Lindane
Analysis of Risks
to
Endangered and Threatened Salmon and Steelhead

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[1] **Comment: Data and the analysis based upon these data reflect information available at the time this report was completed. Additional data, which may have been submitted or changes in status after the submission date are not included in the authors evaluations, presentations, or comments.**

Summary

Lindane is an organochlorine insecticide that was widely used on a large range of different sites. It was used on major field crops, orchards, vegetables, and ornamentals. A majority of these applications have been removed from both the registered use sites and from the labels. Currently the only registered agricultural use for this chemical is pre-plant seed treatment in barley, corn, oats, rye, sorghum, and wheat. Both the registration status and tolerance levels have been revoked for all other use.

The Agency, at the time of issuing the Reregistration Eligibility Determination indicated prohibiting the dust formulations for use on the farm as mitigation. Registered formulations include the Technical Grade for manufacturing use, formulation as a dust, emulsifiable concentrate, flowable concentrate, and ready-to-use liquid.

In addition, it is a component of FDA approved shampoos and creams for the treatment of lice and scabies. These formulations were banned by the state of California in 2000 (Assembly Bill No. 2318). The use of lindane formulations is strongly discouraged in Washington and Oregon and is considered a “last case”option for medical treatment. There is no other residential use for this product..

Problem Formulation - The purpose of this analysis is to determine whether the registration of lindane as a seed treatment may affect threatened and endangered (T&E or listed) Pacific anadromous salmon and steelhead or adversely modify their designated critical habitat.

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

Much of the quantitative information presented and used was derived from the Reregistration Eligibility Decision (RED) Ecological Risk Assessment (Attachment 1).

Contents

Attachments:

1. Reregistration Eligibility Decision for lindane
2. Example Labels
3. USGS Usage Map

1. Background

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

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

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

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

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

Comparative toxicology has demonstrated that various species of scaled fish generally have equivalent sensitivity, within an order of magnitude, to other species of scaled fish tested under the same conditions. Exceptions are known to occur for only an occasional pesticide, as based on the several dozen fish species that have been frequently tested. Sappington et al. (2001), Beyers et al. (1994) and Dwyer et al. (1999), among others, have shown that endangered and threatened fish tested to date are similarly sensitive, on an acute basis, to a variety of pesticides and other chemicals as are 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 degradates 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 determine EECs. Older reviews and Reregistration Eligibility Decisions (REDs) may use this approach, but it was excessively conservative and does not provide a sound basis for modern risk assessments. For the purposes of endangered species consultations, we will attempt to revise this old approach with the GENEEC model, where the old screening level raised risk concerns.

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

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

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

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

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

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

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

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

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

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

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

Aquatic plant acute EC50[a]	>1[b]	May be indirect effects on aquatic vegetative cover for T&E fish

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

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

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

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

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

It would appear that the Scholz et al (2000) work contradicts the 6x hypothesis for acute effects. The research design, especially the nature and duration of exposure, of the test system used by Scholz et al (2000), along with a lack of dose-response, precludes comparisons with lethal levels in accordance with the 6x hypothesis as used by Tucker and Leitzke (1979). Nevertheless, it is known that olfaction is an exquisitely sensitive sense. And this sense may be particularly well developed in salmon, as would be consistent with its use by salmon in homing (Hasler and Scholz, 1983). So the contradiction of the 6x hypothesis is not surprising. As a result of these findings, the 6x hypothesis needs to be re-evaluated with respect to olfaction. At the same time, because of the sensitivity of olfaction and because the 6x hypothesis has generally stood the test of time otherwise, it would be premature to abandon the hypothesis for other acute sublethal effects until there are additional data. (Hasler, AD. and Wisbey, WJ, 1951; Adron, SW, Mackie, AM, 1978)

2. Description of Lindane:

A. Chemical History: Lindane was initially registered by the USDA in the 1940's for use on a wide variety of fruit and vegetables, tobacco, ornamentals greenhouse vegetable and ornamentals, forestry, farm animal premises, and other sites. Through the last twenty years numerous reviews and regulatory decisions have significantly reduced these applications. Under current registration and label standards, lindane use is limited to agricultural seed treatment for wheat, corn, barley, sorghum, and rye. Use as a seed treatment for canola is under review at the time of this report.

At the present time lindane has been banned in many nations and 23 have prohibited import (Pesticide news (http://www.pan-uk.org/pestnews/activities/Lindane.htm) including Finland, Indonesia, Korea, Netherlands, New Zealand, Saint Lucia, and Sweden. Severe restrictions on use have been imposed in Australia, Austria, Cyprus, Norway, and Sri Lanka

(Pesticide News, http://www.pan-uk.org/pestnews/actives/Lindane.htm). Lindane is subject to many bilateral and multinational treaties, including:

The Great Lakes Binational Toxic Strategy (http://www.epa.gov/glnpo/bns/)

The persistent Organic Chemicals (POPs) Protocol to the Convention on Long-Range Transboundry Air Pollution (LRTAP), a legally-binding regional treaty (http://www.unece.org/env/lrtap/)

The Rotterdam Convention on Prior Informed Consent (http://www.fao.org/waicent/FaoInfo/Agricult/AGP/AGPP/Pesticid/PIC/pichome.htm)

The North America Free Trade Agreement, NAFTA (http://www.cec.org/programs_projects/pollutants_health/smoc/)

Lindane is currently listed as a United Nations Prior Informed Consent (PIC) product and is a U.S. Nominated Pesticide. The U.S. has also classified it as a severly limited pesticide (http://www.epa.gov/cgi-bin/epaprintonly.cgi)

In addition the Agency Office of Pesticide Programs has initiated a preliminary partnership with India and China, two of the few countries to manufacture lindane, to institute risk reduction programs (Chapman, 2004)

B: Chemical Description:

- ❑ Common Name: lindane
- ❑ Chemical Name: gamma isomer of Hexachlorocyclohexane
- ❑ Chemical Family: organochlorine
- ❑ Case Number: 0315
- ❑ CAS Registry Number: 58-89-9
- ❑ OPP Chemical Code: 009001
- ❑ Empirical Formula: $C_6H_6Cl_6$
- ❑ Trade and Other Names: Agrox Premiere®, Germate Plus®, Isotox®, Kernal Guard®, DB Green®, Vitavax®, Enhance®, Seed Shield®
- ❑ Basic Manufacturer: Inquinosa International, SA

Lindane is a white, crystalline solid with a melting point of 112-113° C. Lindane is slightly soluble in water to 10 ppm at 20°C, and in most organic solvents, including acetone and aromatic and chlorinated hydrocarbons. Lindane is only slightly soluble in mineral oils. It has a specific gravity of 1.85, octanol/water coefficient (K_{ow}) of 3135, and a vapor pressure of 9.4 x 10^{-6} mm Hg at 20° C. Lindane is stable to light, heat, air, and strong acids, but decomposes in alkali solutions to trichlorobenzines and HCl.

C. Chemical Use: The following is based on the currently registered uses of lindane:

- Type of Agent: Insecticide

- Classification: General Use

- Summary of Sites:

  - Food/Feed Crops: seed treatment for barley, corn, oats, rye, sorghum, and wheat.

  - Other Agriculture Use: None

  - Residential: None

  - Public Health: pharmaceutical (prescription) use as a shampoo or cream registered by the U.S. Food and Drug Administration

  - Non-food Crops: None

  - Target Pests: Wireworm, and, less effectively, flea beetles, seed corn maggots, seed corn beetle, and white grubs

- Formulation Types Registered: Technical Grade/Manufacturing-Use Product (MUP), technical 100% a.i

- End-use Product; dust, emulsifiable concentrate, flowable concentrate, and ready-to-use fluid.

- Method and Rate of Application:

  - Equipment: liquid seed treater, planter/seed box, air seed treater, canister tube applicator, and slurry-type treater.

  - Method: Lindane is pre-plant treatment of seeds. This is done in a container or the planter box by staged addition of seed with lindane, and paddle mechanical mixing.

- Timing: Application prior to storage or planting, a single application is made in the spring for most crops, or fall for winter wheat seed.

Application rates for California are based on the California Department of Pesticide Regulation tables (2002). For the Pacific Northwest determinations are based on the typical number of pounds of seed used to plant a field (i.e 50 lbs corn/2 to 2.5 acres depending on row spacing, W. Murphy and W. Williams, personal communication). The Agency estimates are considerably lower, determing that 14 lbs of corn seed/acre, 9 lbs/acre sorghum, and 96 lbs/acre of barley will be planted..

Current data (1998) from the United States Geological Survey (USGS), National Water - Quality Assessment (NAWQA) indicate no use of lindane in Idaho, Oregon, or Washington (see attachment 3).

