United States
Department of
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Forest Service
Pacific Northwest Region

**Healthy Forests Make
A World of Difference**

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Triclopyr

HERBICIDE INFORMATION PROFILE

This information profile is produced by the USDA Forest Service, Pacific Northwest Region, for employees, forest workers, and the public. It provides information on forest and land management uses, environmental and human health effects, and safety precautions for the herbicide triclopyr and its formulations. A list of definitions is included in Section VIII of this profile. For general information on herbicide use by the Forest Service, refer to the PNW Region Treatment Methods Profile for Herbicides.

The principal sources of information and findings in this profile are the PNW Region FEIS (Final Environmental Impact Statement) for Managing Competing and Unwanted Vegetation (USDA/FS 1988), an updated risk assessment on triclopyr prepared for the Forest Service (SERA 1996) and herbicide product labels (Dow AgroSciences 1999a,b; 2000d) and Material Safety Data Sheets (Dow AgroSciences 2000a,b,c).. Information from other sources is specifically referenced.

The PNW Region periodically publishes a bibliography of recent anecdotal and scientific accounts, and analyzes reported worker health effects. This herbicide information profile is updated from a previous profile prepared in February 1997 and reflects new information from a review of new published literature.

I. BASIC INFORMATION

COMMON NAME: Triclopyr

CHEMICAL NAME: [(3,5,6-trichloro-2-pyridinyl)oxy]-acetic acid

PRODUCT NAMES: Garlon 3A®; Garlon 4®; Pathfinder II®; Remedy®

REGISTERED USE STATUS: "General Use"

FORMULATIONS: Formulated triclopyr products contain one or more substances besides triclopyr itself. These substances are called inert ingredients, because they do not kill plants by themselves. The identities of inert ingredients are not usually listed on the label.

Dow AgroSciences manufactures all the products discussed in this profile. The manufacturer revealed the identity of all inerts to U.S. Environmental Protection Agency (EPA). The Forest Service has

asked the manufacturer to identify inert ingredients for public disclosure in this profile. Inerts are classified by the U.S. EPA as ranging from inerts of toxicologic concern (List 1) to inerts of minimal concern (List 4). The definitions used by the U.S. EPA are listed at the end of this profile.

The manufacturer did not reveal the identity of inert ingredients listed as "surfactants," and "emulsifiers" in Garlon® formulations (DowElanco 1992a). The inert ingredients in Pathfinder II® are described as a single solvent that is a naturally-derived, non-petroleum oil (DowElanco 1996). This solvent is classified by EPA on Inert List 4 (DowElanco 1995). Where the identity of inerts is not available, this profile may not fully characterize possible hazards to human health and the environment associated with the triclopyr formulation.

Garlon 3A®

Triclopyr, as the triethlyamine salt	44.4%
Inert ingredients:	55.6%
Water	
Emulsifiers and surfactants	
Ethanol	≈1%

Garlon 4® and **Remedy®**

Triclopyr, as the butoxyethyl ester (BEE)	61.6%
Inert ingredients:	38.4%
Kerosene	>1<6%
Emulsifiers	

Pathfinder II®

Triclopyr, as the butoxyethyl ester	13.6%
Inert ingredients:	86.4%
Non-petroleum natural oil solvent	

Pathfinder II® is purchased as a ready-to-use product; no further additives or mixing are required. Additional oil, water, and/or surfactants must be mixed with the other triclopyr herbicides before use in most applications.

Other formulations are available that contain mixtures of triclopyr and another herbicide. These mixture formulations are not covered in this profile and this profile does not address the possible effects of these formulated herbicide mixtures.

RESIDUE ASSAY METHODS: The U.S. EPA (1997) recommends gas chromatography for the detection of triclopyr in water and many food and dairy products. High performance liquid chromatography is recommended for triclopyr butoxyethyl ester. The U.S. EPA (1997) does not specify limits of detection for the recommended methods. The manufacturer cites the following limits of detection:

Water	1	ppb
Soil	10	ppb
Plants	50	ppb

(DowElanco d Undated). Sensitive enzyme-linked immunosorbant assays (ELISA) were developed for triclopyr in soil and water with limits of detection of 0.1 ppb (Fischer and Michael 1997; Johnson and Hall 1996). ELISA methods also were developed for the TCP (3,5,6-trichloro-2-pyridinol), a degradation product of triclopyr (Manclus and Montoya 1996a,b; Shackelford et al. 1999). Gas chromatography with ion trap detection can be used to assay very small quantities of triclopyr, but specific limits of detection are not reported (Vogel 1998).

II. HERBICIDE USES

REGISTERED FORESTRY, RANGELAND, RIGHT-OF-WAY USES: Recommended for the control of unwanted woody plants and annual and perennial broadleaf weeds in forests, and on non-crop areas including industrial manufacturing and storage sites, rights-of-way, roadsides and railroads, fence rows, non-irrigation ditch banks, around farm building, grazed areas, and for the establishment and maintenance of wildlife openings.

Target Plants: Triclopyr is used to control woody plants and broadleaf weeds. Triclopyr does not injure grasses when used at recommended application rates.

Mode of Action: Triclopyr mimics indole auxin plant growth hormones and cause uncontrolled growth in plants. Triclopyr is absorbed by green bark, leaves, roots, and cut stem surfaces and moves throughout the plant. Triclopyr accumulates in the meristem (growth region) of the plant.

Method of Application: Triclopyr may be applied as a ground or aerial foliage spray, basal bark and stem treatment, cut surface treatment, tree injection.

Use Rates: In the PNW, application rates may range from 0.025 to 9 pounds acid equivalent per acre. The highest labeled application rate for triclopyr is 9 lbs a.e./acre for Garlon 3A® and 8 lbs a.e./acre for Garlon 4®.

