VEGETATION MANAGEMENT WITH HERBICIDES in the EASTERN REGION

FINAL ENVIRONMENTAL STATEMENT

EASTERN REGION
FOREST SERVICE • U.S. DEPARTMENT OF AGRICULTURE

RECORD OF DECISION

Vegetation Management with
Herbicides in the Eastern Region
Environmental Statement
USDA - Forest Service
Eastern Region

Based on the analysis in the Final Environmental Statement, it is my decision to allow the use of herbicides to be considered as a viable vegetation management alternative where appropriate. The proposed annual use of herbicides in the Eastern Region is approximately 42,700 acres. The final use decision will be dependent upon site specific environmental assessment reports considering all identified alternatives.

Implementation of this plan will not take place until December 1, 1978, after the Final Environmental Statement has been received by the Environmental Protection Agency and this Record of Decison has been made available to interested individuals, organizations, and agencies.

for [signature]
STEVE YURICH
Regional Forester
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Date 8/30/78
Milwaukee, Wisconsin

USDA FOREST SERVICE ENVIRONMENTAL STATEMENT
VEGETATION MANAGEMENT WITH HERBICIDES IN THE EASTERN REGION
USDA - FS - R9 - FES - ADM - 77 - 10

Prepared in Accordance with
Section 102(2)(c) of Public Law 91-190

SUMMARY SHEET

I. DRAFT ( ) FINAL (X)

II. NAME OF AGENCY: FOREST SERVICE, EASTERN REGION

III. ADMINISTRATIVE (X) LEGISLATIVE ( )

IV. DESCRIPTION OF ACTION

This Statement proposes the use of herbicides on National Forest System lands in the Eastern Region of the Forest Service, USDA. This includes National Forest System land located in the States of Illinois, Indiana, Maine, Michigan, Minnesota, Missouri, New Hampshire, New York, Ohio, Pennsylvania, Vermont, West Virginia and Wisconsin. It is estimated that approximately 45,000 acres (0.4 percent) of the 11,250,000 acres of National Forest land in the Eastern Region will be involved annually in chemical vegetation control activities. Vegetation management is needed primarily for the management of roads and trails, grazing areas, recreation developments, special use areas, timber management practices and wildlife activities.

A variety of herbicides are used in the Eastern Region. This is because of a diverse vegetation management program, the limited uses allowed by individual herbicide labels, and the large variety of herbicides available for purchase throughout the Eastern Region. All herbicides used will be registered by the U.S. Environmental Protection Agency (EPA). Only application methods and dosage rates approved by EPA will be used.

It is the policy of the Forest Service, USDA, not to use any herbicide that is not registered by EPA. Thus, all herbicides and all uses of herbicides proposed for consideration in this enviromental statement are registered in accordance with the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act, as Amended. All herbicides proposed for use meet the two primary criteria of this Act. Namely, when used in accordance with label instructions they are effective for the usage proposed; and they are safe when used in accordance with label instructions.

This Statement also describes the procedural requirements for the pretreatment review of all herbicide applications. It is intended that the data on the environmental impacts and effects of the proposed programs will apply on a continuing basis. This Statement will be reviewed annually and revised if new research indicates changes in the presently known environmental effects of any of the herbicides being considered. Revisions will be available at the Forest Supervisor offices and Regional Office.

This Statement is general in nature. Individual projects will be properly described and analyzed in detail in a site-specific environmental assessment report or environment statement, written to provide public and other agencies full understanding of the proposed project.

V. SUMMARY OF ENVIRONMENTAL IMPACT AND ADVERSE ENVIRONMENTAL EFFECTS

Herbicide residues in the air or water, while possible, are uncommon within the National Forests of the Eastern Region. When they have occurred, the levels have been below established limits considered hazardous to non-target organisms. The herbicides used are EPA rated moderately toxic to nearly non-toxic to man. Their persistence in the forest environment is short, with approximately 95 percent of the applied herbicide decomposing within 3 months after application.

The application of herbicides may cause a temporary adverse impact on local aesthetics. Vegetation which is highly susceptible to the herbicide being used will die or experience reduced vigor. However, non-susceptible plants will respond to the changed environment with increased vigor and will tend to dominate the site. The increased vigor results in greater survival and growth of the desired plants.

Twenty-five years of proper herbicide use by the Forest Service in the Eastern Region have produced no known health problems in Forest Service personnel, herbicide applicators, or local Forest residents. On a local basis, the incidence per capita of cancer in rural areas where herbicides are used has not increased since 1930. Scientific data which was gathered after approved herbicide applications shows little if any human health hazards exist from current herbicide use. Public objection to herbicide use, however, continues to be an issue.

Favorable effects of herbicide use include enhanced production and protection of resources, and improved economic welfare and community stability. Where vegetative management can be safely accomplished with herbicides, the greatest dollar savings to the taxpayer and consumer will be realized.

VI. ALTERNATIVES CONSIDERED

A. Biological
B. Fire
C. Herbicides
D. Manual
E. Mechanical
F. No Action or Postponing Action

VII. FEDERAL AGENCIES, STATE DEPARTMENTS OF NATURAL RESOURCES, ORGANIZATIONS, GROUPS, INDIVIDUALS AND COMPANIES.

A Total of 226 copies of the Draft Environmental Statement were mailed out. Twenty-four response were received:

Agencies, Groups and Individuals that responded to the Draft Statement and to whom the Final Statement will be sent:

Federal Agencies

1. Agricultural Research Services, USDA
   Soil Conservation Service, USDA
   Department of Interior
   Environmental Protection Agency

State Agencies

2. Illinois, Bureau of The Budget
   Maine, Department of Conservation
   Michigan, Department of Natural Resources
   Minnesota, Department of Natural Resources
   Ohio, Department of Natural Resources
   Pennsylvania, Department of Environmental Resources
   West Virginia, Department of Natural Resources
   Wisconsin, Department of Natural Resources

Associations

3. Coalition For Economic Alternatives
   Defenders of Wildlife
   Environmental Defense Fund
   Friends of the Earth
   The Izaak Walton League of America
   Minnesota Herbicide Coalition
   The Wilderness Society

Others, Individuals and Companies

4. Mason C. Carter, Purdue University
   Harvey A. Holt, Purdue University
   Mrs. G. Altonen
   Consolidated Papers, Inc.
   TSI Company

VIII. Date Draft Environmental Statement made available to the Environmental Protection Agency and to the public September 19, 1977.

Date Final Environmental Statement made available to the Environmental Protection Agency and to the public OCT 24 1978.

OCT 24 1978

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VEGETATION MANAGEMENT WITH HERBICIDES IN THE EASTERN REGION
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Prepared in accordance with
Section 102(2)(c) of Public Law 91-190

Type of Statement: Final

Date of Transmission to EPA: OCT 24 1978

Type of Action: Administrative

Responsible Official: Steve Yurich
Regional Forester
Eastern Region

TABLE OF CONTENTS

I. DESCRIPTION

A. INTRODUCTION

On September 30, 1973, the Eastern Region of the Forest Service made a Final Environmental Statement, The Use of Herbicides in the Eastern Region, available to the Council on Environmental Quality and the public. The 1973 herbicide statement covered all herbicide projects within the Eastern Region through CY 1978.

This statement which incorporate significant new information covers the Eastern Region's National Forest herbicide program of the future. It does not concern herbicide use on privately owned land adjacent to, or intermingled with, National Forest land. This statement will focus on the scope and direction of a broad and continuing Regional herbicide program. Detailed impacts of local projects and local benefit/cost reviews will be united with this statement through site specific environmental analysis (Appendix B); or environmental statements, if required. Herbicide use is discussed for six management activities: timber management; forest roads and facilities; special use permits; wildlife; range; and, recreation. The environmental impacts and the effects of this program will be reviewed annually, and when necessary, addenda will be published to update this statement. Addenda will be published in the Federal Register and filed in National Forest offices within the Eastern Region.

When alternative methods of vegetation management are technologically available and economically feasible they will be preferred over the use of herbicides. Herbicides will be recommended and used when they will achieve the specific resource management objectives with the least potential hazard to non-target components of the environment.

1. Environmental Objectives

The environmental objectives of vegetation management include preserving the integrity of the ecosystem, avoiding irreversible degradation, and protecting human health and endangered plant and animal species while selectively altering the composition and density of plant communities. The purpose is to create growth conditions favorable to certain forest trees, range grasses and forbs, wildlife browse, and other preferred plant species, while discouraging unfavorable or unwanted pest plants. Vegetation management also includes the modification of environmental factors associated with plant growth: soil protection, exposure to sunlight, adequate moisture, and available nutrients.

2. Management Objectives

Management's objective in the Eastern Region is to manage the Forests so as to, maximize the net public benefits while staying within the constraints set by the environmental objectives. Activities where vegetation management benefits the public include:

a. Forest Roads, Trails and Facilities

Vegetation management on forest roads and trails is necessary to prevent brush encroachment into driving lanes, to maintain sight distances on curves for the safety of the traveler, to permit drainage ditches and associated structures to function as intended, and to reduce roadway maintenance costs. The possibility of accidents involving pedestrians, animals, and vehicles is decreased when brush is controlled and rights-of-way are maintained.

A method of vegetation control is needed that can be used without disturbing highly erodable soil on cut or fill slopes, where rock out croppings exist, and where stones and stumps are present. Roadside maintenance often receives a low priority, compared to maintenance of the road's driving surface. When dollars are available for roadside maintenance, a method is needed that will produce lasting results, especially if brush is a problem.

Control of pest grasses and woody vegetation near radio transmitter sites, equipment storage areas, warehouses, sign posts, and parking lots is needed to reduce the risk of fire and to protect the facility from physical damage. In addition, uncontrolled vegetation and algae growth in sewage lagoons interfers with the treatment process, equipment operation, and can create a health hazard.

b. Range

Vegetation management on range allotments is necessary where past grazing and/or management practices have allowed less palatable or noxious forage to increase at the expense of more desirable forage plants. Often times, the invading plants are poisonous. A method of forage renovation is needed that does not involve complete destruction of the whole forage resource for a long period of time.

Brush and trees that invade range lands compete with forage grasses for sunlight, moisture, space, and nutrients. They need to be controlled. A method which keeps fences and cattle guards clean of brush and vines is needed. Otherwise, the life of these structures is shortened, resulting in costly repairs and replacements.

The 1975 national assessment, prepared in accordance with the Forest and Rangeland Renewable Resources Planning Act of 1974, predicts that the Nation's range forage demand will increase by 17 percent between 1970 and 1980. There seems to be little possibility that grain production costs or demand for grain as a human food are going to decrease significantly to lessen this growing demand for forage. In fact, range forage, as a source of livestock feed can be converted to meat with less expenditure of fossil fuel, labor, and fertilizer than grain and is receiving increased attention. The Eastern Region's National Forest System lands are capable of producing additional forage. Range management programs designed to control vegetation can improve operating efficiency and increase total forage production.

c. Recreation

Vegetation management is used in recreation areas for the safety and convenience of the public. At these sites, methods of plant control are needed which allow for elimination of target weed or encroaching vegetation with a minimum of disturbance.

Poisonous weeds in areas of concentrated public use such as campgrounds, picnic sites, and swimming beaches, are a danger to people, especially children. Skin poisoning accounts for an annual loss of 330,000 working days in the U.S., plus added days of restricted activity (Du Pont Co. 1976). A method which would control these poisonous plants and reduce their resprouting, yet not directly expose workers to the toxic effects of the weeds is desirable.

Recreation area walkways and parking lots require protection from invading grasses and weeds that break up black top surfaces, hide traffic control structures, and lower aesthetic values.

d. Special Use Permits

The Eastern Region has granted permits allowing other government agencies, industry, and individuals to construct and maintain roads, pipelines, power and communication lines, and recreation facilities, and to engage in agricultural activities on National Forest land. Special use permits require the development of a joint management plan by the Forest Service and permittee. Vegetation maintenance often needs to be a part of this management plan.

(1) Utilities and Communication Uses. Having the facilities necessary to carry available services to the public is only one challenge utility companies must face in providing reliable services to customers. Utility companies, such as gas, electric, and communication, must maintain their rights-of-way so as to provide reliable service and at the same time provide an aesthetically pleasing appearance and a land area capable of supporting wildlife and recreation activities. Trees or brush growing into conductors not only cause outages, but other major and costly problems. Uncontrolled vegetation growth can be a fire hazard, hinder access of maintenance crews, and hide potential problems from line inspectors. The aim of right-of-way vegetation management is to grow select vegetation requiring little maintenance, while affording benefits for scenic, wildlife, and recreation values, and soil stabilization.

(2) Transportation Uses. Approximately 2,480 miles of roads, highways and railroads (21,300 acres) located on Eastern Region National Forest System lands are maintained by someone other than the Forest Service. These travelways are regulated by easements and permits issued mainly to individuals, industry, or State or local government highway departments. The vegetation management problems on these roadways are similar to those stated for Forest Service roadway maintenance. Vegetation control along railroad tracks is required to allow the train engineer a clear view of the tracks ahead and to lessen the chance of train caused wild fires.

(3) Agriculture Uses. About 5,000 acres of Eastern Region National Forest land is under permit for cultivation of crops and pasture. These lands are managed similar to commercial agriculture lands and present many of the same weed control problems. There is a need for control of weeds in crop lands and noxious and poisonous plants on pasture lands. Most of the permit areas are small in size, and the permittees prefer to manage them with the equipment and practices accepted for use on the family farm.

(4) Recreation Uses. Selected areas of the Eastern Region are under permit or cooperative agreement

to individuals or groups for the development and maintenance of recreation facilities. These developments range from summer home cabins used by a single family, to winter recreation complexes available to thousands. In 1975, the number of recreation permits was 1,355 (8,830 acres). The objective of vegetation management on special use recreation lands is to present a visually attractive and natural, but safe landscape. This involves highly selective management of vegetation in lawns, along trails and walkways, and around buildings, sewage treatment facilities, parking lots, signs, and play areas.

e. Timber Management

Ensuring an adequate and containing supply of timber and timber products was a major reason for establishing the National Forest System in 1897. Today, supplying wood fiber remains a major function of the National Forests, as reaffirmed by Congress with the passage of the National Forest Management Act of 1976.

Demand for timber from U.S. Forests is expected to increase. Using medium level projections and a 1970 price base, the The Nation's Renewable Resource, An Assessment, 1975, shows demand could rise from 11.7 billion cubic feet in 1970, to 27.3 billion cubic feet by 2020; an increase of 133 percent in 50 years. Under present conditions, both the Nation's supply and demand for wood products are rising. Because demand is rising faster than supply, either the price of wood products will climb to the point of balancing supply with demand, or supplies must be increased to the point of holding down price rises. Therefore, given a fixed or decreasing land base it is necessary to intensify management so a drastic increase in relative price can be avoided.

Future supply increases will depend largely on the level of forest management, the area of land available for commercial timber production, and timber cutting practices and policies. However, supply projections based on a trio of present trend assumptions indicate a demand-supply squeeze will occur. The three assumptions are: (1) recent levels of management will continue, (2) cutting practices and policies will be similar to those of recent years, and (3) the slow downward trend in available commercial timber land area will extend through the next 45 years. (Resources Planning Act, 1975).

Improvements in utilization and increases in net imports of softwoods from Canada and hardwoods from tropical regions can meet part of the projected growth in demand. However, these potentials are relatively small, when compared to the total increase in demand. The Nation must look to its own domestic timber resources as the best means of meeting this demand. Intensive vegetation management on private and public lands is one way to help meet the demand.

In some timber stands, individual trees assert dominance over others and the stands develop efficiently. In other cases, crowding becomes serious. At its worst, this crowding results in death, stagnation, or spindly stands of small trees, all of which are seldom marketable, even with long stand rotations. In most cases, greater stand growth efficiency can be achieved by judicious removal of some of the trees; new growth is concentrated on trees that are best able to grow to a large size.

Vegetation management early in the life of a timber stand can have a major beneficial impact on future timber yields. A practice known as timber stand improvement (TSI) can increase the average annual yields of wood per acre on National Forest lands in the Eastern Region. Common TSI activities include:

(1) Release. This constitutes any type of treatment that frees young trees from overtopping or closely surrounding vegetation, which is inhibiting their establishment as the new forest stand. Some typical examples are cutting, halting the growth of unwanted trees and brush which overtop young conifers, and deadening large cull trees in stands of young hardwoods. Removal of grass, weeds, or brush from around individual seedlings or small trees to reduce competition for nutrients, soil moisture, and sunlight also constitutes release.

(2) Thinning. Thinning operations aim at optimizing the growth and development of trees in established stands by controlling the stocking or tree numbers. Felling or deadening of trees in an immature stand, in order to accelerate diameter growth, control species composition, or improve average form of the remaining trees, without permanently breaking the stand canopy, may be classified as thinning (Figure 1).

It is in the land management and timber management plans that guidelines on what

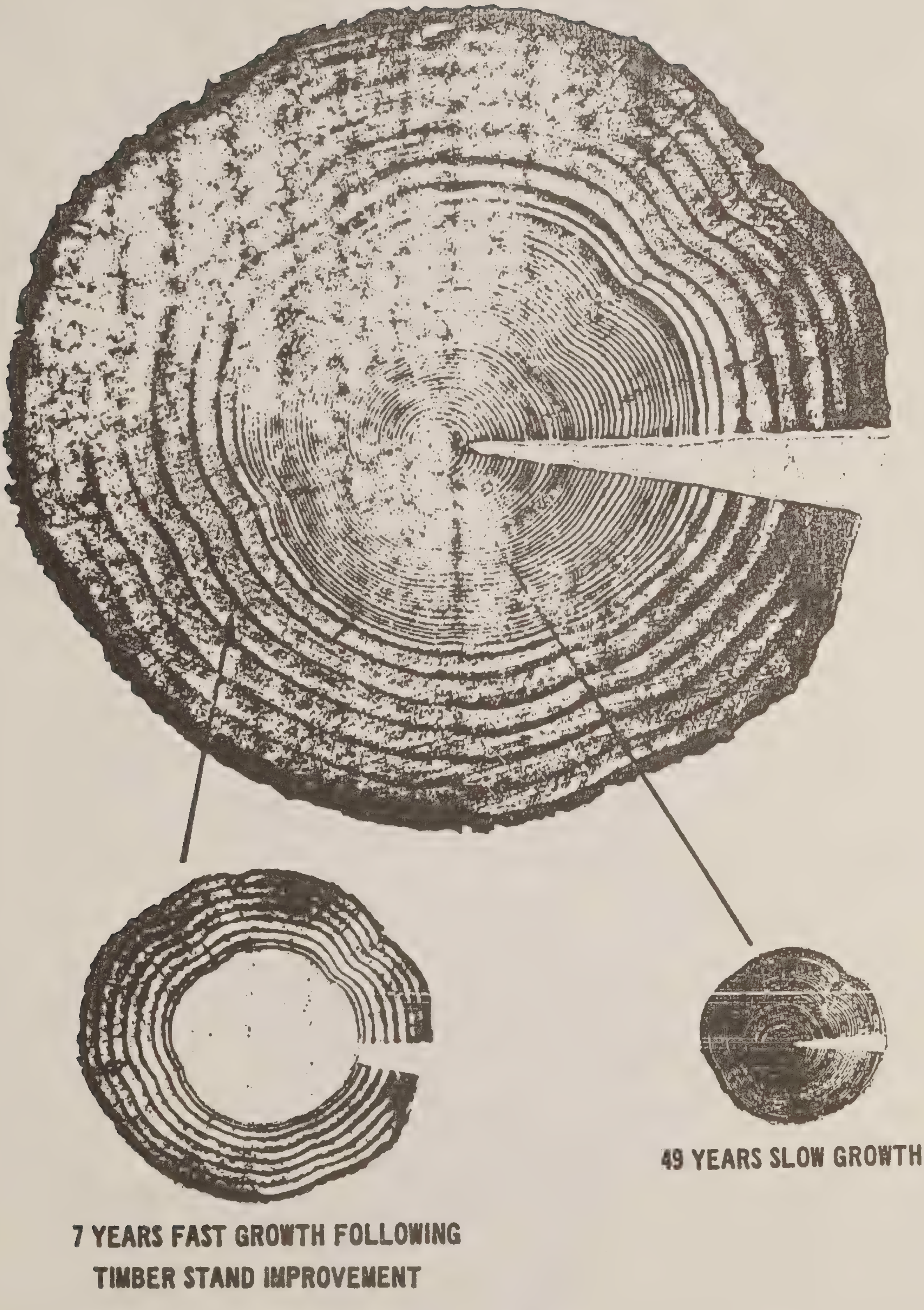


Figure 1. Cross-section of a tree left in an area that was thinned. Average annual growth per acre increased by 94 percent after thinning.

percentage of each National Forest should be in hardwood and conifer acreages are noted. The decision to release or thin a timber stand which needs treatment is follow-up to a prior commitment to grow conifers or hardwoods.

(3) Tree Nurseries. Nursery production of trees for private, State, and Federal reforestation programs is carried out in Federal and leased nurseries on Eastern Region National Forest System lands. The nursery beds used for growing seedlings are fertilized regularly and properly watered. But, these conditions are also favorable for weed growth. If the weeds in nursery beds were not controlled, their fast growth characteristics would enable them to dominate the tree seedlings, causing heavy mortality

(4) Reforestation. Another timber activity, reforestation, requires vegetation management. In preparation for planting, seeding, or natural regeneration, a site must be prepared. Foresters call this practice site preparation. Reforestation sites may be abandoned pastures or fields, rights-of-way, brush fields, or recently harvested timber stands. Site preparation can be for either artificial reforestation, such as planting or seeding by people, or for natural reforestation where new trees are the result of volunteer growth. In either instance, site preparation is the act of modifying vegetation and/or soil to make it suitable for artificial or natural reforestation.

f. Wildlife

The objective of vegetation management in wildlife management is to retard or change plant succession. Descriptions of the wildlife programs in the Eastern Region which depend on the activity follow:

(1) Wildlife Openings in Forest Areas

(a) Opening Maintenance. Small, 1-5 acre openings, for game and non-game species, are important wildlife habitat components. Numerous openings result temporarily from timber harvest, fire, mechanical disturbance, and natural change. Others are developed and maintained through effective management plans. Although the inventory is not complete, approximately 1 percent of the

Region's lands are in permanent openings. The long-term objective is to eventually maintain 3-5 percent of the Region's lands in wildlife openings. Natural and manmade openings require maintenance to control the encroachment of conifers and broad-leaved trees. Controlling some plant species along opening edges preserves other shrub species of value to wildlife.

(b) Sharptail Grouse Management. Approximately 23,000 acres are managed in the Eastern Region so suitable habitat can be maintained for sharptail grouse, and a variety of wildlife associated with an open environment. The optimum range for sharptail grouse includes a mixture of open, shrub, and escape cover. Treatments are needed to maintain areas in a low shrub vegetation community.

(c) Kirtland's Warbler Habitat Management. Some 55,000 acres of jack pine stands have been identified as critical habitat for the nesting of Kirtland's Warblers on the Huron National Forest. Jack pine regeneration requires the stands be burned under prescribed conditions. (Jack pine cones require heat to open and release their seeds.) However, experience has shown that burning in jack pine stands stimulates oak sprouting. Where the density of oak stems occupy over 25 percent of the area, these stands will not be used by the Kirtland's Warbler. A method is needed to eliminate the oak sprouts or sprouting potential.

(2) Browse Production

Production of red maple, dogwood and other high value browse species, preferred by deer, can be increased with properly timed vegetation treatments. Aerial application of herbicides in scrub aspen stands have been found to increase browse by 4,000 stems per acre. Vegetation treatments stimulate such species as red maple, to increasing browse yield at greater rates than lower value browse species. In general, a favorable browse increase results when the density of less desired overstory vegetation is reduced.

(3) Wetland Plant Management

Managed wetland systems, such as greentree reservoirs which replace lost waterfowl habitats, often require some plant management to keep weed growth from blocking water flow in ditch channels. Dikes built to control water levels require protection from tree roots of sprouting trees. The roots penetrate the dikes, allowing water to escape and weaken the dike.

(4) Aquatic Plant Management

Vegetation found in an aquatic environment is as diverse and specialized as that associated with any forest habitat. A variety of submergent and emergent aquatic plants, along with various forms of algae, are present. These plants serve as food sources for herbivorous animals, and provide habitat for insect production upon which fish, waterfowl, and other animals are dependent for food. The aquatic environment is generally less "stable" than the terrestrial environment, and is sensitive to minute changes in the environment.

Situations may exist where algae or aquatic plants become dangerous or a nuisance to man and wildlife. Aquatic vegetation can reduce the diversity of the aquatic ecosystem, and effect the dissolved oxygen levels of water, which can result in fish kills. An excess of aquatic vegetation and algae is considered undesirable in ponds and lakes used for fishing, boating, and swimming. Several species of blue-green algae, (cyanophyceae), produce toxic substances when they die and decay. These algae have been responsible for mammalian, avian, and fish deaths (Bennett 1971). Controlling aquatic vegetation can improve many of these situations.

B. ENVIRONMENTAL SETTING

This 20-State Eastern Region covers a diverse area, with every land form from jagged mountain peaks to gently rolling fields represented. The Forest Service has broken the Region down into five major areas to facilitate land management planning. Each area is made up of National Forests reflecting similar geographic, climatic, and social-economic conditions. The areas include the: Appalachians, Lake States, Midlands, New England, and Ozark Highlands.

1. Appalachians

The Appalachian area consists of hilly or mountainous uplands extending from northern Pennsylvania to southern Ohio and West Virginia. The National Forests in this are the Allegheny, Monongahela, and Wayne. (Figure 2)

The climate is characterized by distinct seasons, frequent changes of weather, considerable precipitation, high humidity, moderate cloudiness, and winds. The sources of many rivers are located in the highlands. These headwaters are cold, clear, and generally clean. However, in some areas, water has been polluted by sediment, acid water from coal mine drainage, sewage, and industrial discharges and spillage. The soils of the Appalachian hardwood forest are highly variable and affect the capability of the area to produce timber, wildlife forage, water, and a variety of recreational opportunities.

The Eastern hardwood forests are some of the most complex biological communities known. The Appalachian hardwood forests are dominated by oaks, with spruce and fir occurring on the higher elevations. A wide variety of other trees and shrubs, many of which are unique, also occur in the area. Living in close association are many forms of wildlife, including rare and endangered species.

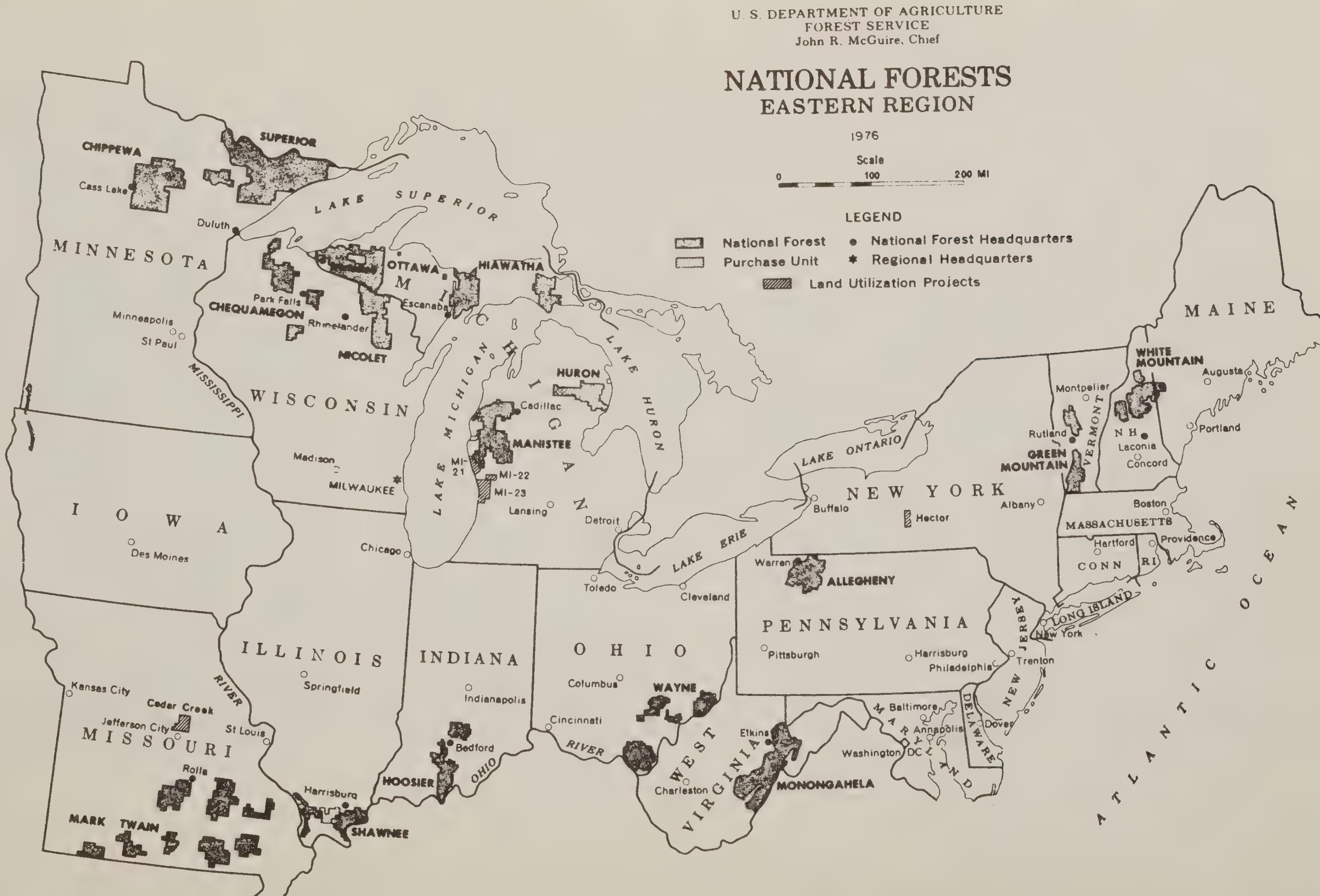
Range is of minor but growing importance. Fossil fuel and mineral production is major.