Table 3:Use data for lindane

Application	**Application Rate (lbs a.i./A)**	**Maximum Application per Crop**
Corn Seed	0.125	1
Wheat Seed	0.0512	1
Sorghum Seed	0.00425	1
Barley Seed	0.03125	1
Oat Seed	0.03125	1
Rye Seed	0.03125	1
Canola Seed	0.12	1

The use of lindane has decreased significantly through revocation of approved sites and a reduction in use for the remaining (seed treatment) applications. Table 4 summarizes average usage data from 1996 -2001.

Table 4: Use Estimate for Lindane (national from the 2002 RED)

Crop	Acres	Lbs a.i. Applied (Max)	Percent of Crop Treated (Max)
Barley, Wheat Seed	68,373,000	153,294	12%
Corn Seed	79,545,000	77,318	9%
Oats, Rye Seed	5,812,000	1,685	2%
Sorghum Seed	9,195,000	662	2%

Within the states of concern Table 5 indicates actual or estimated total usage of lindane.

Table 5: State Estimates

State	Acres	Lbs a.i. Applied (Max)
California (2002 CA DPR)	26,639	202
Idaho (estimate from 1997 ag census)	93,028	5,328
Oregon (estimate from 1997 ag census)	95,465	6,085
Washington (estimate from 1997 ag census)	338,578	18,233

D. Incidents: A total of 181 incident reports are on file, the majority of which are associated with the use of Happy Jack Kennel Dip®, which was initially canceled. A challenge to this decision was made and it was subsequently approved for veterinary use only. Home use remains canceled. Aquatic incidents include a tank truck spill into a bog in 1995, which resulted in several hundred trout deaths. In 1999 one fish kill, as well as human effects and plant damage was reported. In 1997 California reported 33 incidents involving death to birds, trout, and mammals. Carbofuran was considered the causative agent, but lindane was also present. In 2003 the state of Washington filed 84 incidents, primarily associated with plant damage and ecological effects associated with lindane formulations. These incidents occurred prior to the 2002 revised RED for lindane and subsequent label changes.

For surface water, the U.S. EPA STORET data base reported 8,775 detections of lindane with median and mean concentrations of 0.005 and 0.18 ppb, respectively. STORET indicates detections were reported in nearly all regions of the contiguous U.S. In the USGS NAWQA study, lindane was detected in 2.58% of surface water samples (0.67% at levels greater than 0.05 ppb, maximum concentration was 0.13 ppb). These data are from an era before the current RED and subsequent label changes were in place.

E. Ecological Effects Toxicity Assessment:

Lindane is persistent and moderately mobile. It has a soil half-life of 2.6 years and a mean K_{OC} of 1,368 mg/L. It is resistant to photolysis and hydrolysis (except at high pH) and degrades very slowly by microbial actions. Because lindane is a relatively volatile, persistent and lipophilic organochlorine pesticide, it can migrate over a long distance through various environmental media such as air, water, and sediment. Volatilization from soil and surface waters is a major dissipation route for lindane. Bioaccumulation is significant, however it is cleared rapidly after exposure terminates. To a lesser degree lindane can also enter the air as adsorbed phase on suspended particles. Lindane has often been detected in ambient air, precipitation, and surface water throughout North America, and lindane and it's isomers have been detected in areas of non use (e.g. the Arctic), indicating that global atmospheric transport may occur. The source of these lindane detections is unclear, but may be the result of past widespread use in the U.S. and other countries, its extreme persistence, and to a lesser extent the current seed treatment use which has been declining in recent years. The pharmaceutical use of lindane, for head lice and scabies, is under close observation and regulation by the FDA and has been banned in California.

The slowly derived degradates are predominantly pentachlorohexane, 1,2,4-trichlorbenzene, and 1,2,3-trichlorobenzene.

i. Freshwater Fish: The minimum data required to establish the toxicity of lindane to freshwater fish is from two species. The preferred species are rainbow trout and bluegill sunfish. Results of these tests are shown in Table 6. These data are derived from the Environmental Fate and Effects Division (EFED) chapter for the RED.

Table 6: Freshwater Fish, Acute Toxicity (EFED RED Chapter for lindane)

Species	% a.i.	96-hour LC_{50}	Toxicity Class
Oncorhynchus mykiss (rainbow trout)	99.0	23 ppb	Very Highly Toxic
Oncorhynchus mykiss (rainbow trout)	25.0	90 ppb	Very Highly Toxic
Oncorhynchus mykiss (rainbow trout)	40.0	69 ppb	Very Highly Toxic
Oncorhynchus mykiss (rainbow trout)	20EC	120 ppb	Very Highly Toxic
Lepomis macrochirus (bluegill sunfish)	99.0	25 ppb	Very Highly Toxic
Lepomis macrochirus (bluegill sunfish)	20EC	280 ppb	Very Highly Toxic
Lepomis macrochirus (bluegill sunfish)	40.0	160 ppb	Very Highly Toxic
Ictalursu melas (black bullhead)	99.0	64 ppb	Very Highly Toxic
Salmo trutta (brown trout)	99	22.0 ppb	Very Highly Toxic
Ictalurus punctatus (channel catfish)	99	44 ppb	Very highly Toxic

Perca flavescens (yellow perch)	99	68 ppb	Very Highly Toxic
Peepholes pro melas (fathead minnow)	99	67 ppb	Very Highly Toxic
Salvelinus namaycush (lake trout)	99	32 ppb	Very Highly Toxic
Oncorhynchus kisutch (coho salmon)	99	70 ppb	Very Highly Toxic
Lepomis cyanellus (green sunfish)	99	70 ppb	Very Highly Toxic
Micropterus salmoides (largemouth bass)	99	32 ppb	Very Highly Toxic

Lindane is classified as very highly toxic to freshwater fish.

ii. Freshwater Fish, Chronic: A freshwater fish early life-cycle test was performed. Results available are listed in Table 7.

Table 7: Freshwater Fish Life Cycle Testing (Ecotoxicity Data Base)

Species	LOEC	NOEL	EFFECT
Oncorhynchus mykiss (rainbow trout)	6.0 ppb	2.9 ppb	Growth, Survival
Oncorhynchus mykiss (rainbow trout	6.0 ppb	2.9 ppb	Growth, Survival
Lepomis macrochirus (bluegill sunfish)	200 ppb	100 ppb	NR
Lepomis macrochirus (bluegill sunfish)	160 ppb	180 ppb	NR

Growth of freshwater fish is affected at 2.9 ppb.

iii. Freshwater Invertebrates, Acute: The preferred species for testing lindane toxicity in freshwater invertebrates is the Waterflea. Results of acute toxicity tests are shown in Table 8:

Table 8: Acute Toxicity of lindane in Freshwater Invertebrates (Ecotoxicity Data Base)

Species	% a.i.	48-hour LC_{50}/EC_{50} (ppm)	Toxicity Class
Daphnia pulex (Waterflea)	99.0	460 ppb	Very Highly Toxic
Gammerus fasciatus (scud)	99.0	10 ppb	Very Highly Toxic
Gammerus lacustris (scud)	100.0	88 ppb	Very Highly Toxic

Lindane is categorized as very highly toxic to freshwater invertebrates on an acute basis.

iv. Freshwater Aquatic Invertebrate Life Cycle Testing

These data were not available at the time of this review.

v. Esturaine/Marine Fish Acute Toxicity

Table 9: Esturaine/Marine Fish Acute Toxicity (Ecotoxicity Data Base)

Species	% a.i.	96 hour LC50	Toxicity Category
Fundlus similis (longnose killifish)	100.0	190 ppb (48 hour)	Very Highly Toxic
Cyprinodon variegatus (sheepshead minnow)	100.0	100 ppb	Very Highly Toxic

These studies indicate that lindane is very highly toxic to Esturaine/ marine fish.

vi. Esturaine and Marine Invertebrate Organisms, Acute Toxicity:

Table10: Acute Toxicity of Lindane to Marine/Esturaine Invertebrates (Ecotoxicity Data Base)

Species	% a.i.	LC_{50}/EC_{50}	Toxicity Class
Mysidopsis bahia	100.0	15 ppb	Very Highly Toxic
Crassostrea virginica	100.0	240 ppb	Very Highly Toxic

These studies indicate that lindane is very highly toxic to esturaine/marine invertebrates.

vii. Esturaine/marine Invertebrate Life-Cycle Testing
Testing of lindane in esturaine/marine invertebrate life cycles was not available

F. Risk Quotients for Subject Species:

Based on toxicity and Estimated Environmental Concentrations (EEC) data, risk quotients were calculated. The results of these calculations are presented in table 11. Wheat was selected as a surrogate for seed treatments. EEC's were calculated with the Tier-1 Generic Estimated Environmental Concentration (GENEEC) model. This is a Tier I computer model based on a 1 hectacre pond within a 10 hectacre agricultural site. It assumes the maximum application rate of the chemical to 100% of the crop. In general, this represents a "worst-case scenario". Because the species of concern exist in rapid flowing water and, in some cases, large lakes the EECs provided by the model are likely to be significant overestimates of the actual chemical concentration in the

ESUs currently under review.