Special Precautions: Always read all of the information on the product label before using any pesticide. Read the label for application restrictions.

Use Restrictions: For triclopyr products discussed in this profile, livestock grazing and hay production are restricted in treated areas. These restrictions are intended to prevent residues of triclopyr in meat and milk that may exceed U.S. EPA standards. Consult the product label for exact restrictions when planning for or applying triclopyr products where grazing occurs.

Timing of Applications: For foliar treatment, apply triclopyr during active plant growth. Basal bark and cut surface treatments can be applied at any time of the year. Dormant stem application can only be done when trees and brush are dormant.

Drift Control: Apply triclopyr only when there is little or no chance of spray drift. Do not allow spray to come in contact with broadleaf crops. Spray only when wind speed is low. Avoid fine sprays, which may drift.

IV. ENVIRONMENTAL FATE

SOIL

RESIDUAL SOIL ACTIVITY: Triclopyr is absorbed by plant roots, but it is not considered effective as a soil-applied herbicide. When soil from a recent clearcut was treated with Garlon 4®, the germination of soil-stored seed was inhibited at triclopyr concentrations of 50 mg/kg and completely stopped at concentrations of 500 mg/kg (Morash and Freedman 1989). These concentrations represent approximately 10

and 100 times, respectively, the soil concentrations of triclopyr actually measured after forestry applications (Newton et al. 1990).

ADSORPTION: The organic matter content is the primary factor in the degree of soil adsorption of triclopyr. Adsorption of triclopyr is generally characterized as "not strong." For triclopyr acid, soil adsorption decreases with both decreasing organic matter and increasing pH (Pusino et al. 1994).

PERSISTENCE AND DEGRADATION: Microorganisms degrade triclopyr readily. It degrades more rapidly under warm, moist conditions which favor microbial activity. Persistence varies widely, depending on soil type and climate. Reported half-lives for triclopyr in western Oregon soils range from 75 to 81 days (Norris et al. 1987). This study found detectable triclopyr residues in soil 477 days after treatment. Comparable half-lives were reported for triclopyr in soil after applications of Garlon 3A® (10-39 days) (Deubert and Corte-Real 1986) and Garlon 4® (approximately 14 days in clay or sand) (Stephenson et al. 1990).

METABOLITES/DEGRADATION PRODUCTS AND POTENTIAL ENVIRONMENTAL EFFECTS: TCP is the major initial product of degradation. TCP is also a major degradation product of chlorpyrifos, an insecticide. Reported half-lives for TCP range from 8 to 279 days in tests on 15 soil types. TMP is another degradation product although it is found less often and in smaller amounts. Reported half-lives for TMP range from 50 to 300 days in three soils. Carbon dioxide was identified as a final degradation product; other degradation products were not identified.

WATER

Solubility: The solubility of triclopyr in water ranges from 408 to 430 mg/L (SERA 1996). The PNW Region FEIS rating would be "Low" solubility. Garlon 4® and Pathfinder II® (esters) are relatively insoluble in water; Garlon 3A® (amine) is highly soluble in water.

Potential for Leaching and Degradation into Ground Water: Triclopyr has some characteristics conducive to leaching behavior. It is not strongly adsorbed to soil particles, and adsorbed molecules may later detach into water moving through the soil. The potential for triclopyr leaching increases as soil organic matter decreases, and as climatic conditions reduce soil microbial activity.

Triclopyr exceeds the threshold for solubility used by U.S. EPA (30 ppm) when evaluating potential for leaching into groundwater (U.S. EPA 1986). Long-term forest and pasture field studies found very little indication that triclopyr will leach substantially either horizontally or vertically in loamy soils (Newton et al. 1990; Norris et al. 1987).

A trace amount of the metabolite TCP was detected in groundwater at a golf course site. Chlorpyrifos, but not triclopyr, was also detected (Dupuy 1986). In soil leaching tests, little or no triclopyr was found below surface layers. The metabolites of triclopyr were less mobile than triclopyr itself. Triclopyr contamination of groundwater is not reported.

Surface Waters: Sunlight rapidly breaks down triclopyr in water. The half-life of triclopyr in water exposed to sunlight ranged from 3 hours to 4.3 days under field

conditions (Solomon et al. 1988; Woodburn et al. 1993). In western Oregon, triclopyr was detected in runoff 9 months after application. Researchers concluded that the triclopyr did not come from upslope sprayed areas. The triclopyr was sprayed directly onto dry streambeds, which became flowing streams during the rainy season, and carried the triclopyr downstream (Norris et al. 1987).

AIR

Volatilization: Triclopyr has a very low vapor pressure, and volatilization is not likely to be a quantitatively significant transport process. In monitoring of southern Oregon airsheds, trace amounts of triclopyr were detected in less than 10% of all samples (Bentson and Norris 1989).

Potential for By-Products from Burning of Treated Vegetation: Dow AgroSciences reports irritating vapors from burning Garlon 3A®: nitrogen oxides, and hydrogen chloride; from burning Garlon 4®: nitrogen oxides, hydrogen chloride, and phosgene; and from burning Pathfinder II®: nitrogen oxides, hydrogen chloride, phosgene, and carbon monoxide (Dow AgroSciences 2000 a,b,c).

The potential for inhalation exposure to triclopyr from brown-and-burn operations was assayed directly by McMahon and Bush (1992). For brown-and-burn operations conducted 32-97 days after application, at which time mean triclopyr residues ranged from 9.9 to 21 mg/kg, no triclopyr was detected in the air based on 140 breathing zone samples (detection limit = 0.1-4 $\mu g/m^3$).

