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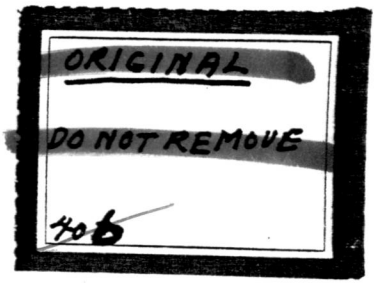


# WORKSHOP ON THE IMPACT OF HERBICIDES ON THE EASTERN BOREAL FOREST ECOSYSTEM

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# IMPACT OF HERBICIDES IN THE SOIL SYSTEM

Logan A. Norris, Chief Research Chemist
Pacific Northwest Forest and Range Experiment Station
USDA Forest Service, Corvallis, Oregon

Chemicals are important tools in forestry, but their use is minute compared to their use in agriculture. Based on figures for the USDA Forest service, in fiscal year 1979 herbicides accounted for 63% of all pesticides used on National Forests in the United States. Insecticides accounted for 23%. Aerial application was involved in 84% of insecticide applications, but in only 23% of herbicide applications. 2,4-D and picloram, alone or in combination with other herbicides, accounted for 70% of the herbicides used.

Evaluation of the hazard or risk (to nontarget species) associated with the use of herbicides requires equal consideration of both toxicity and exposure. There are two general kinds of toxicity, acute and chronic. Acute toxicity is the relatively rapid response of organisms exposed to a few relatively large doses of chemical over a short period of time. Chronic toxicity is the long term response of organisms exposed to many relatively small doses of chemical over a long period of time. The nature of organism response is greatly influenced by three quantitative characteristics of exposure: the size of the dose, and the frequency and duration of exposure. The behaviour (movement, persistence, and fate) of herbicides in the forest environment determines the nature (magnitude, frequency, and duration) of the exposure which organisms in the forest will receive. Herbicide behavior in the forest floor and soil determines the potential for (1) the exposure of plants and soil organisms, (2) contamination of ground water, and (3) entry to streams and lakes (exclusive of drift and direct application of the chemical to the surface of the water).

Adsorption, persistence, and leaching are the three most important processes affecting the behavior of herbicides in forest floor and soil. Adsorption represents "temporary storage" of the herbicide by organic or mineral matter. It is an equilibrium reaction and as the concentration of herbicide in the soil solution is reduced by transport or degradation processes, some of the herbicide in the adsorbed state will be released to reestablish the equilibrium. All herbicides disappear from the soil with time, but the rate of disappearance varies with the herbicide. The following herbicides are important in forestry and are listed in decreasing order of their persistence in the forest floor and soil: picloram, atrazine, 2,4,5-T, 2,4-D, amitrole, fosamine ammonium, and glyphosate. The last two are rapidly absorbed in soil, making them biologically inactive, although they may be chemically recovered and measured for a longer period of time. Herbicides are usually more mobile in soil than insecticides. With few exceptions, herbicide leaching in the soil profile is limited to distances of less than 1 meter. The highest concentrations usually are found in the surface layers. When a forest floor or highly organic surface soils are present, 90+ percent of the herbicide is usually found in the 0- to 15 cm zone of the profile.

Although little research has been done on herbicide behavior in the boreal forest ecosystem, reasonable inferences can be made from studies done in other areas. Research in more temperate forests shows the herbicides important in forestry are not particularly persistent or mobile in soil.

The residues which infrequently occur in forest streams (exclusive of drift and direct application to the water surface) are the result of mobilization of surface residues in ephemeral stream channels. These are short term phenomena and do not result in high level or long term stream contamination. Overland flow and leaching do not appear to be important routes of entry for herbicides to streams. The concentration of herbicide in the water is most important in assessing direct toxic risks, however, in some cases the total amount of herbicide discharged from forested watersheds is an important consideration. The following percent of the herbicide applied has been recovered in stream water in three watershed level studies: 2,4-D - 0.02%; picloram - 0.35%; 2,4,5-T - 0.02%; triclopyr - 0.003%.

High content of organic matter, low pH, and high water table are factors unique to the forest floor and soil of some boreal forest sites. The effect of these factors on herbicide behavior (movement, persistence, and fate) in the boreal forest needs to be determined.

## IMPACT OF HERBICIDES ON AQUATIC SYSTEMS

Brendan C. Birmingham and Brian Colman
Department of Biology
York University

The impact of herbicides on the aquatic component of forest ecosystems is poorly documented. Most of our knowledge comes from studies related to aquatic nuisance control or runoff from agricultural systems. Potential ecological damage to the aquatic ecosystem following exposure to herbicides as a result of direct spraying or runoff directly after spraying were reviewed. Primary or direct effects include acute toxicity to plants or animals and/or sublethal effects on the biochemistry, physiology or behaviour of these organisms which may lead to decreased growth potential, disease resistance or reproductive success of the species involved. Secondary effects are ecosystem changes resulting from the loss or altered behaviour of species affected directly. The most important secondary effects are related to loss or changes in the structure and composition stream bank submersed or planktonic plant life as these influence the physical and chemical properties of water and provide food and/or habitat for aquatic invertebrates and fish.