Table 11: Acute and Chronic Risk Quotient Determinations for Freshwater Fish (RED for Lindane, 2002)

Site/Rate	Initial (Peak) EEC	Mean EEC	Acute RQ	Chronic RQ
Wheat	0.67 ppb	0.48 ppb	0.55	0.30
Canola	0.67 ppb	0.48 ppb	1.51	0.81

The results indicate the endangered species levels of concern are exceeded for aquatic fish at the maximum application rates for all sites examined. High risk and restricted use risk LOC's were exceeded in both model scenarios

Marine/esturaine RQs were similarly determined and are shown in Table 12.

Table 12: Risk Quotient Determinations for Marine/Esturaine Fish (RED for Lindane, 2002)

Site/Rate	Initial (Peak) EEC	Mean EEC	Acute RQ	Chronic RQ
Wheat	0.67	0.48	0.04	NR
Canola	0.67	0.48	0.11	NR

Endangered species RQ was exceeded for use of lindane on canola, but not for wheat application.

Risk Quotients were also determined for aquatic (freshwater) invertebrates. Results of these calculations are shown in Table 13.

Table 13: Risk Quotients for Lindane in Freshwater Invertebrates (RED for Lindane, 2002)

Site/Rate	Initial (Peak) EEC	Mean EEC	Acute RQ	Chronic RQ
Wheat	0.67	0.40	0.94	0.30
Canola	0.67	0.40	0.81	0.05

The endangered species level of concern for invertebrates is exceeded on an acute level. Acute high risk LOC's are exceeded in both models.

Table 14: Esturaine/Marine Invertebrate risk Quotients

Site/Rate	Initial (Peak) EEC (ppb)	Mean EEC ppb	Acute RQ	Chronic RQ

Wheat	0.67	0.40	12.2	NR
Canola	0.67	0.40	33.4	NR

Acute endangered species, restricted use, and high risk LOC's are exceeded for all of the modeled applications.

G. Discussion and Characterization of Risk Assessment.

Lindane is a non-restricted use insecticide that appears highly toxic to both fish and invertebrates. It is, however, currently applied in very limited quantities to a small number of sites as a seed treatment. There are no aerial, spray boom, or irrigation system applications. By the nature of the use practices, lindane is immediately soil incorporated in the form of seed coatings. The Agency has previously (RED for Lindane, 2002, page xiii) determined that the calculated risks for lindane are significantly overstated and determined that actual aquatic risks to be lower due to an overestimate of movement to water in the pond model.

Lindane is a ubiquitous pollutant with probable world-wide distribution. It tends to accumulate in arctic climates due to it's extreme stability. The Agency attributes this pattern to former high rates of use in the U.S. and other countries and to the volatility, extreme stability and long life of the chemical. Lindane formulations frequently include other chemicals, such as captan, which has been reviewed separately. The apparent goal of these formulations is to minimize damage to the seeds by wireworms (lindane) and fungal infection (captan). These combined uses focus on significantly different metabolic pathways and are not likely to be sympathetic.

H. Existing Protections: As part of the current RED and resulting label changes, most uses have been canceled and tolerances revoked except for seed treatment on barley, corn, oats, rye, sorghum, and wheat. Use of the dust formulation on the farm was eliminated.

I. Proposed Protections: seed, new tolerances are being sought for the treatment of wheat, barley, oats, rye, corn, and sorghum.

3. Description of Pacific salmon and steelhead Evolutionarily Significant Units relative to lindane use sites.

The following review of lindane use in California and the Pacific Northwest is derived from several sources. California data is taken directly from the Department of Pesticide Regulations published census for 2002 and tabulation of actual chemical used. The tables for Idaho, Oregon, and Washington are constructed with the 1997 USDA Census of Agriculture as the basis for crops present in each state. Specific usage estimates are derived from the USDA Census and the EPA estimated use table, contained in the RED. All available crops are included in reported data for Oregon, Washington, and Idaho. The estimated use of lindane is based on national estimated use (Table 4) and the application rate (Table 3). These calculated values may represent significant over estimates of actual use in the Pacific Northwest. Within California, only the specific crops and pesticide usage reported are considered. as published by the California DPR.

1. Southern California Steelhead ESU

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

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

Within San Diego County, the San Mateo Creek runs through Camp Pendleton Marine Base and into the Cleveland National Forest. While there are agricultural uses of pesticides in other parts of California within the range of this ESU, it would appear that there are no such uses in the vicinity of San Mateo Creek. Within Los Angeles County, this steelhead occurs in Malibu Creek and possibly, but unlikely, Topanga Creek. Neither of these creeks drain agricultural areas. There is a potential for steelhead in waters that drain agricultural areas in Ventura, Santa Barbara, and San Luis Obispo counties, but the small quantities of lindane used make effects highly unlikely. Usage of lindane in counties where this ESU occurs are presented in Table 15.

Table 15. Counties supporting the Southern California steelhead ESU

County	Site	Acres Treated	lbs a.i. Applied
Los Angeles			None
San Diego			None
San Luis Obispo	Landscape*	NS	16
San Luis Obispo	Broccoli*	29	14

Santa Barbara	Cauliflower*	22	22
Ventura	Outdr Plants*	14.31	43

***These uses are no longer supported**

2. South Central California Steelhead ESU

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

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

Table 16: Counties supporting the South Central California steelhead ESU

County	Site	Acres Treated	lbs. a.i. Applied
Monterey	Asparagus*	648	833
Monterey	Carrot*	2879	2198
Monterey	Celery*	437	840
Monterey	Outdr Flower*	7	7
Monterey	Rights of Way*	NR	20
Monterey	Uncultivated Ag*	2	2
San Benito			None
San Mateo	Landscape*	NR	6
San Luis Obispo	Landscape*	NR	16
Santa Clara	Landscape*	NR	1

Santa Clara	Outdr Transplants*	1	1
Santa Cruz			None

[1]***These uses are no longer supported**

3. Central California Coast Steelhead ESU

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

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

Counties of occurrence for this ESU are Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Mendocino, Napa, Alameda, Contra Costa, Solano, and Santa Clara counties. Usage of lindane in the counties where the Central California coast steelhead ESU is presented in Table 17.

Table 17: Counties supporting the Central California Coast steelhead ESU

County	Site	Acres Treated	lbs. a.i. Applied
Alameda			None
Contra Costa			None
Marin			None
Mendocino			None

Napa			None
San Francisco			None
San Mateo	Landscape*	NR	4
Santa Clara	Landscape*	NR	1
Santa Clara	Outdr Transplants*	1	1
Santa Cruz			None
Solano	Corn Seed	89	1
Sonoma			None

***These uses are no longer supported**

4. California Central Valley Steelhead ESU

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

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

Table 18 Counties supporting the California Central Valley steelhead ESU.

County	Site	Acres Treated	lbs. a.i. Applied
Alameda			None
Amador			None
Butte	Corn Seed	136	4
Butte	Landscape*	2	4
Butte	Safflower*	72	1

Calveras			None
Contra Costa			None
Glenn			None
Marin			None
Merced	Corn Seed	24,488	114
Merced	Fumigation*	15	5
Merced	Sugarbeet*	52	13
Merced	Vertebrate Control*	NR	5
Nevada			None
Placer			None
San Joaquin	Corn Seed	351	8
San Joaquin	Outdr Plants*	4	8
San Francisco	Landscape*	NR	1
San Mateo	Landscape*	NR	6
Shasta			None
Solano	Corn Seed	89	1
Sonoma			None
Stanislaus	Corn Seed	50	5
Sutter	Bean, Succulent*	150	1
Sutter	Corn Seed	288	26
Sutter	Fumigation*	NR	1
Tehama			None
Tuolumne			None
Yolo	Corn Seed	362	4
Yolo	Cotton*	374	5
Yolo	Safflower*	68	1

***These uses are no longer supported**

5. Northern California Steelhead ESU

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

This Northern California coastal steelhead ESU occupies river basins from Redwood Creek in Humboldt County, CA to the Gualala River, inclusive, in Mendocino County, CA. River entry ranges from August through June and spawning from December through April, with peak spawning in January in the larger basins and in late February and March in the smaller coastal basins. The Northern California ESU has both winter and summer steelhead, including what is presently considered to be the southernmost population of summer steelhead, in the Middle Fork Eel River. Counties included appear to be Humboldt, Mendocino, Trinity, and Lake. Table 18 shows the use of lindane in the counties where the Northern California steelhead ESU occurs.

