Lake Dam-Emigrant Lake), Upper Rogue (upstream barriers - Agate Lake Dam-Agate Lake; Fish Lake Dam-Fish Lake; Willow Lake Dam-Willow Lake; Lost Creek Dam-Lost Creek Reservoir), and Sixes. Related counties are Humboldt, Mendocino, Trinity, Glenn, Lake, Del Norte, Siskiyou in California and Curry, Jackson, Josephine, 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 the agricultural areas where acrolein might be used.

Tables 20 and 21 present acrolein usage reported for California and irrigated acreage where acrolein could be used in Oregon. Acrolein is known to be used in Siskiyou County in the

Klamath and Tule Lake areas which are upstream of the critical habitat for this coho salmon ESU. It is possible, but does not seem very likely that some acrolein could be used below Irongate Reservoir. In Oregon, the lack of recent usage in Jackson and Josephine counties is expected to change in the future, but we cannot estimate amounts likely to be used.

Table 20. Use of acrolein in California counties within the Southern Oregon/Northern California coastal coho salmon ESU.

County	site	2001 lb ai	2000 lb ai	1999 lb ai	1998 lb ai	1997 lb ai
Humboldt		0	0	0	0	0
Mendocino		0	0	0	0	0
Del Norte		0	0	0	0	0
Siskiyou	rights-of-way	2593	495	831	1725	4250
	ditch bank	107	67			
	landscape maintenance	78	78			
	aquatic area		3861	2690	2461	3563
	alfalfa[a]					890
	potatoes[a]					116
Trinity		0	0	0	0	0
Lake		0	0	0	0	0

[a] Acrolein is not registered on crops. These uses were presumably for vertebrate control.

Table 21. Irrigated acreage in Oregon counties containing habitat for the Southern Oregon/Northern California Coastal coho salmon ESU.

State	County	Irrigated acreage	Total acreage
OR	Curry	3,380	1,041,557
OR	Jackson	53,416	1,782,633
OR	Josephine	12,080	1,049,308

It is unlikely that acrolein would affect the Southern Oregon/Northern California Coastal coho salmon ESU, if it is used in accordance with all label requirements, specifically the six-day holding period before release into natural fish-bearing waters. We are informed that fish screens exist on all of the relevant irrigation supply canals, so there should be little opportunity for individuals to get into canals where it is used. But there have been several notable incidents in the areas where this ESU occurs. It is our understanding that the physical causes of such incidents, leakage or premature release, have been rectified. It is also our understanding that the Talent Irrigation District at least, and probably others in the area, have sought NPDES permits for acrolein use. If as a result, monitoring is conducted, it seems possible that the results would indicate no effect when used according to label directions. However, such information is not yet available. Therefore, our relevant information is limited. Given the current label requirements, the specialized training required, and the scrutiny likely to occur when acrolein is used in this area, we conclude that the use acrolein in accordance with label directions may affect, but is not likely to adversely affect, the Southern Oregon/Northern California Coastal coho salmon ESU if it is used in accordance with all label requirements.

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

1. There has been no recent use of acrolein within the range of the Northern California Coastal Steelhead ESU, the California Coastal Chinook Salmon ESU, and the Central California Coast Coho Salmon ESU; and there is no reason to think this will change. There will be no effect of acrolein on these ESUs.

2. There is no recent use of acrolein, except to treat "impounded waters" not connected with any river or stream within the critical habitat of the Southern California and South Central California Steelhead ESUs, and there is no reason to think this will change. There will be no effect of acrolein on these ESUs.

3. There is a small amount of acrolein use within the critical habitat of the Central California Coast steelhead ESU. While it appears to be very unlikely, given the uncertainties outlined in section 4 above, the use of acrolein in accordance with label directions may affect, but is not likely to adversely affect, this ESU.

4. There is extensive usage of acrolein, especially in Merced and Stanislaus counties, within the critical habitat of the California Central Valley steelhead ESU, and within the range of the proposed Central Valley Fall/Late Fall-run Chinnok Salmon ESU. Given the uncertainties outlined in section 4 above, the use of acrolein in accordance with label directions may affect, but is not likely to adversely affect, these ESUs.

5. There is considerable usage of acrolein within the critical habitat of the Sacramento River Winter-run Chinook Salmon ESU and the Central Valley Spring-run Chinook Salmon ESU. Given the uncertainties outlined in section 4 above, the use of acrolein in accordance with label directions may affect, but is not likely to adversely affect, these ESUs.