2. Lake States

The Lake States area is known for many water bodies and diversified terrain. About 1 out of every 16 acres is surface water. Portions of three States - Michigan, Minnesota, and Wisconsin, in which eight National Forests are located, make up the area. The Forests are the Chequamegon, Chippewa, Hiawatha, Huron, Manistee, Nicolet, Ottawa, and Superior.

The area has long, cold winters and short growing seasons. Much of the moderate precipitation falls as snow and spring run-off goes to recharge the many lakes and wetlands. Streams are plentiful, but compared to other areas of the Eastern Region they carry little water. Water quality is generally high, tends to be soft, and is often stained brown by drainage from organic wetlands.

The soils in the Lake States are reflections of glacial deposit, featuring glacial outwash, upland moraine, lowland moraine, lacustrine plains, and organic soils. Erosion and stream sedimentation hazards are insignificant except in small areas. A variety of minerals are found under these surface soils.


U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
John R. McGuire, Chief
NATIONAL FORESTS
EASTERN REGION
1976
Scale
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100
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LEGEND
National Forest
Purchase Unit
Land Utilization Projects
National Forest Headquarters
Regional Headquarters
MINNESOTA
CHIPPEWA
Cass Lake
SUPERIOR
Duluth
Minneapolis
St Paul
MISSISSIPPI
LAKE SUPERIOR
WISCONSIN
CHEQUAMEGON
Park Falls
Rhinelander
NICOLET
OTTAWA
Escanaba
HIAWATHA
Madison
MILWAUKEE
MICHIGAN
HURON
Cadillac
MANISTEE
MI-21
MI-22
MI-23
Lansing
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Annapolis
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VERMONT
Montpelier
Rutland
GREEN MOUNTAIN
N H
Laconia
Concord
WHITE MOUNTAIN
MAINE
Augusta
Portland
MASSACHUSETTS
Boston
CONN
Hartford
RI
Providence
ATLANTIC OCEAN

Figure 2

The National Forest System

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE — EASTERN REGION
REGIONAL HEADQUARTERS
633 W. Wisconsin Ave., Milwaukee, Wisconsin 53203

FIELD OFFICES

ILLINOIS

Shawnee National Forest
317 E. Poplar St.
Harrisburg, Ill. 62946

Ranger Districts and Headquarters

Elizabethtown	Elizabethtown, Ill.
Jonesboro	Jonesboro, Ill.
Murphysboro	Murphysboro, Ill.
Vienna	Vienna, Ill.

INDIANA-OHIO

Wayne-Hoosier National Forests
1615 J Street
Bedford, Indiana 47421

Brownstown	Brownstown, Ind.
Tell City	Tell City, Ind.
Athens	Athens, Ohio
Ironton	Ironton, Ohio

MICHIGAN

Hiawatha National Forest, 2727 N. Lincoln Rd.
Escanaba, Mich. 49829

Manistique	Manistique, Mich.
Munising	Munising, Mich.
Rapid River	Rapid River, Mich.
St. Ignace	St. Ignace, Mich.
Sault Ste. Marie	Sault Ste. Marie, Mich.

Huron-Manistee National Forests
421 S. Mitchell Street
Cadillac, Michigan 49601

Baldwin	Baldwin, Mich.
Cadillac	Cadillac, Mich.
Harrisville	Harrisville, Mich.
Manistee	Manistee, Mich.
Mio	Mio, Michigan
Tawas	East Tawas, Mich.
White Cloud	White Cloud, Mich.

Ottawa National Forest
Ironwood, Michigan 49938

Bergland	Bergland, Mich.
Bessemer	Bessemer, Mich.
Iron River	Iron River, Mich.
Kenton	Kenton, Mich.
Ontonagon	Ontonagon, Mich.
Watersmeet	Watersmeet, Mich.

MINNESOTA

Chippewa National Forest
Cass Lake, Minnesota 56633

Blackduck	Blackduck, Minn.
Cass Lake	Cass Lake, Minn.
Deer River	Deer River, Minn.
Marcell	Marcell, Minn.
Walker	Walker, Minn.

Superior National Forest, 236 Federal Bldg.
Duluth, Minnesota 55801

Aurora	Aurora, Minn.
Gunflint	Grand Marais, Minn.
Isabella	Isabella, Minn.
Kawishiwi	Ely, Minn.
LaCroix	Cook, Minn.
Tofte	Tofte, Minn.
Two Harbors	Two Harbors, Minn.
Virginia	Virginia, Minn.

MISSOURI

Mark Twain National Forest Rolla, Mo. 65401

Ranger Districts and Headquarters

Ava	Ava, Mo.
Cassville	Cassville, Mo.
Cedar Creek LU Area	Fulton, Mo.
Doniphan	Doniphan, Mo.
Fredericktown	Fredericktown, Mo.
Houston	Houston, Mo.
Poplar Bluff	Poplar Bluff, Mo.
Potosi	Potosi, Mo.
Rolla	Rolla, Mo.
Salem	Salem, Mo.
Van Buren	Van Buren, Mo.
Willow Springs	Willow Springs, Mo.
Winona	Winona, Mo.

NEW HAMPSHIRE & MAINE

White Mountain National Forest, Federal Bldg.
719 Main St., Laconia, N. H. 03246

Ammonoosuc	Littleton, N. H.
Androscoggin	Gorham, N. H.
Evans Notch	Bethel, Maine
Pemigewasset	Plymouth, N. H.
Saco	Conway, N. H.

PENNSYLVANIA

Allegheny National Forest, Spiridon Bldg.
Warren, Pa., 16365

Bradford	Bradford, Pa.
Marienville	Marienville, Pa.
Ridgway	Ridgway, Pa.
Sheffield	Sheffield, Pa.

VERMONT & NEW YORK

Green Mountain National Forest
Federal Building West Street
Rutland, Vermont 05701

Manchester	Manchester, Vt.
Middlebury	Middlebury, Vt.
Rochester	Rochester, Vt.
Hector LU Area	Montour Falls, N.Y.

WEST VIRGINIA

Monongahela National Forest, Dept. of Agric. Bldg.,
Sycamore St., Elkins, W. Va. 26241

Cheat	Parsons, W. Va.
Gauley	Richwood, W. Va.
Greenbrier	Bartow, W. Va.
Marlinton	Marlinton, W. Va.
Potomac	Petersburg, W. Va.
White Sulphur	White Sulphur Springs, W. Va.

WISCONSIN

Chequamegon National Forest, Federal Bldg.
Park Falls, Wisconsin 54552

Glidden	Glidden, Wis.
Hayward	Hayward, Wis.
Medford	Medford, Wis.
Park Falls	Park Falls, Wis.
Washburn	Washburn, Wis.

Nicolet National Forest, Federal Bldg.
Rhinelander, Wis. 54501

Eagle River	Eagle River, Wis.
Florence	Florence, Wis.
Lakewood	Lakewood, Wis.
Laona	Laona, Wis.

Many different timber types make up the forest cover, including most northern hardwoods and different conifers - pine, spruce, fir, hemlock, and cedar. Within these forests, a diversity of wildlife is found. The most important Lake States breeding ranges for the bald eagle, osprey, Kirtland's Warbler and eastern population of greater sandhill crane are located on the National Forests. Grazing is minor within this area .

3. Midlands

The Midlands consist of rough and rolling lands in southern Illinois and Indiana. The National Forests are the Shawnee and Hoosier.

The climate is characterized as continental. Temperature extremes from 115 $^{\circ}$F to -26 $^{\circ}$F have been recorded. Precipitation ranges from 40 to 50 inches annually, with most falling as rain. Violent spring and summer storms are not unusual and are sometimes accompanied by tornadoes. Stream run-off is variable, with many smaller tributaries going dry in summer and flow deficiencies restricting water use in lower reaches. To improve this situation and provide a water supply for such uses as recreation, fish and wildlife habitat, a number of ponds and multi-purpose reservoirs have been constructed on streams originating within, or passing through, the Shawnee or Hoosier National Forests. These ponds, reservoirs, and streams are a valuable fishery resource for the Midlands.

Midland soils are derived from sandstone, shale and limestone; are usually acid, low in phosphates, calcium, and nitrogen; and, are susceptible to erosion. The Forest lands are capable of rapid hardwood growth. Highly productive agriculture lands are present in scattered locations, especially along river bottoms.

A mixture of plants are found within the Forests. Hardwoods are the most evident, but other plants, ranging from xerophytic prickly pear cactus to hydric swamp tupelo and bald cypress can also be found. Several rare and unique plants also occur. Associated with the diverse vegetation is a variety of terrestrial wildlife. Local waters are used as resting and wintering areas by migrating waterfowl.

The unglaciated Midland's terrain exhibits unique geological formations and is rich in archeological history. Forest ownership is extremely scattered. Agricultural uses are increasing.

4. New England

The New England area, laced with numerous streams and dotted with lakes and ponds, contains rolling foothills, coastal plains, and the highest mountain peaks in the Northeast. National Forests are the Green Mountain and White Mountain, located in the States of Maine, New Hampshire, and Vermont. The New England year is divided into four distinct seasons, with frequent weather changes influenced by the ocean and high elevation.

Today, forests composed primarily of northern hardwoods and spruce-fir cover 70 percent of the area. Alpine and subalpine vegetation is found in higher mountain areas. The vegetation provides productive habitat for an assortment of game and non-game wildlife. National Forest water yield and quality is high, while that which is closer to population and industrial centers is seriously degraded. The waters provide a variety of fishing experience.

Forage and agricultural uses are common on private lands within the Forests. Mineral activities are limited to common variety sand, gravel, and stone.

5. Ozark Highlands

The Mark Twain National Forest in Missouri, is located in the Ozark Highlands. Landscape, climate, vegetation, and wildlife in the Ozark area is often varied and distinct. The range of soil fertility is extreme, from rich river bottom lands to almost barren glades. The Ozark plateau is underlain with limestone and dolomite bedrock, honeycombed with underground streams and caverns. It is here that such rare animal life as the Indiana bat and the blind cave fish can be found.

National Forest land in Missouri now represents 11 percent of the State's commercial forest land. Total commercial forest land acreage may be shrinking by as much as 100,000 acres annually, as private landowners convert their brush or forest land to grass. Urbanization is also reducing the State's acreage of forest land. The decreasing acreage of forest land in private ownership is increasing the pressure on publicly owned forested lands.

This area has local problems with water quality, timing of flows, and duration of flows; however, it does not suffer from a shortage of water. The nature of karst topography allows easy contamination of ground water. In spite of considerable precipitation and high humidity, lack of available surface water places limits on the wildlife and recreation resources.

Forest types are primarily oak-hickory and pine hardwoods. Mixed with the forests, is a large range resource. Mineral deposits are found throughout the area.

C. SOCIAL AND ECONOMIC CONSIDERATIONS

The Eastern Region is rich in cultural history. On September 1, 1976, the National Register of Historic Places listed 17 sites located within National Forests in the Eastern Region. These 17 sites merit special recognition and management. Many other culturally significant areas within the National Forests are protected through normal multiple use planning and management.

1. Appalachians

The Appalachian Area has historically possessed a specialized economy, heavily dependent on utilization of the Region's natural resources: minerals, timber, farmland, and water. Prior to the early 1960's, the depletion of resources and mechanization of industry caused jobs to disappear and out-migration to occur. The area experienced much social and economic distress; however, with recent expansion of light manufacturing and service industries, employment has shown a marked improvement. In-migration has started in a few areas. Per capita income is increasing at a strong rate.

2. Lake States

The economy of the Lake States Area is dependent on natural resource-based businesses. Forest industries employ the largest number of people; agriculture, mining and recreation are the other leading employers. Growing demands for wood products, increased interest in minerals, and the desire of many individuals in Eastern cities to "get away from it all" offers an optimistic outlook for the area's economic future. (USDA Forest Service, LSAG)

Natural resource-based economies have traditionally grown slower than industrialized economies. The Lake States Area is no exception, as demonstrated by a long history of slow economic growth.

Seeking greater financial security, many young people have moved from the area. This out-migration is reflected in 33 percent of the Lake States area residents being 65 years of age or older (only ten percent of the National population falls into this age bracket). Also, there are only 28 people per square mile, about half of the National average. The life style of the area is classified as rural, with the area's largest urban center being Duluth - Superior and having a population of 150,000 people. Total population within the Lake States Planning Area was estimated at 3.1 million people in 1970, it is expected to increase to 3.3 million by 1990, and 3.4 million by 2000.

3. Midlands

The Midland Area ecomony is truly a mixed economy. Industrial activities, manufacturing, and service jobs account for more than half the area's employment. Mining, agriculture, and forestry are important in some areas.

Social and economic development has been influenced by the major rivers of this area, which serve as the principle commercial link between the Midlands and the rest of the central United States, from Pennsylvania to New Orleans. At the same time, these rivers have helped isolate the area, slowing economic and social interchanges. Economically, the negative effects are felt through high tolls on products, and the need to travel great distances in order to reach a bridge and cross a waterway.

4. New England

The New England Area, with its 35 million people, is one of the most populated areas of the country. The National Forests of New England are among the most intensively used forested areas in the Nation. With 17 percent of the Nation's people, the population density averages 340 people per square mile, compared to a National average of 58.

Population distribution is extremely uneven, with concentrations along the eastern seaboard megalopolis and only 2 million people in the more rural States of Maine, New Hampshire, and Vermont. The projected growth within, and adjacent to, the New England Forests will have a marked impact on both public and private lands within the area. The National Forests are a significant portion of the public land in this area, and they will share this impact in the form of ever-increasing pressures for the goods and services they provide.

5. Ozark Highlands

Although agriculture has been the basic industry of the area, the presence of an abundance of natural resources has provided for considerable hunting, fishing, logging and mining. The population of the Ozark Highlands Area has changed irregularly over the past 40 years, increasing slightly in the 1930's and 1960's, and decreasing in the 1940's and 1950's. One of the major reasons for the decline was the exceedingly high rate of out-migration by young people. The lack of employment opportunities is the major factor behind this out-migration. Also of significance, is the change in land ownership patterns. Farm ownership has given way largely to owners who use the land for rural residence, hunting clubs, investment purposes, etc.

The per capita personal income of the area has increased steadily since 1940; in addition, the dollar gap between the Nationwide per capita personal income average and that of the area is closing. Some influx of light industry has occurred. Through proper management and better utilization, the forest-based industries will substantially increase and contribute to the economy. The mineral industry will continue to increase its contribution to the area's economic well-being. The improved economic outlook is already reflected in a decreasing rate of out-mitgration by the area's population; however, the population growth in the Ozark Highlands is not keeping pace with the National growth.

The National Forest System lands are a significant economic entity in the area. From 36 million to 45 million people live within a day's driving distance of the area. Current programs are estimated to be directly or indirectly responsible for over 1,200 jobs, with their total value to the area said to exceed $15 million. A program aimed at supplying the apparent future demands would more than double the economic benefits.

D. ALTERNATIVES

1. Biological

a. Control. Biological control of vegetation is a natural process featuring animals, insects, disease, biochemical interference, and environmental changes. Releasing more of a plant's natural enemies or pathogens can induce natural vegetation control. The objective is to work against the pest plants by either reducing their growth during a specific period of time or to reduce their numbers.

The use of livestock is one form of biological control. Livestock has been used to reduce competeing grasses and forbs from plantations. In some areas, livestock have been used to reduce buildup of specific vegetation species by intensive grazing.

Some advantages in using livestock are:

a) Low cost.

b) Should the population increase and more food production lands be last to development, using livestock to manage vegetation could become a very important social benefit.

c) Produces a very low environmental hazard to man.

d) And, if rare, endangered or threatened plants exist on or near the treatment site, they can be protected from grazing and trampling damage by fencing or other physical barriers.

Disadvantages:

a) Competition between wildlife and some forms of domestic livestock for food, water, and shelter will exist. Continual disturbance to wildlife will exist when livestock is present.

b) Cold weather and winter snows have excluded grazing animals from some areas of Region 9. This is especially true of goats, which have a low tolerance to cold.

c) Livestock are affected by some diseases that could spread to wildlife, such as deer. However, with proper precautions, the opportunities for transmitting diseases to wildlife could be reduced.

d) Soil compaction can be a problem in bedding areas. Livestock trails can be a source of erosion.

e) Biological controls using livestock may cause a serious predation problem, making predator control necessary and giving rise to pressure from livestock owners for such control programs.

f) Rare, endanagered, and threatened plants and their habitat stand the chance of being harmed or destroyed if not excluded from use by livestock.

g) Confinement of livestock to specific areas can involve high costs, but if the animals are left to wander, areas not intended for grazing may be used.

The Eastern Region's potential for forage production is receiving more attention. Where livestock is available and Forest Service people are trained to administer grazing, it could become a method of biological vegetation control.

Aquatic vegetation control is mostly a problem in manmade lagoons, ponds and lakes. While lagoons are found Region wide, the manmade ponds and lakes are common to the Ozark, Midlands and Appalachian areas. Ducks and geese can be used to control excess duck weed and other aquatics. By up-rooting plants in search for bottom food, carp can control aquatic vegetation. Efforts at such aquatic vegetation control result in increased water turbidity and a change in bottom nutrients to a more usable form. The long-term effect is a more luxurious vegetative growth. In many States, it is illegal to utilize grass carp to control vegetation. Very little, if any, of this control method will be used in the Eastern Region.

Insect damage to plants may be in the form of defoliation, girdling, or sap removal. Common life forms of the attacking insects are larval, nymphal, and adult. The attacked plants are weakened or killed.

Diseases are caused by living parasitic agents, which live and feed on, or in, plants. They are most commonly caused by fungi, bacteria, and viruses. Environmental conditions have to be right before infection occurs. Injury may be in the form of overdeveloped tissues, stunting, lack of chlorophyll, incomplete organ development or death of plant tissue. Pioneering research by the Stanford Research Institute (Wilson 1969) in the use of plant pathogens to control weeds has identified the following principles:

a) the natural resistance of host plants acts as the primary deterrent to biological control of weeds by restricting disease to insignificant levels.

b) natural weed populations may be expected to display a relatively high degree of natural resistance to most local disease organisms.

c) disease susceptibility is, therefore, the exception rather than the rule and high degrees of susceptibility are exceptional.

d) most natural plant disease epidemics in the past have resulted from the accidential importation of foreign pathogens.

e) the fact that local plant populations develop resistance to local pathogens or insect pests does not preclude their susceptibility to forms from which they have been protected by natural barriers.

Biological control can include non-living agents. These agents include such things as nutrient adjustments, extreme heat or cold, plant-toxic chemicals (other than herbicides), and too little or too much water. These causes do not act like a disease, in that they are not transmitted from one plant to another.

Allelopathy, biochemical interference among plants, can be an important form of external regulation of plant growth. Foliage extracts from some species of fern, goldenrod, and aster has been found to be inhibit seed germination of some other plants. Aster foliage extract has inhibited both shoot and root growth of seedlings growing on cotyledon reserves. Foliage extracts of fern, grass, goldenrod, and aster, and root washings of goldenrod and aster have inhibited shoot growth and dry weight accumulation of seedlings which had exhausted cotyledon reserves and were dependent upon soil medium for nutrition (Horsley).

Biological control holds promise for the future, but more research is needed before it can become a viable alternative in forest vegetation management. Many problems still exist. The major disadvantage being there is no way to contain biological agents within a specific target area; they could spread into adjacent areas. Another problem is the biological agent may not be sufficiently specific to the target plants and devastate beneficial plants as well.

b. Tree Improvement. Providing resource managers with plants having superior growth characteristics can reduce the need for competing vegetation control. An example is reforestation. A growth advantage is wanted for the planted trees. This advantage could be obtained through biological development of the trees which will be planted, rather than pest plant control.

Biological evolution of vegetation is a process featuring genetics, nursery practices, and soil preparation for planting and succession. The objective is to work through the preferred plants. Individual plant characteristics for tolerance and early, fast growth can be identified, and through genetic breeding passed along to offspring. Plants bred for favorable growth characteristics could reduce the need for control of associated vegetation.

Transplants conditioned for early, fast growth could prevent better established plants from squeezing them out. Physiological shock is often exhibited by plants transplanted from a controlled nursery environment to an uncontrolled field situation. An adjustment in nursery soil nutrients and introduction of mycorrhizal fungi could reduce this shock, making the plants heartier.

Programs aimed at reestablishing vegetation usually require some type of site preparation prior to planting or seeding. Site preparation involves exposing mineral soil by altering, removal or repositioning of accumulated vegetative matter. A thorough job of site preparation can often reduce the need for control of unwanted pest plants.

Vegetative communities are never static for very long. Conditions are either moving toward, or away from climax stands. The maturity of a vegetative community is determined by the complex association of plants found there and what will happen under the given conditions. Based on sound knowledge of natural succession, host plants could be matched to ecological conditions, rather than competing against them.

Better use of host vegetation, holds promise for the future. Research is under way, but findings are slow due to the time involved in working with many forest plant species. As a reliable method of vegetation management, biological control is technically unavailable and its economic benefits unknown.

2. Fire

Fire, as a vegetation manipulator, has long been a part of the forest environment. Used as a prescribed and controlled tool, today fires are a part of the vegetative management program in timber, range, wildlife, fuels management, and rights-of-way clearing. The average annual acreage in the Eastern Region receiving prescribed burns is about 6,400 acres (average of 1974 and 1975 accomplishments).

A 2 year summary of prescribed burning plans for the Region shows the following:

FISCAL YEAR	TIMBER	WILDLIFE	RANGE	MANAGEMENT	FUELS OTHER	ESTIMATED COST/ACRE
1975	891 ac.	1,864 ac.	131 ac.	3,869 ac.	10 ac.	$ 4.96
1976	874 ac.	2,134 ac.	4 ac.	360 ac.	5 ac.	$10.68

Some of the advantages in using fire for vegetation management are:

1. Fire is a natural phenomenon which plays an important role to varying degrees in different ecosystems.

2. Plant communities have different tolerances and responses to fire.

3. Fires of varying intensities, applied knowledgeably at the proper times of the year, can have a beneficial impact on the resources.

4. Fire is one of the most economic methods of achieving various objectives in land management.

5. Depending on the type of vegetation burned, the visual impacts can be minimal, with greening occuring in 2 to 3 weeks.

Some of the drawbacks in using fire for vegetation management are:

1. Smoke from prescribed fires adds particle matter to the air. However, by choosing the proper weather conditions, the effects can be minimized.

2. If prescribed fire is not properly applied, damage can occur to the humus, soil, and wildlife.

3. Visual impact can be heavy if woody tree growth is common to the area.

4. Weather conditions required for a successful burn do not always occur.

5. The proper quantity of fuel may not be available to support a fire which is necessary to accomplish the job.

6. The use of fire is generally limited to areas where selectivity is not required. Endangered or threatened plant species may be injured.

7. Unwanted plants that are native to an area, but have long been suppressed by successional change, can be released by fire and once again dominate the site.

8. If the prescribed fire is not hot enough to control plants with well established root systems, prolific sprouting can occur.

9. The number of days when fire can be used effectively are limited. In fact, some years they do not occur at all; or when they do, the danger of wild fire is very high, reducing the availability of fire fighters and equipment.

10. Burning also results in the loss of significant amounts of nitrogen through volatilization.

A properly prescribed fire which is skillfully applied can meet specific vegetative management objectives. As more is learned of fire's vegetation management potential and more people are trained to administer prescribed fire, it will receive increased emphasis in the Eastern Region's vegetation management program. Fire will be used where non-selective vegetation management is needed and proper environmental safeguards can be met.

3. Herbicides

Chemical control of vegetation involves the use of materials that cause a malfunction in plant growth processes. Many of these chemicals are related to naturally occurring plant growth regulators. Entry into the plant may be through foliage, stems or roots. Herbicides, as these chemicals are called, may be selective or non-selective. The selective herbicides generally act on broad-leaved plants, whereas most grasses, coniferous trees, and certain legumes are relatively resistant. The non-selective herbicides generally control all vegetative types.

Herbicides are considered an alternative method, because they have been found to be both effective and useful for vegetation management. Effectiveness is shown by a herbicide's ability to control a specific target pest or produce a wanted plant reaction. Usefulness is determined by the ability to achieve desired results while applying herbicides according to directions and cautions on the label, without causing unreasonable adverse environmental effects.

Vegetation growth is affected by available light, heat, nutrients, and water. Generally, the use of light and heat are functions of the plant's foliage, while uptake of nutrients and water are functions of the roots. The best vegetation management alternative is that method which not only controls the competition for above ground light and heat, but also controls root competition for nutrients and water. Herbicides are the only available alternative which consistently meet these objectives.

Today, herbicides are available for vegetation management programs in timber, range, wildlife, agriculture, recreation, and rights-of-way maintenance. Some application methods are appropriate only at certain times of the year, while others are suitable all year long. The major advantages in using herbicides are lasting effectiveness, minimum environmental impact, and low cost.

It is becoming increasingly apparent that alternative non-herbicide techniques may be more violent and more destructive to ecosystems. Selective herbicides do not kill all vegetation or physically disrupt the soil. There are no physical effects on wildlife, except as they relate to habitat change and the availability of favored food species. Wildlife habitat areas treated with herbicides remain accessible to browsing animals. In contrast, areas matted with heavy slash from downed trees and brush are only partially accessible, and by the time wildlife can move around, the browse has often grown above their reach.

Because of the minimum physical impact on an area treated with herbicides, many benefits occur that are not possible with other alternative methods: (1) Soil protection is not removed, (2) cover and food still remain for wildlife, (3) nutrients are not removed or bunched, (4) microclimatic extremes are minimized, (5) new undesirable plants find it difficult to become established due to competition from preferred vegetation, (6) dying plants gradually add their branches, leaves, and bark to the forest floor, where they form a mulch that enriches the soil and conserves moisture, (7) as pest overstory plants gradually fade from the plant community, increased amounts of sunlight and precipitation, necessary for the vigorous development of preferred vegetation, can reach the ground, and (8) the source of new growth, the plants roots can be controlled.

Costs of herbicide use are generally lower than for other alternatives. Costs, however, are not the overriding consideration in prescribing herbicide applications in selected areas. The environmental effects, social impacts, and combined resource objectives all must be considered reviewed, then, if herbicide use is still an available option, it should be chosen over a higher cost alternative which is more destructive.

In managing the National Forest's grazing resource, herbicides can be used to reduce unpalatable plants and noxious or poisonous plants from range and pasture lands, without tilling the soil. Plowing to eliminate unwanted plants destroys usable forage plants, increases erosion, and takes the area out of production for up to 1 year, while the new plants get established to where they can stand the stress of livestock grazing. Herbicides are also useful in range revegetation programs, for controlling trees and brush that are competing with wanted forage species for sunlight, moisture, heat, and nutrients. Fences entwined with brush and vines are easily freed and kept clean through the use of herbicides.

The use of herbicides for vegetation management along roads and trails is often coordinated with mechanical equipment use. Mechanical equipment alone is unsatisfactory for some species of brush control, due to excessive stump and root sprouting, rock outcroppings, stones, and cut or fill slopes. Using herbicides to control woody growth allows for maintenance of roadsides where mowing equipment would disturb highly erodable soils. Because herbicides reduce resprouting of stumps and brush, the time between maintenance operations is extended, freeing dollars for other much needed road maintenance activities.

Herbicides can also be used at recreation areas to extend the life of walkways and parking lots. They may be used to control aquatic weeds, and to improve aesthetics. Trails can be kept free of stump sprouts and tree seedlings. At remote or limited access recreation sites, where mechanical or hand vegetation control methods are impossible or extremely costly, herbicides become the only effective vegetation control method. Herbicides may be selected over other plant control methods at a recreation site where a target weed or the encroachment of vegetation must be eliminated with a minimum of disturbance.

The use of herbicides has been controversial, especially the aerial application of 2,4,5-T. Much of the concern originated from publicity given to a chemical used in Vietnam. Agent Orange contained an impurity - tetrachlorodibenzo-p-dioxin, more commonly known as TCDD or dioxin. The TCDD dioxin content now contained in 2,4,5-T has been reduced to a fraction of the level in Agent Orange. TCDD has been found to be one of the most toxic chemicals known to scientists, but when 2,4,5-T is used according to label directions, it is not believed to result in significant danger to the environemnt from TCDD. Even when new monitoring programs, capable of dioxin detection to 1 part per trillion, became available, debates on the use of 2,4,5-T will continue.