Table 19: Counties supporting the Northern California steelhead ESU

County	Site	Acres Treated	lbs. a.i. Applied
Humboldt			None
Lake			None
Mendocino			None
Trinity			None

6. Upper Columbia River steelhead ESU

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

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

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

Tables 20 and 21 show the cropping information and maximum potential lindane use for Washington counties where the Upper Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 20. Spawning and rearing areas supporting the Upper Columbia River steelhead ESU

State	County	Site	Acres Treated	lbs a.i. Applied
WA	Benton	Corn Seed	1,415	177
WA	Benton	Wheat Seed	253	13
WA	Benton	Barley Seed	8	1
WA	Franklin	Wheat Seed	13,125	673
WA	Franklin	Corn Seed	2,085	261
WA	Franklin	Barley Seed	11,311	579
WA	Grant	Corn Seed	2,696	337
WA	Okanogan	Barley Seed	74	4
WA	Okanogan	Oat Seed	28	1
WA	Yakima	Corn Seed	1,724	216
WA	Yakima	Barley Seed	60	3
WA	Yakima	Wheat Seed	6,052	310

Table 21: Oregon and Washington counties that are migration corridors for the Upper Columbia River steelhead ESU.

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Columbia	Corn Seed	5	1
OR	Gilliam	Wheat Seed	11,470	587
OR	Gilliam	Barley Seed	1,581	81

OR	Gilliam	Oats Seed	91	3
OR	Hood River			None
OR	Morrow	Corn Seed	1,170	146
OR	Morrow	Wheat Seed	20,048	1,027
OR	Morrow	Barley Seed	322	10
OR	Multnomah	Wheat Seed	203	10
OR	Multnomah	Barley Seed	26	1
OR	Multnomah	Corn Seed	109	14
OR	Sherman	Wheat Seed	11,980	613
OR	Sherman	Barley Seed	2,568	80
OR	Umatilla	Wheat Seed	28,395	1,454
OR	Umatilla	Corn Seed	808	101
OR	Wasco	Wheat Seed	7,604	389
OR	Wasco	Barley Seed	290	9
WA	Chelan	Wheat Seed	224	12
WA	Clark			None
WA	Columbia	Corn Seed	5	1
WA	Columbia	Wheat Seed	9,301	476
WA	Columbia	Barley Seed	2,106	66
WA	Columbia	Oat Seed	38	1
WA	Cowlitz	Wheat Seed	26	3
WA	Cowlitz	Corn Seed	1,144	143
WA	Klickitat	Wheat Seed	3,336	186
WA	Klickitat	Barley Seed	896	46
WA	Klickitat	Oat Seed	23	1
WA	Pacific			None
WA	Wahkiakum			None

WA	Walla Walla	Corn Seed	589	30
WA	Walla Walla	Wheat Seed	232,419	11,900
WA	Walla Walla	Barley Seed	2,710	139

7. Snake River Basin steelhead ESU

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

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

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

Tables 22 and 23 show the cropping information for the Pacific Northwest counties where the Snake River Basin steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 22: Rearing/spawning areas supporting the Snake River Basin steelhead ESU .

State	County	Site	Acres Treated	lbs a.i. Applied
ID	Adams	Corn Seed	9	1
ID	Adams	Wheat Seed	24	1
ID	Adams	Barley Seed	37	1
ID	Blain	Wheat Seed	286	15
ID	Blain	Barley Seed	2,072	65
ID	Boise	Barley Seed	36	1
ID	Clearwater	Wheat Seed	1,093	56
ID	Clearwater	Barley Seed	727	23
ID	Custer	Wheat Seed	77	4
ID	Custer	Barley Seed	286	9
ID	Idaho	Wheat Seed	7,474	383
ID	Idaho	Barley Seed	3,465	108
ID	Latah	Wheat Seed	10,885	557
ID	Latah	Barley Seed	2,234	70
ID	Lemhi	Barley Seed	58	2
ID	Nez Perce	Wheat Seed	10,789	553
ID	Nez Perce	Barley Seed	2,536	79
ID	Valley	Wheat Seed	78	4
ID	Valley	Oat Seed	34	1
OR	Baker	Wheat	755	39
OR	Baker	Barley	234	7
OR	Union	Wheat Seed	4,367	224
OR	Union	Barley Seed	914	29
OR	Union	Oat Seed	24	1
OR	Wallowa	Wheat	1,740	89
OR	Wallowa	Barley Seed	1,056	33

WA	Asotin	Wheat Seed	253	13
WA	Asotin	Barley Seed	1,225	63
WA	Columbia	Corn Seed	5	1
WA	Columbia	Wheat Seed	9,301	476
WA	Columbia	Barley Seed	2,106	66
WA	Columbia	Oat Seed	38	1
WA	Franklin	Wheat Seed	13,125	673
WA	Franklin	Corn Seed	2,085	261
WA	Franklin	Barley Seed	11,311	579
WA	Garfield	Barley Seed	4,330	135
WA	Garfield	Wheat Seed	8,624	131
WA	Walla Walla	Corn Seed	589	30
WA	Walla Walla	Wheat Seed	232,419	11,900
WA	Walla Walla	Barley Seed	2,710	139

Table 23. Washington and Oregon counties through which the Snake River Basin steelhead ESU migrates

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Clatsop			None
OR	Columbia	Corn Seed	5	1
OR	Gilliam	Wheat Seed	11,470	587
OR	Gilliam	Barley Seed	1,581	81
OR	Gilliam	Oat Seed	91	3
OR	Hood River			None
OR	Morrow	Corn Seed	1,170	146
OR	Morrow	Wheat Seed	20,048	1,027
OR	Morrow	Barley Seed	322	10

OR	Multnomah	Wheat Seed	203	10
OR	Multnomah	Barley Seed	26	1
OR	Multnomah	Corn Seed	109	14
OR	Sherman	Wheat Seed	11,980	613
OR	Sherman	Barley Seed	2,568	80
OR	Umatilla	Wheat Seed	28,395	1,454
OR	Umatilla	Corn Seed	808	101
OR	Wasco	Wheat Seed	7,604	389
OR	Wasco	Barley Seed	290	9
WA	Benton	Corn Seed	1,415	177
WA	Benton	Wheat Seed	253	13
WA	Benton	Barley Seed	8	1
WA	Clark			None
WA	Cowlitz	Wheat Seed	26	3
WA	Cowlitz	Corn Seed	1,144	143
WA	Klickitat	Wheat Seed	3,336	186
WA	Klickitat	Barley Seed	896	46
WA	Klickitat	Oat Seed	23	1
WA	Wahkiakum			None
WA	Pacific			None
WA	Walla Walla	Corn Seed	589	30
WA	Walla Walla	Wheat Seed	232,419	11,900
WA	Walla Walla	Barley Seed	2,710	139

8 Upper Willamette River steelhead ESU

The Upper Willamette River steelhead ESU was proposed for listing as threatened on

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

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

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

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

Tables 24 and 25 show the cropping information for Oregon counties where the Upper Willamette River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 24: Spawning and rearing habitat of the Upper Willamette River steelhead ESU.

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Benton	Wheat Seed	521	27
OR	Benton	Oat Seed	32	1
OR	Benton	Corn Seed	516	65
OR	Linn	Corn Seed	520	65
OR	Linn	Wheat Seed	637	33
OR	Linn	Oat Seed	29	1
OR	Polk	Wheat Seed	1,169	60
OR	Polk	Corn Seed	165	21

OR	Polk	Barley Seed	46	1
OR	Polk	Oat Seed	45	1
OR	Clackamas	Wheat Seed	214	11
OR	Clackamas	Corn Seed	98	12
OR	Clackamas	Barley Seed	31	1
OR	Columbia	Corn Seed	5	1
OR	Marion	Wheat Seed	1,247	64
OR	Marion	Corn Seed	1,309	164
OR	Marion	Barley Seed	31	1
OR	Marion	Oat Seed	52	2
OR	Yamhill	Wheat Seed	1,679	86
OR	Yamhill	Corn Seed	373	47
OR	Yamhill	Barley Seed	46	2
OR	Yamhill	Oat Seed	511	16
OR	Washington	Wheat Seed	2,042	105
OR	Washington	Corn Seed	287	36
OR	Washington	Barley Seed	18	1
OR	Washington	Oat Seed	105	3

Table 24. Oregon and Washington counties that are part of the migration corridors of the Upper Willamette River steelhead ESU.