Triclopyr was almost completely consumed when burning treated wood under natural fire conditions. Under smoldering conditions, however, 68% of triclopyr was recovered intact in smoke (Bush et al. 1987).

IV. ECOLOGICAL EFFECTS

Please refer to Section X for definitions of categories for ecotoxicity.

NON-TARGET TOXICITY:

Soil Microorganisms: Triclopyr at concentrations up to 500 parts per million did not affect the growth of soil microorganisms (USDA/FS 1984). No studies regarding the effects of these triclopyr formulations have been reported.

Plants: Triclopyr is toxic to many broadleaf plants. Even very small amounts of spray may injure some plants and clippings contaminated with triclopyr may injure sensitive plant species when the clippings are used as mulch (Branham and Lickfeldt 1997).

Triclopyr residue may be found in edible plant parts; the maximum residue level in berries was reported at 2.4 ppm when harvested 6 days after treatment (USDA/FS 1984). TCP residues were detected in root crops following application of chlorpyrifos which also degrades to TCP (Chapman 1980).

No effects were noted in aquatic algae from triclopyr concentrations up to 2.6 ppm (Peterson et al. 1994). This is consistent with a more recent study on the toxicity of triclopyr to *Ankistrodesmus*, a species of freshwater green alga (Gardner et al. 1997).

Aquatic Animals: Triclopyr, triclopyr BEE, and triclopyr formulations were tested for

acute and subacute effects in fish and aquatic invertebrates. Standard acute 48- to 96-hour LC_{50} values for triclopyr salts range from about 100 to 500 ppm, corresponding to toxicity classifications of slightly toxic to practically non-toxic. The corresponding values for triclopyr BEE range from about 0.75 to 2.5 ppm, corresponding to toxicity classifications of moderately to highly toxic. Some reported LC_{50} values for triclopyr and Garlon® formulations are summarized below:

LC_{50} Values[1]

Species	Triclopyr	Garlon 3A®	Garlon 4®
frog (tadpole)			>1.2 ppm[a]
trout	117 ppm[d] 8.4 ppm[b]	420 ppm[b]	2.7 ppm[b]
salmon	7.8 ppm[b]	275 ppm[b]	1.4 ppm[b]
bluegill	148 ppm[d]		
daphnia	133 ppm[d]		1.2 ppm[c]

(a Berrill 1994; b; Wan 1987; c: Servizi 1987; d: DowElanco undated. All values are 96-hour exposures except a: 48 hours.)

The level of 0.6 ppm appears to be a functional NOEL for Garlon® 4 (SERA 1996). That is, no frank toxic effects should be apparent in fish. Based on the time course data of Kreutzweiser et al. (1994) and Wan et al. (1987), acute exposures to Garlon 4® at levels of 1 ppm for 24 hours or 20 ppm for 1 hour would be associated with substantial mortality. For Garlon 3A®, an acute NOEL of 200 ppm could be taken based on the threshold for behavioral changes (Morgan et al. 1991) but this value is very close to lethal levels reported by other investigators. In the SERA (1996) risk assessment, a judgmental estimate of 50 ppm over a 1-day exposure period was used as the estimated NOEL in fish for triclopyr salts. This is below the lower limit of any reported LC_{50} values. Substantial lethality could be expected in some fish species at concentrations >200 ppm.

Recent studies on the toxicity of triclopyr and triclopyr BEE to aquatic species support the above assessment. Abdelghani et al. (1997) reported LC_{50} values ranging from 91 to 6397.5 ppm for triclopyr BEE in three aquatic species, two fish and one invertebrate. A recent field study conducted in Washington state found no effects on aquatic invertebrates after the application of Garlon 3A® in wetlands (Gardner and Grue 1996). Similarly, applications of Garlon 4® were not associated with mortality or reduced feeding of insects at expected environmental concentrations (Kreutzweiser et al. 1998).

Terrestrial Animals: Triclopyr is slightly toxic to mammals and to birds. Triclopyr is practically non-toxic to bees. In 8-day dietary studies in birds, the LC_{50} for triclopyr ranged from 2935 ppm to greater than 5000 ppm. The formulations were less toxic than triclopyr itself to birds in both acute toxic and dietary studies .

No tests of formulations for acute toxicity to wildlife mammals were reported. Triclopyr and its formulations were not tested for chronic effects in wildlife mammals.

Populations of several native mammals and birds were studied for several years following triclopyr, prescribed burning, and combination treatments in oak-savanna woodlands. Populations for all species showed either no change or increases

following treatments. Thymus gland weights showed a statistically significant increase in burned areas both with and without triclopyr applications (Lochmiller et al. 1995). Recently published studies showed no impact of triclopyr applications on wildlife populations, relative to non-herbicide based vegetation management practices (Duchesne et al. 1999; Harpole and Haas 1999; Leslie et al. 1996; Leutenschlager et al. 1998; Lindgren et al. 1998; Nolte and Fulbright 1997). One study (Obenshain et al. 1997) reports that the combined use of triclopyr with 2,4-D and glyphosate may lead to concentrations of these herbicides in water that may cause adverse effects which are not detailed in the publication.

In mammals, most triclopyr is excreted, unchanged, in the urine. Triclopyr was observed to concentrate slightly in ovaries of laboratory animals given repeated doses. No accumulation was observed in other tissues. The authors concluded that triclopyr and its metabolites are likely to have a low potential to accumulate upon repeated exposure (Timchalk et al. 1990).

Threatened and Endangered Species: Triclopyr may be a hazard to endangered plant species if it is used in areas where they occur. The U.S. EPA has not determined whether triclopyr is a hazard to endangered animal species.

V. HEALTH EFFECTS TESTING

These data, which are the results of laboratory animal studies, were evaluated by the Forest Service and are used to make inferences relative to potential human health effects.