The Eastern Region has used herbicides since 1950. Experience has shown the herbicide alternative for vegetation management to be effective, of reasonable cost, and when used as directed, it does not constitute a hazard to humans, animals or the general quality of the environment. Herbicide use still remains as a preferred method for most vegetation management programs.

4. Manual

Manual vegetation management methods include the use of hand-operated tools such as the axe, brush whip, brush axe, chain saw, and brush cutter. Manual methods are used in timber, range, wildlife, recreation, fire, and right-of-way maintenance programs.

Generally speaking, manual methods have little adverse effect on the environment. This method can be selective and accomplished with little visual impact in areas of concentrated public use. Control of vegetation can be exact, making this method suitable for use along streams, in recreation areas, around buildings, and near wildlife projects. The season of year has little effect, unless it is winter cold or snow depth. Long term local employment is possible.

The major disadvantages are high cost and ineffective results. It is not unusual for an acre of land to contain over 26,000 brush or hardwood stems (Jensen 1977). If stems were placed on a 2-foot by 2-foot spacing, 10,890 stems could be fitted to an acre. Forlish (1972) found 3-4 year old aspen clearcuts contain 12,700-13,700 aspen stems, plus other species like cherry, red maple, birch, and hazel. In the Ozark and Midlands areas, hardwood reproduction would be less; about 3,500 stems per acre (Brinkman-Lining, 1961).

A research project in the southeastern Adirondacks showed that felling cull trees, which range in size from 8 to 36 inches d.b.h., require an average of 2.88 minutes per tree. To manually fell 50 trees, would cost $14.40 per acre, if the hourly rate for the chain saw operator is $6. This would still leave the smaller trees and brush to remove. Assuming there are 5,000 brush stems per acre and a man is able to remove 240 stems per hour at $3 per hour, it would add another $62.50 per acre to the cost of manual brush removal.

Manual labor projects can help a local economy; however, finding people to work at physically demanding jobs is a problem. Many National Forest areas have a limited labor supply. Urbanites are often unwilling or unable to commute to rural areas for work, especially, when the pay is low, the work seasonal, and the working conditions are physically demanding.

It would require a minimum of 10 people working a full year to clear 1,000 acres of heavy brush with hand tools. Only specially funded public employment programs could support such a large program. Programs of this nature are established by the President and Congress, not the Forest Service. To relocate the unemployed, while possible, has a high cost and low worker appeal. Labor skills learned in cutting brush and hoeing weeds have little application for preparing the unemployed to find meaningful employment. Recent public employment programs have focused on helping urban areas with high unemployment levels.

The most discouraging aspect of manual vegetation control is its ineffectiveness. Hand cutting brush, like mowing a lawn, can result in only a temporary reduction in plant growth. Stumps and roots will send up sprouts to soon replace those cut. In one year's time most new sprouts have replaced the growth removed by cutting.

Many woody species vegetation are prolific sprouters. Along roadsides, under utility lines, in hay or pasture fields, and in young conifer plantations, a need exists for lasting vegetation control. Cutting the aerial portions of pest plants does not reduce the number of stems that resprout the following year; rather, in some species, there are substantial increases. The height of the new growth can exceed 3 to 4 feet in the first year (Arend and Roe, 1961). To annually or biennially crop these sprouts in a 30,000-40,000 acre program, amounts to a major expenditure of tax dollars, or in the case of utility rights-of-way, an increased cost to the consumer.

Experience has shown that heavy cutting of brush and cull trees in an area creates a mat of interlocking tree branches and stems, impassable to many forms of wildlife. Manual control of grass and weed pests in hay and range pastures and removal of duck weed or algae blooms from water, is physically impractical, if not impossible.

The accident rate for people involved in woods work is high. The 1972-1974 severity rate, (days of lost work due to injury per 1 million man-hours of work), for the logging industry group was only exceeded by 16 of 207 industrial groups listed by the National Safety Council in the 1975 Work Industry Rates. Daily exposure to sharp cutting edges, rough terrain, climatic extremes, and physically demanding work make accidents a major factor in discouraging the use of manual labor crews.

Manual control methods, while a part of the Regional vegetation management program, are limited by cost and ineffectiveness.

5. Mechanical

This method involves the use of motorized equipment to either push-pull, or drive other pieces of equipment designed to treat vegetation. It involves bulldozing, shearing, tractor scarification, discing, cultivating, chaining, chopping and mowing. Mechanical vegetation control is used in range, agriculture timber, and rights-of-way construction and maintenance programs.

Mechanical methods have the advantage of being able to alter the position or form of the vegetation. Dozer operated equipment can knock down or dig up vegetation to create openings, brushhogs and hydro-axes can grind up vegetation, and discing or cultivating will bury vegetation. Excellent site preparation can thus be accomplished. If done properly, the mechanical control of vegetation is suitable for use in visually sensitive areas. Large areas can be treated with minimum manpower needs and low cost. Mechanical equipment also allows the clean up of unwanted or unutilized vegetation which has accumulated, while leaving adequate root material to provide for vigorous resprouting.

Limits on the use of mechanical equipment are caused by rough and rocky terrain, erosive soils, steep slopes, winter weather, and muddy soil conditions. Soil erosion and its affect on water quality and soil compaction are two environmental concerns associated with mechanical vegetation management. Soil compaction is of concern because it reduces soil productivity. Selectivity is not usually possible with mechanical methods, and the cost of treating small areas is excessively high. Mechanical methods can seriously impact wildlife which require a specific, localized ecological niche.

Unless plant roots of sprouting plants are completely dug out of the ground, the effectiveness of mechanical vegetation control is reduced. Mowing operations followed by chemical treatment have proven worthwhile for use on roadsides and other areas where aesthetics are of major concern.

Increasing prices and reduced availability of fossil fuels may not make large mechanical vegetation control projects possible in the future.

Mechanical treatment of vegetation is the first step to helping establish desirable vegetation, and future use will emphasize this objective.

6. <u>No Action or Postponing Action</u>

The "no action" alternative should not be interpreted as the halting of all current land management programs; rather, it means no efforts will be made to control vegetation once an activity has been started. In other words, once the needed vegetative community was established by the land manager, nature would be allowed to take its course. No maintenance projects would be undertaken, even if the vegetation became detrimental to the program, i.e. trees growing into electrical wires; old, brittle branches hanging over trails, etc. This method is very different from other alternatives. Short-range costs and environmental impacts are the least under this alternative.

Without treatment, fish species management in small reservoirs and ponds can change from high dissolved oxygen-demanding fish, such as trout and pike, to bull heads and other rough species which require less oxygen. This would be caused by aquatic plant and algae buildup and the extraction of oxygen during vegetation decomposition. Aquatic vegetation provides cover which may cause some small forage fish, such as bluegill, to survive in over-abundant populations, thus leading to stunted growth. Another detrimental effect which comes from not controlling weed and algae growth is the physical obstacle such growth presents to fishing enthusiasts. Swimming would also be affected by the low water quality, and the activity would be limited to those periods of low algae populations or before aquatic plants mature.

Without human manipulation of vegetation, forest cover diversity, in a protected forest, decreases. This reduces wildlife diversity and populations. Species requiring forest types found in early successional stages become very scarce.

Failure to control roadside vegetation would decrease sight distance on curves and at intersections, hide traffic control structures and directional signs, and keep many gravel roads damp and muddy throughout the summer because of shading.

Succession in the Eastern Region goes from grass communities to woody vegetation. Without vegetative manipulation, the acreage and condition of the range resource would deteriorate, reducing the number of animals that could be allowed to graze. A decrease in range forage without a corresponding reduction in domestic livestock would mean an increased demand for expensive, supplemental feeds, such as corn and soybeans.

An acre of forest land is limited in the amount of vegetation it can produce. However, with management, those plants which are beneficial to man can be proportionately increased and their growth stepped up, eliminating unwanted vegetation which is competing for available nutrients, moisture, and space. This is the practice followed in timber management through selective control of vegetation. Without selective control, more growth would go into brush and trees of low fiber yield. Until new technology and methods for utilizing brush and low yield trees are developed, the Nation is faced with reducing the timber supply or harvesting increased acreage each year to supply existing demands.

Failure to control noxious weeds could result in a National Forest noxious weed source that may be detrimental to local agriculture.

David Marquis (1976) found that heavy tree thinning in New England increased crop tree basal area growth by 53 percent and diameter growth by 64 percent over that of unthinned controls. Williams (1976), in an 18-year study of yellow poplar seedlings which were completely released by herbicides in 1957, found growth of completely released trees were four times taller and five times larger in diameter by 1973, than seedlings not released.

The need for release is shown by experiments conducted on the Chippewa National Forest in Minnesota. Prepared plots showed that after 5 years, failure to release red pine resulted in a reduction of 70 percent in survival, more than 90 percent in height growth, and 99 percent in total dry weight.

In Lower Michigan, studies evaluated the effects of various degrees of overtopping aspen and scrub oak on the growth of planted red pine. Growth was measured 5 to 15 years later. The results showed that when a 30 square foot basal area hardwood overstory (90-150 trees, 6-8 inches d.b.h. per acre) is retained, cubic foot volume growth is reduced 20 percent of the maximum; the diameter growth is limited to 55 percent maximum; and, the height growth declines to 58 percent of the maximum.

It is recognized that unchecked tall growing vegetation along power and telephone rights-of-way, is a hazard that could cause shorting, arcing, or other undesirable effects. These conditions interrupt electric services to customers, and in some cases, unmanaged right-of-way growth could inhibit surveillance, maintenance and repair of lines.

E. DESCRIPTION OF HERBICIDES PROPOSED FOR USE

Herbicide use in the Eastern Region involves a variety of chemicals which have been selected to treat a wide range of plants at various times of the year. The complex relationship between host and target vegetation, and the method in which each can be reached by a herbicide, are considered when selecting a chemical for use.

The Following descriptions were extracted from the Herbicide Handbook of the Weed Science Society of America (1974

Edition) and Agricultural Chemicals - Book II (Herbicides) by W.T. Thomson.

AMITROLE - (3-amino-s-triazole)

A. HERBICIDIAL USE

1. General:

a. Perennial broadleaf weeds and grasses in non-cropped areas.

b. Some aquatic weeds.

c. Most crops if contacted by spray are sensitive.

d. Used in mixtures with more persistent herbicides for general weed control in non-cropped areas and as a directed spray in ornamental nurseries.

2. Application methods: Foliage spray on weeds.

3. Rates: 20 to 10 lb/A.

4. Usual carrier: Water - 20 to 200 gpa; water-soluble.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Absorption characteristics: Absorbed slowly.

2. Translocation characteristics: Good translocation.

3. Mechanism of action: Inhibits chlorophyll formation and regrowth from buds.

4. Metabolism and persistence in plants: Glycine and serine of plants are utilized in biosynthesis of B-(3-amino-s-triazolyl-1-)a-alanine.

AMS - (ammonium sulfamate)

A. HERBICIDIAL USE

1. General: Effective in killing most woody plants, including hardwood and coniferous species such as alder, ash, birch, cedar, elm, gum, hickory, maple, oak, pine, willow, and poison ivy. Also is an effective contact spray for control of herbaceous perennials such as leafy spurge, bitter dock, goldenrod, perennial ragweed, milkweed, and blueweed, as well as most annual broadleaf weeds and grasses.

2. Application methods: (a) As foliar spray; (b) as crystals or concentrated solution to cut surfaces (frills, notches, or cups cut in bark, or freshly cut stumps).

3. Rates: (a) As foliar spray for brush, using hydraulic equipment, 60 lb aihg water, 50 lb aihg oil-water emulsion (up to 400 lb aihg used in air-blast equipment; (b) as contact spray for herbaceous plants, 100 lb aihg; (c) for spray application to cut surfaces, 7 to 10 lb in 2 gal water; or (d) sprinkle crystals directly on cut surface.

4. Usual carrier: Applied in water solution or in oil-water emulsion in sufficient volume for full coverage of foliage, stems, limbs, and base of woody plants. Applications to freshly-cut surfaces should saturate cut area. Oil-water emulsion is prepared by dissolving herbicide in one-fourth the required amount of water, then adding a pre-mix of one quart Du Pont Surfactant WK or equivalent in 4 gal of No. 2 fuel oil per 100 gal of finished spray, followed by remainder of water.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Absorption characteristics: Rapidly absorbed through foliage and green stems; use of spreader-stickers or application in oil-water emulsion improves wetting. Crystals or concentrated solutions applied to freshly cut wood surfaces are readily absorbed.

2. Translocation characteristics: Translocation has been demonstrated in woody plants and in herbaceous plants.

<u>ASULAM</u> - (Methyl sulfanilylcarbamate)

A. HERBICIDIAL USE

1. General: Effective for control of certain perennial weeds such as johnsongrass, horsetail, rush, bracken fern, and tansy ragwort in noncrop, range, and forest management areas.

2. Application methods: Aerial and ground foliage spray.

3. Rates: 1 to 6 lb ai/A depending on weeds present.

4. Usual carrier: Water-5 to 40 gpa.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: It is readily absorbed by foliage, with the rate increased by the addition of a wetting agent.

2. Translocation characteristics: It may be taken up by either roots or leaves and translocated to other parts of the plant. In certain grasses, there is evidence that asulam is translocated from the leaves into the root system resulting in the death of several of the dormant buds on the rhizomes.

3. Mechanism of action: The site of action appears to be the meristematic regions of the plant, and the activity appears to be due to interference with the process of cell division and expansion.

ATRAZINE - (2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine)

A. HERBICIDIAL USE

1. General: Atrazine is a widely used selective herbicide for control of broadleaf and grass weeds. It is used also in some areas for selective weed control in conifer reforestation, Christmas tree plantations and grass seed fields, as well as for non-selective control of vegetation in chemical fallow. Atrazine also is used widely as a non-selective herbicide for vegetation control in non-crop land. Combination granules of atrazine plus propachlor, atrazine plus alachlor and atrazine + Sutan are presently marketed for weed control in corn. In addition the granular combination of AAtrex plus sodium chlorate and sodium metaborate is currently marketed for non-selective vegetation control. Sugarbeets, tobacco, oats, and many vegetable crops are very sensitive to atrazine.

2. Application methods: Depending upon the crop or intended use atrazine sprays may be applied preplant, preemergence, or post-emergence, but before weed seedlings are more than 1-1/2 inches high with few exceptions. These exceptions include postemergent application for yellow nutsedge and Canada thistle control. Preemergence use is generally the perferred method of application where it can be used. Under dry conditions, a shallow incorportion may increase the degree of weed control. A single lay-by cultivation is sometimes useful to prevent relatively tolerant late season grasses from developing. Aerial applications have been very successful, especially when wet weather prevents the use of ground equipment and in cases where rough terrain such as in conifer reforestation makes ground applications impractical. A liquified formulation containing 4 lb ai/gal has been developed and is currently registered for weed control in corn and sorghum. Postemergent application

of either the wettable powder or liquified formulation of atrazine are usually made in combination with a nonphytotoxic crop oil, crop oil concentrate or surfactact. These additions enhance the uptake of atrazine and hence its activity.

3. Rates: Rates the equivalent of 2 to 4 lb/A are required for selective weed control for most situations. Higher rates are used for nonselective weed control. Lower rates will effectively control cheatgrass and most other weeds in chemical fallow or rangeland uses, and many common annual broadleaf weed species.

4. Usual carrier: Water at 10 gpa or more is the usual carrier for uniform ground application. Nitrogen solution and other liquid fertilizers have been widely and successfully used as carriers. The major advantage is applying both herbicide and fertilizer in one operation. Agitation in the spray tank is necessary to keep the chemical in suspension. Recently it has been recommended that aerial application of atrazine be applied in a minimum of 2 gallons of water per acre. The typical volume of oil applied by ground means is one gpa. This volume is reduced to 1/2 gpa for aerial application.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Absorbed through both roots and foliage, although foliar absorption often is small in most plants under field conditions, depending on factors as species and environmental conditions. The herbicide can be washed off plant foliage by rain.

2. Translocation characteristics: Following absorption through roots and foliage, it is translocated acropetally in the xylem and accumulates in the apical meristems and leaves of plants.

3. Mechanism of action: A photosynthetic inhibitor, but may have additional effects.

4. Metabolism and persistence in plants: Atrazine is readily metabolized by tolerant plants to hydroxy-atrazine and amino acid conjugates. The hydroxy-atrazine can be further degraded by dealkylation of the side chains and by hydrolysis of resulting amino groups on the ring and some CO_2 production. These alterations of atrazine are major protective mechanisms in most tolerant crop and weed species. Soil placement selectivity is also important in the care of some deep rooted perennial crops. Unaltered atrazine accumulates in sensitive plants, causing chlorosis and death.

5. Biological properties other than herbicidial: Limited studies have shown some minor fungicidal and nematocidal activity but no insecticidal activity.

<u>BENEFIN</u> - N-butyl-N-ethyl-a,a,a-trifluoro-2,6-dinitro-p-toluidine

A. HERBICIDAL USE

1. General: Controls grasses and several broadleaf weeds such as carpetweed, chickweed, knotweed, lambsquarters, pigweed, purslane, redmaids, and Florida pusley. Tolerant crops include lettuce, peanut, alfalfa, clover, birdsfoot trefoil, transplant burley and dark tobacco, and established turfgrasses. Sensitive crops include beets, sorghum, oats, ad spinach.

2. Application method: Benefin is a preemergence herbicide and must be soil incorporated within eight hours after application with equipment that breaks up large clods and mixes the soil thoroughly; e.g., PTO-driven cultivators, hoes, tillers; double disc; rolling cultivator; bed conditioner. Application and incorporation can be preplanting or postplanting.

3. Rates: 1.12 to 1.5 lb/A.

4. Usual carrier: Water at 5 to 40 gpa is the carrier for the 1.5 lb/gal liquid concentrate. A 2.5 percent granule is also available for use on peanut and burley tobacco.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Benefin is a soil incorporated, preemergence herbicide and is not normally applied to plant foliage.

2. Translocation characteristics: There is no significant absorption or translocation of benefin in crops grown in soil treated with benefin.

3. Mechanism of action: Benefin affects seed germination and associated physiological growth processes.

4. Metabolism and persistence in plants: No significant terminal residues or specific metabolites of benefin have been detected in mature plants.

BENSULIDE - O,O-diisopropyl phosphorodithioate S-ester with N-(2-mercaptoethyl)benzenesulfonamide

A. HERBICIDAL USE

1. General: Betasan is registered for control of crabgrass, annual bluegrass, redroot, pigweed, watergrass, lambsquarters, shepherdspurse, goosegrass, and deadnettle in grass and dichondra lawns. Prefar is registered for controlling various grass and broadleaf weeds in cotton, lettuce, cucumbers, canaloupes, squash (summer & winter), Crenshaw and Persian melons, muskmelons, watermelons, tomatoes, peppers, broccoli, cabbage, and cauliflower.

2. Application method: Besatan should be used prior to germination of weed seeds. It should be applied to established grass lawns, prior to planting, at the time of planting, or on established dichondra lawns. The compound must be watered into the soil after application. Bensulide provides long residual control of the weeds for which it is registered. Care should be exercised if reseeding with grass is planned following treatment.

3. Rates: Rates of application are from 10 to 20 lb/A for Betasan and 2 to 6 lb/A for Prefar.

4. Usual carrier: Water at the rate of 15 to 30 gal per 3000 to 3600 sq ft is the usual carrier for emulsifiable liquid formulations of Betasan. Prefar is applied in 20 to 50 gallons of water per acre.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Translocation characteristics: It is absorbed on the root surfaces, and a small amount is absorbed by the roots, but very little or none is translocated upward to the leaves.

2. Mechanism of action: It inhibits the growth of roots of weeds, but the mechanism of action is not known.

3. Metabolism and persistence in plants: Unchanged ring-labelled Prefar-^{14}C could be detected in the roots of lettuce plants after root application, but none could be detected in the leaves. A large part of the radioactive material in the leaves was evolved as radioactive CO_2 and some was present as labelled amino acids.

BROMACIL - 5-bromo-3-sec-butyl-6-methyluracil
(5-bromo-6-methyl-3-(1-methylpropyl)uracil)

A. HERBICIDIAL USE

1. General type of plants controlled: Used on non-croplandareas for control of a wide range of annual and perennial grasses and broadleaf weeds, and certain woody species. Combinations with diuron (Krovar®) used noncropland areas.

2. Application methods: Bromacil is sprayed or spread dry(as granules, etc.) on soil surface, preferably just before or during period of active growth of weeds.

3. Rates: 1.5 to 5 lb/A - general weed control (where bare ground is desired for an extended period)-controls most annuals. 5 to 10 lb/A - controls many perennial weeds, grasses and woody species. 12 to 24 lb/A - controls hard-to-kill perennials such as johnsongrass, bermudagrass, dallisgrass, vaseygrass, nutsedge, saltgrass, bouncingbet, dogbane, bracken fern, and horsetail.

   Higher levels of dosage ranges are used on adsorptive soils (usually those high in organic matter or carbon). For basal treatment of brush mix 2 lb of bromacil in 5 gal of water and apply 1 to 2 fl oz per stem 2 to 4 inches in basal diameter; wet base of stem to run-off.

4. Usual carrier: Water in sufficient volume to uniformly cover area to be treated. Wettable powder form requires continuous agitation to maintain suspension; water-soluble form requires agitation only until dissolved. Bromacil also can be applied in oil solutions or suspensions, or in dry, granular formulations.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Bromacil is mostly readily absorbed through root system; less so through foliage and stems. Addition of a suitable surfactant to the spray enhances foliar activity.

2. Translocation characteristics: Orange plants maintained for 4 weeks in sand on a nutrient solution containing 10 ppm of ^{14}C-2-bromacil took up less than 5% of the applied activity. Approximately 85% of this activity was found in the roots and 17% in the stem and leaves of the plant.

3. Mechanism of action: Bromacil has been shown to be a potent and specific inhibitor of photosynthesis.

BROMOXYNIL - 3,5-dibromo-4-hydroxybenzonitrile
(4-cyano-2,6-dibromophenol)

A. HERBICIDAL USE

1. General: Registered for use on wheat, barley, oats rye, flax, and newly seeded turf to control certain broadleaf weeds. Also, registered for the control of certain weeds such as Russian thistle on industrial sites, vacant lots, roadsites, and railroad rights-of-way. Promising for sorghum and fall-seeded legumes.

2. Application methods: Ground and aerial foliage spray in water - postemergence.

3. Rates: 0.5 to 1 lb ai/A.

4. Usual carrier: Water - 2 to 20 gpa.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: The oil soluble amine and ester have the capacity to resist removal from foliage by rain, the sodium salt does not since it is water soluble.

2. Translocation characteristics: Relatively little movement once absorbed.

3. Mechanism of action: Photosynthetic and respiratory inhibitor.

4. Metabolism and persistence in plants: May be hydrolyzed to benzoic acid.

5. Biological properties other than herbicidal: Molluscicide.

CACODYLIC ACID - hydroxydimethylarsine oxide

A. HERBICIDAL USE

1. General: Cacodylic acid is a contact herbicide which will defoliate or desiccate a wide variety of plant species. The phytotoxic properties of this herbicide are quickly inactiviated on contact with the soil. Current experimental uses include: weed control in crops and in nut, fruit, and citrus orchards, and weed control in new seedling areas. Commercial uses

include: cotton defoliation, lawn renovation, general weed control in noncrop areas such as around buildings, near perennial ornamentals, along fence rows, and spot control of noxious weeds and forest management practices.

2. Application methods: Used as a directed spray, postemergence.

3. Rates: Three to 10 lb/A.

4. Usual carrier: Mix with water plus 2 qt surfactant per 100 gal of solution and apply at 40 gpa. All formulations are 100% water soluble.

<u>CHLORAMBEN</u> - 3-amino-2,5-dichlorobenzoic acid

A. HERBICIDAL USE

1. General:

   a. Preemergence control of seedling grass and broadleaf weeds.

   b. Preemergence use on soybeans, drybeans, lima beans, seedling asparagus, pumpkin, squash, corn; post-transplanting on tomatoes, peppers, sweet potatoes, and various ornamentals.

2. Application methods: Ground spray or granular application. Shallow incorporation recommended under some conditions.

3. Rates: 2 to 4 lb/A.

4. Usual carrier: Water, attaclay, or concentrate through Economizer.

B. PHYSIOLOGICAL AND BIOCHEMCIAL BEHAVIOR

1. Absorption characteristics: Some foliar absorption, resulting in epinasty.

2. Mechanism of action: Inhibits root development of seedling weeds.

<u>2,4-D</u> - (2,4-dichlorophenoxy)acetic acid

A. HERBICIDAL USE

1. General: 2,4-D is a systemic herbicide and is widely used for control of broadleaf weeds in cereal crops, sugarcane, turf, pastures, and noncrop land. Most dicot crops are susceptible at normal herbicidal rates. The salt and long chain ester formulations

are of sufficiently low volatility that, with care, they may be used near fairly susceptible crops, if spray drift is prevented. High volatile ester formulations should not be used in or near susceptible crop areas. Salt formulations are safest; they do not release enough vapors to cause damage off the treated areas.

2. Application methods: Spray application is usually postemergence, applied by aerial or ground equipment.

3. Rates: For crops and pastures, 0.25 to 2 lb/A postemergence for most weeds. For brush control, rates of 3 to 4 lb/100 gallons of spray are often used.

4. Usual carrier: Water, diesel oil, or both, dependingupon formulation used. Low volumes (e.g., 3 to 10 gpa) are generally used for aerial application, and higher volumes (up to 400 gpa) are used for ground application. Surfactants have enhanced activity in some cases. Agitation is needed for some formulations.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Plant roots absorb polar (salt) forms of 2,4-D most readily. Leaves absorb nonpolar (ester) forms most readily. A rain-free period of 4 to 6 hr usually is adequate for uptake and effective weed control. The esters of 2,4-D tend to resist washing from plants and are rapidly converted to the acid by the plants.

2. Translocation characteristics: Following foliar absorption, 2,4-D translocates within the phloem, probably moving with food material. Following root absorption, it may move upward in the transpiration stream. Translocation is influenced by the growth status of the plant. Accumulation of the herbicide occurs principally at the meristematic regions of shoots and roots.

3. Mechanism of action: The mechanism of action of 2,4-D has been studied more than for any other herbicide. Investigation has shown that it causes abnormal growth response and affects respiration, food reserves, and cell division; but the primary mode of action has not been clearly established.

4. Metabolism and persistence in plants: Studies have shown complexes with protein or amino acids, oxidation of the acetate moiety and of the ring, hydrolysis to the free phenol, and combination with glycosides.

5. Biological properties other than herbicidal: It can act as a plant growth regulator and low rates can induce rooting and blossom set. Also, it controls the ripening of bananas and citrus fruits and delays preharvest dropping of some fruits. Apparently, 2,4-D has little or no biological activity on insects, nematodes, or plant pathogens.

DALAPON - 2,2-dichloropropionic acid

A. HERBICIDAL USE

1. General: For the contol of annual and perennial grasses, dalapon is used in sugarcane, sugarbeets, corn, potatoes, asparagus, grapes, flax, new legume spring seedlings, citrus, and deciduous fruit; coffee, certain stone fruits, and nut trees.

2. Application methods: Can be applied with conventional aerial or ground equipment as a foliage application. Apply prior to crop emergence or postemergence. Addition of wetting agent is usually helpful.

3. Rates: Rates range from 0.75 lb/A in flax to 20 lb/A or more on noncropland. Multiple treatments at lower rates are also used under certain conditions.

4. Usual carrier: Dalapon is used with a water carrier at volumes of 5 to 300 gpa, depending on crop situation, grass species, and method of application and equipment available.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Absorbed by both roots and leaves. Easily washed off foliage.

2. Translocation characteristics: Translocates readily throughout the plant. Accumulates in young tissue.

3. Metabolism and persistence in plants: Is not degraded in plants.

DCPA - dimethyl tetrachloroterephthalate

A. HERBICIDAL USE

1. General: Annual grasses and certain annual broadleaf species throughout the USA.

2. Application methods: Generally at planting time, preemergent to the weeds; applied with conventional sprayer.

3. Rates: Four to 10 lb/A, depending on soil type and weed population.

4. Usual carrier: Apply in spray rigs delivering 25 to 40 gal of water per acre.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Not absorbed by foliage.

2. Translocation characteristics: Not translocated in the plant.

3. Mechanism of action: Kills germinating seeds; exact mechanism not yet known.

4. Metabolism and persistence in plants: Not considered to be metabolized by plants.

DICAMBA - 3,6-dichloro-o-anisic acid

A. HERBICIDAL USE

1. General: Preemergence applications control both annual broadleaf and grass weeds. Foliar and soil applications control phenoxy-tolerant annual and perennial broadleaf weeds and brush species. Registered uses in small grains, corn, flax, perennial seed grasses, turf, and non-crop lands. Useful also in sorghum, grass pasture, rape, tame mustard, sugarcane, cole crops, and certain orchard crops. Numerous growth regulatory uses in early stage of development. Soybeans, other beans, and most small-seeded legumes are sensitive. Spray drift to these and other ornamentals and vegetable crops should be prevented.