6. There is modest usage of acrolein within the counties in Siskiyou County in the critical habitat of the Southern Oregon/Northern California Coastal Coho Salmon ESU. However, usage in Siskiyou County appears to all be in the Klamath and Tule Lake areas away from the critical habitat of this ESU. Conversely, there has been no acrolein use in the last two years in Jackson and Josephine counties in Oregon, but there is an intention that acrolein will be used in the future, at least in the Talent Irrigation District, and probably in other districts in these two counties. Given the uncertainties outlined in section 4 above, the use of acrolein in accordance with label directions may affect, but is not likely to adversely affect, this ESU.

Table 22. Summary conclusions on specific ESUs of salmon and steelhead for acrolein.

Species	ESU	finding
Chinook Salmon	California Coastal	No effect
Chinook Salmon	Central Valley spring-run	May affect, but is not likely to adversely affect
Chinook Salmon	Sacramento River winter-run	May affect, but is not likely to adversely affect
Chinook Salmon	Central Valley fall/late fall run (proposed for listing)	May affect, but is not likely to adversely affect
Coho salmon	Southern Oregon/Northern California Coast	May affect, but is not likely to adversely affect
Coho salmon	Central California	No effect
Steelhead	Northern California	No effect
Steelhead	Central California Coast	May affect, but is not likely to adversely affect
Steelhead	South-Central California	No effect
Steelhead	Southern California	No effect
Steelhead	Central Valley, California	May affect, but is not likely to adversely 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.

Bilby RE, Fransen BR, Bisson PA, Walter JK. 1998. Response of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*) to the addition of salmon carcasses to two streams in southwestern Washington, U. S. A. Can. J. Fish. Aquat. Sci. 55:1909-1918.

Bond CE, Lewis RH, Fryer JL. 1960. Toxicity of various herbicidal materials to fishes. Pp96-101 *in* Tarzwell CM (ed.) Biological problems in water pollution. Trans. 1959 Semin., Robert A. Taft Sanit. Eng. Cent. Tech Rept W60-3.

Caravello H. 1988. Final report: 1986 Magnacide H Herbicide lifetime monitoring study in Washington State. Baker Performance Chemicals, Inc. Research and Technical Service Report No. RD0016.187, 52 pp.

DeGraeve GM, Geiger DL, Meyer JS, Bergman HL. 1980. Acute and embryo-larval toxicity of phenolic compounds to aquatic biota. Arch. Environ. Contam. Toxicol., 9(5): 557-568.

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

Eisler R. 1994. Acrolein Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Contaminant Hazard Reviews, Report 28. National Biological Survey, Biological Report 23, USDI, Washington DC. 68 p.

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

Lorz HW, Glenn SW, Williams RH, Kunkel CM, Norris LA, Loper BR. 1979. Effects of selected herbicides on smolting of coho salmon. Environmental Research Report EPA-600/3-79-071. U. S. EPA, Corvallis, Oregon. 103 p.

Louder DE, McCoy EG. 1962. Preliminary investigations of the use of aqualin for collecting fishes. Proc. Ann 16th Conf. Southeast. Assoc, Game & Fish Commissioners, pp. 240-242.

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

Snyder-Conn E. 1997. Acrolein on Aquatic Ecosystems In Tule Lake National Wildlife Refuge. Unpublished US FWS report available at URL: htttp://pacific.fws.gov/ecoservices/envicon/pim/reports/default.htm

Tucker RK, Leitzke JS. 1979. Comparative toxicology of insecticides for wildlife and fish. Pharmacol. Ther. 6:167-200.

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

U. S. EPA. 1980. Ambient Water Quality Criteria for Acrolein. EPA-440/5-80-016. Office of Water Regulation and Standards, Washington, DC. 102 p.

U. S. FWS. 1995. Final Biological Opinion on the use of pesticides and fertilizers on federal lease lands and acrolein and herbicide use on Klamath project rights-of-way located on the Klamath project (reinitiation of consultation on the use of acrolein for aquatic weed control in Bureau canals and drains). Memorandum, Reference Number 1-7-95-F-26, Oregon State Office, US FWS to Bureau of Reclamation Area Manager, Klamath Falls, OR. February 9, 1995.

WHO. 1991. Environmental Health Criteria for Acrolein. World Health Organization Environmental Health Criteria Number 127, Geneva, Switzerland.

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