For triclopyr and Dow AgroSciences formulations containing triclopyr as the only active ingredient (Garlon 3A®, Garlon 4®, and Pathfinder II®), findings are from studies sponsored or conducted by the manufacturer. These studies were submitted to the U.S. EPA to support product registration but may not be available to the public. Formulation tests are noted for each category of acute toxicity. Numerical results are noted only for tests of formulations that showed significantly greater toxicity than triclopyr alone.

ACUTE TOXICITY:

Acute Oral Toxicity: Triclopyr has a low order of acute lethal potency with oral LD_{50} values in rats ranging from about 300 to more than 2000 mg/kg, corresponding to a classification of Slightly Toxic (Category III). All formulations listed in this profile were tested and found to be less toxic than triclopyr itself.

Acute Dermal Toxicity: Animal studies involving dermal exposure to triclopyr or triclopyr formulations at doses greater than the oral LD_{50} (>2000 mg a.e./kg) failed to demonstrate mortality in experimental mammals. Again, this result corresponds to a classification of Slightly Toxic (Category III).

Primary Skin Irritation: Technical grade triclopyr is a slight to moderate skin irritant (Toxicity Category III to IV). All formulations of triclopyr may cause skin irritation from prolonged or repeated exposure. Exposure to undiluted Garlon 3A® causes slight erythema (Keeler et al. 1974); whereas, exposure to undiluted Garlon 4® causes more severe effects including moderate erythema, slight edema,

and slight to moderate necrosis (Lichy et al. 1975). Thus, the irritant potential for dermal exposures appears to be: triclopyr < Garlon 3A® < Garlon 4®. Garlon 4® and Pathfinder II® are considered potential skin sensitizers (Dow AgroSciences 2000b,c).

Primary Eye Irritation: Effect on eyes appears to follow a different pattern from that seen with skin irritation, with Garlon 4® causing no eye irritation (Lichy et al. 1975), Garlon 3A® causing severe irritation and corneal damage (Keeler et al. 1974), and triclopyr itself causing only mild irritation (Olson 1967).

Acute Inhalation: In rat studies, exposure to 5.34 ppm of triclopyr for 1 hour caused no adverse effects (Toxicity Category III). Garlon 4® caused nasal irritation but no deaths in rats exposed to 0.82 ppm concentrations for 4 hours. The material safety data sheet (MSDS) for Garlon 4® (Dow AgroSciences 2000b) specifies that inhalation exposure to Garlon 4® vapors may cause central nervous system effects attributable to kerosene.

CHRONIC TOXICITY:

These data are based on tests in laboratory animals. U.S. EPA requires these tests only for the active ingredient triclopyr. Section X provides an explanation of how the NOEL (No-observed-effects level) is used.

The Pacific Northwest Region FEIS risk assessment evaluated the quality of the testing that was done for triclopyr up to 1988. Quality consideration for individual studies included: ranges of doses and species that were tested; length of test; identification of the most sensitive effect. In addition, the degree of quantitative agreement among all tests for an effect was considered. Please refer to Section X for an explanation of qualitative ratings in this section.

SYSTEMIC TOXICITY: Several subchronic or chronic NOELs are available for triclopyr. These values are important because they are used as the basis for characterizing risks from chronic exposure. The PNW FEIS used a NOEL of 2.5 mg/kg/day from a study in dogs based on the U.S. EPA (1985) assessment of triclopyr. More recently, the U.S. EPA (1995) identified a NOEL of 0.5 mg/kg/day in dogs. This latter NOEL is used in the SERA (1996) risk assessment of triclopyr.

Recent comparative pharmacokinetic studies on triclopyr in dogs and monkeys as well as an assessment of pharmacokinetic studies in rats and humans suggest that the dog may be an inappropriate animal model for the assessment of potential health effects in humans because of the impaired ability of the dog to excrete triclopyr (Timchalk and Nolan 1997; Timchalk et al. 1997). This general issue is discussed in SERA (1996).

In 1988, the PNW Region FEIS rated the quality of testing as Marginal-Inadequate. The currently available studies are adequate for the assessment of the potential risks posed by the registered uses of triclopyr (U.S. EPA 1995).

CARCINOGENICITY/MUTAGENICITY: Triclopyr was negative in several laboratory tests for mutagenicity (the ability to cause genetic damage), but was weakly positive in one test in rats. Recent tests accepted by the U.S. EPA were negative for all tested mutagenic effects (U.S. EPA 1995).

The PNW Region FEIS rated the quality of

testing as Marginally Adequate for these effects.

REPRODUCTIVE EFFECTS: A three-generation reproduction study in rats did not show any adverse effects on fertility or reproduction at doses up to 30 mg/kg per day.

DEVELOPMENTAL EFFECTS: Laboratory studies with triclopyr acid in pregnant rats (at dose levels up to 200 mg/kg per day) and rabbits (at dose levels up to 100 mg/kg per day) indicated no evidence of teratology (birth defects). In pregnant rats at the 200 mg/kg per day dose level, there were signs of mild toxicity to the fetus. Doses of 100-300 mg/kg/day of ester and amine formulations of triclopyr produced toxic effects in both the mother and fetus (Bryson 1994a,b,c).

The PNW Region FEIS evaluated the testing as Marginally Adequate for these effects. With the more recent studies detailed in SERA (1996) (i.e., six teratology studies and a three generation reproduction study) the available information is adequate for assessing the potential reproductive effects of triclopyr. Most importantly, the NOEL for reproductive/developmental effects (30 mg/kg/day) is above the NOEL for systemic toxic effects.