2. Application methods: May be applied by either ground or aerial spray or as granules, by basal application, and preemergence and postemergence, depending on specific use.

3. Rates: Preemergence - 0.5 to 3 lb/A.
   Foliar spray on broadleaf annuals - 0.06 to 0.25 lb/A.
   Foliar spray on broadleaf perennials and brush species - 0.5 to 10 lb/A.

4. Usual carrier: Water, applied at from 2 to 40 gpa. No additional surfactant nor agitation necessary. Attapulgite, vermiculite, and liquid and dry fertilizers also have been used as carriers.

DICHLOBENIL - 2,6-dichlorobenzonitrile

A. HERBICIDAL USE

1. General: Dichlobenil is a powerful inhibitor of germination and of actively dividing meristems and acts primarily on growing points and root tips. These properties lead to the following herbicidal characteristics:

   a. Both monocotyledons and dicotyledons are controlled, especially by inhibition of germinating seeds and growth of young seedling plants.

   b. Older plants, especially when shallow-rooted, are controlled under favorable conditions and/or high dosages. This applies especially to some annual grass weeds.

   c. The growth of emerging sprouts of perennial weeds is stopped.

   Crop plants for which the compound can be useful: In general, established crops tolerate treatment very well. In such cases the roots do not come into contact with the dichlobenil that is located in the upper layers of the soil. On the following crops the product is in practical use: alfalfa, aquatic weed control, citrus, vineyards, top-, soft-, cane- and stone-fruits, fruit tree and tree nurseries, ornamental plants and trees, nursery stock, shelterbelt trees, cranberries, avocados, mangos, transplanted rice, winter wheat, total weed control and home gardening.

2. Application method: Application between sowing and emergence of crop usually gives rise to prohibitive phytotoxicity, especially with small-seeded crops. With a number of relatively large-seeded crops (e.g., corn, cotton, wheat), when planted rather deeply, there is marginal selectivity.

   Over established crops dichlobenil can be applied, either as a dispersible or wettable powder or as granules, as a ground or aerial application. The product must always be applied to the soil. For total weed control and for weed control under trees, dichlobenil should be applied to the soil. Under circumstances of high water evaporation from the soil (high temperature, wet soil, low relative air humidity) dichlobenil can evaporate very rapidly. From dry soil the evaporation of dichlobenil is dependent on soil types and temperature. To enhance the herbicidal effect under natural conditions the best time for application is on dry soil just before rainfall. An increase in herbicidal effectiveness can also be obtained by incorporation (mechanically or by irrigation), preferably after application on dry soil. The herbicide should be used postemergence or postplanting to the crop.

3. Rates:

Aquatic weed control: 4.5 to 17 kg/ha (4 to 15 lb ai/A) dependent upon depth of water body.

Total weed control: 7 to 22, kg ai/ha (6.5 to 20 lb ai/A) dependent upon weeds present.

Bearing and nonbearing fruit trees and bushes: 4 to 8 kg ai/ha (3.5 to 7 lb ai/A).

Ornamental trees and shrubs: 2.7 to 9 kg ai/ha (2.5 to 8 lb ai/A).

Under asphalt: 11 to 13 kg ai/ha (10 to 12 lb ai/A).

4. Usual carrier: The dispersible powder is suspended in water. Granular formulations are usually preferred because of excessive loss by volatilization from the dispersible powder formulations under certain conditions.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR IN PLANTS

1. Foliar absorption characteristics: Dichlobenil is absorbed from the soil by the root system; depending on soil type and plant species, the herbicide can accumulate in the roots up to three-fold. From the vapor phase rapid uptake through the leaves takes place.

2. Translocation characteristics: Recent studies have shown that translocation from the roots into the aerial parts is fast. In the leaves two competitive processes take place: a part of dichlobenil evaporates whereas another part of the herbicide is hydroxylated. The ratio between these two processes is dependent on the plant species. After take of dichlobenil through the leaves the downward translocation is rather slow.

3. Mechanism of action: Dichlobenil acts primarily on growing points and root tips. Definite characteritics at the toxic level in intact plants include a rapid growth inhibition, followed by gross disruption of tissues, notably in the meristems and phloem, which may result in the swelling or collapse of stem, root, and petiole, and a generalized brown discoloration, frequently accompanied by the exudation of gummy material from shoots. Leaves may absciss and exhibit black discoloration over veins and a deepened blue-green color intensity interveinally.

4. Metabolism and persistence in plants: Plants grown in soil treated with dichlobenil are exposed also to 2,6-dichlorobenzamide (BAM) and due to the transport of BAM with the transpiration stream, this compound and possibly its hydroxy metabolites may be present in leaves.

DICHLORPROP - 2-(2,4-dichlorophenoxy)propionic acid

A. HERBICIDAL USE

1. General: Brush control in nonagricultural land.

DINOSEB - 2-sec-butyl-4,6-dinitrophenol
(2-(1-methylpropyl)-4,6-dinitrophenol)

A. HERBICIDAL USE

1. General: Controls seedling weeds and grasses in crops. Does not control established perennial weeds and grasses except with repeat treatments. Can be used in fruit and nut orchards, grape vineyards, mint, small grains, soybeans, peanuts, beans, potatoes, corn, peas, pumpkins, squash, strawberries, and certain forage crops.

2. Application methods: Applied as an overall or band type application with conventional farm spray equipment.

3. Rates: Rates of application range from 0.75 to 12 lb/A, depending upon crop, weed species, and time of application.

4. Usual carrier: Water. (Oil-water emulsion or oil solution for General type.)

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Principally direct contact effect. Salts readily washed from foliage; oil solution more resistant.

2. Translocation characteristics: Essentially no true translocation. No residues have been traced to foliar or root uptake.

3. Mechanism of action: Direct cell necrosis.

4. Biological properties other than herbicidal: Has fungicidal and insecticidal properties.

DIQUAT - 6,7-dihydrodipyrido[1,2-a:2',1'-c]pyrazinediium ion (9,10-dihydro-8a,10a-diazoniaphenanthrene-2A)

A. HERBICIDAL USE

1. General: Diquat is registered as a noncrop weed killer, a general aquatic herbicide and as a preharvest top killer or desiccant of seed crops. Soil type or general climatic types do not directly influence diquat usage.

2. Application methods: Aquatic weed control - submerged weeds: Water treatments may be applied by injecting diquat below the water surface, or by pouring it directly from the container into the water while moving slowly over the water surface in a boat. Distribute evenly over infested areas. Floating weeds: Apply by thoroughly wetting foliage.

   Non-crop weed control - apply for full coverage and thorough weed contact to point of run-off. The younger the weeds, the better will be the control obtained.

3. Rates: Aquatic weed control: 2 to 4 lb/surface A.
   Noncrop weed control: 0.5 lb/A.

4. Usual carrier: Water: 15 to 30 gpa for ground spraying; 5 to 10 gpa for aerial spraying. No agitation required. Addition of X-77 or other nonionic or cationic surfactant: Dilute spray - 1/2 pt/100 gal. Concentrate spray - 2 oz/10 gal.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Very rapidly absorbed by foliage. Very resistant to removal by rain.

2. Translocation characteristics: Local systemic action has been noted. Translocation via xylem can occur under certain conditions.

3. Mechanism of action: Both the herbicidal activity and organic chemical reactions of diquat formulations are dependent solely upon the diquat cation, and are not influenced by the nature of the associated anion, since the salts are largely dissociated in aqueous solution. A unique reaction of the diquat cation is its facile one-electron reduction to a stable free radical in aqueous solution. It is believed that this free radical is formed in treated plants and is responsible for the herbicidal activity, being readily re-oxidized by atmospheric oxygen to regenerate diquat and at the same time liberate short-lived but very active radicals such as peroxide radical within the plant cells.

4. Metabolism and persistence in plants: Metabolic breakdown does not occur in plants. It is degraded photochemically on plant surfaces.

5. Biological properties other than herbicidal: Diquatis not useful as a fungicide, nematocide, or insecticide.

DIURON - 3-(3,4-dichlorophenyl)-1,1-dimethylurea

A. HERBICIDAL USE

1. General: Low rates selectively control germinating broadleaf and grass weeds in crops such as cotton, sugarcane, pineapple, grapes, apples, pears, citrus, and alfalfa. At higher rates, diuron is a general weed killer.

2. Application methods: For selective weed control, diuron is sprayed on soil as a preemergence and/or as a directed postemergence treatement; emerged weeds (up to 2 inches high) are controlled in certain crops when applied with a suitable surfactant added to spray suspension, otherwise any well-established weeds should first be removed by mechanical or other means. For general weed control, diuron is sprayed or spread dry (as granules) at any time except when ground is frozen, but best results are obtained if applied shortly before weed growth begins; dense growth should be removed before application. Increased contact activity on established weeds may be obtained when applied with a suitable surfactant added to spray suspension.

3. Rates: Selective in crops - 0.6 to 6.4 lb/A, depending on crop and soil type. General weed control (where bare ground is desired for an extended period) - 4 to 16 lb/A controls most

annuals; 16 to 48 lb/A controls most annuals and perennials. Higher rates and repeat treatment may be required where a longer period of control is desired or when hard-to-kill deep-rooted perennial weeds are present.

4. Usual carrier: Water in sufficient volume to uniformly cover area to be treated. Continuous agitation is required to maintain suspension. Also can be applied for general weed control in oil suspensions, or in dry, granular formulations.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Diuron is most readily absorbed through the root system; less so through foliage and stems.

2. Translocation characteristics: Translocation is primarily upward in the xylem. (Also see monuron.)

3. Mechanism of action: Diuron is a strong inhibitor of the Hill reaction.

<u>ENDOTHALL</u> - 7-oxabicyclo[2,2,1]heptane-2,3-dicarboxylic acid (3,6-endoxohexahydrophthalic acid)

A. HERBICIDAL USE

1. General: Various formulations are useful as a preemergence and postemergence herbicide, turf herbicide, aquatic herbicide, and harvest aid. The compound is selectively toxic to plants.

2. Rates: Apply at dosages on crops or weeds as recommended on container label.

3. Usual carrier: Water, in the case of liquid formulations.

<u>ERBON</u> - 2-(2,4,5-trichlorophenoxy)ethyl 2,2-dichloropropionate

A. HERBICIDAL USE

1. General: A nonselective herbicide for general vegetation control in noncrop areas.

2. Application methods: Applied with conventional spray equipment either as a water spray (emulsion) or mixed with oil. Apply as a thorough, drenching spray to all exposed vegetation and oil.

3. Rates: For the control of established grasses and broadleaf weeds use 120 to 160 lb/A. Use higher dosages in areas of high rainfall. For spot treatment, use 10 to 20 lb/10 gal water and apply to wet all vegetation and exposed bare ground.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Absorption characteristics: Erbon is absorbed by both foliage and roots. As it is persistent in the soil, its major effect on perennial broadleaved weeds results from root uptake.

2. Translocation characteristics: Following absorption, the compound is effectively translocated to growing points.

GLYPHOSATE - N-(phosphonomethyl)glycine

A. HERBICIDAL USE

1. General: Roundup is a very broad spectrum herbicide, is relatively nonselective, and is very effective on deep-rooted perennial species and on annual and biennial species of grasses, sedges, and broadleaved weeds. Selectivity may be achieved by directional application.

2. Application methods: Apply as postemergence spray to foliage of vegetation to be controlled. Use diluent volumes of 20 to 30 gpa for normal use. Higher volumes may be necessary for heavy, tall, and dense foliage to assure adequate spray coverage of understory vegetation. Use low pressures of 30 to 40 psi and suitable nozzles to avoid small droplets which could lead to spray drift and to injury of nearby susceptible plants.

3. Rates: Rates of use vary with species to be controlled. Normally from 0.3 to 1.0 lb/A a.e. will control annual species. Perennials will require rates from 1.0 to 4.0 lbs/A a.e. with the majority of perennials requiring 1.5 to 2.0 lb/A a.e.

4. Usual carrier: Water at 10 to 30 gpa or higher volumes if extremely dense foliage. Does not need agitation during application.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Absorbed through foliage and other photosynthetically active portions of plant. Visual effect on foliage may not occur for 2 to 4 days for annual species and 10 days or more for perennial species. May be washed off plant foliage by rain, if rain occurs within 6 hours of application.

2. Translocation characteristics: Facile translocation throughout aerial and underground portions of the contacted plant following absorption through foliage. The underground plant parts of perennial species are affected, resulting in failure of regrowth from these propagation sites and subsequent destruction of plant tissue. Root uptake from soil is one or two orders of magnitude lower than for other types of herbicides.

3. Mechanism of action: Not known at this time, but the herbicide appears to inhibit the aromatic amino acid biosynthetic pathway and may inhibit or repress chlorismate mutase and/or prephenate dehydratase.

4. Metabolism and persistence in plants: Studies with ^{14}C labeled glyphosate show that plants can metabolize glyphosate to give CO_2 and natural organic products.

<u>KRENITE</u> - Ammonium Ethyl Carbamoylphosphonate

TYPE: Krenite is a carbamate compound used as a post-emergence growth regulator - herbicide.

TOXICITY: LD_{50} - 24,000 mg./kg.

FORMULATIONS: 4 EC

USES: Used to control bud growth in most woody species.

RATES: Applied at 2-6 lbs. actual/100 gallons of water and use 150-300 gallons of spray solution/acre. Use the higher rates on large plants, dense growth or hard to control species.

APPLICATION: Apply within 2 months of leaf senescense (coloration) in the fall. For suppression with minimum bud effect, make an application during leaf expansion in the spring.

PRECAUTIONS: Do not use on food or feed crops. Avoid drift to desirable tree species. It has failed to produce bud break where off-season temperatures are not low enough to cause prolonged dormancy.

ADDITIONAL INFORMATION: Safe to fish and wildlife. This compound either prevents spring bud break or provides growth suppression. Plants treated in the summer or fall will not show any symptoms until the folloing spring when they will not leaf out. Spring application causes growth retardation with abnormal leaf growth. Not effective when applied to the soil. May be applied with a surfactant. Phytotoxic symptoms occur when applied to new growth in the spring but do not occur when applied in the summer or fall.

LINURON - 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea
(N'-(3,4-dichorophenyl)-N-methoxy-N-methylurea)

A. HERBICIDAL USE

1. General: Linuron selectively controls germinating and newly established broadleaf weeds and grasses in crops such as soybeans, cotton, corn, sorghum, potatoes, carrots and parsnips. It is also used for short-term control of annual weeds in noncropland areas.

2. Application methods: Linuron is sprayed on soil as a preemergence or postemergence treatment. With a suitable surfactant as a directed spray in certain crops, it controls weeds up to 5 inches high; without surfactant as a non-directed postemergence spray in carrots, it controls emerged grasses up to 2 inches and broadleaf weeds up to 6 inches high.

3. Rates: Selective in crops - 0.5 to 3 lb/A, depending on crop and soil type.
Noncropland areas - 1 to 3 lb/A in 40 to 100 gpa water.
Add surfactant for control of established annual weeds.
Usual rate for surfactant is 0.5% by volume.

4. Usual carrier: Water in sufficient volume to uniformly cover area to be treated. Continuous agitation is required to maintain suspension.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Absorption characteristics: Linuron is most readily absorbed through the root system; less so through foliage and stems. However, foliar absorption of liuron is significantly greater than that of diuron, monuron, or fenuron.

2. Translocation characteristics: Translocation is primarily upward in the xylem (see monuron).

3. Mechanism of action: Linuron is a strong inhibitor of the Hill reaction. (Also see monuron.)

MAA - Methanearsonic acid

A. HERBICIDAL USE

1. General: One of the first major uses was as a selective herbicide for the postemergence control of crabgrass, dallisgrass, and other weedy grasses in turf. Currently it is used extensively as a selective postemergent herbicide in cotton and noncrop areas for the control of johnsongrass, nutsedge, watergrass, sandbur, foxtail, cocklebur, pigweed, and other weeds. It is widely used also for controlling weeds and grasses in noncrop areas. Also mixed with 2,4-D/2,4,5-T brushkillers on noncropped areas to increase conifer and other brush species kill or dieback.

2. Application methods: In noncrop vegetation spray foliage to obtain good coverage.

3. Rates: For lawn and ornamental use, 2.0 to 3.8 lb/A.

4. Usual carrier: Mix the recommended per-acre rates with water and apply in a sufficient volume of spray solution to obtain good coverage of the vegetation. From 1 to 2 qt of a compatible surfactant per 100 gal of spray solution will usually improve vegetation control For cotton, 40 gpa spray volume on a broadcast basis is usually sufficient. In noncrop areas apply whatever spray volume is needed to obtain coverage. All formulations are 100% water soluble.

B. PHYSICAL AND BIOCHEMICAL BEHAVIOR

1. Biological properties other than herbicidal: Some fungicidal action.

MCPA - [(4-chloro-o-tolyl)oxy]acetic acid
(2-methyl-4-chlorophenoxyacetic acid)

A. HERBICIDAL USE

1. General: Selective foliage broadleaf killer, similar to 2,4-D. More selective than 2,4-D at equal rates on cereals, legumes, and flax.

2. Application methods: Aerial and ground application; low-volume spray.

3. Rates: Used at rates from 0.12 to 1 lb ai/A.

4. Usual carrier: Water 2 to 30 gpa.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIORS

1. Foliar absorption characteristics: Similar to 2,4-D. Absorbed through leaves or roots. Washed off by rain if it follows soon after application. Absorption increased by wetting agents.

2. Translocation characteristics: Readily translocated in plant; movement with food material. Concentration of herbicide where foods actively utilized (meristematic regions of growing plants).

3. Mechanism of action: Hormone type action. Low volatile esters more effective on hard-to-control weeds than salts of MCPA.

4. Metabolism and persistence in plants: Inactivation follows many pathways. Complexing by proteins probable. Decarboxylation in many instances.

MECOPROP - 2-[(4-chloro-o-tolyl)oxy]propionic acid
(2-(2-methyl-4-chlorophenoxy)propionic acid)

A. HERBICIDAL USE

1. General: Mecoprop formulations are broadleaf weed killers particularly effective for control of chickweed, cleavers, clover, and plantain. The weeds on which the various formulations of this compound are particularly effective include common chickweed, mouseear chickweed, clover, plantain, knotweed, dichondra, pigweed, ragweed, lambsquarters, and ground ivy. Mecoprop is useful for control of weeds in cereals such as wheat, oats, and barley and for lawn and turf.

   Climatic conditions affect the action of mecoprop in the same way they affect the action of other phenoxy herbicides. Moist, warm conditions are conducive to good results. Cold weather and drought produce a delay in weed control action.

2. Application methods: Postemergence foliage application.

3. Rates: Established turf in lawns and fairways-2.24-3.36 kg/ha.

   For weed control in cereals - 1.5-2.5 kg/ha

4. Usual carrier: Water at 350-900 L/ha.

The salt formulations of mecoprop used are highly soluble in water; there is no need for additional agitations after initial mixing.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Mecprop formulations may be rendered ineffective if washed off by rain immediately after application.

2. Translocation characteristics: Translocation of mecoprop takes place from the foliage into roots of treated plants.

3. Mechanism of action: Mecoprop acts in a similar fashion to other phenoxy acids.

<u>MONURON</u> - 3-(p-chlorophenyl)-1,1-dimethylurea
(N'-(4-chlorophenyl)-N,N-dimethylurea)

A. HERBICIDAL USE

1. General: For general weed control in noncropland areas.

2. Application methods: For general weed control, monuron is sprayed or spread dry (as granules) at any time except when ground is froxen, but best results are obtained if it is applied shortly before weed growth begins. Dense growth should be removed before application.

3. Rates: General weed control (where bare ground is desired for an extended period) - 4 to 16 lb/A control most annuals; 6 to 48 lb control most annuals and perennials. Higher rates and repeat treatment may be required where a longer period of control is desired or when hard-to-kill, deep-rooted perennial weeds are present.

4. Usual carrier: Water in sufficient volume to uniformly cover area to be treated (continuous agitation is required to maintain suspensions, or in dry, granular formulations).

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Absorption characteristics: Monuron is most readily absorbed through root system; less so through foliage and stems.

2. Translocation characteristics: Translocation is primarily upward in the xylem. In studies where application was made to aerial parts of plants, little or no monuron was detected below the lowest point of application.

3. Mechansim of action: Monuron is a strong inhibitor of the Hill reaction.

   Intensive studies have shown that herbicidal action is due partially to the build-up of a substance which is phytotoxic to the oxygenliberating pathway in photosynthesis.

NITROFEN - 2,4-dichlorophenyl-p-nitrophenyl ether

A. HERBICIDAL USE

1. General: Controls annual grasses and broadleaf weeds. Highly tolerant crops include asparagus, cole crops (Brassica), carrots, peas, beans, peanuts, soybeans, other legumes, potatoes, onion, cotton, sunflower, and certain cucurbits. Highly sensitive crops include lettuce, spinach, tomatoes, eggplant, pepper, annual ryegrass, millet, and sudangrass. Registered for preemergence use on certain cole crops, carrots, celery, horseradish, parsley, and postemergence on certain cole crops, carrots, celery, horseradish, onions, and parsley.

2. Application methods: On vegetables and field crops and soil applications of a wet spray preemergence and to highly tolerant crops postemergence.

3. Rates: Four to 6 lb/A appear to be sufficient for most common weeds.

4. Usual carrier: Water at about 50 to 75 gpa.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Mechanism of action: Contact herbicide.

2. Biological properties other than herbicidal: None known.

CONTACT OILS, DIESEL OIL, FORTIFIED OILS, FUEL OIL, KEROSENE, MINERAL SPIRITS, PAINT THINNERS, PETROLEUM SOLVENTS, STOVE OIL, STODDARD SOLVENT, AND WEED OILS

TYPE: Weed oils are both selective and non-selective contact herbicides applied post-emergence before the crop emerges.

FORMULATIONS: One hundred percent petroleum compounds or various dilutions.

USES: Alfalfa, ditch banks, blueberries, clovers, walnuts, ornamentals, agricultural premises, irrigation water, and non-crop areas.

IMPORTANT WEEDS CONTROLLED: Most weeds that are brought into contact with it.

APPLICATION: Usually applied pre-emergence or as a directed post-emergence spray.

1. Selective Oil - These include only the light oil fractions with boiling ranges from 200-400^{o}F, such as kerosene and stoddard solvent. Used on most crops at 40-80 gallons actual/acre.

2. Contact Oils - These include crude oils, waste crankcase oil, gasoline, kerosene, and fuel oils that are derived from paraffin and naphthalene bases. They kill the top growth of weeds upon contact. Use undiluted or mixed with water and an emulsifier. Heavy oils injure the growing point of weeds producing slow chronic toxicity. Light unsaturated oils cause rapid burning and acute toxicity develops. Very light oils burn only the parts contacted and evaporate rapidly causing only local injury to plants. Used considerably in non-crop areas and applied pre-emergence to many crops before they emerge and to orchard floors.

3. Fortified Oils - These form a contact spray material. Usually fortified with Pentachlorphenol, Dinitro compounds, TCA, 2,4-D, and other related compounds. With this method less oil is needed for adequate control. Fortified oils will kill such oil-tolerant weed as fennel, poison hemlock, and St. Johnswort.

PRECAUTIONS: Do not apply on desired plants unless otherwise recommended. Avoid drift.

ADDITIONAL INFORMATION:

1. Fuel Oils - Sold by grades from 1 to 6. The lower the grade, the greater the toxicity to plants.

2. Stoddard Solvents - Used for selective weed control in certain tolerant crops. The aromatic content should be no greater than 25%.

3. Diesel Oil - Used as a non-selective contact herbicide. Often fortified.

4. Kerosene - It has a low toxicity to plants. Can be used on small carrots for selective weed control. Often used as a diluent in oil soluble herbicides where an oil of low plant toxicity is needed.

   All petroleum oils are exempt from residue tolerances. Viscosity influences the rate an oil will spread over and penetrate a plant. The higer the viscosity, the slower the penetration. Most contact oils hve a flash point of over 180°F. Most selective oils have a flash point of over 100°F. Oils for weed control should contain a high percentage of unsaturated hydrocarbon and have a sulfonatable residue of at least 25%. Those used selectly are usually more highly refined so that unpleasant odors or taste in market crops are reduced or eliminated. Oils also express insecticidal activity.

<u>PARAQUAT</u> - 1,1'-dimethyl-4,4'-bipyridinium ion
[as dichloride salts]

A. HERBICIDAL USE

1. General: Paraquat is registered for weed control during establishment of grass seed crops. It is registered as a general contact herbicide for noncrop usages, as a herbicide for orchard weed control, as a preemergence herbicide and as a direct postemergence herbicide. Pasture renovation is another area of development.

2. Application methods: Ground or air foliar spray - contact activity mainly.

3. Rates: Grass seed bed weed control - 0.5 lb/A.
   Desiccation - 0.25 to 0.75 lb/A.
   General weed control - 0.5 to 1 lb/A.

4. Usual carrier: Water 5 to 50 gpa.

   X-77 surfactant or equivalent is recommended for use with paraquat. Other nonionic and cationic surfactants are compatible with paraquat. When applied in liquid fertilizers or nitrogen solutions, 16 to 32 oz. of X-77 is recommended.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Very rapidly absorbed by the foliage. Very resistant to removal by rain.

2. Translocation characteristics: Local systemic action has been noted. Transloction via the xylem can occur under certain conditions.

3. Mechanism of action: Both the herbicidal activity and the organic chemical reactions of paraquat formulations are dependent solely upon the paraquat cation, and are not influenced by the nature of the associated anion, since the salts are largely dissociated in aqueous solution.

4. Metabolism and persistence in plants: It has been demonstrated that there is no metabolic breakdown of paraquat in tomato, broad bean, and maize plants. In sunlight, however, some photochemical breakdown occurs for paraquat which remains on the outside of treated plants. The extent of this breakdown under conditions of high light intensity is about 25 to 50% in 3 weeks, the only products formed being N-methyl isonicotinic acid and methylamine (both of which have very low mammalian toxicities). Since plants are killed rapidly in bright sunlight, significant quantities of the breakdown products are formed only on the surface of dead tissus, and there is no movement of these substances from the dead tissues to other parts of the plant.

5. Biological properties other than herbicidal: Paraquat has shown usefulness as a means of controlling columnaris, a myxobacterial disease of fish. No insecticidal or nematocidal properties have been demonstrated.

<u>PICLORAM</u> - 4-amino-3,5,6-trichloropicolinic acid

A. HERBICIDAL USE

1. General: For general woody plant control and control of most annual and perennial broadleaf weeds. Most grasses are resistant, and broadleaf weed control in grass crops is feasible. Most broadleaf crops are sensitive.

2. Application methods: Granular formulations can be applied by hand or with most commercial granular applicators. Liquid sprays can be applied aerially, or by ground equipment, knapsack equipment, and tree

injectors. All applications should be applied in a manner to avoid drift. Liquid formulations can be applied under conditions favorable for plant growth anytime up to 3 weeks before frost. Granular applications are most effective when rainfall occurs soon after application.

3. Rates: For thick stands of brush use pellets or beads at the rate of 2 to 8 pounds of picloram per acre distributed evenly to the soil over the roots of the woody plants to be controlled.

   Liquid sprays usually are applied at rates of 2 oz to 3 pounds of picloram per acre.

   Rates for controlling deep-rooted perennial weeds, such as field bind-weed and Canada thistle, usually are 1 to 3 lb/A.

4. Usual carrier: The liquid salt formulations are applied in water sprays. Tordon 155 is applied in fuel oil.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Absorption characteristics: Rapidly absorbed by both tops and roots.

2. Translocation characteristics: Translocates both up and down in plants. Accumulates in new growth.

<u>PROMETONE</u> - 2,4-bis(isopropylamino)-6-methoxy-s-triazine
(4,6-bis(isopropylamino)-2-methoxy-s-triazine)

A. HERBICIDAL USE

1. General: Prometone is a nonselective preemergence and postemergence herbicide which controls most annual and perennial broadleaf and grassy weeds on noncrop land.

2. Application methods: Application of sprays or granules can be made either before or after weed emergence. Since much of its activity is through the roots, adequate rainfall is required to move the chemical into the root zone.

3. Rates: From 10 to 60 lb/A, depending upon the particular weed species. The higher rates are used only for control of hard-to-kill species such as Johnsongrass, Bermudagrass, bindweed, and wild carrot.

4. Usual carrier: Water at 50 to 100 gpa or diesel oil, fuel oil, or weed oil at 100 to 200 gpa are the usual

carriers. Agitation in the spray tank is necessary to keep the chemical in suspension.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Absorbed through both foliage and roots.

2. Translocation characteristics: Translocated from roots and stems acropetally.

3. Mechanism of action: A photosynthetic inhibitor, but may have additional effects.

PRONAMIDE - N-(1,1-dimethylpropynyl)-3,5-dichlorobenzamide
3,5-dichloro(N-1,1-dimethyl-2-propynyl)benzamide

A. HERBICIDAL USE

1. General: Kerb is a selective herbicide that will control many broadleaf and grass weeds preemergence in lettuce. Kerb will also provide effective preemergence and postemergence control of annual bluegrass in bermudagrass turf. Kerb will control quackgrass, perennial ryegrass, downy brome, volunteer cereals, and many other winter grasses in alfalfa, clover, trefoil, crown vetch, blueberries, caneberries, grapes, apples, pears, stone fruits, Christmas trees, and woody ornamental trees and shrubs.