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Multnomah	Wheat Seed	203	10
OR	Multnomah	Barley Seed	26	1
OR	Multnomah	Corn Seed	109	14
OR	Clatsop			None
OR	Columbia	Corn Seed	5	1

OR	Tillamook			None
WA	Clark			None
WA	Columbia	Corn Seed	5	1
WA	Columbia	Wheat Seed	9,301	476
WA	Columbia	Barley Seed	2,106	66
WA	Columbia	Oat Seed	38	1
WA	Cowlitz	Wheat Seed	26	3
WA	Cowlitz	Corn Seed	1,144	143
WA	Wahkiakum			None
WA	Pacific			None

9. Lower Columbia River steelhead ESU

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

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

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

Tables 25 and 26 show the cropping information for Oregon and Washington counties where the Lower Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 25. Spawning/rearing areas for the Lower Columbia steelhead ESU

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Clackamas	Wheat Seed	214	11
OR	Clackamas	Corn Seed	98	12
OR	Clackamas	Barley Seed	31	1
OR	Hood River			None
OR	Multnomah	Wheat Seed	203	10
OR	Multnomah	Barley Seed	26	1
OR	Multnomah	Corn Seed	109	14
WA	Clark			None
WA	Skamania			None

Table 26: Migratory corridors for the Lower Columbia River Steelhead ESU.

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Clatsop			None
OR	Marion	Wheat Seed	1,247	64
OR	Marion	Corn Seed	1,309	164
OR	Marion	Barley Seed	31	1
OR	Marion	Oat Seed	52	2
WA	Pacific			None
WA	Wahkiakum			None

10. Middle Columbia River Steelhead ESU

The Middle Columbia River steelhead ESU was proposed for listing as threatened on

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

This steelhead ESU occupies "the Columbia River Basin and tributaries from above the Wind River in Washington and the Hood River in Oregon (exclusive), upstream to, and including, the Yakima River, in Washington." The Critical Habitat designation indicates the downstream boundary of the ESU to be Mosier Creek in Wasco County, Oregon; this is consistent with Hood River being "excluded" in the listing notice. No downstream boundary is listed for the Washington side of the Columbia River, but if Wind River is part of the Lower Columbia steelhead ESU, it appears that Collins Creek, Skamania County, Washington would be the last stream down river in the Middle Columbia River ESU. Dog Creek may also be part of the ESU, but White Salmon River certainly is, since the Condit Dam is mentioned as an upstream barrier. There is limited data on the status of the Dog and Collins creeks. The only other upstream barrier, in addition to Condit Dam on the White Salmon River is the Pelton Dam on the Deschutes River. As an upstream barrier, this dam would preclude steelhead from reaching the Metolius and Crooked Rivers as well the upper Deschutes River and its tributaries.

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

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

Tables 27 and 28 show the cropping information for Oregon and Washington counties where the Middle Columbia River steelhead ESU is located and for the Oregon and Washington counties where this ESU migrates.

Table 27: Spawning/Rearing areas for the Middle Columbia Steelhead ESU

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Crook			None

OR	Gilliam	Wheat Seed	11,470	587
OR	Gilliam	Barley Seed	1,581	81
OR	Gilliam	Oat Seed	91	3
OR	Jefferson	Wheat Seed	1,496	77
OR	Morrow	Corn Seed	1,170	146
OR	Morrow	Wheat Seed	20,048	1,027
OR	Morrow	Barley Seed	322	10
OR	Sherman	Wheat Seed	11,980	613
OR	Sherman	Barley Seed	2,568	80
OR	Umatilla	Wheat Seed	28,395	1,454
OR	Umatilla	Corn Seed	808	101
OR	Wasco	Wheat Seed	7,604	389
OR	Wasco	Barley Seed	290	9
OR	Wheeler			None
WA	Benton	Corn Seed	1,415	177
WA	Benton	Wheat Seed	253	13
WA	Benton	Barley Seed	8	1
WA	Chelan	Wheat Seed	224	12
WA	Douglas	Wheat Seed	24,035	1,231
WA	Douglas	Barley Seed	330	10
WA	Grant	Corn Seed	2,696	337
WA	Kittitas	Corn Seed	10	1
WA	Okanogan	Barley Seed	74	4
WA	Okanogan	Oat Seed	28	1
WA	Skamania			None
WA	Franklin	Wheat Seed	13,125	673
WA	Franklin	Corn Seed	2,085	261

WA	Franklin	Barley Seed	11,311	579
WA	Walla Walla	Corn Seed	589	30
WA	Walla Walla	Wheat Seed	232,419	11,900
WA	Walla Walla	Barley Seed	2,710	139
WA	Yakima	Corn Seed	1,724	216
WA	Yakima	Barley Seed	60	3
WA	Yakima	Wheat Seed	6,052	310

Table 28. Washington and Oregon counties through which the Middle Columbia River steelhead ESU migrates

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Clackamas	Wheat Seed	214	11
OR	Clackamas	Corn Seed	98	12
OR	Clackamas	Barley Seed	31	1
OR	Columbia	Corn Seed	5	1
OR	Harney			None
OR	Hood River			None
OR	Multnomah	Wheat Seed	203	10
OR	Multnomah	Barley Seed	26	1
OR	Multnomah	Corn Seed	109	14
OR	Union	Wheat Seed	4,367	224
OR	Union	Barley Seed	914	29
OR	Union	Oat Seed	24	1
OR	Wallowa	Wheat	1,740	89
OR	Wallowa	Barley Seed	1,056	33
WA	Clark			None
WA	Cowlitz	Wheat Seed	26	3

WA	Cowlitz	Corn Seed	1,144	143
WA	Pacific			None
WA	Wakiakum			None

B. Chinook salmon

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

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

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

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

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

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

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

Table 29 shows the Lindane usage in California counties supporting the Sacramento River winter-run chinook salmon ESU. Use of Lindane 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.

Table 29: California counties supporting the Sacramento River, winter-run chinook ESU.

County	Site	Acres Treated	lbs a.i. Applied
Alameda			None
Amador			None
Butte	Corn Seed	136	4
Butte	Landscape*	NR	2
Butte	Cotton*	4	2
Butte	Safflower*	72	1
Colusa			None
Contra Costa			None
Glenn			None
Marin			None
Napa	Landscape*	NR	1
Nevada			None

Placer			None
Sacramento			None
San Francisco	Landscape*	NR	1
San Mateo	Landscape*	NR	6
Shasta			None
Solano	Corn Seed	89	1
Sonoma			None
Sutter	Bean, Succulent*	150	1
Sutter	Corn Seed	288	26
Sutter	Fumigation*	NR	1
Tehama			None
Yolo	Corn Seed	362	4
Yolo	Cotton*	374	5
Yolo	Sunflower*	68	1

***These uses are no longer supported**

2. Snake River Fall-run Chinook Salmon ESU

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

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

Hydrologic units with spawning and rearing habitat for this fall-run chinook are the Clearwater, Hells Canyon, Imnaha, Lower Grande Ronde, Lower North Fork Clearwater, Lower Salmon, Lower Snake-Asotin, Lower Snake-Tucannon, and Palouse. These units are in Baker, Umatilla, Wallowa, and Union counties in Oregon; Adams, Asotin, Columbia, Franklin, Garfield, Lincoln, Spokane, Walla Walla, and Whitman counties in Washington; and Adams, Benewah, Clearwater, Idaho, Latah, Lewis, Nez Perce, Shoshone, and Valley counties in Idaho. Custer and Lemhi counties in Idaho are not listed as part of the fall-run ESU, although they are included for the spring/summer-run ESU. Because only high elevation forested areas of Baker and Umatilla counties in Oregon are in the spawning and rearing areas for this fall-run chinook, they were excluded them from consideration because lindane would not be used in these areas.

Table 30 shows the cropping information for Pacific Northwest counties where the Snake River fall-run chinook salmon ESU is located. Migration corridors are the same as those in Table 23.

Table 30 : Spawning/rearing areas supporting the Snake River Fall-run chinook salmon ESU

State	County	Site	Acres Treated	lbs a.i. Applied
ID	Adams	Corn Seed	9	1
ID	Adams	Wheat Seed	24	1
ID	Adams	Barley Seed	37	1
ID	Clearwater	Wheat Seed	1,093	56
ID	Clearwater	Barley Seed	727	23
ID	Idaho	Wheat Seed	7,474	383
ID	Idaho	Barley Seed	3,465	108
ID	Latah	Wheat Seed	10,885	557
ID	Latah	Barley Seed	2,234	70
ID	Lewis	Barley Seed	3,462	108
ID	Lewis	Wheat Seed	7,724	396
ID	Lewis	Oat Seed	28	1
ID	Nez Perce	Wheat Seed	10,789	553
ID	Nez Perce	Barley Seed	2,536	79
ID	Shoshone			None

OR	Union	Wheat Seed	4,367	224
OR	Union	Barley Seed	914	29
OR	Union	Oat Seed	24	1
OR	Wallowa	Wheat Seed	1,740	89
OR	Wallowa	Barley Seed	1,056	33
WA	Adams	Corn Seed	484	61
WA	Adams	Wheat Seed	36,458	1,868
WA	Adams	Barley Seed	1,203	38
WA	Asotin	Wheat Seed	253	13
WA	Asotin	Barley Seed	1,225	63
WA	Franklin	Wheat Seed	13,125	673
WA	Franklin	Corn Seed	2,085	261
WA	Franklin	Barley Seed	11,311	579
WA	Garfield	Barley Seed	4,330	135
WA	Garfield	Wheat Seed	8,624	131
WA	Walla Walla	Corn Seed	589	30
WA	Walla Walla	Wheat Seed	232,419	11,900
WA	Walla Walla	Barley Seed	2,710	139

3. Snake River Spring/Summer-run Chinook Salmon

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

Hydrologic units in the potential spawning and rearing areas include Hells Canyon, Imnaha, Lemhi, Little Salmon, Lower Grande Ronde, Lower Middle Fork Salmon, Lower

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

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

Table 31 shows the counties where the Snake River spring/summer-run chinook salmon ESU occurs. The cropping information for the migratory corridors is the same as for the Snake River fall-run chinook salmon and is in the Table 22.