OTHER POSSIBLE HEALTH EFFECTS: There was insufficient information available to evaluate the potential for effects to the nervous or immune systems. The results of long-term feeding studies to evaluate systemic toxic effects indicate no signs of nervous system toxicity at the levels at which other toxic effects were noted (SERA 1996). The metabolite TCP was not shown to be neurotoxic, carcinogenic, mutagenic, or to cause birth defects in studies of chlorpyrifos reviewed by U.S. EPA in 1984 (U.S. EPA 1984).

VI. HUMAN HEALTH EFFECTS

FOREST SERVICE EVALUATION OF HUMAN HEALTH RISKS: The Pacific Northwest Region evaluated a range of triclopyr health effects data, including some laboratory studies cited in Section V. Both quantitative (numerical) estimates of toxicity, and the quality of data used to make numerical estimates were evaluated. The new information cited in Section V improves the "quality of information" ratings in those categories. The use of the newer NOEL of 0.5 mg/kg/day reduces the margins of safety cited in the FEIS by a factor of five.

The FEIS Quantitative Risk Assessment predicts the amount of human exposure—both to project workers and to the public—from typical forestry operations and also from a large accidental spill. The risk assessment used this information to assess health risks from typical uses. These risks are compared with U.S. EPA standards of acceptable risk for human health effects. The FEIS risk assessment identifies as "Moderate" or "High" any predicted risks from Forest Service operations that were greater than U.S. EPA standards.

Specific mitigation measures were designed to reduce human exposure from these operations; they are mandatory for every applicable project on National Forest Lands.

The complete set of risk ratings is provided in Section X.

The quality of the existing data affects the reliability of these risk ratings. The FEIS

judged the overall quality of the available data on triclopyr toxicity to be "Marginal to Inadequate." There were some studies of marginal quality that provided useful information, but studies were inconsistent and some contained flaws. New studies are cited throughout this profile in the more recent SERA (1996) risk assessment. These newer studies, particularly the lower NOEL of 0.5 mg/kg/day, change some of the some FEIS estimates of health effects, as detailed in Section X.

POTENTIAL FOR HEALTH EFFECTS TO THE PUBLIC: Forest visitors and nearby residents could be exposed to herbicide drift, to vegetation with herbicide residues, and to accidental spraying. They also could eat food or drink water containing herbicide residues.

There are no studies regarding public exposure to forest applications of triclopyr. Public doses were estimated based on the behavior of the herbicide in the environment. "Routine Application" estimates maximum possible public exposure under normal operating conditions. The "Large Spill" situation models the highest doses that can reasonably be expected. Typical public exposures and risks would be much lower than either situation.

TRICLOPYR RISKS TO THE PUBLIC AND MITIGATING MEASURES TO REDUCE THEM:

"Moderate" risk of general health effects, and of reproductive health effects for people who receive multiple exposures from a large (400 acre) aerial application project. "Low" risk for smaller (40 acre) aerial projects, and for all ground-based applications.

Consider potential for public exposure when designing contact procedures, posting and signing needs in the Herbicide Application Plan.

"High" risk of general health effects, and "High" risk of reproductive effects if exposed to concentrated triclopyr from a large spill.

Prevent all public contact with accidental spills (emergency spill notification system, restrict public access to spill site).

PROBABILITY OF A WORKER RECEIVING A DOSE THAT AFFECTS GENERAL HEALTH OR REPRODUCTION:

Worker exposure and dose are estimated for typical forestry applications. Studies have measured actual worker doses of herbicide formulations in typical forestry applications using varying levels of applicator protection (Middendorf 1992). In contrast, the worker doses used in the FEIS do not account for any reduction in exposure from following safety precautions or mitigating measures (such as wearing protective clothing).

MITIGATING MEASURES TO REDUCE IDENTIFIED RISKS TO WORKERS:

The probability of worker exposure to a toxic concentration for either general health or reproductive effects was rated "Low" or "Negligible" for all application methods except for backpack sprayers, for which risk was rated "Moderate."

In SERA (1996), all applications are rated "Moderate Risk". In the PNW Region FEIS, Mitigating Measure 13 requires workers applying any herbicide to wear protective clothing. Mitigating Measure 23 requires worker exposure monitoring for all herbicide application projects.

The 1992 Amendment to the PNW Record Of Decision requires workers to review this Information Profile before agreeing to apply triclopyr herbicides. The worker may request reassignment without penalty. Additional personal protective equipment must be available at the work site for workers who want to reduce their exposure to the herbicide.

All these mitigation requirements apply to all application methods. Therefore, they mitigate the moderate risk ratings from both the FEIS and from SERA (1996).

ACUTE TOXICITY (POISONING)

Reported Effects: Cases of eye and skin irritation were reported in workers exposed to triclopyr formulations. Absorption and excretion of triclopyr was measured in human volunteers. Both oral and skin exposures were studied. Orally administered triclopyr was rapidly absorbed and rapidly excreted as unchanged triclopyr in the urine. Triclopyr was slowly and poorly absorbed through human skin. The authors concluded that the potential for triclopyr to bioaccumulate, and the potential to be absorbed through skin to acutely toxic levels are both low. Medical examinations of the volunteers after each test found no treatment-related health effects (Carmichael et al. 1989).

Triclopyr was reported to have been detected in the urine of a Forest Service employee who was mixing herbicides. No health effects were reported (Hoglund 1985).

LONG TERM HUMAN HEALTH EFFECTS:

Reported Effects: There are no reported cases of long-term health effects in humans due to triclopyr or its formulations.

Potential for Adverse Health Effects from Inert Ingredients Contained in the Formulated Product: The manufacturer has revealed the identity of some inert chemicals in triclopyr formulations; other inerts are not identified. Specific toxicity information is not available for every inert ingredient.