2. Application methods: Conventional surface preemergence applications of Kerb are most effective when there is ample rainfall or sprinkler irrigation. Shallow soil incorporation (1 to 2 inches) will be beneficial in dry environments or in fields watered by furrow irrigation. Kerb will also provide excellent postemergence control of quackgrass and many other grass weeds and several important dicot species when applied in the fall or early winter.

3. Rates: 0.75 to 2.0 lb/A.

4. Usual carrier: Water at 30 to 50 gpa.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: To obtain activity, Kerb must move into the root zone of the weeds. Little activity is obtained from foliar contact alone.

2. Translocation characteristics: Kerb is readily absorbed by plants through the root system, translocated upward, and distributed into the entire plant. The degree of translocation from leaf absorption is not appreciable.

3. Mechanism of action: Kerb is strong inhibitor of mitosis but may have additional effects.

4. Metabolism and persistence in plants: Metabolized slowly by both tolerant and sensitive plants. The metabolites observed involve alterations of the aliphatic side chain.

5. Other biological properties: None

SIDURON - 1-(2-methylcylohexyl)-3-phenylurea

A. HERBICIDAL USE

1. General: Selectively controls certain germinating annual weed grasses such as crabgrass (smooth and hairy), foxtail and barnyardgrass, in newly seeded or established plantings of bluegrass, fescue, redtop, smooth brome, perennial ryegrass, orchardgrass, zoysia, and the following strains of bentgrass: Pencross, Seaside, Highland, Astoria, Nimisila, C-1, C-7, and C-19. Should not be used on other bentgrass strains nor on bermudagrass.

2. Application methods: Applied as a preemergence treatment to bare soil as final operation following spring seeding, or to new fall seedings or established turf in the spring just before expected emergence of annual weed grasses.

3. Rates: New seedings - 2 to 6 lb/A.
Spring treatment of fall seedings or for established turf - 8 to 12 lb/A.

4. Usual carrier: Water in sufficient volume to uniformly cover area to be treated. Continuous agitation is required to maintain suspension. Dry formulations can be spread by suitable equipment.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Absorption characteristics: Most readily absorbed through root system; less so through foliage and stems.

2. Translocation characteristics: Experimental evidence indicates that siduron is translocated in the xylem.

3. Mechanism of action: Unlike other substituted urea herbicides, siduron is not a potent inhibitor of photosynthesis; phytotoxic symptoms appear to be associated with root growth inhibition.

4. Metabolism and persistence in plants: In studies with ^{14}C-labeled siduron, no metabolites of siduron were detectable in barley plants after an 8-day absorption period.

SILVEX - 2-(2,4,5-trichlorophenoxy)propionic acid

A. HERBICIDAL USE

1. General: For control of woody plants, broadleaf herbaceous weeds, and aquatic weeds. It is also useful as selective postemergence herbicide in rice and bluegrass turf. In sugarcane, it is used to control wild lettuce, chicory, nightshade, tievine, and certain other weeds not susceptible to 2,4-D. For brush control in rangeland improvement programs, especially post, blackjack, sand shinnery oaks, yucca, and salt cedar. Controls alligator weed in ditches and riverbanks. Controls 2,4-D tolerant weeds such as chickweeds, spurges, and black medic in turf.

2. Application methods: Generally used postemergence. Brush treatment by aerial or ground equipment.

3. Rates: Rice, 0.75 to 1.25 lb/A; sugarcane, 1 to 5 lb/A; turf, 1.5 lb/A; conifer release, 2 to 3 lb/A; brush spray, 1.5 to 16 lb/A; aquatic weeds, 4.25 lb/acre foot of water.

4. Usual carrier: Water or oil-water mixture. Oil for basal bark, stump, and dormant cane treatment.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Absorption characteristics: Similar to 2,4-D. It is absorbed through roots and foliage. Ester forms are generally more effective as foliage sprays than salts.

2. Translocation characteristics: When applied to the foliage, it is translocated along with food materials in the phloem.

3. Mechanism of action: Similar to 2,4-D in disturbing the normal processes of cell differentiation.

4. Metabolism and persistence in plants: Similar to 2,4-D.

5. Biological properties other than herbicidal: Useful in reducing preharvest fruit drop of apples. Little or no biological activity on insects nematodes, or fungi.

SIMAZINE - 2-chloro-4,6-bis(ethylamino)-s-triazine

A. HERBICIDAL USE

1. General: Simazine is a widely used selective herbicide for control of broadleaf and grass weeds in corn, citrus, deciduous fruits and nuts, olives, pineapple, established alfalfa, and perennial grasses grown for seed or pasture, turf grasses grown for sod, ornamentals, nursery plants, Christmas tree plantations, sugarcane, asparagus, and artichokes. It is used also as a nonselective herbicide for vegetation control in noncropland. Sugarbeets, tobacco, oats, and many vegetable crops are very sensitive to simazine.

2. Applications methods: Applications of either sprays or granules should be made on bare soil prior to weed emergence. It also may be applied prior to planting for many crops. Simazine has little or no foliar activity and must be absorbed by plant roots. Under dry conditions, a shallow incorporation may increase the degree of weed control.

3. Rates: The equivalent of 2 to 4 lb/A are required for selective weed control under most conditions. Higher rates are used for nonselective weed control and in several specific weed crops situations.

4. Usual carrier: Water at 20 gpa or more is the usual carrier for uniform application. Agitation in the spray tank is necessary to keep the chemical in suspension. Granules also are used widely in citrus, fruit trees, and ornamentals.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Absorbed mostly through plant roots with little or no foliar penetration. It has low adhering ability and is readily washed from foliage by rain.

2. Translocation characteristics: Following root absorption it is translocated acropetally in the xylem, accumulating in the apical meristems and leaves of plants.

3. Mechanism of action: A photosynthetic inhibitor; but may have additional effects.

4. Metabolism and persistence in plants: Simazine is readily metabolized by tolerant plants to hydroxy-simazine and amino acid conjugates. The hydroxy-simazine can be further degraded by dealkylation of the side chains and by hydrolysis of resulting amino groups on the ring and some CO_2 production. These alterations of simazine are major protective mechanisms in most tolerant crop and weed species. Unaltered simazine accumulates in sensitive plants, causing chlorosis and death.

5. Biological properties other than herbicidal: Limited studies have shown some minor fungicidal and nematocidal activity but no insecticidal activity.

SODIUM CHLORATE - Sodium chlorate

A. HERBICIDAL USE

1. General: Used as a herbicide for morningglory, St. Johnswort, Russian knapweed, Canada thistle, and johnsongrass; and as defoliant. A nonselective herbicide.

2. Rates: 1/2 to 2-1/2 lb/100 sq. ft.

3. Usual carrier: Apply only in dry form.

2,4,5-T - (2,4,5-trichlorophenoxy)acetic acid

A. HERBICIDAL USE

1. General: For the control of woody and herbaceous weed plants by air or ground spray application under a variety of conditions. Use rates vary: foliage spraying of woody vegetation - 4 to 16 lb/A; basal bark - up to 16 lb/A; dormant brush - up to 9 lb/A; selective conifer release - 2 to 3 lb/A; rangeland and pasture - 0.5 to 3 lb/A. Also useful in frill and injection tree treatment and for weed control in rice, sugarcane, and turf. Often used with 2,4-D for brush control.

2. Application methods: Used postemergence in conventional ground or air equipment as foliar spray, as individual tree and stump treatment, as directed dormant stem spray.

3. Rates: 0.5 to 16 lb/A as noted above.

4. Usual carrier: Water, oil, or oil water emulsion

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Absorption characteristics: Similar to 2,4-D. Absorbed through roots, bark, and foliage. Esters of 2,4,5-T are more resistant than salts to the washing action of rain.

2. Translocation characteristics: Through phloem tissue following foliar application. Characteristics similar to those of 2,4-D.

3. Mechanism of action: Similar to 2,4-D. Several modes of action have been demonstrated, but the basic mechanism of action stil is not fully know.

4. Metabolism and persistence in plants: Similar to 2,4-D.

5. Biological properties other than herbicidal: Little or no biological activity on insects, nematodes or fungi. It has been used as growth regulator to increase size of citrus fruits and reduce excessive drop of deciduous fruit.

<u>2,3,6-TBA</u> – 2,3,6-trichlorobenzoic acid

A. HERBICIDAL USE

1. General: Primarily for control of broadleaf deep-rooted, noxious perennial weeds such as field bindweed, leafy spurge, Canada thistle, Russian knapweed, bur ragweed, blueweed, and climbing milkweed; also used for nonselective control in noncropland and for control of certain weedy plants and vines such as smilax, honeysuckle, trumpet vine, spruce, balsam, fir, cedar, pine, Macartney rose, sumac, persimmon, sassafras, and hackberry. Spray drift may injure susceptible crops such as beans of all types, tomatoes, peas, cotton, tobacco, and various ornamentals, orchard, and vine crops.

2. Application methods: By ground equipment as a coarse spray applied with low or moderate pressure to both weed foliage and soil. Best results are obtained if applied after weed foliage appears in spring, but before growth has progressed sufficiently to retain more than half the spray.

3. Rates (ae/A): Noxious perennial weeds - 10 to 20 lb
   Mixed broadleaf weeds - 20 to 30 lb for control greater than 1 year
   Woody vines - 10 to 20 lb
   Woody brush - 4 lb

The above rates will give relatively long-term residual soil action.

4. Usual carrier: Water is the usual carrier for 2,3,6-TBA. With light ground cover use 50 gpa, and on denser areas use 100 to 200 gpa. Uniform foliage and soil coverage is essential for optimum results. The spray mixture is a true solution, so once mixed agitation is not necessary. Little data is available as to possible benefits of surfactants. Some Texas studies indicate no advantage of surfactants or "penetrating aids."

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Foliar absorption characteristics: Both foliage and root absorption contributed to plant kill. Since the dimethylamine formulation is water soluble, the absorptive properties of an aqueous solution would be dependent upon the wetting ability of the carrier.

2. Translocation characteristics: The 2,3,6-TBA is readily mobile in xylem, phloem, and mesophyll cells. It, like phosphorus, moves freely through both living and nonliving plant tissues. 2,3,6-TBA accumulates in both the growing tips of plant roots and shoots. The acid form placed on stems or leaves of bean plants was absorbed and translocated throughout the plants, causing growth modification. The compound moved downward into roots and out into the surrounding soil, whereupon roots of nearby untreated plants absorbed the compound and translocated if upward into their aboveground parts. Transfer of the compound also occurred between the root systems of various other genera.

3. Mechanism of action: Functions as a growth regulator. Acid form 2,3,6-isomer) demonstrated high physiologic activity in the Avena coleoptile test. This isomer caused cell elongation and proliferation of tissue, induced adventitious roots, modified leaves and other plant organs, and caused parthenocarpic fruit development.

4. Metabolism and persistence in plants: Extremely stable in plants and not subject to rapid enzymatic decomposition.

<u>TCA</u> - trichloroacetic acid

A. HERBICIDAL USE

1. General: For control of grass seedlings and certain established perennial grasses and cattails. Common

crop plants for which the compound is useful: sugarbeets, red beets, and sugarcane as a preemergence application or directed spray. It has been used for grass control in other crops. It is used also on noncropland including plant sites and road shoulders for grass control.

2. Application methods: Can be applied with conventional spray equipment.

3. Rates: For nonselective treatment, rates of 50 to 200 lb/A are used depending upon grasses to be controlled. For selective use on crops, rates of 6 to 30 lb are used depending upon crop tolerance and grass species.

4. Usual carrier: Sodium TCA is usually applied in a water spray.

B. PHYSIOLOGICAL AND BIOCHEMICAL BEHAVIOR

1. Absorption characteristics: Absorbed more rapidly by roots than by foliage. Is easily removed from foliage by rain.

2. Translocation characteristics: Translocates readily. Accumulates in growing tissues.

<u>TEBUTHIURON</u> - 1-(5-tert.-butyl-1, 3, 4-thiadiazol-2-yl)-1, 3 - dimethylurea

TYPE: Tebuthiuron is a substituted urea type compound used as a pre-emergence herbicide.

FORMULATIONS: 80% WP, 5, 10, 20 and 40% pellets.

IMPORTANT WEEDS CONTROLLED: Alfalfa, bluegrasses, bromes, bouncingbet, butter cups, chickweed, clovers, cocklebur, dock, fescue, fiddleneck, filaree, foxtails, goldenrod, henbit, horseweed, kochia, lambsquarters, morning glory, mullein, nightshade, wild oats, pigweed, puncture vine, ryegrass, prickley sida, sowthistle, spurge, sunflower, Russian thistle, vetch, witchgrass and many others.

USES: Total vegetation control. Experimentally being tested on sugar cane, pineapple, on range and pasture land and in reforestation programs.

RATES: Applied at 3/4-8 lbs. actual/acre.

APPLICATION: Total vegetation control - apply as either a pre- or post-emergence treatment to railroad right-of-ways, industrial sites, tank farms, highway medians, etc. Rainfall is required to move the chemical into the soil. Apply either before or during the period of active plant growth.

PRECAUTIONS: Do not use on any food or feed crop until registration has been obtained. Do not apply near desirable trees or plants.

ADDITIONAL INFORMATION: May be used in combination with other herbicides. Controls a number of woody species of plants. Use higher rates and/or repeat application to control hard to kill perennial species. Spot treatment on range and pasture land is effective. Water solubility is 2.5 ppm. Low toxicity to fish and wildlife. Vertical leaching in the soil is slow and no lateral chemical movement has been observed. Readily absorbed through the root system and inhibits photosynthesis. The half life in the soil is 12-15 months in areas of 40-60 inches of rainfall.

VELPAR - 3-Cyclohexyl-6-(dimethylamino) -1-methyl-s-triazine-2,4(1H, 3H)-dione

FORMULATIONS: 90% water soluble powder.

USES: Experimentally being tested on sugar cane and for total vegetation control.

IMPORTANT WEEDS CONTROLLED: Annual boradleaf and grass seedlings as well as most annual and perennial grasses, broadleaf weeds, and vines depending upon rates.

RATES: Applied at 1 - 3 lb. on seedling weeds, 2 - 6 lb./acre for top kill and short-term control of established annual and perennial weeds and 4 - 10 lb./acre for season-long general vegetation control.

APPLICATION: Applied post-emergence during periods of active plant growth. Application when vegetation is dormant or semi-dormant may not be effective. Spray to lightly wet the foliage.

PRECAUTIONS: Do not use until registration has been obtained. This material will not dissolve completely in spray concentrations exceeding 12-1/2 lbs./50 gallons of water. Do not use near desirable trees or plants. Prevent drift.

ADDITIONAL INFORMATION: May be used with a surfactant to improve the wetting properties. Relatively harmless to fish and wildlife. Taken up by both roots and foliage. Looks very effective on brush and hard to kill perennial weeds. This material is very rate responsive to the type of weed to be controlled and the length of control desired. Water solubility 32,000 ppm. More effective the higher the air temperature.

F. METHODS OF APPLICATION

In order to be effective, a herbicide must enter the plant and move to the site of action. Entry may be through various parts of the plant: leaves, roots, seedling shoot before emergence, or above-ground stem. Entry may also be forced, as when the cut-surface method of application is used. Penetrating agents or penetrants may be added to the herbicide to improve its penetration of the plant foliage or stem surface. Before a herbicide can enter the foliage, the cuticle or wax surface must be penetrated. Some entry may take place through the stomata on the under side of the leaf.

Entry of herbicides into plant roots is not as difficult as entry into foliage, since no wax layer or cuticle is present. The major problem with root uptake is getting the herbicide through the soil to the roots. Soil-applied herbicides are active on germinating seeds or small seedlings. Before emergence, the shoot has a poorly developed cuticle and probably no wax layers, making it more easily penetrated by herbicides. Herbicides that are quite mobile in the soil, such as picloram, will control large brush and trees.

Young stem tissue of herbaceous plants may be penetrated by herbicide solutions in much the same way as leaves. However, stems are less important than leaves because of the small surface available.

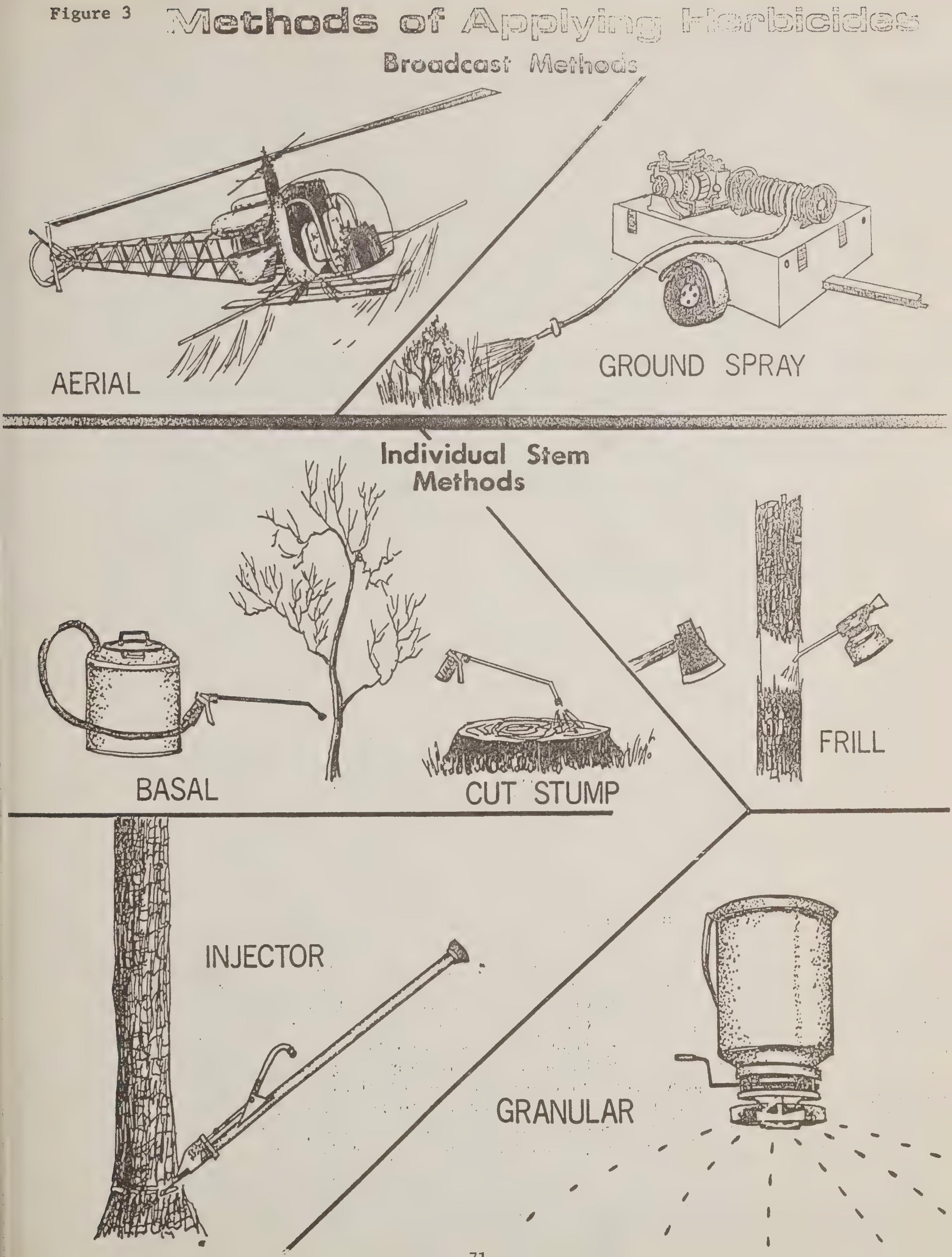
Once in the plant, the herbicide must still move to the site of action. Some of the herbicide may be chemically bound in the plant, making it inactive. The remaining herbicide moves through the xylem and/or phloem. Herbicides that enter the roots or foliage may move upward in the xylem with the transpiration stream. Phloem movement of herbicides is usually down, but may also be up in some plants. Applications to the leaves of perennial plants can thus move to the roots. Phloem movement is associated with sugar transport and, therefore, good light conditions are helpful. Also, it is very important not to kill the leaf and stem tissues rapidly, since transport is via living tissue.

To make use of this knowledge, the following methods of herbicide application are used in the Eastern Region: (Figure 3)

1. Basal Stem - Application is made to this area via a coarse-droplet spray at low pressure about 12 or 18 inchesabove the soil surface. Spray is applied until an excess runs off onto the soil surface at the base of the stem.

2. Cut Surface - This involves insertion of herbicides into cuts made with special tools, or by applying herbicides into frills or hacks made by axes or mechanical cutters. This method includes applying herbicides to stumps of cut stems.

Figure 3


Methods of Applying Herbicides
Broadcast Methods
AERIAL
GROUND SPRAY
Individual Stem Methods
BASAL
CUT STUMP
FRILL
INJECTOR
GRANULAR

3. Foliage - Here, the foliage is sprayed from air or ground. Applications may be either broadcast to cover several acres, directed at groups of plants, or a treatment of individual plants. Helicopters are used exclusively for aerial applications in the Eastern Region. Ground equipment may consist of individually operated back pack (garden type) sprayers, large 100 to 300 gallon tank type hydraulic sprayers mounted on trailers, or four-wheel drive or crawler type vehicles. Coarse sprays are used to control drift. In addition, invert emulsions, foams and other drift control agents or equipment may be used to produce large drops and control of aquatic weeds where herbicides or algacides are introduced into the water through a boat bailer or surface spray.

4. Soil Treatment - This involves application of a herbicide, liquid or granular in form, to the soil. Granules are a type of formulation in which the active ingredient is mixed and pressed with an inert carrier to form a small pellet that can be distributed on the soil. As the granules slowly decompose, the herbicide is released into the soil. Other soil treatments with liquids act as soil sterilants, and when present in or on the soil, prevent the growth of plants (Figure 3).

G. REVIEW OF PLANNED USES

See Table 1

Table 1

G. REVIEW OF PLANNED USES

PROPOSED AVERAGE ANNUAL HERBICIDE PROGRAM

Forest Management Activity / Method of Application	Totals	MODE OF ACTION: Growth Regulators: 2,4-D	2,4,5-T	other 2,4-D/2,4,5-T	Picloram	Dicamba	Organic Arsenicals	Photosynthetic Inhibitors	Mitotic Poisons	Soil Applied Inhibitors	Chlorophyll Inhibitors	Free Radical Formation	Interfere w/ Protein Metabolism	Misc.
a. Forest Road, Trail and Facilities	2,680*													
Basal Stem		5	10	-	560	-	-	-	-	-	-	-	-	-
Cut Surface		30	110	-	15	-	-	-	-	-	-	-	-	-
Foliage		985	110	200	10	-	10	-	-	-	500	-	55	55
Soil Treatment		-	-	-	-	-	-	25	-	-	-	-	-	-
b. Range	795													
Basal Stem		30	105	-	50	-	-	-	-	-	-	-	-	-
Cut Surface		100	30	-	-	-	-	-	-	-	-	-	-	-
Foliage		-	30	100	50	-	100	-	-	-	25	-	25	-
Soil Treatment		-	-	-	110	-	-	40	-	-	-	-	-	-
c. Recreation	100													
Basal Stem		-	-	-	-	-	-	-	-	-	-	-	-	-
Cut Surface		-	-	-	-	-	-	-	-	-	-	-	-	-
Foliage		15	-	-	-	-	-	-	-	-	5	-	-	60
Soil Treatment		-	-	-	-	-	-	-	-	-	-	-	15	5
d. Special Uses	4,125													
Basal Stem		185	585	-	840	55	-	-	-	-	-	-	-	-
Cut Surface		-	-	-	-	-	-	-	-	-	-	-	-	-
Foliage		155	260	65	520	450	-	-	-	-	-	-	-	-
Soil Treatment		-	-	-	-	-	-	-	-	500	-	510	-	-
e. Timber Management	29,465													
Basal Stem		480	595	-	1,520	-	-	-	-	-	-	-	-	-
Cut Surface		8,080	1,080	-	1,540	-	2,070	-	-	-	-	-	-	-
Foliage		10,960**	1,620	-	-	-	-	-	-	-	40	30	240	75
Soil Treatment		-	-	-	25	-	-	930	155	25	-	-	-	-
f. Wildlife	5,530													
Basal Stem		-	1,095	130	55	-	-	-	-	-	-	-	-	-
Cut Surface		30	-	25	90	-	-	-	-	-	-	-	-	-
Foliage		-	-	-	25	-	-	-	-	-	-	5	-	35
Soil Treatment		-	-	-	4,040	-	-	-	-	-	-	-	-	-
Totals	42,695*	21,055	5,630	520	9,450	505	2,180	995	155	525	570	545	335	230

*Figures are in acres treated.
**Includes annual aerial spray program of 7,000-9,000 acres.

II. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

This section is an analysis of both the anticipated favorable and possibly adverse impacts of herbicide use in the Eastern Region, as they may affect the local, regional, national, and international environment. The environment, in this case, includes not only the natural environment, but the social and economic environment as well.

Planned measures to minimize and mitigate adverse environmental impacts of herbicide use, including specifications and standards necessary to maintain and protect environmental quality, are found in Appendix A under Controls on Herbicide Use.

A. NON-LIVING COMPONENTS

1. Air. Herbicides can enter the air system and contribute to air pollution. Entry may be in the form of drift or vapors. Drift is defined as that part of the spray which moves out of the target area in fine drops and deposits on adjacent property. Vapors are volatilized or photo-altered herbicide molecules from falling or fallen spray drops. Recent experiments have shown the amount of herbicides recovered on the target area to be at least 70% to 85% (Norris, Montgomery, and Warren, 1976)

   The different factors affecting drift are summarized in Table 2. These factors do not have equal importance and change with different herbicides, method of application, and geographic location.

Table 2
Effect of Various Factors on Herbicide Drift

Less Drift	Factor	More Drift
Lower	A. Release Height	Higher
Lower	B. Wind Speed[1/]	Higher
Faster	C. Droplet Fall Rate	Slower
Larger	1. Droplet Size	Smaller
Lower	a. Pressure	Higher
Jet	b. Nozzle Type[2/]	Wide angle cone or fan
Larger	c. Orifice Size	Smaller
Lower	d. Air Shear on Spray	Higher
Higher	e. Surface Tension[3/]	Lower
Higher	f. Relative Humidity[4/]	Lower
Higher	g. Viscosity	Lower
Higher	2. Drop Density[5/]	Lower
Less	D. Air Stability	Greater
	E. Aircraft Turbulence	
Slower	1. Speed	Faster
Clear	2. Aircraft Aerodynamics	Rough
Climbing	3. Flight Attitude	Falling
Closer	4. Nozzle Location on Boom cf. Center	Farther out
Smaller	F. Size of Treated Area	Larger

1/ Below speed at which air stability is reduced.
2/ Certain nozzle types can produce larger drops or narrower range.
3/ Higher oil or surfactant content reduces surface tension.
4/ Important with evaporative carriers (water).
5/ Oil carriers are lighter (less dense) than water.

Spray droplets are measured as drop diameters in units of micrometers or microns. A micron is 1/25,400 of an inch. A droplet, with twice the diameter of another, has eight times the volume or mass. The smaller droplet has about 1/4 the surface of the large droplet and therefore, will respond 16 times more to the force of air movements.

Research has shown that there is a rapid decrease in a droplets drift potential as their size increases above 200 microns. (Figure 4)

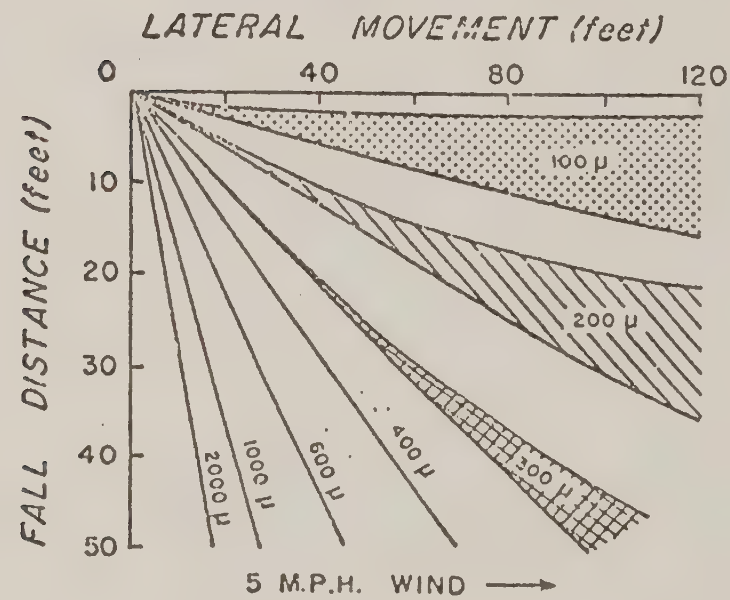


Figure 4 - Lateral movement of spray particles of various diameter falling at terminal velocity in a 5 mph cross-wind. Shaded areas indicate uncertainty due to varying droplet evaporation (Reimer, et al. 1966)

As droplets fall through air which has less than 100 percent relative humidity, they will decrease in size and can become increasingly subject to drift. The size of the original drop and the distance it falls has a great influence on the amount of evaporation. Covering the drop with a coat of oil will aid in reducing the evaporation. The position of the spray nozzle on the application equipment and the speed at which the nozzle moves through the air has a direct affect on drift. As the spray leaves the nozzles mounted on an air craft, it travels at speeds of about 25 m.p.h. It is subject to shearing by the air through which the nozzle is moving; this force will cause a break up of the drops. (Warren 1976). Drop size is affected very little by this force with ground application moving 5 to 10 m.p.h.