Table 31: Spawning/rearing area supporting the Snake River spring/summer chinook ESU

State	County	Site	Acres Treated	lbs a.i. Applied
ID	Adams	Corn Seed	9	1
ID	Adams	Wheat Seed	24	1
ID	Adams	Barley Seed	37	1
ID	Benewah	Wheat Seed	3,532	181
ID	Benewah	Barley Seed	541	17
ID	Clearwater	Wheat Seed	1,093	56
ID	Clearwater	Barley Seed	727	23
ID	Idaho	Wheat Seed	7,474	383
ID	Idaho	Barley Seed	3,465	108
ID	Latah	Wheat Seed	10,885	557
ID	Latah	Barley Seed	2,234	70
ID	Lewis	Barley Seed	3,462	108
ID	Lewis	Wheat Seed	7,724	396

ID	Lewis	Oat Seed	28	1
ID	Nez Perce	Wheat Seed	10,789	553
ID	Nez Perce	Barley Seed	2,536	79
ID	Shoshone			None
ID	Valley	Wheat Seed	78	4
ID	Valley	Oat Seed	34	1
OR	Union	Wheat Seed	4,367	224
OR	Union	Barley Seed	914	29
OR	Union	Oat Seed	24	1
OR	Wallowa	Wheat Seed	1,740	89
OR	Wallowa	Barley Seed	1,056	33
WA	Asotin	Wheat Seed	253	13
WA	Asotin	Barley Seed	1,225	63
WA	Franklin	Wheat Seed	13,125	673
WA	Franklin	Corn Seed	2,085	261
WA	Franklin	Barley Seed	11,311	579
WA	Garfield	Barley Seed	4,330	135
WA	Garfield	Wheat Seed	8,624	131
WA	Walla Walla	Corn Seed	589	30
WA	Walla Walla	Wheat Seed	232,419	11,900
WA	Walla Walla	Barley Seed	2,710	139

4. Central Valley Spring-run Chinook Salmon ESU

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

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

Table 32: California counties supporting the Central Valley spring-run chinook salmon ESU.

County	Site	Acres Treated	Lbs a.i. Applied
Alameda			None
Amador			None
Butte	Corn Seed	136	4
Butte	Landscape*	NR	2
Butte	Cotton*	4	2
Butte	Safflower*	72	1
Colusa			None
Contra Costa			None
Glenn			None
Marin			None
Napa	Landscape*	NR	1
Nevada			None
Placer			None
Sacramento			None
San Francisco	Landscape*	NR	1
San Mateo	Landscape*	NS	6
Shasta			None

Solano	Corn Seed	89	1
Sonoma			None
Sutter	Bean, Succulent*	150	1
Sutter	Corn Seed	288	26
Sutter	Fumigation*	NR	1
Tehama			None
Yolo	Corn Seed	362	4
Yolo	Cotton*	374	5
Yolo	Sunflower*	68	1
Yuba			None

***These uses are no longer supported**

5. California Coastal Chinook Salmon ESU

The California coastal chinook salmon ESU was proposed as threatened in 1998 (63FR11482-11520, March 9, 1998) and listed on September 16, 1999 (64FR50393-50415). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches and esturaine 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 lindane could be used are Humboldt, Trinity, Mendocino, Lake, Sonoma, and Marin.

Table 33: California counties supporting the California coastal chinook salmon ESU.

County	Site	Acres Treated	Lbs a.i. Applied
Glenn			None
Humboldt			None
Lake			None
Marin			None
Mendocino			None

Sonoma			None
Trinity			None

6. Puget Sound Chinook Salmon ESU

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

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

Table 34: Washington counties where the Puget Sound chinook salmon ESU is located.

State	County	Site	Acres Treated	lbs a.i. Applied
WA	Clallum	Barley Seed	54	2
WA	Clallum	Corn Seed	4	1
WA	Grays Harbor	Corn Seed	117	15
WA	Jefferson			None
WA	King	Corn Seed	17	2
WA	Kitsap			None
WA	Lewis	Corn Seed	60	8
WA	Lewis	Wheat Seed	133	7
WA	Lewis	Barley Seed	105	3
WA	Mason	Corn Seed	10	1
WA	Pierce	Corn Seed	33	4
WA	San Juan			None

WA	Skagit	Corn Seed	59	7
WA	Skagit	Wheat Seed	417	21
WA	Skagit	Barley Seed	99	3
WA	Snohomish	Corn Seed	23	3
WA	Snohomish	Wheat Seed	51	3
WA	Snohomish	Barley Seed	24	1
WA	Thurston	Corn Seed	5	1
WA	Whatcom	Corn Seed	21	3

7. Lower Columbia River Chinook Salmon ESU

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

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

Table 35: Oregon and Washington counties where the Lower Columbia River chinook salmon ESU occurs.

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Clackamas	Wheat Seed	214	11
OR	Clackamas	Corn Seed	98	12
OR	Clackamas	Barley Seed	31	1
OR	Clatsop			None

OR	Hood River			None
OR	Marion	Wheat Seed	1,247	64
OR	Marion	Corn Seed	1,309	164
OR	Marion	Barley Seed	31	1
OR	Marion	Oat Seed	52	2
OR	Multnomah	Wheat Seed	203	10
OR	Multnomah	Barley Seed	26	1
OR	Multnomah	Corn Seed	109	14
OR	Wasco	Wheat Seed	7,604	389
OR	Wasco	Barley Seed	290	9
OR	Washington	Wheat Seed	2,042	105
OR	Washington	Corn Seed	287	36
OR	Washington	Barley Seed	18	1
OR	Washington	Oat Seed	105	3
WA	Clark			None
WA	Cowlitz	Wheat Seed	26	3
WA	Cowlitz	Corn Seed	1,144	143
WA	Klickitat	Wheat Seed	3,336	186
WA	Klickitat	Barley Seed	896	46
WA	Klickitat	Oat Seed	23	1
WA	Lewis	Corn Seed	67	8
WA	Pacific			None
WA	Pierce	Corn Seed	32	4
WA	Skamania			None
WA	Wakiakum			None

8. Upper Willamette River Chinook Salmon ESU

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

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

Tables 36 and 37 show the cropping information for Oregon counties where the Upper Willamette River chinook salmon ESU occurs and for the Oregon and Washington counties where this ESU migrates.

Table 36: Spawning/Rearing areas for the Upper Willamette River chinook ESU

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Benton	Wheat Seed	521	27
OR	Benton	Oat Seed	32	1
OR	Benton	Corn Seed	516	65
OR	Clackamas	Wheat Seed	214	11
OR	Clackamas	Corn Seed	98	12
OR	Clackamas	Barley Seed	31	1
OR	Douglas	Wheat Seed	15	1
OR	Douglas	Corn Seed	16	2
OR	Lane	Wheat Seed	318	16
OR	Lane	Barley Seed	18	1
OR	Lane	Corn Seed	233	29

OR	Lincoln			None
OR	Marion	Wheat Seed	1,247	64
OR	Marion	Corn Seed	1,309	164
OR	Marion	Barley Seed	31	1
OR	Marion	Oat Seed	52	2
OR	Polk	Wheat Seed	1,169	60
OR	Polk	Corn Seed	165	21
OR	Polk	Barley Seed	46	1
OR	Polk	Oat Seed	45	1
OR	Wasco	Wheat Seed	7,604	389
OR	Wasco	Barley Seed	290	9
OR	Yamhill	Wheat Seed	1,679	86
OR	Yamhill	Corn Seed	373	47
OR	Yamhill	Barley Seed	46	2
OR	Yamhill	Oat Seed	511	16
OR	Washington	Wheat Seed	2,042	105
OR	Washington	Corn Seed	287	36
OR	Washington	Barley Seed	18	1
OR	Washington	Oat Seed	105	3

Table 37: Migration corridors of the Upper Willamette River chinook salmon ESU.