The U.S. EPA classifies inerts into four lists ranging from most hazardous (List 1) to least hazardous (List 4). Definitions associated with each list are included at the end of this profile.

All triclopyr inert ingredients were categorized as either List 3 or List 4. Although some forms of kerosene have been categorized by U.S. EPA as potentially toxic (List 2), Garlon 4® contains only deodorized kerosene (List 3).

Garlon 3A® contains1% ethanol (ethyl alcohol). Ethanol causes adverse health effects if swallowed, including neurological effects, liver effects, birth defects, and decreased male fertility. Information is inadequate to determine potential cancer-causing and mutagenic effects. Exposure to ethanol from the use of Garlon 3A® would be very low in typical forestry operations. Garlon 3A® also contains the triethylamine salt of ethylenediaminetetraacetic acid (EDTA). This compound is classified as a List 3 inert and several EDTA salts are approved as food additives (Clydesdale. 1997).

Garlon 4® contains between 1% and 6% kerosene (SERA 1996). Kerosene may cause lung damage or death if inhaled. Kerosene vapors may affect the central nervous system (Dow AgroSciences 2000b). Kerosene is a skin irritant. Kerosene did not damage DNA or chromosomes in tests, or

cause cancer in laboratory animals. Kerosene does contain small amounts of other petroleum compounds that are known to cause cancer. The PNW Region FEIS did not find adequate information to evaluate the risk of health effects from kerosene in Garlon 4® in forestry operations.

The inert ingredients in Pathfinder II® are described as a single solvent that is a naturally-derived, non-petroleum oil (DowElanco 1996). This solvent is classified by U.S. EPA on Inert List 4 (DowElanco 1995). Available data on this inert are inadequate to evaluate carcinogenicity; laboratory tests for cell mutagenicity yield some positive and some negative results (Dow AgroSciences 2000c).

Health Effects Associated with Contaminants: No known contaminants. The potential to form a dioxin-related compound during the manufacture or burning of triclopyr has been speculated. DowElanco reports that this compound has not been detected in triclopyr products, and is not produced upon heating of triclopyr (Rohrer 1984). A consortium of state extension services found there is no possibility of dioxin-family contaminants occurring in triclopyr (Extoxnet No date).

Health Effects Associated with Other Formulations: Some formulations contain triclopyr mixed with the herbicides 2,4-D or picloram. The information profile for Picloram describes its properties and potential effects. A profile for 2,4-D has not been written. No profile fully describes the potential for health or environmental effects from formulations containing multiple herbicides. Additional information on properties and potential effects of these formulations will be prepared before they are used in the PNW Region.

SOCIETAL PERCEPTIONS: Public opinion about herbicide use ranges from a perception that herbicides are completely safe, to a perception that they are very hazardous. A full range of opinion is available in the PNW Region FEIS. This profile provides workers and the general public with information that may be useful in assessing the hazards associated with the use of triclopyr in the PNW Region.

VII. SAFETY PRECAUTIONS

SIGNAL WORDS AND DEFINITIONS:

Pathfinder II® and Garlon 4® - CAUTION - Harmful if swallowed, inhaled or absorbed through skin.

Garlon 3A® - DANGER- Corrosive. Causes irreversible eye damage. Harmful if swallowed or inhaled. Prolonged or frequently repeated skin contact with herbicide concentrate may cause an allergic skin reaction in some individuals. Do not get in eyes or on clothing. Avoid contact with skin. Avoid breathing vapor or spray mist.

PROTECTIVE PRECAUTIONS FOR WORKERS: Avoid contact with eyes, skin, or clothing. Avoid contamination of food. Avoid breathing mists or vapors. Wash thoroughly after handling. Remove and wash contaminated clothing before reuse. For Garlon 3A®, wear goggles, face shield, or safety glasses, and rubber gloves when handling.

Medical Treatment Procedures (Antidotes): FIRST AID:

Garlon 3A®

EYES: Immediate and continuous irrigation with flowing water for at least 30 minutes is imperative. Prompt medical consultation is essential.
SKIN: Wash off in flowing water or shower.
INGESTION: Do not induce vomiting. Give large amounts of water or milk if available and transport to medical facility. Do not give anything by mouth to an unconscious person.
INHALATION: No adverse effects anticipated by this route of exposure incidental to proper industrial handling.
NOTE TO PHYSICIAN: Ingestion may cause tissue destruction leading to stricture. If lavage is performed endotracheal and/or esophageal control is suggested. If burn is present, treat as any thermal burn, after decontamination. No specific antidote. Supportive care. Treatment based on judgment of physician in response to the condition of the patient.

Garlon 4® **AND PATHFINDER II®**
Eyes: Flush eyes with plenty of water.
SKIN: Wash off in flowing water or shower.
INGESTION: Do not induce vomiting. Call a physician and/or transport to emergency facility immediately.
INHALATION: Remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to medical facility.
NOTE TO PHYSICIAN: The decision of whether to induce vomiting or not should be made by an attending physician. If lavage is performed, suggest endotrachael and/or esophageal control. Danger from lung aspiration must be weighed against toxicity when considering emptying the stomach. If burn is present, treat as any thermal burn, after decontamination. No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient.

HANDLING, STORAGE, AND DISPOSAL:
Keep out of reach of children. Avoid contact with eyes, skin or clothing. Do not ship or store with food, animal feeds, drugs or clothing. Triclopyr formulations are combustible. Do not use or store near heat or open flame. Do not cut or weld container. Triclopyr is stable for at least 2 years under normal storage conditions. Do not contaminate water by disposal. Dispose of this pesticide according to federal, state, or local procedures.