As Table 2 and the above discussion indicate, drift can be affected by many factors. Most of these can be controlled, or adjusted to by the applicator, to eliminate any environmental impact. With the best available technology, it is routinely possible to deposit 97 - 99% percent of the released spray within ordinary target areas by aircraft or ground equipment (CAST Report).

The vaporization potential of herbicides is known, so appropriate formulation that will not produce unacceptable air pollution or off-target effects can be used. The main climatic factor affecting volatilization is temperature. The amount of vapor accumulating in the air would increase with higher temperatures, larger treatment areas (over 100 acres in size), fine sprays, and stable air conditions. The Eastern Region's contribution to this source of pollution would be negligible due to the small acreage, 7,000 to 10,000 acres, treated across the Region each year. The average area size treated in the Eastern Region is between 35 to 45 acres.

Herbicides, as air pollutants, are removed from the air by rainfall, photo decomposition, atmospheric fallout, and adsorption to particulate matter. Atmospheric washout allows entry into the oceans (Rabson, and Plimmer 1973); therefore, this pathway, if not avoided, could be an important contribution to worldwide pollution.

The Clean Air Act has been studied, and the U.S. Environmental Protection Agency contacted (letter of March 9, 1977), for guidelines on air quality and herbicide application. There is nothing that indicate that aerially applied herbicides would be considered pollutants under Federal law.

2. History and Archeology. Executive Order 11593 (Protection and Enhancement of the Cultural Environment) requires that Forest Service plans and programs contribute to the preservation and enhancement of structures and objects of historical, architectural, or archeological significance. The cultural resources of the National Forests are a non-renewable resource of growing importance. They are extremely fragile and can be altered by relatively minor disturbances.

   Herbicides applied indiscriminately on archeological sites could contaminate archeological materials and affect the correctness of carbon-14 dating. For contamination to take place, items of archeological significance would have to be on, or close to, the soil surface. Herbicides proposed for use do not readily leach into the soil and are not persistent. Most of the herbicide applications are to sites that have been grossly altered by prior activities, such as road construction, cultivated fields, timber sales and site preparation, and utility rights-of-ways. To effectively identify and protect a site of historical or archeological importance, an archeological search must be made before the major soil disturbance takes place.

3. Land Ownership - Land Use. Major consideration must be given to land management, especially prime agriculture lands. When possible, land use decisions which irrevocably commit prime lands to non-farmland, non-range, and non-forest land uses should be avoided, thereby foreclosing the options for future generations. The 1976 USDA Secretary's Memorandum No. 1827, Supplement 1, advocates that land uses that preclude land from future agriculture uses be avoided. Proper herbicide use on forest lands in the Eastern Region will not affect the long-term productivity or uses which can be made of treated lands. The ability to use herbicides as a management tool does identify some Forest lands with a primary use, as in the case of utility rights-of-way, agricultural uses, and range allotments. Pressure to use Forest lands for these purposes exists because permittees feel that once they establish an investment in the land or the facilities they will be able to maintain that use. These lands, however, in no way exclude compatible use by the general public.

4. Soils. The forest floor is a major receptor of herbicides. Deposition may be direct, washed from vegetation by rain, or excreted from vegetation. Once on the forest floor, some herbicide loss will occur by photo-alteration and through volatilization. The remainder will be washed into the humus layer and lower soil layers by rainfall. What happens to the herbicide after it enters the soil depends on the herbicide in question and on a number of soil factors. High organic content, moisture, aeration, temperature, iron oxides, pH, and clay content reduces herbicide mobility in the soil and aids rapid herbicide breakdown.

   Undisturbed forest soils tend to be acid, low in organic matter, have a cool temperature, and are dry, all of which favors slow breakdown. However, most sites receiving herbicides, have been disturbed by human activities, i.e. road and utility rights-of-way construction, site preparation, land clearing for agriculture, and abandoned man-made clearings. Such disturbance can reduce the humus layer which protects the soil; but, it also opens the area to sunlight and increased soil temperature. Under field conditions, most herbicides have been found to quickly degrade. Herbicides give non-toxic and naturally abundant end products, such as carbon dioxide, and water; and chlorine, nitrogen, sulfer, and phosphrus.

Adsorption and leaching also take place in the forest floor and soil. Most herbicide molecules attached to soil particles provide temporary soil storage for later release. The free and released molecules are subject to leaching, movement with soil erosion to water sources, volatilization, chemical degradation, biological degradation, and plant uptake. Herbicide leaching in the soil is a slow process and generally measured in inches. Maximum persistence for some photosynthetic inhibitors may reach 2 years. Most herbicide persistence is measured in weeks, however.

Soil loss by erosion averages up to 0.1 ton/acre per year from forest land. This must be accepted as a normal geologic process. The rate probably varies from less than 0.05 ton to 0.3 ton per year, depending on geology, soil, climate, and vegetation. This process is the most active where annual precipitation ranges from 15 to 30 inches per year. (Patric, 1976). This might indicate soil bound herbicide molecules could move with soil erosion to surface water. However, most soil erosion within the undisturbed forest is not sheet erosion, but almost always originates in stream channels. On land sloping less than 35 degrees, there is no evidence that tree death accelerates soil erosion much above geologic rates. (Patric, 1976). Massive rainfalls, bare soils, or excessively steep slopes combined with soils containing herbicide molecules can be an exception to this norm.

5. Visual. Visual impacts associated with using herbicides to control vegetation include dead leaves, dead branches, standing dead trees, and a change in vegetation contrast.

   The "brown out" caused by curing of the target vegetation following herbicide application has an immediate and adverse visual impact. Visual and aesthetic values are generally lowered during "brown out," however, the effect is temporary, lasting only until leaf fall. When dead brush and snag trees are left following herbicide use, the visual signs may last 10 years or more.

   The objective of herbicide use is to create a vegetation change to desirable (economic, aesthetic) species at the expense of undesirable species. This change can be either temporarily adverse or pleasing, depending on the thinking of the viewer. If the contrast in vegetation looks artificial or out of place, the visual impact can be negative. At the same time, the diversity of vegetation and new stands of trees or grass, as encouraged by treatment, add to the attractiveness of an area. The visual impact of herbicide use often depends on location, topography, access, shape, likelihood of recreation use, etc.

Aquatic weed control can result in a temporarily displeasing sight, caused by floating dead plants.

6. Water. No area of environmental concern has received as much attention as water quality and quantity. The waters associated with the Forests in the Eastern Region are mainly headwaters and are known for their purity and sensitivity to contamination. Only a few of the projects involving herbicides call for application of a chemical to water. Only those herbicides specifically registered for use in water will be used for these projects.

   Certain concentrations of herbicides in water could adversely effect the potability of drinking water; food chain organisms in the aquatic environment; sensitive irrigated crops; and, the industrial and recreational uses of such water. Entry into the surface water may be direct, by soil erosion, air wash out, or ground water flow. Direct entry is mainly caused by an error in application or through drift. Concentrations may reach 1 ppm, be short term, and local in nature.

   The National Interim Primary Drinking Water Regulations list the maximum contaminant levels (MCL) for organic chemicals in drinking water. These MCL's are for community water systems, where use for human consumption is considered long-term. Most forest water systems are considered non-community systems because they serve transients (hikers, picnic areas, campground, etc.). The proposed pesticide levels shown in the regulations have been found safe for long-term human exposure, and therefore are lower than levels necessary to protect intermittent users.

Herbicide	Interm MCL
2,4-D	100 ppb
Silvex (2,4,5-TP)	10 ppb

   Soil erosion to be a source of contamination, it must overcome considerable resistance from forest vegetation and humus layers protecting the soil. However, massive rainfalls immediately following an herbicide application, unprotected soils, steep slopes, and a short distance from treated soil to surface water all increase the chance of surface waters becoming contaminated from an herbicide treatment area.

Herbicides which vaporize during application or from the surface of vegetation eventually precipitate or wash out of the air as the parent compound or as a photo-chemical degradation product. Such fallout may be far removed from the application site and is of low intensity, but usually decreases very rapidly with distance from the origin (Caro, 1971).

Some movement from certain herbicides to surface water can occur through groundwater, but rarely if ever has been shown to do so. This has greater possibility in the Ozarks, where Karst topography is found. In other areas, the slow movement of water through the upper soil profiles allows for rapid herbicide degradation in the forest floor and rooting zone before the herbicide has moved very far. Wiese and Davis, (1964) found that esters of 2,4-D commonly used in forest management, do not leach beyond the top 3.1 inches of the soil profile. The more persistent and active an herbicide is, the more likely it is to leach down to the ground water.

Although its known that herbicides can enter the surface water, it is important to relate here what has actually occurred during field use when label use directions and Forest Service application procedures were followed. From 1972 to 1976, 30 separate water surface sites close to aerial applications of 2,4-D were monitored on National Forests in the Lake States. The surface waters included rivers, lakes, pot holes, impoundments, and marshes. One hundred and sixty-one water samples were collected and tested. These samples were collected according to a planned schedule: immediately after spraying; 4 hours later; 24 hours later; 65 hours later; and after the first rain. Only three samples showed detectable amounts of 2,4-D; the highest being 16.0 ppb which showed up following a rainfall totaling .32 inches. The rainfall was the day after spraying. The water sample was taken adjacent to the spray area at the mouth of an ephemeral steam that ran through the spray area. The dry stream bed received a direct application of herbicide. This was will below the 100 ppb limit allowed for public water supplies by EPA and much below the LC_{50} values for sensitive crustaceans and fish. Measures are now taken to protect ephemeral streams from direct applications of aerially applied herbicides.

By moving downstream 1 mile, a 100-fold reduction in herbicide concentration has been observed in several instances; but, it is difficult to give an exact rule of thumb because of the nature of the dilution process in forest streams. If we accept a 25-fold reduction in concentration over a mile of stream as a conservative estimate, then if a maximum herbicide concentration of 0.01 ppm was observed at the boundary of a treated area it would be less than 0.0004 ppm 1 mile downstream. There will be a return to nondetectable ($<$0.001 ppm) levels in less than 24 hours after application. Therefore, the highest level which humans could be exposed to might be 0.01 ppm for 24 hours, if water was taken for consumption from the stream immediately downstream from the treated area. Of course, the more remote the treated area is from the stream, and the further the water which is to be drunk is from the water entry point, the less likely a detectable residue will occur (Abrahamson and Norris, 1976).

Mullison (1970) reviewed the concentrations of herbicides found in water after spraying adjacent uplands. Detected concentrations were from 0 to 70 ppb (phenoxys) and up to 370 ppb (picloram). Time needed for total disappearance ranged from 2 to 17 days (phenoxys), up to 16 months (picloram). A June 1973 EPA monograph stated, "Under field conditions picloram does not present a serious threat to water quality a short distance downstream from the site of application. It is evident that precautions given on herbicide label are adquate to allow the material to be used safely."

The effects of vegetation management on tiny headwater stream flow within a National Forest may be measurable. However, it is seldom detectable when the greater volumes of flow are measured in large rivers. Stream flow increases in proportion to the area and severity of vegetation control. Water quantity increases as evaporation losses through vegetation transpiration and interception decrease. Vegetation regrowth may return the area's transpiration level to what it was to before herbicide treatment in 1 to 10 years, depending on the degree of control. This makes the increase in water quantity short-lived, as well as minute. A minor, long-term water quantity outflow may occur due to a change in vegetation. Permanently foliaged conifers intercept, as well as transpire, more water than do deciduous hardwoods, while grass uses less than either kind of tree (Patric 1976).

Abrahamson and Norris (1976) reported on the results of extensive water monitoring investigations following present-day forestry herbicide applications. Forest stream monitoring for several herbicides, over extended periods of time, has consistently shown that leaching of herbicides in forest soils have not resulted in detectable (less than 0.001 ppm) concentrations of herbicide in forest streams. Field testing on forest lands has verified that overland flow of herbicides is restricted to localized events, and that the overland flow showed marked reduction in herbicide concentration as it moves over uncontaminated soil. These measurements were made immediately downstream from treatment unit boundaries and, therefore, represent maximum concentrations in the stream system. When herbicide concentrations have been detected, more than 99 percent of all concentrations have been less than 0.01 ppm.

B. LIVING COMPONENTS

1. Domestic Animals. The impact of herbicide use around livestock and other domesticated animals is becoming well documented. The lethal doses for various test animals using particular chemicals are known. The acute oral toxicity of a single dose of the phenoxy herbicides to mammals ranges from 100 mg/kg to 2,000 mg/kg (CAST Report No. 39). Signs of poisoning include loss of appetite, loss of weight, weakness, lack of coordination, alternations of the liver and other internal organs, and in some instances, defective offspring.

   Since domestic grazing animals can tolerate up to 2,000 ppm of some phenoxy herbicides continouously in feed, forage residue poses no hazard to animals, even from ranges and pastures treated at exaggerated rates. No residues appeared in the milk of cows which consumed rations containing up to 300 ppm of 2,4-D, MCPA or silvex, and up to 30 ppm of 2,4,5-T. Similar effects have been found with swine, sheep, and other other animals. When grain, with a picloram residue of 5 ppm, was fed to a cow, 97.7 percent of the picloram was recovered unchanged in the urine (Fisher and others, 1965). Because the dog has a lower capacity to excrete some herbicides, it has been found that herbicides are about three times more toxic to dogs than other test animals.

   Milk from both diary and beef cows that had grazed on 2,4,5-T treated pasture or range was analyzed for TCDD residues by Mahle et al. (1977). Milk was obtained from treated farms in Missouri, Arkansas, and Oklahoma, and compared with control milk purchased in a Midland, Michigan, supermarket. The control milk would have had very little likelihood of contact with 2,4,5-T. At a detection level of one ppt, control milk was indistinguishable from milk from cows grazing on grass treated with 2,4,5-T.

   TCDD residues have been confirmed in three beef fat sample and possibly one liver sample by the EPA during Phase 1 of the Dioxin Implementation Program. Samples of beef fat and livers were obtained from animals which had grazed on lands treated with 2,4,5-T and non-treated areas. A total of 85 beef fat and 43 liver samples were collected. Approximately 25 percent of the samples were from nontreated areas.

A meeting of the analytical collaborators (Dow Chemical Company, Havard University, and Wright State University) was held on June 15, 1976, to discuss the results obtained to date. The conclusions given by the analytical collaborators were:

a. Of the beef fat samples (85) analyzed, one showed a positive TCDD level at 60 ppt; two samples appeared to have TCDD levels at 20 ppt; and five may have TCDD levels which range from 5 to 10 ppt. While several laboratories detected levels (5 to 10 ppt) in this range, the values reported were very near the sample limits of detection.

b. The analytical method is not valid below 10 ppt.

c. A neutral extraction technique shows promise of detecting levels below 10 ppt. However, this method has been demonstrated by only one laboratory at this time and has not been validated by other analytical facilities.

d. The samples analyzed were peritoneal fat and kidney fat taken from cattle which had grazed on rangelands of known treatement with 2,4,5-T. Controls were the same sample type taken from cattle from nontreated areas within the same site.

e. Of the liver samples (43) analyzed, only one sample suggested any TCDD residue, which was too close to the sensitivity of the sample detection limits for quantification. The fat sample analyzed from the same animal showed no TCDD residue. Three liver samples (for which fat samples were analyzed and showed positive data) showed no TCDD residues.

f. None of the collaborators reported TCDD in samples of beef fat taken from cattle in nontreated areas (at the sensitivity of the analytical method). Three of the laboratories receiving liver samples from cattle in nontreated areas observed no TCDD in the samples (Ross 1976).

An additional dioxin collaborator's meeting was held in Bay St. Louis, Mississippi, on March 3 and 4, 1977. Dr. Ralph Ross (1977), reporting to the EPA on that meeting, stated, "the reliability of Harvard's neutral extraction technique is very poor at the low ppt range, particularly below 13 ppt." Later he states, in regard to Harvard data, "Also, it is strange that there was no inclusion of spiked samples below 13 ppt." Ross indicates that analytical data reported by Wright State University, Dow Chemical Company, and Harvard University is more reliable for samples spiked by EPA with known levels to TCDD than data furnished by Harvard where they themselves add TCDD. The conclusions quoted in the preceding paragraphs are those of EPA or those participating in the Dioxin Implementation Program.

Work in Russia suggested that the threshold taste and odor concentractions of auxin compounds, especially of phenolic derivatives such as 2,4-D, that would prove unacceptable to the consumer were considerably below the threshold concentrations for toxic effects. No residues of either 2,4-DB or 2,4-D were found in the milk of cows that had been fed these compounds (Way 1969). Bache et al. (1964a) also noted the absence of 2,4-D residues in milk at any time during the study when a jersey cow was fed 50 ppm (based on a daily ration of 50 pounds) of 2,4-D for 4 days.

Herbicides are generally less toxic to birds than to mammals. The acute oral LD_{50} for poultry, mallards, and pheasants ranges upwards of 2,500 ppm, and is typically greater than 5,000 ppm when fed in treated feed. (Pimentel 1971)

A subtle effect of herbicide treatment on some plants is an increase in potassium nitrate to a lethal concentration. Nitrogen uptake in plants is in the nitrate form. When the metabolic process of certain plants is interrupted by drought, heat, or chemicals, the nitrates are not properly converted to non-toxic protoplasm. In plants like Canadian thistle, smartweed, and black cherry, the leaves may become toxic after an herbicide treatment. They can have adverse effects if eaten in sufficient quantities by herbivors.

Herbicide applications following label instructions approved by EPA have not proven harmful to domestic livestock. However, there have been instances where poisonings occcurred from the use of certain herbicides or contamination resulted from herbicide accidents. The herbicide most often associated with these accidents is 2,4,5-T and the dioxin that contaminates it. Reports of these instances help expose the perils of an accident, but should not be purported as examples of regulated use. These accidents involve 2,4,5-T and dioxin levels far above labeled allowances and use in the National Forests.

2. Human Health. To do their job, herbicides must be able to control target pests. By their nature, they are toxic. Therefore, some may be hazardous to people. The

hazards, however, are relative. A highly poisonous chemical may present less of a hazard than a less toxic one, depending on the conditions of use.

Proof of safety of a properly registered pesticide is not the responsibility of the user. Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as amended in 1972, EPA has the responsibility to determine whether an herbicide or any other pesticide, when used consistent with its labeled directions will perform its intended function without unreasonable adverse effects on the environment, human beings, livestock, or wildlife.

The following is a discussion of human health consideration as they relate to herbicides used by the Forest Service. The material is complex and there is not complete agreement among researchers. However, an attempt has been made to include as broad a base as possible to reflect this range of opinions. A great deal of literature is available outside this document for more details.

It should be pointed out, first, that the proposed herbicide program would use low application rates, carried out in areas of low human population, during a limited time of the year. Only a small portion of commercial forest land is treated each year. A maximum of three or four (normally, one or two) applications would be used during the life of a stand of trees. (The life of a stand of trees, its "rotation age," ranges from 85 to 140 years in this region.)

The degree of hazard or risk to humans from use of herbicides in the forest depends on two factors. One is the actual toxicity of the material itself (its toxicological potential). The second is the risk of exposure to levels that approach a hazardous dose. Human exposure to a herbicide depends on the pattern of use, frequency of application, amounts used, and fate of the herbicide in the environment. Human exposure may occur from handling concentrate before dilution, from inhalation of spray or dust during application, or from ingesting chemicals through food or water. Because the highest risks are from the concentrate and because humans handle the chemicals in this form at all stages from manufacture to application dilution, humans involved with application experience a greater risk than any other organisms.

Toxicity is a measure of how poisonous a substance is. For pesticides, acute oral toxicity is usually expressed as the "LD_{50}", or lethal dose for 50 percent of the test animals. The LD_{50} is usually given in terms of millagrams of pesticides per kilogram of body weight (mg/kg body weight). LD_{50} values are useful primarily when comparing the toxic characteristics of two or more chemicals.

Norris (1971) describes two kinds of toxicity: acute and chronic.

Acute toxicity is the fairly rapid response of organisms to a few relatively large doses of chemical administered over a short period of time. Chronic toxicity is the slow or delayed respose of organisms to the exposure of relatively long period of time. There are, of course, all gradations in between these two extremes. The kind of response (acute or chronic) we observe in an organism depends on the magnitude of the dose and the duration of the exposure which results from the behavior of the chemical.

Toxic levels of specified herbicides are usually unkown in humans, but can be projected from LD_{50} data compiled on other mammals. Selected information on herbicide toxicity was compiled by Heikes (1967) and is summarized in Table 3.

TABLE 3 - Relative Toxicity of Herbicides to People

Common Name or Designation	Some Common Trades Names	LD_{50} mg/kg	Toxicity Rating
2,4,5-T	Various	300	3
2,4-D	Various	500	4
Aspirin*		750	4
Dicamba	Banvel-D	1,040	4
Atrazine	Atrazine	3,080	4
Table salt*		3,320	4
Amitrole-T	Amitrole-T, Cytrol	5,000	4-5
Picloram	Tordon	8,200	5

*Aspirin and table salt are not used as herbicides. These household compounds are included to give the reader a reference point in studying this toxicity table.

TABLE 4 - Explanation of Toxicity Ratings

Toxicity Rating	Class	LD_{50} mg/kg	Probable Lethal Dose for 150 lb. person
1	Extremely toxic	Less than 5	A taste (less than 7 drops)
2	Very toxic	5-49	7 drops - 1 teaspoonful
3	Moderately toxic	50-499	1 teaspoonful - 1 ounce
4	Slightly toxic	500-4,999	1 ounce - 1 pint (1 lb.)
5	Nontoxic	5,000-14,999	1 pint - 1 quart
6	Nontoxic	15,000- & above	More than 1 quart

Maximum Possible Human Exposure to Auxin-Type Herbicides from Use by the Forest Service

The maximum use of herbicides in the 85 to 140-year rotation of a timber stand would be as follows:

One treatment during:

Year 1	-	Site Preparation
Year 3	-	Release
Year 4, 5 or 6	-	Release

The treatment may consist of a single auxin-type herbicide, another type of herbicide, or a combination of herbicides depending on plant species composition and the objective of the treatment.

The time between treatments would not be less than 2 years between site preparation and a first release application; not less than 1 year between the first and second release applications; not less than 85 to 140 years until the next site preparation treatment.

Herbicides may be applied by hand or backpack to individual plants for control of poisonous weeds. With treatment of individual plants, the amount of herbicide applied per acre will vary with the number of stems per acre. However, the maximum application rate probably does not exceed 1 pound per acre. Livestock will be removed from the area of treatment prior to application. Removal of livestock would be dependent upon the amount of danger presented to livestock from the wilting of poisonous plants rather than to any hazard from herbicide residues. A given section of range would be treated with no less than 15 years between treatments, and more normally with 20 years between treatments.

2,4-D is used for range rehabilitation. It may be applied aerially at the rate of 2 to 3 pounds per acre. Because a range rehabilitation program involves the removal of livestock from an area prior to application and for a period of approximately one growing season following application, the possibility of contacting 2,4-D residues is remote. Range rehabilitation programs on a given area of rangeland would occur at intervals of no less than 15 to 20 years. Most rangeland in the National Forests would never require any chemical applications at all.

In the right-of-way maintenance programs, the use of herbicides is based on the needs of the individual area but would not generally exceed one application per year on any given area.

3. Soil Organisms. The soil contains a large and varied population of bacteria, fungi, actinomyctes, algae, protozoa, insects, earthworms, and arachnids. The populations are measured in the millions. Their activity varies greatly with temperature, moisture, organic content, aeration, and soil texture. Soil organisms are beneficial to higher plants and are essential for decomposing vegetative matter and aiding the nutrient cycle.

The reaction of the soil organisms depends on the herbicide and conditions found within the soil. There is no evidence to indicate that the herbicides used, when applied at recommended rates, will have any lasting effects on soil organism populations (Bollen 1961). Analyses of herbicide treatments at Eglin Air Force Base, Florida, showed population levels of soil micro-organisms to be the same on treated areas, three years after spraying, as those found on adjacent control areas of similar soil and vegetation (Young 1974). Investigation of 2,4-D on penicillia mycelial dry weight and total nitrogen content revealed both decreases and increases, depending on pencillia investigated and the concentrations of 2,4-D used (Pandey 1975).

In another study of 2,4-D with soil microflora soil microflora enzyme systems were found to adjust, either through mutation or selection (or both), and to utilized 2,4-D as a food source. At first, the 2,4-D was slow to degrade. After 12 days the degradation accelerated with no 2,4-D detected 6 days later. Successive additions of 2,4-D were completely degraded in 1 to 4 days (Audus 1964).

Some acceleration of nitrificaton was observed in soil treated with atrazine, but the total production of nitrates did not increase. During 4 years of applying atrazine at a rate of 5.4 lb/ac, no change was found in the number of micro-organisms in the soil, regardless of the medium used for micro-organism determination (Balicka and Sobieszczanski 1969, Balicka 1969).

During 4 years of applying linuron at 5.4 lb/ac, no change was observed in the number of micro-organisms in the soil; however, linuron caused apparent changes in the composition of micro-organisms associated with roots of treated plants. Linuron did not cause any change in nitrification of the soil, but cellulose decomposition in soil was impaired. (Balicka 1969).

The herbicide picloram at levels of 100 ppm had no measurable effect on populations of bacteria and fungi found in the soil, and it did not reduce nitrification (Goring et al., 1967).

Simazine applied at 2-4 lb/ac for weed control, did not significantly affect the relative numbers of fungi and bacteria in soil or the growth of some fungi (Eno, 1962). Farmer, Benoit and Chappell (1965) noted inhibition of nitrification with simazine at concentrations of 6 ppm or greater. Other investigators observed some acceleration of nitrification in soil treated with normal application rates of simazine, but reported no increase in total production of nitrates (Balicka 1969).

4. Vegetation

a. General: Herbicides are used to elicit a certain response from the vegetation. This response is measured by the immediate reaction of target pests to the herbicidal action of the chemical used. The response is also measured in long-term composition changes produced within the vegetation. A variety of herbicides, formulations, applicaton techniques, and timing are used to achieve the desired effects.

A new plant community quickly appears following the initial loss in plant numbers after an herbicide treatment. The new community is different in size and age, and may have a greater variety of species, especially in the grass-forb community. The wildlife and bird populations show a similar change. Desirable plants, once in a subordinate position, can now move to a dominant position. The objective of vegetation management is to maintain this new plant community once it consists of plant species desirable to the resource manager.

A short-term vegetation impact of herbicide use is the immediate reduction in the number of plants on the treatment area. As vegetation metabolizes and absorbs the herbicide, the chemical make up of an individual plant species may change. Willard (1950) reported that 2,4-D altered the palatability of some plant species to animals. For example, livestock would eat Canadian thistle, velvet-leaf, jimson weeds, wild parsnip, sunflowers, round-leafed mallow, and other unpalatable weeds. The ragwort weed, highly toxic to cattle, had a marked increase in sugar content after treatment with 2,4-D. This made the plants attractive to cattle, but they were still highly toxic. Normally, livestock and wildlife will not feed on ragwort unless forced to do so.

After the treatment of weed species with sublethal concentrations (0.25 lb/ac) of 2,4-D, potassium nitrate content declined from 44 percent to 6 percent in five species, and increased from 12 percent to 47 percent in the other four species (Frank and Grigsby, 1957). The plant species were sufficiently toxic to cause nitrate poisoning in livestock, if they were consumed in large enough quantities.

Fifteen days after black cherry brush had been treated, until wet, with a 2,4,5-T concentration of 2,000 ppm, Grigsby and Ball (1952) reported hydrocyanic acid content was reduced 85 percent.

Silvex, at 2 ppm, had no adverse effect on either phytoplankton or zooplankton, which were at the base of the food chain in small test ponds (Cowell, 1965).

Very little of the herbicide which reaches the vegetation is metabolized. Rain washes much of the herbicide left on the plant surface to the forest floor. Some herbicides are passed through the plant and excreted by the roots into the soil. The remaining herbicides and breakdown products will eventually enter the soil, either in leaf fall or decomposition of dead stems and roots.

In the Elgin Air Force Base tests, a sample area, measuring 1 square mile, received a total of 345,117 pounds of herbicide between 1962 and 1970 (Young 1974). A comparison of vegetative cover and occurrence of plant species on the area between June 1971 and June 1973 indicates that areas with 0-60 percent vegetation cover in 1971, had a coverage of 15-85 percent in June 1973. The rate of change in cover seemed to depend on soil type, soil moisture, and wind. There was no evidence to indicate that the existing vegetation coverage was in any way related to herbicide residue in the soil; dicotyledonous or broadleaf plants, normally susceptible to damage from herbicide residues, occurred throughout the entire test area. In 1971, 74 dicotyledonous species were found.