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Clatsop			None
OR	Columbia	Corn Seed	5	1
OR	Lincoln			None
OR	Multnomah	Wheat Seed	203	10
OR	Multnomah	Barley Seed	26	1

OR	Multnomah	Corn Seed	109	14
ORE	Tillamook			None
WA	Clark			None
WA	Cowlitz	Wheat Seed	26	3
WA	Cowlitz	Corn Seed	1,144	143
WA	Pacific			None

9. Upper Columbia River Spring-run Chinook Salmon ESU

The Upper Columbia River Spring-run Chinook Salmon ESU was proposed as endangered in 1998 (63FR11482-11520, March 9, 1998) and listed a year later (64FR14308-14328, March 24, 1999). Critical habitat was designated February 16, 2000 (65FR7764-7787) to encompass all river reaches accessible to listed chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River, as well as all down stream migratory corridors to the Pacific Ocean. Hydrologic units and their upstream barriers are Chief Joseph (Chief Joseph Dam), Similkameen, Methow, Upper Columbia-Entiat, Wenatchee, Upper Columbia-Priest Rapids, Middle Columbia-Lake Wallula, Middle Columbia-Hood, Lower Columbia-Sandy, Lower Columbia-Clatskanie, Lower Columbia, and Lower Willamette. Counties in which spawning and rearing occur are Chelan, Douglas, Okanogan, Grant, Kittitas, and Benton (Table 36), with the lower river reaches being migratory corridors (Table 37).

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

Tables 38 and 39 show the cropping information for Washington counties that support the Upper Columbia River chinook salmon ESU and for the Oregon and Washington counties where this ESU migrates.

Table 38. Counties Supporting the Upper Columbia Chinook ESU Spawning/Rearing Area

State	County	Site	Acres Treated	lbs a.i. Applied
WA	Benton	Corn Seed	1,415	177
WA	Benton	Wheat Seed	253	13

WA	Benton	Barley Seed	8	1
WA	Chelan	Wheat Seed	224	12
WA	Douglas	Wheat Seed	24,035	1,231
WA	Douglas	Barley Seed	330	10
WA	Grant	Corn Seed	2,696	337
WA	Kittitas	Corn Seed	10	1
WA	Kittitas	Wheat Seed	627	32
WA	Kittitas	Barley Seed	16	1
WA	Kittitas	Oat Seed	18	1
WA	Kittitas	Corn Seed	399	50
WA	Okanogan	Barley Seed	74	4
WA	Okanogan	Oat Seed	28	1
WA	Skamania			None

Table 39: Migration corridors for the Upper Columbia River Chinook salmon ESU.

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Clatsop			None
OR	Columbia	Corn Seed	5	1
OR	Gilliam	Wheat Seed	11,470	587
OR	Gilliam	Barley Seed	1,581	81
OR	Gilliam	Oat Seed	91	3
OR	Hood River			None
OR	Morrow	Corn Seed	1,170	146
OR	Morrow	Wheat Seed	20,048	1,027
OR	Morrow	Barley Seed	322	10
OR	Multnomah	Wheat Seed	203	10
OR	Multnomah	Barley Seed	26	1

OR	Multnomah	Corn Seed	109	14
OR	Sherman	Wheat Seed	11,980	613
OR	Sherman	Barley Seed	2,568	80
OR	Umatilla	Wheat Seed	28,395	1,454
OR	Umatilla	Corn Seed	808	101
OR	Wasco	Wheat Seed	7,604	389
OR	Wasco	Barley Seed	290	9
WA	Cowlitz	Wheat Seed	26	3
WA	Cowlitz	Corn Seed	1,144	143
WA	Franklin	Wheat Seed	13,125	673
WA	Franklin	Corn Seed	2,085	261
WA	Franklin	Barley Seed	11,311	579
WA	Klickitat	Wheat Seed	3,336	186
WA	Klickitat	Barley Seed	896	46
WA	Klickitat	Oat Seed	23	1
WA	Skamania			None
WA	Pacific			None
WA	Walla Walla	Corn Seed	589	30
WA	Walla Walla	Wheat Seed	232,419	11,900
WA	Walla Walla	Barley Seed	2,710	139
WA	Yakima	Corn Seed	1,724	216
WA	Yakima	Barley Seed	60	3
WA	Yakima	Wheat Seed	6,052	310

C. Coho Salmon

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

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

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

1. Central California Coast Coho Salmon ESU

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

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

Table 40: California counties supporting the Central California coast Coho salmon ESU.

County	Site	Acres Treated	Lbs a.i. Applied
Marin			None

Mendocino			None
Napa	Landscape*	NR	1
San Mateo	Landscape*	NR	6
Santa Cruz			None
Sonoma			None

***These uses are no longer supported**

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 esturaine areas and tributaries) between the Mattole River in California and the Elk River in Oregon, inclusive.

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

Tables 41 shows the usage of lindane in the California counties supporting the Southern Oregon/Northern California coastal coho salmon ESU. Table 42 shows the cropping information for Oregon counties where the Southern Oregon/Northern California coastal coho salmon ESU occurs..

Table 41:California Counties where the Southern Oregon/Northern California Coastal Coho Salmon ESU Occurs

County	Site	Acres Treated	Lbs a.i. Applied
Del Norte	Outdr Transplants*	188	102
Humboldt			None
Lake			None
Mendocino			None
Trinity			None

***These uses are no longer supported**

Table 42: Oregon counties where there is habitat for the Southern Oregon/Northern California coastal coho salmon ESU.

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Curry			None
OR	Douglas	Wheat Seed	15	1
OR	Douglas	Corn Seed	16	2
OR	Jackson	Corn Seed	22	3
OR	Jackson	Wheat Seed	155	8
OR	Jackson	Barley Seed	65	2
OR	Josephine			None

3. Oregon Coast coho salmon ESU

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

This ESU includes coastal populations of coho salmon from Cape Blanco, Curry County, Oregon to the Columbia River. Spawning is spread over many basins, large and small, with higher numbers further south where the coastal lake systems (e.g., the Tenmile, Tahkenitch, and Siltcoos basins) and the Coos and Coquille Rivers have been particularly productive. Critical Habitat includes all accessible reaches in the coastal Hydrologic reaches

Necanicum, Nehalem, Wilson-Trask-Nestucca (upstream barrier - McGuire Dam), Siletz-Yaquina, Alsea, Siuslaw, Siltcoos, North Umpqua (upstream barriers - Cooper Creek Dam, Soda Springs Dam), South Umpqua (upstream barrier - Ben Irving Dam, Galesville Dam, Win Walker Reservoir), Umpqua, Coos (upstream barrier - Lower Pony Creek Dam), Coquille, Sixes. Related Oregon counties are Douglas, Lane, Coos, Curry, Benton, Lincoln, Polk, Tillamook, Yamhill, Washington, Columbia, Clatsop. .

Table 43: Oregon counties where the Oregon coast coho salmon ESU occurs.

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Benton	Wheat Seed	521	27
OR	Benton	Oat Seed	32	1
OR	Benton	Corn Seed	516	65
OR	Clatsop			None
OR	Columbia	Corn Seed	5	1
OR	Coos	Corn Seed	18	2
OR	Curry			None
OR	Douglas	Wheat Seed	15	1
OR	Douglas	Corn Seed	233	29
OR	Josephine			None
OR	Lane	Wheat Seed	318	16
OR	Lane	Barley Seed	17	1
OR	Lincoln			None
OR	Polk	Wheat Seed	1,169	60
OR	Polk	Corn Seed	165	21
OR	Polk	Barley Seed	46	1
OR	Polk	Oat Seed	45	1
OR	Tillamook			None
OR	Yamhill	Wheat Seed	1,679	86
OR	Yamhill	Corn Seed	373	47
OR	Yamhill	Barley Seed	46	2

OR	Yamhill	Oat Seed	511	16
OR	Washington	Wheat Seed	2,042	105
OR	Washington	Corn Seed	287	36
OR	Washington	Barley Seed	18	1
OR	Washington	Oat Seed	105	3

D. Chum Salmon

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

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

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

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

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

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

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

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

Tables 44: Washington counties where the Hood Canal summer-run chum salmon ESU Occurs.

State	County	Site	Acres Treated	lbs a.i. Applied
WA	Island	Barley Seed	58	2
WA	Jefferson			None
WA	Kitsap			None

2. Columbia River Chum Salmon ESU

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

Critical habitat for the Columbia River chum salmon ESU encompasses all accessible reaches and adjacent riparian zones of the Columbia River (including esturaine areas and tributaries) downstream from Bonneville Dam, excluding Oregon tributaries upstream of Milton Creek at river km 144 near the town of St. Helens. These areas are the Hydrologic units of Lower Columbia - Sandy (upstream barrier - Bonneville Dam, Lewis (upstream barrier - Merlin Dam), Lower Columbia - Clatskanie, Lower Cowlitz, Lower Columbia, Lower Willamette in the counties of Clark, Skamania, Cowlitz, Wahkiakum, Pacific, Lewis, Washington and Multnomah, Clatsop, Columbia, and Washington, Oregon. It appears that there are three extant populations in Grays River, Hardy Creek, and Hamilton Creek.