ACCIDENTAL RELEASE MEASURES:

GARLON 3A®: Contain small spills and absorb with an inert material such as clay or dry sand. Report large spills to Dow AgroSciences at 800-992-5994

GARLON4 and REMEDY®: Keep out of streams and domestic water supplies. Absorb small spills in inert material such as dry sand. Eliminate all ignition sources. Report large spills to Dow AgroSciences at 800-992-5994.

PATHFINDER II®: Dike large spills. Keep out of streams and domestic water supplies. Absorb small spills in inert material such as dry sand. Eliminate all ignition sources. Report large spills to Dow AgroSciences at 800-992-5994.

VIII. DEFINITIONS

Absorption -- The process by which a chemical passes through the body membranes and enters the bloodstream. The main routes by which toxic agents are absorbed are the gastrointestinal tract, lungs, and skin.

Acute toxicity – The amount of a substance as a single dose to cause poisoning in a test animal.

Acute exposure -- A single exposure or multiple exposure occurring within a short time (24 hours or less).

Adsorption – Tendency of a chemical to bind to a media such as soil.

Adverse-effect level (AEL) -- Signs of toxicity that must be detected by invasive methods, external monitoring devices, or prolonged systematic observations.

a.e. – Acid equivalents. The amount of the active ingredient excluding any salt or ester in the formulation.

Arid – A terrestrial region lacking moisture, or a climate in which the rainfall is not sufficient to support the growth of trees or woody plants.

Assay -- A kind of test (noun); to test (verb).

Basal treatment – Application method by which herbicide is applied to the stem of a plant just above the soil.

Bioconcentration factor -- The concentration of a compound in an aquatic organism divided by the concentration in the ambient water of the organism.

Broadleaf weed -- A nonwoody dicotyledonous plant with wide bladed leaves designated as a pest species in gardens, farms, or forests.

Carcinogen -- A chemical capable of inducing cancer.

Chronic exposure -- Long-term exposure studies often used to determine the carcinogenic potential of chemicals. These studies are usually performed in rats, mice, or dogs and extend over the average lifetime of the species (for a rat, exposure is 2 years).

Contaminants -- Impurities present in a commercial grade chemical.

Degraded -- Broken down or destroyed.

Dermal -- Pertaining to the skin.

Drift -- That portion of a sprayed chemical that is moved by wind off a target site.

Formulation -- A commercial preparation of a chemical including any inerts or contaminants.

Half-life – The time required for the concentration of the chemical to decrease by one half.

Herbicide -- A chemical used to control, suppress, or kill plants, or to severely interrupt their normal growth processes.

Inerts -- Adjuvants or additives in a commercial formulation that do not directly affect the target species.

Invertebrate -- An animal that does not have a spine (backbone).

LC_{50} – The concentration of a chemical calculated to kill 50% of test animals.

LD_{50} – The dose of a chemical calculated to kill 50% of test animals.

Leach – To dissolve out by the action of water

Lowest-observed-adverse-effect level (LOAEL) -- The lowest dose of a chemical in a study, or group of studies, that produces statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control.

Margin of safety (MOS) -- The ratio between an effect or no effect level in an animal and the estimated human dose.

Metabolite -- A compound formed as a result of the metabolism or biochemical change of another compound.

mg/kg -- A common way of expressing dose: milligram of a toxic agent per kilogram of body weight.

Microorganisms -- A generic term for all organisms consisting only of a single cell, such as bacteria, viruses, and fungi.

Mutagenicity -- The ability to cause genetic damage (that is damage to DNA or RNA). Mutations can lead to birth defects, miscarriages, or cancer.

Nontarget -- Any organism that is exposed to treatment inadvertently or unavoidably.

No-observed-adverse-effect level (NOAEL) -- The dose of a chemical at which no statistically or biologically significant increases in frequency or severity of adverse effects were observed between the exposed population and its appropriate control. Effects may be produced at this dose, but they are not considered to be adverse.

No-observed-effect level (NOEL) -- The dose of a chemical at which no treatment-related effects were observed.

Persistence – The tendency of an applied pesticide to remain in the environment.

Pharmacokinetics – The study of how compounds are taken up and eliminated by organisms.

ppb – An abbreviation for *parts per billion*. Equivalent to µg/L for concentrations in water and to µg/kg for concentrations in soil or other non-aqueous media.

ppm -- An abbreviation for *parts per million*. Equivalent to mg/L for concentrations in water and to mg/kg for concentrations in soil or other non-aqueous media.

Reproductive effects -- Adverse effects on the reproductive system that may result from exposure to a chemical or biological agent.

RfD -- A daily dose that is not expected to cause adverse human health effects over a lifetime of exposure. These values are derived by the U.S. EPA.

Systemic toxicity -- Effects that require absorption and distribution of a toxic agent within an organism from its entry point to other internal point where effects are produced. Systemic effects are the opposite of local effects.

Teratogen – A compound that causes birth defects**.**

Toxicity -- The inherent ability of an agent to affect living organisms adversely.

Uncertainty Factor (UF) -- A factor used in operationally deriving the RfD and similar values from experimental data. UFs are intended to account for (1) the variation in sensitivity among members of the human population; (2) the uncertainty in extrapolating animal data to the case of humans; (3) the uncertainty in extrapolating from data obtained in a study that is less than lifetime exposure; and (4) the uncertainty in using LOAEL data rather than NOEL/NOAEL data. Usually each of these factors is set equal to 10.

IX. Information Sources

For general information on herbicide use by the Forest Service, refer to the PNW Region Treatment Methods Profile for Herbicides.

The principal sources of information and findings in this profile are the PNW Region FEIS (USDA/FS 1988), a more recent risk assessment on triclopyr prepared for the Forest Service (SERA 1996), and update literature searches conducted on MEDLINE, AGRICOLA, and various sites on the Internet.