Favorable effects of herbicide use can be seen in the survival and growth of preferred plants. The benefits are measured in increased food, forage, fiber, wildlife, and maintenance of existing physical structures. In other cases, the beneficial effects are shown by the removal of target plants which are poisonous to humans or animals.

Wilde (1970a, 1970b) calculated that pine plantations in Wisconsin require about 331 gallons of water to produce 2.2 pounds of merchantable wood, whereas evapotranspiration of ground vegetation consumes about 23.5 gallons of water per 2.2 pounds of oven-dry tissue. In turn, each 2.2 pounds of weed biomass in the plantations reduces wood production by 0.15 pounds throughout the years. Therefore, timber growth in plantations with a heavy cover of shrubby plants may underproduce more than 15 cords per acre over a 40-year rotation, or more than a 1/3 cord per acre per year. At current stumpage prices, pest plant control is apparently an excellent investment, and likely to be more important in the future.

In other Eastern Region growth studies, diameter growth in a 7-year-old Wisconsin red pine plantation increased 30 percent the first year after herbicide application, and 8 percent the following season. Height growth increased 13 percent the second year. When shrub competition was eliminated in another red pine plantation, growth increased by 300 percent. In Minnesota, conifer plantation studies show more seedlings were killed by competing vegetation than any other factor (Dawson and Noste, 1976).

Hardwood plantations seem to respond even more dramatically to competition control. Studies with Populus showed a 425 percent growth increase after 4 years of complete vegetation control in a plantation, compared to only clearing a 12-inch square around each tree. In investigation involving silver maple, white ash, white pine and white spruce in fertilized plots, the 3-year growth increase for complete vegetation control ranged from 750 percent for white ash to 37 percent for white spruce. These results demonstrate the benefits which can be realized from vegetation management (Dawson and Noste, 1976).

b. Endangered or Threatened Plant Species. Vegetation management under six of the seven alternatives considered would probably affect endangered or threatened plants if they were in the area being treated. The alternative with little or no effect would be the "No Action" alternative. Broadcast treatments are more likely to unintentionally damage unknown populations of such plants, than are selective treatment methods. Herbicides are no exception. The sensitivity of all plants to the various herbicides is not known. It must be assumed, however, that an herbicide application to an unknown endangered or threatened plant will have an adverse effect upon its population, but has never been known to completely eliminate any species because kill is never 100%.

The Endangered Species Act of 1973 directs the Secretary of the Interior and Secretary of Commerce to determine which species are endangered or threatened and to publish them in the Federal Register. The proposed list contains some 1,700 plants found in the United States. Forty of these plants are found in the 20-State Eastern Region. At this time, only three have been found on National Forest lands, and all in Illinois.

5. Forest Vertebrate Animals

a. General. A wide variety of wildlife species inhabit the National Forest land of the Eastern Region. The survival needs of some species, such as the Kirtland's Warbler, are very specific. Animals like the bear or skunk are adaptable to a wide range of foods, habitat conditions, and disturbances by man. Proposed herbicide applications will occur on areas occupied or visited by a significant number of these easily adapted species. The wildlife impacts of any herbicide application project depend on the wildlife species present, the herbicide used, the size of the area treated and long-term resource management objective for the treated area. Routine activities of individual wildlife species may result in contacts with treated vegetation, soil or water, or ingestion of treated food. Under forest conditions, such exposure has not proven hazardous to wildlife.

b. Mammals. A hazard could occur to mammals, if they are exposed to an acutely toxic dose of herbicide. The acute oral toxicity of a single dose of the phenoxy herbicides to mammals ranges from 100 mg/kg to 2000 mg/kg, depending upon the test animal and the particular chemical or formulation. The herbicides are absorbed after ingestion, transported via the plasma, concentrated in the kidneys, and rapidly eliminated in the urine (Cast Report 39, 1975).

Controlled feeding trials and laboratory tests have shown some herbicides to be toxic, teratogenic, carcinogenic, or mutogenic to mammals. LD_{50} rates have been established for most chemicals available to man. The dosage rates used in controlled experiments are not reached under conditions found with normal forestry herbicide applications.

An evaluation of wildlife populations, following massive field applications of herbicides at Elgin Air Force Base, showed no difference in mouse population densitities on herbicide treated areas and control areas affording comparable habitats. Mice collected on the treatment area were allowed to breed in the laboratory and there were no birth defects observed in the offspring. There were no adverse impacts on reproduction of beach mice after 30 generations were exposed to TCDD. Post-mortem examination of mice, rats, snakes, and a toad showed no damage to liver, kidney, and gonadal tissues, and no cleft palates. Observations of five fox kits born and raised in a den within the spray area found all kits to be apparently healthy and normal, even though their mother had been observed on the test area for a year. This fox family lived in the middle of the heaviest sprayed area, where back-to-back, day-to-day applications of 27 pounds of herbicide per acre were made.

One significant finding of the Elgin Air Base studies was that rodents showing no evidence of physical abnormalities after gross and microscopic examinations did show a TCDD like chemical, in fat tissue and livers. The levels of TCDD like chemical, 210-540 ppt, encountered would be suspect to teratogenic or pathologic abnormalities. However, defects were not found in either the animals tested or the progeny of those that were pregnant.

Cottontail rabbits, given a choice of either 2,4,5-T treated vegetation or untreated vegetation ate almost none of the treated vegetation (Springer 1957). Deer allowed to browse 2,4-D and 2,4,5-T areas sprayed to improve deer browse showed no preference for either untreated or herbicide stimulated branch growth (Krafting and Hansen, 1963). Test animals are often repelled by herbicide residue on their natural foods. When only limited areas are treated, as proposed in the Eastern Region, very few animals will be forced to feed solely on food contaminated with herbicide.

Newton and Norris (1968) found that deer exposed to feed treated with maximum field applications of 2,4-D, 2,4,5-T, and atrazine did not accumulate significant amounts of herbicide. Forty-three days after exposure, the muscle tissue of the deer showed residue of 2,4-D and 2,4,5-T at less than 0.006 ppm. Atrazine levels could not be detected after 44 days. This study, the U.S. Department of Health, Education,and Welfare's Food Basket studies of meat, fish, and poultry, and EPA supported beef fat monitoring programs all point out that herbicides proposed for registered use in the Eastern forests do not contaminate meat used for human consumption.

A more subtle and long-term impact of vegetation management is its effect on wildlife habitat. Vegetation management by herbicides is no exception. It affects the vegetative layering of the treated area and the species of plants making up the replacement community. Because many wildlife species habitat needs are very specific, some animals will be adversely affected while others will benefit. Westing (1971) found that as the vegetation replacement community becomes established, the original set of animal populations will be replaced largely by a different set with lesser diversity. The replacement animals will have higher numbers with fewer species, many of them new to the sprayed area.

The greater the number of plant species controlled at any herbicide site, the greater the impact on wildlife habitat. The method of herbicide application, broadcast or selective, also influences this impact. Herbicide use generally sets vegetation succession back to an earlier stage. Small mammals, with limited home ranges or very narrow habitat tolerances, will be most affected by the thoroughness of individual herbicide treatments. Large mammals like the moose, deer, or bear benefit the most, as food availability and food nutrition are improved within their home range. Even small treatments that remove all mast producing hardwoods will have an adverse effect on squirrels and other mammals depending heavily on mast for food.

A 19-year study of selective vegetative management in Pennsylvania showed a diversity of food plants, useful to wildlife, developed on the sample right-of-way following spraying. These plants included common herbs of the Forest, as well as invaders usable as food by many animals. Woody plants were found interspersed throughout the treated area. The taller, woody plants were found to supply food throughout the year and were of particular value as emergency food when deep snow covered the ground. The right-of-way was used heavily by such common wildlife species as white-tailed deer, rabbit, grouse, and wild turkey. A special study was made of the white-tailed deer on the right-of-way and showed consistent and heavy use in all seasons. This indicated that attractive food and cover had been developed (Bramble and Byrnes, 1972).

Herbicides are the most effective vegetative control method currently available for use. However, most vegetation species are only controlled for a period of time, and then return shortly to the treated site unless controlled periodically by man or suppressed by host plants. Wildlife biologists have long known this, and manipulate vegetaton diversity and manatain wildlife openings with herbicides to benefit a variety of animals.

The activities of man and equipment during herbicide applications will disturb wildlife. Large animals will be able to leave the site temporarily, while small mammals will head for cover or go underground. This disturbance can have a serious impact if it occurs during mating or at the time of birth. Adverse impacts on wildlife, following herbicide applications in the forest, have been found to be local in nature and to cause fluctuations in animal population. This occurs because of changes in specific ecological niches, and not because of toxic harm to the wildlife.

c. Birds. Herbicides have been found to be generally less toxic to birds than mammals. The acute oral LD_{50} for the most common forms of game birds found in the Eastern Region have ranged from 300 mg/kg to greater than 5000 mg/kg. The LC_{50} for these birds which were fed with herbicide treated feed is typically greater than 5,000 ppm. Under field conditions, a bird would have to consume daily all the herbicide applied aerially to approximately 10 acres to duplicate the 5,000 ppm fed under controlled trials.

Herbicide treated feeds, at rates lower than the LD_{50} or LC_{50} have affected the reproduction of test birds. Feeding trials found that 2,4-D, when fed at daily rates of 1,250 ppm and 2,500 ppm, depressed mallard duck reproduction. Mallard ducks which were fed 2,500 ppm and 5,000 ppm of silvex daily showed a nearly 100 percent reduction in reproduction (USDI, 1970a). Both amitrole and dalapon depressed mallard duck reproduction levels 25 percent less than those which produced mortality (USDI, 1962).

Bramble and Brynes (1972) found wild turkeys used right-of-way areas which had been treated with 2,4-D and 2,4,5-T. The young turkeys were attracted to the openings to feed on the various insects which were more abundant on the grassy right-of-way than within the wooded areas. Ruffed grouse numbers also increased. The grouse were found on the edges, within 150-200 feet of the right-of-way, rather than on the right-of-way itself. This emphasizes the importance of using herbicides to create an edge effect.

Aqueous solutions of 2,4-D, picloram and 2,4-D, and 2,4,5-T, equivalent to 10 times recommended field concentrations, were sprayed on fertile pheasant eggs preceding incubation. None of the treatments were found to have any adverse effects on hatching success, or increase the incidence of malformed embryos or subsequent chick mortality when compared to water-sprayed control eggs. Herbicide contamination was found to facilitate weight gain of roosters from 0-4 weeks of age, while hens failed to show a response. Residue analysis verified herbicide deposition on the shell and entry into the egg (Sommers and others 1974).

Insect feeding woodpeckers and tree cavity nesting birds benefit from herbicide projects which leave dead trees standing in the forest. These standing cull trees can have many long term benefits to a variety of birds.

d. Fish and Amphibians. The toxicity of herbicides to fish is highly variable, and affected by chemical formulation, water pH, temperature, water hardness, oxygen content, suspended organic matter, and dilution rate. The lakes, ponds and rivers of the Eastern Region contain an abundance and variety of both warm and cold water fish. These fish are important as a sports fishery and contribute to the commercial fisheries of the Region. The harvesting of frogs is popular in the Ozarks and Midlands.

For the phenoxy herbicides, the LC_{50} values range from less than 1 ppm to more than 1,000 ppm in water (one pound of herbicide active ingredient on an acre-foot of water is equivalent to 0.370 ppm). These values are equivalent to treatments of 10-10,000 pounds of phenoxy herbicide per acre in a pond 4 feet deep; much higher than the 2-3 pounds of herbicide active ingredient allowed for aerial application over land by most label use directions. Those phenoxy herbicides registered for aquatic weed control are used at rates designed to keep water residues below the 0.1 ppm level (CAST Report 39, 1975).

Schultz and Harman (1974) investigated the effects on fish when 2,4-D was applied directly to water. Rates used were 2, 4, and 8 lbs per acre. Only 7 percent of the fish, analyzed 28 days or more after treatment, contained detectable 2,4-D residues; and, only 1 percent (one fish) of those analyzed 56 days or more after treatment contained detectable residues. If tolerance levels are based on the level of the parent compound only, it would appear that fish could be consumed 1 month after treatment. They also found little danger of bio-magnification of 2,4-D in the aquatic food chain. It was noted, however, that when fish were exposed to radiated 2,4-D, radioactive compounds were present in all fish tissues examined. Degraded 2,4-D products were also evident for as long as 84 days after some treatments. Therefore, the identity and potential toxicity of these degraded products must not be overlooked. However, EPA requires the herbicide registrant to provide this data as well. In general, the degraded herbicide is less toxic then the prevent herbicides.

The ester formulations of phenoxy herbicides are often more toxic to fish than amine or metalic salt formulations. This is probably due to the more effective penetration ability of esters.

A review of Ecological Effects of Pesticides on Non-Target Species found that chemicals can give an off-taste or even toxicity to fish consumed by humans. At some concentrations, herbicides will cause liver degeneration, testicular degenerative lesions, and abnormal spermatozoa in fish; the most sensitive fish, exposure, herbicide combination listed was: bluegills exposed for 48 hours to 0.50 ppm of 2,4,5-T acid. There seems to be a considerable margin of safety, considering the herbicide contamination concentrations found after forest herbicide treatments.

The algacide copper sulfate, used for aquatic weed control, has been found to have a small margin of safety for fish. Trout, the most sensitive, tolerated only 0.14 ppm, while smallmouth bass, the least sensitive, could tolerate a dosage of 2.0 ppm. However, the algacide endothal has been found to have a wide margin of safety for fish when used at rates recommended on the label (Pimentel, 1971).

The effects of herbicide use on amphibians have not been widely investigated. The major impacts would possibly be on frog egg and tadpole development.

Endangered and Threatened Animal Species. The Forest Service does not have direct authority for management of endangered and threatened animal species. The agency's major contribution to preserving any wildlife species on official State or Federal lists is through critical habitat management.

The U.S. Department of Interior, in consultation with the States, is charged under the 1973 Endangered Species Act with completing and maintaining official lists of wildlife species that are classified as endangered or threatened. The Forest Service will adopt these official lists and may expand on an individual Forest basis as a means of protecting unique wildlife species. Each proposed herbicide project will be analyzed for its direct impact on any threatened or endangered animal species for any habitat loss or modification that might occur.

6. Forest Invertebrate Animals

a. General. The number of invertebrates per acre in a forest environment can only be estimated, and would be listed in the millions. The Forest Service is interested in the impact of herbicide use on invertebrates, because these animals are an intricate part of a forest community. Invertebrates are also important because they are food for the vertebrates; thus, they can be an early indicator to potentially dangerous food chain build-ups.

b. Insects. Several studies have been made of how herbicides affect insects. Most of the studies to the aquatic or soil life stages of the insect, and not to the adult stage. No significant hazard to insects is expected as a result of acute toxicity from proposed herbicide use at EPA regulated application rates.

The following species of bottom-dwelling organisms were reduced by 50 percent or more, after an application of 2,4-D ranging from 1 ppm to 4 ppm: mayfly nymphs, horsefly nymphs, common midges, phantom midges, biting midges, caddice fly larvae, and water beetles. Simazine, at 0.5 ppm to 10 ppm, produced similar results, as did atrazine at 0.5 ppm to 2 ppm. Water monitoring samples taken from potholes immediately following a 1971 spray project in the Lake States showed a concentration of .050 ppm of 2,4-D. Mosquito larve, in water treated with 2,4-D at a rate of 100 ppm, showed 60 percent fewer larvae than in the control reached the pupal state (Smith and Isom, 1967). This study added further evidence that 2,4-D is relatively non-toxic to some invertebrate species.

Honey bees have responded in different ways to 2,4-D exposure. In one investigation, honey bees decreased by 22 percent, following a 3 lb/ac 2,4-D treatment in fields they were using. However, dusting bees with 2,4-D did not cause any mortality (Palmer-Jones, 1964). It is not known if the toxicity observed in the field was due to 2,4-D dissolved in the nectar or to the production of a toxic metabolite secreted by the plant into the nectar.

The insects in the Elgin Air Force Base herbicide test grid were sampled in 1971, following completion of spray activities, and again in 1973. A much greater number of small to minute insects were taken in the 1973 survey. The two studies showed similarities in the insects distribution pattern at it related to the vegetation, number of insect species, and insect diversity. Generally, the 1973 study showed a reduction of the extremes found in these parameters during the 1971 study, possibly due to insect succession following vegetation succession.

Chansler and Pierce (1966) reported that cacodylic acid injected at a rate of 1 to 2 ml per injection at 2-inch intervals around the trunk of trees killed bark beetles. The trees were injected with the herbicide soon after the beetles had attacked the tree and before most of the eggs had hatched. The beetles died before constructing their egg galleries. Some of the eggs failed to hatch, and a high brood mortality occurred. Excessive moisture in the phloem, following herbicide injection, has been found to cause severe brood reduction. Cacodylic acid has been screened as a insecticide. It has exhibited no insecticidal properties when applied as a contact spray to insects.

Benefits to some insects, especially honey bees, increase as plant succession is changed to conditions favoring flowering forbs. Other investigations show insect populations can increase following herbicide treatment due to the increase in organic matter which results from the decay of controlled plants.

c. Crustaceans and Mollusks. Detectable residues of herbicides do not appear in surface waters, unless the chemicals are directly added to the water, or fall there incidental to spraying forest vegetation, or are added to control aquatic vegetation. Detectable herbicide residues are not expected to be found in the silt of forest waters either. When herbicide residues have been found in silt outside the forest area, it has been attributed to wind blown erosion from bare soil treated with herbicides. With the forest conditions present and precautions taken, in the Eastern Region, crustaceans and mollusks in or near the National Forests are not expected to be exposed to any residue from a herbicide project.

Should an accident occur during treatment or metrological conditions cause contamination of forest water, the concentration in the water would be expected to fall below detectable levels in a few days. Such residues are diluted through stream flow, decomposed by sunlight, or destroyed by micro-organisms.

Oysters, crabs, mussels, and a wide variety of other crustaceans and mollusks are not directly affected by the phenoxy herbicides at rates approved for direct application to water. Since 1971, concentrations of from 0-16 ppb of 2,4-D have been found during actual forest water sampling in the Eastern Region; however, this is much less than herbicide concentrations approved for direct water application.

Tests with dicamba in a model aquatic ecosystem, clearly show that dicamba or its metabolites did not accumulate in the clams, crabs, or snails examined (Sanborn, 1974).

Bulter (1963) found exposure of oysters to 2.0 ppm of 2,4,5-T for 96 hours had no effect on shell growth. Brown shrimp exposed to 1.0 ppm of 2,4,5-T for 48 hours showed no harmful effects. Similar tests using silvex did, however, show some growth loss and mortality or paralysis.

C. SOCIAL ECONOMIC COMPONENTS

The fact that herbicides are widely used on private rangelands and pasture, on private forests, for a variety of utility and highway right-of-way needs, on home lawns, and on food crops is ample evidence that they are efficient and inexpensive when compared to available alternatives. Herbicides have not been found to have serious unintentional side effects when used under forest conditions following approved use directions. Where vegetation control is needed, herbicides usually have less harmful side effects on the environment than alternative control methods.

Favorable effects of herbicide use are production and protection oriented, and improved economic welfare and community stability are the results. Public and private forest benefits are measured by increased timber volume and value, increased forage for domestic livestock, improved wildlife habitat, increased recreational opportunities, and reduced cost of facility maintenance.

Such forest resources as timber, forage, wildlife, and recreation are all renewable resources. They are also raw materials or basic materials for use in later manufacturing processes. Forest products are at the beginning of the commodity production process; money paid for them tends to stay in the local area, more so than dollars spent in communities based on secondary or later stages of manufacture.

The number of people needed for primary resource production, however, is not as great as the number of people required for the secondary manufacturing processes.

Hunting, fishing, and recreation opportunities bring income into National Forest areas. This income is from the purchase of goods and services. An increase in forest visitors can be accommodated without requiring a corresponding increase in community expenditures for local government, schools, sanitation, etc., that new permanent residents require. Counties in which National Forests are located receive a share of National Forest receipts, and may receive additional payment in lieu of property taxes. The amount of the National Forest receipts shared by the counties in the Eastern Region for Fiscal Year 1975 was $2,946,500.

Aerial herbicide applications are the least labor intensive of the herbicide application methods used. Ground methods of application, especially cut surface and basal stem methods, employ more people. A reduction in the use of herbicides and a move to more manual vegetation control would provide longer or increased employment needs for laborers, (if available and assuming they would work at such tasks) resulting in a favorable short-term economic impact on the local communities. A long-term adverse local employment and economic effect would occur with the reduction in usable resources and future availability. Nationally this would result in an increased cost to the taxpayer. Consumers would feel little impact under the assumption of constant total output. If a constant total output was not maintained, however, a strong increase in consumer price would occur with only a small decrease in output.

D. HERBICIDE TOXICITY

1. 2,4,5-T

In the following dicussion, the toxicity of 2,4,5-T will be discussed first, followed by a separate discussion on the toxicity of TCDD. In these discussions of toxicity, as in subsequent discussions the carcinogenic, mutagenic, embryo-toxic, and teratogenic potential of

2,4,5-T, many laboratory studies will be cited. These studies are useful in indicating that a compound may have the potential for biological activity when administered at high dosages or for prolonged periods. The important consideration is whether or not such potential would be realized under field conditions; whether the necessary dosage level and/or period of exposure would be achieved under forest or rangeland applications.

Acute Toxicity

LD_{50} (lethal dose of 50 percent of the test animals) values for 2,4,5-T are given in Table 5.

TABLE 5 - Toxicological Information on 2,4,5-T (Harvey 1975)

Animal	LD_{50} mg/kg Body Weight
Mouse	389
Rat	500
Guinea pig	381
Dog	+ 100

Rowe and Hymas (1954) have published a more extensive table of of LD_{50} values for various species exposed to different formulations of the phenoxy herbicides (see Table 6). They conclude that the LD_{50} values for 2,4,-D and 2,4,5-T and their common derivatives are the range of 300 to 1,000 mg/kg for the rat, mouse, guinea pig and rabbit..." In this study, dogs wre found to be "somewhat more susceptible" and chicks more tolerant than the species designated above.

Norris (1976a) has reported acute toxicity values Table 7 in general agreement with those of Rowe and Hymas (1954). Norris concludes that "the non-effect or threshold level for an acute toxic response, however, is unlikely to occur in the forest environment." The following section (Fate of 2,4,5-T in the Environment) will discuss the probability of human exposure to a toxic dose of 2,4,5-T resulting from application in a forest environment.

Additional information on the toxicity of 2,4,5-T comes from experimental studies on humans and reports from residents living near sprayed areas.

Five human volunteers ingested a single 5 mg/kg dose of 2,4,5-T. At this dosage rate, which far excess the amount a single person would be likely to encounter in a forest environment, all of the 2,4,5-T was absorbed into the body and excreted unchanged via the urine. Subjects did not present any detectable clinical effects (Gehring et al. 1973).

TABLE 6 - Summary of Acute Oral Toxicity of Various Basic Herbicidal Materials

Material	Species	Sex	Vehicle	LD_{50}	(19/20 confidence limits) (mg./kg.)
2,4-D (2,4-Dichlorophenoxyacetic acid)	Rats	M	Olive oil	375	(302-465)
	Mice	M	Olive oil	368	(312-434)
	Guinea pigs	M and F	Olive oil	460	(397-553)
	Chicks	M and F	Olive oil	341	(358-517)
	Dogs (4)		Capsule	100	Range (25-250)
2,4-D, alkanolamine salts	Chicks (3)		Water (dosage on acid equivalent basis)	--	Range (380-763)
2,4-D sodium salt	Rats	F	Water	805	(610-1,063)
	Rats		Water	666	--
	Guinea pigs	M	Water	351	(417-727)
	Guinea pigs (2)		Water	1,000	--
	Mice (2)		Water	375	--
	Rabbits (2)		Water	800	--
2,4-D, isopropyl ester	Rats	M and F	Olive oil	700	(569-861)
	Guinea pigs	M	Olive oil	350	(451-671)
	Mice	M	Olive oil	341	(398-736)
	Chicks	M and F	Olive oil	1,420	(1,127-1,789)
2,4-D, mixed butyl esters	Rats	F	Corn oil	620	(320-974)
	Guinea pigs	F	Corn oil	848	(604-1,190)
	Rabbits	F	Corn oil	424	(252-712)

Table 6 continued on next page

Table 6 - Continued

					Range
	Mice	F	Corn oil	713	(500-1,000)
	Chicks	M and F	Undiluted	2,000	(1,950-2,960)
2,4-D, mono-, di, tripropylene glycol butyl ether esters	Rats	F	Corn oil	570	(310-640)
2,4,5-T (2,4,5-Trichlorophenoxyacetic acid	Rats	M	Olive oil	500	(391-640)
	Mice	M	Olive oil	389	(243-619)
	Guinea pigs	M and F	Olive oil	381	(307-472)
	Chicks	M and F	Olive oil	310	(211-456)
					Range
	Dogs (4)		Capsule	100	(50-250)
2,4,5-T isopropyl ester	Rats	M and F	Olive oil	495	(420-584)
	Guinea pigs	F	Olive oil	449	(362-557)
	Mice	F	Olive oil	551	(380-799)
2,4,5-T mixed butyl esters	Rat	F	Corn oil	481	(313-739)
					Range
	Rabbit	M	Corn oil	712	(500-1,000)
	Mice	F	Corn oil	940	(674-1,312)
					Range
	Guinea pigs	F	Corn oil	750	(500-1,000)
					Range
2,4,5-T, mixed amyl esters	Rats	F	Olive oil	750	(500-1,000)
					Range
MCP (4-chloro-o-toloxyacetic acid or 2-Methyl-4-chlorophenoxyacetic acid)	Rat	M	Corn oil	700	(500-1,000)
					Range
MCP, amine salt	Rat	M	Water	1,200	(1,000-2,000)
					Range
	Guinea pigs	M	Water	1,200	(630-2,000)
Silvex (2 2,4,5-trichlorophenoxy propionic acid)	Rat	M and F	Corn oil	630	(560-760)
					Range
Silvex, mixed butyl esters	Rat	F	Corn oil	600	(250-1,000)
					Range
	Rabbits	F	Undiluted	750	(500-1,000)
	Chicks	M and F	Corn oil	1,190	(707-2,000)
Silvex, mono-, di, tripropylene glycol butyl ether esters	Rat	F	Corn oil	621	(473-814)
					Range
	Guinea pigs	M	Corn oil	1,250	(300-2,000)
					Range
	Mice	F	Corn oil	1,410	(1,000-2,000)
	Chicks	M and F	Corn oil	1,190	(647-1,670)
	Rabbits	F	Undiluted	819	(610-1,979)

From: Rowe, V. K., and T. A. Hymas, 1954, Summary of Toxicological Information on 2,4-D and 2,4,5-T Type Herbicides and Evaluation of the Hazards to Livestock and Associated with their Use, J. Am. Vet. Res. 15:622-629.

In a similar study, Kohli et al. (1974) reported on absorption and excretion of 2,4,5-T in people. Of eight male volunteers, one volunteer took 2 mg/kg, another 3 mg/kg, and the remaining six volunteers took 5 mg/kg 2,4,5-T. The authors found that "2,4,5-T is readily absorbed from the gastrointestinal tract and eliminated unchanged from the body mainly via the kidneys." The authors reviewed data from other studies on the metabolism of 2,4,5-T in other animal species. They conclude:

> In general the pattern of metabolism of 2,4,5-T in man seems to be similar to the various animal species that have been studied. The comparison of pharmacokinetics indicates that man falls in between rat and dog... It will be therefore justified to speculate that 2,4,5-T will have a low toxicity in man. As suggested by the quick turn-over of the compound in man it would seem that accumulation in the system would be unlikely. Based on the kinetics of single dose administration, Gehring et al. (1974) have calculated the likely plasma concentration to result on repeated exposure to 2,4,5-T and have concluded that plasma concentrations will reach a plateau after 3 days. Fear of cumulative toxicity may therefore be remote.

Shoecraft (1971) reports that, after repeated spraying of forest lands near Globe, Arizona with 2,4-D, 2,4,5-T, and silvex, humans suffered from swelling of eyes, arms, legs, parts of the skin turning dark and purple, loss of hair and eyelashes, problems with vision, inability to talk or swallow, back pain, nose bleeds, inability to walk without limping, rashes, nausea, and muscle spasms. Investigations of the incident by a team representing various professions concluded that neither the incidence nor type of human illnesses in Globe were different from what would be normally expected in other similar communities (Tschirley 1970). Therefore, it is questionable that herbicides "cause" the illnesses.

An anonymous "Herbicide Spray - Fact Sheet" references Acres U.S.A., February 1975, as reporting: "The Women's Center Committee on the Environment, Fayetteville, Arkansas, reported that in Arkansas, a field was sprayed with 2,4,5-T above a spring supplying 20 people; six out of eight babies conceived there miscarried, one severely deformed with a cleft head and no legs." No documentation or verification of this report is presented from scientific literature.