Table 45: Oregon and Washington counties where the Columbia River chum salmon ESU occurs.

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Clackamas	Wheat Seed	214	11
OR	Clackamas	Corn Seed	98	12

OR	Clackamas	Barley Seed	31	1
OR	Columbia	Corn Seed	5	1
OR	Multnomah	Wheat Seed	203	10
OR	Multnomah	Barley Seed	26	1
OR	Multnomah	Corn Seed	109	14
OR	Washington	Wheat Seed	2,042	105
OR	Washington	Corn Seed	287	36
OR	Washington	Barley Seed	18	1
OR	Washington	Oat Seed	105	3
WA	Clark			None
WA	Cowlitz	Wheat Seed	26	3
WA	Cowlitz	Corn Seed	1,144	143
WA	Lewis	Corn Seed	67	8
WA	Pacific			None
WA	Skamania			None
WA	Wahkiakum			None

E. Sockeye Salmon

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

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

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

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

1. Ozette Lake Sockeye Salmon ESU

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

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

Table 46: Clallum County where there is habitat for the Ozette Lake sockeye salmon ESU.

State	County	Site	Acres Treated	lbs a.i. Applied
WA	Clallum	Barley Seed	54	2
WA	Clallum	Corn Seed	4	1

2. Snake River Sockeye Salmon ESU

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

Spawning and rearing habitats are considered to be all of the above-named lakes and creeks, even though at the time of the Critical Habitat Notice, spawning only still occurred in Redfish Lake. These habitats are in Custer and Blaine counties in Idaho. However, the habitat area for the salmon is at high elevation, above the agriculture zone, and in protected areas of a National Wilderness area and National Forest. Lindane cannot be used on such a site, and therefore there will be no exposure in the spawning and rearing habitat. There is a probability that this salmon ESU could be exposed to lindane in the lower and larger river reaches during its juvenile or adult migration.

Table 47 shows the acreage of potential sites in Idaho counties where this ESU reproduces. The critical spawning zones demonstrate, at the maximum allowable application levels, the potential for 5,839,504 lbs a.i if used in forest applications.

Table 48 shows the acreage of crops where lindane can be used in Oregon and Washington counties along the migratory corridor for this ESU.

Table 47. Idaho counties where there is spawning and rearing habitat for the Snake River sockeye salmon ESU.

State	County	Site	Acres Treated	lbs a.i. Applied
ID	Blaine	Wheat Seed	340	17
ID	Blaine	Barley Seed	2,072	65
ID	Blaine	Oat Seed	14	1
ID	Custer	Wheat Seed	77	4
ID	Custer	Barley Seed	286	9

Table 48. Oregon and Washington counties that are in the migratory corridors for the Snake River sockeye salmon ESU.

State	County	Site	Acres Treated	lbs a.i. Applied
OR	Clatsop			None
OR	Columbia	Corn Seed	5	1
OR	Gilliam	Wheat Seed	11,470	587
OR	Gilliam	Barley Seed	1,581	81
OR	Gilliam	Oat Seed	91	3
OR	Hood River			None

OR	Morrow	Corn Seed	1,170	146
OR	Morrow	Wheat Seed	20,048	1,027
OR	Morrow	Barley Seed	322	10
OR	Multnomah	Wheat Seed	203	10
OR	Multnomah	Barley Seed	26	1
OR	Multnomah	Corn Seed	109	14
OR	Sherman	Wheat Seed	11,980	613
OR	Sherman	Barley Seed	2,568	80
OR	Umatilla	Wheat Seed	28,395	1,454
OR	Umatilla	Corn Seed	808	101
OR	Wallowa			None
OR	Wasco	Wheat Seed	7,604	389
OR	Wasco	Barley Seed	290	9
WA	Asotin	Wheat Seed	253	13
WA	Asotin	Barley Seed	1,225	63
WA	Benton	Corn Seed	1,415	177
WA	Benton	Wheat Seed	253	13
WA	Benton	Barley Seed	8	1
WA	Franklin	Wheat Seed	13,125	673
WA	Franklin	Corn Seed	2,085	261
WA	Franklin	Barley Seed	11,311	579
WA	Garfield	Barley Seed	4,330	135
WA	Garfield	Wheat Seed	8,624	131
WA	Walla Walla	Corn Seed	589	30
WA	Walla Walla	Wheat Seed	232,419	11,900
WA	Walla Walla	Barley Seed	2,710	139
WA	Pacific			None

WA	Skamania			None
WA	Whitman			None

4. Specific Conclusions for California and Pacific Northwest Steelhead and Salmon ESUs

Lindane is a chemical that, in previous years, was used on a vast variety of crops and in other applications. It is highly toxic to fish and invertebrates, as well as humans. The use of lindane has been significantly reduced under current guidelines. It has been restricted to use as a seed treatment only in a small number of grains and as a prescription medication, regulated by the FDA. The medical use of lindane is of concern in Washington, Oregon, and Idaho because the procedure indicates it will be directly released into water by rinsing after application. Actual use rates are poorly documented and privileged doctor-patient information, however in Washington and Oregon the use of lindane medical products is strongly discouraged. It is not a concern in California where medical use is not allowed. Use of the product is not allowed as a crop spray, eliminating the potential for drift.

Previous use, by the U.S. and other countries was extensive. It is probable that, due to lindanes high volatility, atmospheric deposition will continue for some time. It should, however, be noted that the major “sink” for atmospheric lindane is in arctic regions.

Numerous international treaties and agreements have been enacted to control the use of lindane. The current review is based largely on the Agencies response to these agreements and internal study. Lindane is currently in very limited use and it is anticipated that atmospheric and surface water levels will decline significantly over time. This review considers lindane use only as currently allowed, and does not evaluate past usages. The high toxicity of lindane, however, requires a determination that in areas where it is used, and with the assumption of maximum use rates some deposition in waters will occur and it is a concern and may affect endangered species. With respect to California ESU’s the California DPR report indicates many sites that are no longer supported by the Agency and have been removed from current labels. This allows a determination of no effect in several areas under current guidelines.

The high toxicity of lindane to aquatic organisms, including endangered salmon and steelhead, is of concern in areas where calculated usage is significant. This includes the large areas in the Pacific Northwest where grain crops are planted. Decisions also are linked to the potential, under current labels for use, regardless of actual use. It should be noted that the USGS survey (Attachment 3) indicates no usage of lindane in the Pacific Northwest, suggesting that the decisions listed below may be quite conservative relative to actual practices.

Table 49: Summary of Findings for California and Pacific Northwest Salmon and Steelhead ESUs

Species	ESU	Finding

Steelhead	Southern California	No Effect
Steelhead	South-Central California Coast	No Effect
Steelhead	Central California Coast	May Affect, but Not Likely to Adversely Affect
Steelhead	Central Valley California	May Affect, but Not Likely to Adversely Affect
Steelhead	Northern California	No Effect
Steelhead	Upper Columbia River	May Affect
Steelhead	Snake River Basin	May Affect
Steelhead	Upper Willamette River	May Affect
Steelhead	Lower Columbia River	May Affect, but Not Likely to Adversely Affect
Steelhead	Middle Columbia River	May Affect
Chinook Salmon	Sacramento River winter run	May Affect, but Not Likely to Adversely Affect
Chinook Salmon	Snake River fall run	May Affect
Chinook Salmon	Snake River spring/summer run	May Affect
Chinook Salmon	Central Valley spring run	May Affect, but Not Likely to Adversely Affect
Chinook Salmon	California Coastal	No Effect
Chinook Salmon	Puget Sound	May Affect, but Not Likely to Adversely Affect
Chinook Salmon	Lower Columbia	May Affect, but Not Likely to Adversely Affect
Chinook Salmon	Upper Willamette	May Affect, but Not Likely to Adversely Affect
Chinook Salmon	Upper Columbia	May Affect
Coho Salmon	Central California Coast	No Effect
Coho Salmon	Southern Oregon/Northern California	May Affect, but Not Likely to Adversely Affect

Coho Salmon	Oregon Coast	May Affect, but Not Likely to Adversely Affect
Chum Salmon	Hood Canal summer run	No Effect
Chum Salmon	Columbia River	May Affect, but Unlikely to Adversely Affect
Sockeye Salmon	Ozette Lake	No Effect
Sockeye Salmon	Snake River	May Affect

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Attachment 1
Reregistration Eligibility Decision for Lindane

Attachment 2
Sample Labels
Lindane

Attachment 3
USGS Usage Map for Lindane