The PNW Region asked the parties to the Mediated Agreement for Managing Competing and Unwanted Vegetation ROD to submit any significant new information on picloram to be evaluated for this Profile revision. NCAP (Northwest Coalition for Alternatives to Pesticides) provided references to one review published in the Journal of Pesticide Reform (Swadener 1993). This review was considered in the SERA (1996) risk assessment.

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X. Toxicity and Risk Categories

ESTIMATES OF HEALTH RISK TO THE PUBLIC AND TO WORKERS FROM FOREST SERVICE OPERATIONS

The FEIS predicts levels of human exposure (dose) for project workers and for the public, for both a typical field project and for a large accidental spill. These dose levels are compared with the highest dose level in animal tests that showed no effect (NOEL). This level of exposure is referred to as the Margin of Safety or Margin of Exposure approach. The SERA (1996) risk assessment used a conceptually similar approach in which the estimated level of exposure is divided by some estimate of acceptable exposure (the RfD). Both the FEIS and the SERA (1996) assessment also express risk qualitatively. In the FEIS, the risk is ranked from "Negligible" to "High" based on the margin between the expected human dose and the highest NOEL "no effect" dose. A "High" risk rating means that the highest NOEL dose is not more than 10 times larger than predicted human dose under the specified conditions. A "Moderate" risk rating means that the highest NOEL dose is between 10 and 100 times larger than the expected human dose.

As illustrated in the following tables, the qualitative expression of risk for both workers and the general public is reasonably consistent between the FEIS and the updated SERA (1996) risk assessments. The PNW Region determined that no new information summarized in this profile or in SERA (1996) would change the public or worker mitigations in the 1988 FEIS, which were based on potential human health risks. These mitigations apply equally to all application methods.

Estimated Health Risks To Project Workers[a].			
Scenario	Risk Category		
	Typical	Lower	Upper
Aerial	Low/ *Moderate*	Negligible/ *Low*	High
Backpack, directed foliar	Moderate	Moderate /*Negligible*	High
Right-of-way, broadcast foliar	Low/ *Moderate*	Low/ *Negligible*	Moderate /*High*

[a] From PNW FEIS and SERA 1996. Where risk classifications differ in the two assessments, the classification from SERA is presented in italics.

Estimated Health Risks To The Public[a].			
Scenario	Risk Category		
	Typical	Lower	Upper
Accidental Spray[b]	Negligible	Negligible	Negligible
Dermal, vegetation [c]	Negligible /*Low*	Negligible /*Low*	Negligible /*Low*
Contamin-ated fruit	Moderate	Negligible /*Low*	Moderate
Contamin-ated water	Low	Negligible	Moderate
Large Spill	High	Low	High

[a] From PNW FEIS and SERA 1999. Where risk classification differ, the classification from SERA (1996) is presented in italics.
[b] PNW is based on spray drift. SERA 1999 assessment is based on direct spray which is not comparable to the PNW assessment..
[d] PNW based on deposition data. SERA 1999 based on method of Durkin et al.(1995).

ECOTOXICOLOGICAL

Mammalian (Acute Oral):	
mg/kg	**Risk Category**
<10	very highly toxic
10-50	highly toxic
51-500	moderately toxic
501-2000	slightly toxic
>2000	practically non toxic

Avian (Acute Oral):	
mg/kg	**Risk Category**
<10	very highly toxic
10-50	highly toxic
51-500	moderately toxic
501-2000	slightly toxic
>2000	practically non toxic

Avian (Dietary):	
mg/kg	**Risk Category**
<50	very highly toxic
50-500	highly toxic
501-1000	moderately toxic
1001-5000	slightly toxic
>5000	practically non toxic

Aquatic:	
ppm	**Risk Category**
<0.1	very highly toxic
0.1-1	highly toxic
>1-10	moderately toxic
>10-100	slightly toxic
>100	practically non toxic

TABLES OF CATEGORIES OF TOXICITY

Human Hazards				
		Route of Administration		
Risk Category	**Signal Word**	**Oral (mg/kg)**	**Dermal (mg/kg)**	**Inhalation (mg/kg)**
I	**DANGER -- Poison**	0-50	0-200	0-0.2
II	**WARNING**	>50-500	>200-2000	>0.2-2.0
III	**CAUTION**	>500-5000	>2000-20,000	>2.0-20
IV	**NONE**	>5000	>20,000	>20

	Hazard	
Category	**Eye Irritation**	**Skin Irritation**
I	corrosive: corneal opacity not reversible within 7 days	corrosive
II	corneal opacity reversible within 7 days; irritation persisting for 7 days	severe irritation at 72 hours
III	no corneal opacity; irritation reversible within 7 days	moderate irritation at 72 hours
IV	no irritation	mild or slight irritation at 72 hours

Category of Quality of Health Effects Data	
Inadequate:	Inadequate information available for evaluating toxicity. There were too few studies of sufficient quality to yield useful or reliable information.
Marginal-Inadequate:	Some useful information exists for evaluating toxicity. There were studies of marginal quality that provided useful information, but studies were inconsistent and some contained flaws. It is likely that new studies would change estimates of health effects.
Marginal:	Marginal but useful information available for evaluating toxicity. There were studies of adequate quality, and results did not vary greatly, but more information would increase reliability. Although new studies may change estimates of health effects, the results are considered moderately reliable.
Adequate:	Adequate information is available. Studies are of sufficient quality and quantity that estimates of human health are considered reliable. New studies are unlikely to change estimates of health effects.

U.S. EPA Classification of Inerts (60 FR 35369)	
List 1	Inerts of toxicological concern.
List 2	Potentially toxic inerts, with high priority for testing.
List 3	Inerts of unknown toxicity.
List 4	Inerts of minimal concerns.