C.A.T.S. (Citizens Against Toxic Sprays, Inc.) (1976) associated spring herbicidal sprays and the use of 2,4-D, 2,4,5-T, and silvex with lung ailments in forest valley residents and unusual uterine bleeding, gynecological problems, higher incidences of spontaneous abortions, and birth defects in offspring. No documentation or verification of this report is presented from scientific literature.

Chronic Toxicity

Chronic toxicity data for 2,4,5-T is given by Norris (1976a) (Table 8). The values reported to cause chronic toxicity are far above those likely to be encountered in a forest environment (see following section on the Fate of 2,4,5-T in the Environment).

Additional data on chronic exposure comes from examining data on occupationally exposed herbicide workers. Pesticide applicators are routinely exposed to 2,4,5-T through their occupation. One study showed a significant increase in chromosomal breaks when workers were exposed to herbicides. Between herbicide application seasons, the incidence of chromosomal breaks was significantly lower than the incidence in an unexposed population. This data does not seem to suggest an overall adverse effect, but may imply that a repair mechanism can compensate for previous exposure (Yoder et al 1973). 2,4,5-T was the least frequently used agent and it is not likely that any observed effect could be attributed to it. In another study, Swedish railroad workers exposed to the phenoxy herbicides 2,4-D and 2,4,5-T had a normal incidence of tumors and mortality (Axelson and Sundall 1974).

TABLE 7 - Acute Toxicity of Herbicides[1]

Organism	2,4-D	2,4,5-T	Amitrole	Picloram
Birds:				
LD_{50}, mg/kg	360-2,000	300	2,000+	2,000+
No effect, ppm[2]	720[3]	600[3]	2,000+[3]	1,000
Rodents:				
LD_{50}, mg/kg	375-800	400-950	5,000+	2,000+
No effect, ppm[2]	1,500	800[3]	2,000+[3]	3,000
Ruminants:				
LD_{50}, mg/kg	400-500	500-1,000	------	2,000
No effect, ppm[2]	2,400[3]	1,200[3]	------	2,000[3]
Other mammals:				
LD_{50}, mg/kg	100	100	1,200+	-------
No effect, ppm[2]	500	200[3]	2,000+[3]	-------
Fish:				
TL_m, ppm[4]	1-60	1-30	325	13-90
No effect, ppm[5]	0.1[6]	0.1[6]	32[6]	1.0[6]
Other Aquatics:				
TL_m, ppm[4]	1-5	0.5-50	20	1+
No effect, ppm[5]	0.1[6]	0.05[6]	2 [6]	0.1[6]

[1]A list of references for specific values in this table is available from the author.

[2]Concentration in diet for a limited exposure which causes no acute effect.

[3]Assumes daily food consumption is 10 percent of body weight and that 20 percent of LD_{50} in daily diet has no acute effect.

[4]48-hour median tolerance limit, i.e., the concentration of herbicide in the water which will kill 50 percent of an exposed population of aquatic organisms in 48 hours.

[5]Concentration in water which has no acute effect following 48 hours' exposure.

[6]Assumes 10 percent of TL_m has no effect.

From: Norris, 1976a.

TABLE 8 - Chronic Toxicity of Herbicides[1]

Herbicides and organism	Dose	Equivalent concentration in diet[2]	Duration	Effect
	mg/kg	ppm	days	
2,4-D:				
Mule deer	240	2,400	30	Slight
Cattle	50	500	112	None
Sheep	100	1,000	481	None
2,4,5-T:				
Dog	10	100	90	None
Cattle	125	1,250	15	None
Sheep	100	1,000	481	None
Amitrole:				
Rat	--	50[3]	476	None
Rat	--	100[3]	730	Thyroid adenomas & adenocarcinoma
Rat	--	500[3]	119 followed by 14 days no amitrole	Normal thyroid
Picloram:				
Sheep	110	1,100	30	None
Dog	150	1,500	730	None
Rat	--	1,000[3]	90	None
Quail	--	500[3]	3 generations	None

[1] A list of references for specific values in this table is available from the author.

[2] Assumes food intake is 10 percent of body weight per day.

[3] Actual concentration tested.

From: Norris, 1976a.

Effects of 2,4,5-T Upon Reproductive Functions

All chemicals are presumed to cause toxic effects upon the developing embryo if they do not cause the death of the mother first. Chemicals can become available to the embryo in spite of the mother's excretion and metabolism capabilities. The embryos would have to be susceptible to the chemical, that is, in a stage where the chemical could produce embryotoxicity.

Embryotoxicity is a generalized term covering manifestations such as lethality, growth retardation, and teratogenicity. Different chemicals may cause either fetal death or teratogenic effects, or both effects may be found depending on the size or the timing of the dose. Teratogens must be present during the formation of the structures that the particular chemical affects. The mother must be exposed to a particular dose at a very precise time in her pregnancy to produce a teratogenic effect.

The teratogenic potential of 2,4,5-T has received wide publicity since 1969 when one company reported it as a teratogen. Allegations were made that its use as a military defoliant had caused fetal malformations in the Vietnamese population. The herbicide used by Bionetics Research Laboratories, Inc., was contaminated to a high degree (about 30 ppm) with TCDD. Some studies confirmed the teratogenicity of 2,4,5-T, but the implication of the herbicide in any increase in birth defects in humans has not been supported.

Levels necessary to produce a teratogenic effect would not be expected as a result of the proposed Forest Service treatment projects. Neither a sufficient dose nor a sufficiently long exposure period could be achieved when 2,4,5-T is used as registered by EPA. The possibility of exposure to a hazardous dose will be discussed in following sections.

Carcinogenic and Mutagenic Potential of 2,4,5-T and TCDD

Dost (1977) has summarized the relationship between carcinogenicity and mutagenicity:

> Probably the most important issue about any chemical introduced into the environment by human activity is the possibility that it may increase the incidence of cancer in the human population. The probability of mutagenic activity is of almost equivalent concern, both because of the possibility of genetic alteration and because mutagenesis may be a

useful predictor of carcinogenic activity. The relationship is by no means constant. However, McCann et al. (1975) have assembled data from a number of laboratories using microbial systems ("Ames test") and find that 85% of known carcinogens are positive, 10% of non-carcinogens are active.

Two previously cited studies (see Chronic Toxicity of 2,4,5-T) have not found either tumors or chromosomal aberrations in herbicide applicators that could be related to 2,4,5-T. There is no evidence that 2,4,5-T or TCDD is mutagenic in 2,4,5-T production workers.

Pesticide and Toxic Chemical News (July 13, 1977) reports yet unpublished research by Van Miller, Lalich, and Allen. The report indicates that TCDD produced neoplasms in rats fed 5, 50, and 500 ppt TCDD and at 1 and 5 ppb (mistakenly reported as 5 ppt) TCDD.

Kociba et al. (1977 has also reported on a yet unpublished feeding study. Dow's studies indicate that neoplasms were produced when TCDD was fed to rats at the rate of 2,200 ppt, but not at 210 or 22 ppt. Dow reports:

> Dow's findings of neoplasms at 2,200 ppt support the University of Wisconsin report of neoplasms at 5,000 ppt, but the absence of neoplastic response at 210 and 22 ppt appear to contradict the University of Wisconsin report of neoplasms at levels as low as 5 ppt.

One study suggests that TCDD may be a promoter of neoplastic activity at levels greater than 1 ppt. At 1 ppt there were no tumors. Further analysis is required to determine the carcinogenic potential of 2,4,5-T.

The current effect level of 80 to 200 ppt TCDD in beef fat set by EPA is based on demonstration of noncarcinogenicity.

Jensen and Renberg, 1976, have evaluated the cytogenic effects of 2,4,5-T and 2,4-D by means of induced micronuclei in erythrocytes of bone marrow. Additional chemical analyses of the test substances reaching the target cells was also performed. The data did not present reliable indication of lack of mutagenic action, but did indicate that the compounds do not seem to enter the cells to any appreciable extent. The authors concluded that, "From the point of view of risk estimation this lack of penetration of the cells and the rapid excretion in mammals do not point to any cytogentic hazard being connected with these herbicides."

Human Exposure to 2,4,5,-T

The hazard 2,4,5-T and 2,4,5-TP presents to humans (in light of the foregoing data) depends on a person being exposed to a hazardous dose of two factors: (1) The pattern of use of the chemical, and (2) Its fate in the environment.

Fate of 2,4,5-T in the Environment

The application of 2,4,5-T results in spray residues in or on vegetation, the forest floor, water, and air. Additionally, smaller amounts of 2,4,5-T may enter the soil or water as spray drift or as residues washed by rain from foliage. Once an application has been made, 2,4,5-T and its contaminant TCDD follow different pathways in the environment.

Vegetation

2,4,5-T deposits on vegetation can only result from direct application or drift. 2,4,5-T can be absorbed by plants (Norris and Freed 1966a, 1966b; Hurtt et al. 1970; Morton et al. 1967). Only 10 to 30 percent of the applied dose of 2,4,5-T and 2,4-D is actually absorbed into the foliage of big leaf maple. Of the material absorbed, only five percent or less is actually translocated from the absorbing organ to other parts of the plant. This accounts for the ability of big leaf maple to resprout from the roots after herbicide application (Norris and Freed 1966a, 1966b). Any absorbed 2,4,5-T not translocated would be subject to degradation either while the leaf remains on the plant or after it has fallen to the forest floor. Some of the material not absorbed by the plant would be washed from the leaf surface by rain.

Norris (1976a) has discussed behavior and impact of 2,4,5-T in the forest. Data from Norris (1976a) are given in Tables 9 and 10. The tables indicate that high levels of 2,4,5-T would not persist on a variety of Forest plants or forage grasses. Norris points out:

> The resprouting of lush, succulent vegetation on many spray areas within a year after application is evidence of this fact. Residues of more than a few parts per million of herbicide would produce visible damage symptoms and/or prevent such resprouting. We conclude, therefore, that residues of this magnitude do not occur in this vegetation.

Norris et al. (1977) examined samples of blackberries, vine maple, Douglas-fir, grass, forest floor, and soil "for 2,4,5-T immediately after and 1, 3, 6, and 12 months after aerial application of 2,4,5-T isooctyl ester at 2 lb/A. This sampling regime was repeated after a second application 12 months later." the authors found:

> Initial concentrations of 2,4,5-T varied among plant species from 11 ppmw in vine maple to 115 ppmw in grass. After 1 month, concentrations

ranged from 0.5 to 11 ppmw; and after 1 year, maximum residues were less than 0.5 ppmw. Residues in understory vegetation were higher after the second application probably because of the reduction in overstory vegetation after the first application. Herbicide residues were not detected in samples collected 1 year later.

Comparison of the values given in this reference with those previously cited for acute and chronic toxicity indicate that there would be little or no chance of being exposed to a health hazard from treated vegetation.

TABLE 9 - Residues of Herbicide[1/] in Forage Grass.

Time of Treatment (weeks)	Herbicide Residue 2,4,5-T[2/]
	...............ppm............
0	100
1	60
2	30
4	15
8	6
16	2
52	

[1/]Rate of appplication - 1 lb/acre (1.12 kg/ha).

[2/]Date from Figure 4 of Morton et al., 1967. From Norris, 1976a.

TABLE 10 - Residues of 2,4,5-T in Forest Vegetation[1/][2/]

Specimen	Months after application					
	0	1	3	6	12	24
	................ppm...............					
Vine maple (*Acer circinatum*)	11	0.5	0.30	0.20	0.50	0.20
Douglas-fir (*Pseudotsuga menziesii*)	44	11.0	0.30	0.50	0.20	0.[3/]
Blackberries (*Rubus* sp.)	55	0.6	0.05	0.02	0.02	0.
Grass (Various species)	114	3.3	0.60	0.10	0.10	0.

[1/]Norris et al., 1975.

[2/]2 lb/acre (2.24 kg/ha) as isooctyl ester applied by helicopter in April.

[3/]0 means less tha 0.01 ppmw. From Norris, 1976a.

Soil - The forest floor is a major receptor of herbicide residues. Residues may result from aerial or ground application of herbicides and from the fall of foliage containing residues (Norris 1967). Herbicides in the forest floor follow four pathways (Norris 1967a): (1) Volatilize and re-enter the air; (2) be adsorbed on soil, mineral, or organic matter; (3) be leached through the soil profile by water; or (4) be degraded by chemical or biological merans. Norris (1967a) reports that phenoxy esters appear to be rapidly hydrolized to nonvolatile forms.

Adsorbed herbicides are not biologically available, although small amounts may become available through adsorption. Norris (1967a) describes the process of adsorption and leaching:

> Adsorption and leaching are processes which work in opposition to one another. Adsorbed molecules are not available for leaching, but adsorption is not permanent, except for pyridydilium derived type herbicides (diquate and paraquate). The amount of herbicide which is adsorbed is in equilibrium with the amount of herbicide in the soil solution. As the concentration of herbicide in the soil solution decreases, more pesticide will be released from adsorption sites....
>
> Leaching is a slow process capable of moving pesticides only short distances (Harris 1967, 1969)... Herbicides are generally more mobile in soil than insecticides, because several are more polar, but mobility is relative, and even the movement of herbicides is measured in terms of only inches or a few feet.

In leaching tests, Wiese and Davis (1964) found that 2,4,5-T bound in soil remained in the upper 6 inches of test columns even after the application of 4.5 inches of water. It is unlikely leaching will significantly reduce the amount of herbicide in the forest floor.

The most important pathway for reducing the herbicide load in the forest floor is degradation. In a laboratory study Norris (1970) has established that 2,4,5-T, while more persistent than 2,4-D, approached 90 percent degradation after 4 months in red alder forest floor material. The degradation rate of 2,4,5-T was not greatly influenced when 2,4-D was applied concurrently.

In a recent field study (Norris et al. 1977a), samples of foliage, forest floor, and soil were examined for residues of 2,4,5-T.

> Initially residues in forest floor were equivalent to 0.3 lb/A 2,4,5-T both shortly after the first application and 1 month later. A 90% decline in herbicide level occurred the first 6 months after application, and less than 0.02 lb/A remained after 1 year. Initial levels were 1.3 lb/A after the second application which reflects decreases in overstory vegetation after the first application. The residue level decreased more than 90% the first 30 days after the second application and less than 0.02 lb/A remained 12 months later.
>
> There was little leaching of 2,4,5-T from forest floor into soil. No residues were found deeper than 12 inches, and maximum residues did not exceed 1 ppmw. Residue levels were generally lower in soil after the second application.

After reviewing 11 references on the degradation of 2,4,5-T in the soil under varying conditions, the EPA Advisory Committee on 2,4,5-T (Wilson 1971) concluded that "Although the rate of disappearance varies, there have been no reports of carryover of 2,4,5-T from one year to the next indicating that no build-up in the soil would result from recommended rates of treatment applied annually."

Water - Herbicide entry into forest streams may occur through three possible routes: (1) Subsurface water flow or leaching; (2) overland flow; and (3) direct application and drift. As discussed in the preceding section, leaching is a relatively slow process which is unlikely to contribute significant residues to forest streams.

Abrahamson and Norris, 1976, have discussed herbicide entry further.

> Overland Flow--Runoff: Overland flow of herbicides can occur only if overland flow of water occurs. Hydrologists report that overland flow of water is extraordinarily uncommon on nearly all forest lands. The infiltration capacity of forest lands far exceeds intense rates of precipitation. There are areas, such as roads, skid trails, and landings where some localized overland flow can occur. These areas, where the soil is compacted or bare of vegetation, are scattered and can usually be avoided during application. Field testing on forest lands has verified that overland flow of herbicide is restricted to localized events involving bare, compacted, or water repellent soils and litter immediately adjacent to streams

and that the overland flow has shown marked reduction in herbicide concentration in water as it moves over uncontaminated soil.

Direct Application and Drift: Direct application or drift of spray materials are the principal routes of entry to forest streams. This is a physical process, independent of the particular herbicide applied which can be markedly influenced by man. Herbicide concentrations in forest streams which are in or adjacent to treated areas range from nondetectable limits (less than 0.001 ppm), to a maximum of 1 ppm, with more than 99 percent of all values less than 0.01 ppm even when no particular effort is made to avoid direct application to stream surface with either ground or aerial application methods. Research has shown that the location of forest treatment units with a buffer strip along the streams reduced maximum herbicide concentrations in streams to less than 0.01 ppm with residues detected for less than 1 day after application.

These measurements were made immediately downstream from treatment unit boundaries and, therefore, represent maximum concentrations in the stream system. Extensive monitoring of present-day operational applications of herbicide in forests show most applications do not result in measureable concentrations of herbicide in nearby streams. Improved formulations, equipment, application technology, coupled with an increasing awareness of the forest manager's opportunity to prevent stream contamination with herbicides are the reasons for these successful programs.

2,4,5-T has been found in forest streams only when applied directly to the stream or from spray drift. Even under these conditions, the concentration of 2,4,5-T decreased from approximately 1.0 ppm to less than 0.01 ppm within 1 day after treatment (Norris 1967). Heavy rains 6 months after treatment did not result in detectable 2,4,5-T residues in streams (Norris 1968).

If residues of 2,4,5-T should occur in streams (as when direct application is made), downstream dilution, including the addition of uncontaminated water from downslope or side streams, could reduce residues. Assuming a conservative 25-fold reduction in concentration over a mile of stream "...maximum herbicide concentrations of 0.01 ppm observed at the boundary of a treated area would be nondetectable (less than 0.001 ppm) 1 mile downstream" (Abrahamson and Norris 1976).

The risk analysis for herbicides in general may be applied to 2,4,5-T. "The maximum expected human exposure level is calculated to be 0.01 ppm for 24 hours if water for consumption is taken from the stream immediately downstream from the treated area."

Norris determined that herbicide concentrations in excess of 0.1 ppm are seldom encountered in streams close to treatment areas even immediately after spraying (Norris 1971). It has been calculated that a 150-pound person would have to drink 179 gallons of water containing 0.1 ppm 2,4,5-T to ingest 1/100 of the calculated LD_{50} for humans (Norris 1967).

Stream water was sampled after 2,4,5-T and 2,4-D had been applied to adjacent brush stands. The herbicides were detected at rates ranging from 0.5 ppb to 70 ppb. The herbicide concentration amounts fell below the detectable level in a few days (Tarrant and Norris 1967). This is below the .1 ppm tolerance level for potable water for human consumption recommended by the EPA Advisory Committee on 2,4,5-T (Wilson 1971). More recent EPA guidelines have recommended that a level of 60 ppb be adopted as the water quality criteria for 2,4,5-T levels (Newton 1977).

Buffer strips are used around streams in order to minimize the chances of herbicides entering the streams. The local project supervisor may increase the width of the buffer strip from a minimum of 100 feet because of the unusually rough topography, especially sensitive crops, or other similar reasons.

Air - Relatively little is known about the exact fate of 2,4,5--T in the air in a forest environment. Although spray may volatilize or be dispersed by the wind as fine droplets (drift), both problems may be minimized through the use of current spray technology and by observing responsible practices when applying herbicides.

The EPA Advisory Committee on 2,4,5-T (Wilson 1971) concluded that:

> Probably most of the 2,4,5-T that gets into the air very soon either settles out or is washed out by rain and thereby is returned to soil and water. There is no evidence to suggest that 2,4,5-T remains in the air for more than a few weeks after insertion.

Tschirley (1971) has analyzed the hazard of human exposure to 2,4,5-T based on the amount of 2,4,5-T and 2,4-D that remains suspended in the air. He based his analysis on data taken from the State of Washington where phenoxy herbicides were widely used for weed control in wheat during the spring and early summer.

> The hazard of human exposure to 2,4,5-T suspended in the air is extremely small, based on the data of Bamesberger and Adams showing the amount of 2,4-D and 2,4,5-T in the air... They found levels of 0.06 micrograms per cubic meter. Assuming a man will inhale about 30 cubic meters of air per day, the exposure would be 1.8 micrograms per day. For a 70 kg man, this would be 0.025 micrograms per kg body weight per day ... This is about one-two millionth of the "no effect level" (50 mg/kg).

Although this analysis is not directly applicable to a forest situation, these figures provide an approximation of the hazard to people from contaminated air.

Summary - From the foregoing references, the following can be concluded for forest management applications of 2,4,5-T:

1. High levels of 2,4,5-T would not persist on forest vegetation, but would be degraded roughly 90 percent in 1 month.

2. 2,4,5-T would not persist in the forest floor, but be approximately 90 percent degraded after 4 months.

3. 2,4,5-T residues would not enter forest streams in significant amounts unless a direct application is made to streams. Careful planning and current spray technology can minimize or eliminate direct application to or drift of herbicides to water. Where detectable levels have been found, they have not persisted more than a few days.

4. 2,4,5-T suspended in the air is expected to settle or wash out, and is not expected to remain suspended for long periods.

When used as registered by the Environmental Protection Agency (even immediately after spraying), 2,4,5-T residues have not been found to exceed the acute or chronic toxicity levels discussed earlier. Because 2,4,5-T does not persist in various components of the forest environment, initial levels of 2,4,5-T decrease rapidly, quickly reducing the already remote possibility of receiving a toxic dose. Since 2,4,5-T residues on any component of the forest environment are quickly degraded, repeated applications of 2,4,5-T separated by one year intervals (as in two release sprayings on the same site) are not expected to significantly increase either the human health hazard or residue levels beyond those expected from a single application of 2,4,5-T.

2. TCDD (Contaminant)

TCDD, an impurity in 2,4,5-T, is much more toxic than 2,4,5-T itself. LD_{50} values for TCDD is reported by Harvey (1975):

Animal	LD_{50} mg/kg Body Weight
Rat, male	0.022
Rat, female	0.005
Guinea pig	0.0006

A more extensive table of LD_{50} values is given by Schwetz et al. (1973) (Table 11). The most susceptible laboratory animal tested in these studies was the guinea pig. Schwetz et al. (1973) reports: (1) TCDD is highly embryotoxic, citing studies by Sparschu et al. (1971); (2) accidental contact with chlorodibenzo dioxins should not present a serious threat to vision based on extrapolations to people from rabbit eye irritation tests; and (3) repeated contacts with the skin of small amounts of TCDD may be expected to produce chloracne.

TABLE 11 - Lethality of 2,3,7,8-tetrachlorodibenzo-p-dioxin[a]

Species and sex	Sample	Route of adminis-tration	Time of death, days postadmin-istration	LD_{50} mg/kg	Dose mg/kg	Number deaths/ number treated
Rat, male	c	Oral	9-27	0.022	0.008	0/5
					0.016	0/5
					0.032	10/10
					0.063	5/5
Rat, female	c	Oral	13-43	0.045 (0.030-0.066)		
Guinea pig, male	c	Oral	5-34	0.0006 (0.0004-0.0009)		
Guinea pig,	d	Oral	9-42	0.0021 (0.0015-0.0030)		
Rabbit, mixed	c	Oral	6-39	0.115 (0.038-0.345)		
	c	Skin	12-22	0.275 (0.142-0.531)		
	c	Intraperitoneal	6-23	-	0.032	0/5
					0.063	2/5
					0.126	2/5
					0.252	2/5
					0.500	3/5
Dogs, male	c	Oral	9-15		0.30	0/2
					3.00	2/2
Dogs, female	c	Oral	-		0.03	0/2
					0.10	0/2

[a] Response to individual doses are given in those cases in which an LD_{50} could not be calculated. The LD_{50} for oral administration to rabitts was calcuated by using the method of Litchfield and Wilcoxon (9); the remaining values were calculated by using the Weil modificaton of the method of Thompson (15, 16).

[b] Letters refer to sample identification in Table 1.

From: Schwetz, B.A. et al. 1973. Toxicology of Chlorinateu Dibenzo-p-dioxins, Environ. Health Perspect. 5:

> A "safe" human dosage level for TCDD has not been established. The human hazard from TCDD has been estimated by extrapolating from the toxic dose for laboratory animals and applying a safety factor. There is disagreement among scientists as to what the safety factor for humans should be, and as to whether or not TCDD contaminated pesticides should be used without establishment of these levels. Streisinger (1976) suggests that setting a safety factor at 10 or 100 times the toxic level for guinea pigs (the most sensitive animal so far tested) may not be adequate to protect humans. He further points out that individual people vary in their sensitivity to many drugs. Occupational exposure or exposure from industrial accidents discussed in this section suggest that people are not more sensitive than laboratory animals.

Information on the effect of TCDD on humans comes from studies of occupationally exposed industrial workers (Wilson 1971):

> The Dow Chemical Co. ... has prepared an extensive health inventory of 126 manufacturing personnel in an effort to identify adverse effects of inhaled 2,4,5-T. The inhalation rate of the agent was estimated to be 1.6 to 8.1 mg/day per worker, depending on the work assignment, for periods of up to three years and at total career exposures in excess of 10,000 mg. The survey indicates that no illness was associated with 2,4,5-T intake. Specifically there was no increase in skin ailments or of alkaline phosphatase of SGPT levels as compared with controls having no exposure to 2,4,5-T.
>
> The result was entirely different in a plant where the 2,4,5-T produced contained a high proportion of dioxin. The latter plant was studied by Bleiberg...in 1964 and again six years later by Poland et al...who also reviewed earlier studies in factories in other countries where TCDD had been a problem. Poland and associates reported on 73 employees whose health was found to be improved compared to that of workers in the plant six years earlier. Eighteen percent of the men had suffered moderate to severe chloracne, the intensity of which correlated significantly with the presence of residual hyper-pigmentation, hirsutism, and eye irritation... The chloracne did not correlate with job location or duration of employment at the plant or with coproporphyrin excretion. One of the men had uroporphy-rinuria but, unlike the situation six years earlier, no porphyria could

be found. Systemic illness such as may be produced by TCDD was markedly less than that reported in previous studies of 2,4,5-T plants and probably no greater than expected in unexposed men of the same age.

Dost (1977) describes several more incidences of human exposure to TCDD:

> Probably the first clinical description of human TCDD exposure arose from the study by Kimmig and Schulz (1957) of workers in chlorophenol factories in Germany. The principal symptom was a persistent skin lesion (chloracne; so-called because it is characteristic of a number of related compounds and was at one time thought to be caused by free chlorine (Herxheimer, 1899)).
>
> The active agent was established as TCDD, and animal studies showed that the same lesions appeared on rabbit ears after application of as little as 0.002% TCDD (Kimmig and Schulz, 1957). High topical doses and oral doses of 50 mg/kg or greater caused liver necrosis. A similar industrial intoxication in France was reported by Dugois and Colomb (1957).
>
> Several severe accidental exposures to TCDD have occurred in recent years. In three notable cases, runaway chlorophenol plant reactions caused widespread exposures. An explosion in a British plant in 1968 resulted in 79 cases of chloracne (May 1973). In Czechoslovakia a pentachlorophenate production stream overheated under pressure, producing large amounts of TCDD (Jirazek et al. 1974). (It should be noted that in this and some earlier German work a different numbering convention was used. 2,3,6,7-TCDD and 2,3,7,8-TCDD are the same compound.) Of 80 exposed workers, 76 developed chloracne, porphyria cutanea tarda, disorders of plasma lipids, hepatic damage, neural lesions, and neurasthenia.
>
> All of these exposures were to a mixture of TCDD with other agents. Possibly the only published amount of exposure to pure TCDD is the description by Oliver (1975) of laboratory contact by three individuals associated with synthesis experiments. The individuals all had utilized typical protective procedures but sufficient contact developed nonetheless. The exposures were not sufficient to cause porphyrinuria or liver damage but serum cholesterol was raised. In two cases personality changes and neural disorders developed two years after exposure.

> In the U.S., TCDD extracted form hexachlorophene production was stored in oil, then mistaken for waste lubricating oil and sprayed on several horse arenas and farms in Missouri, for dust control. The incidents occurred in spring and summer of 1971. On one horse breeding farm, 62 of 85 horses exercised in the sprayed area became ill and 48 died, the last in January, 1974, two and a half years later. Hundreds of birds and rodents died, along with a number of dogs and cats. Several children were exposed through play in the arena soil. One developed a severe hemorrhagic systitis and others showed clear evidence of chloracne. All recovered. The TCDD concentration in the soil was later established at more than 30 ppm, a truly massive amount. (This concentration amounts to 120 lb per acre per foot of depth, assuming 4×10^6 lb soil/acre-foot or 6×10^8 times more than presently allowed by EPA at 2 lbs 2,4,5-T/A.) The details of the latter event are described by Carter et al. (1975) and Kimbrough et al. (1975).

Approximately five years after the initial exposure, a child who had played in the contaminated horse arena, was studied again along with her sister and mother, who also frequented the area. The results of all studies indicated that the responses of all three patients were normal. Beale et al. concluded:

> In the patient presented here, the toxicity of the compound appeared relatively early and was self-limited. However, our experience demonstrates that people exposed to dioxin can recover completely with no apparent sequelae from the toxin. It remains to be determined whether the exposure to dioxin in these children will result in abnormal pregnancies or affect their offspring.

In a recent court case, C.A.T.S. vs. Bergland, and in previously cited references, residents living near the Siuslaw National Forest reported varied ill effects from the use of 2,4,5-T on adjoining National Forest land. There are, however, apparently no verified cases of chloracne, one of the most conspicuous and best documented effects of TCDD exposure in industrial workers.

In January 1977, U.S. Congressman Jim Weaver requested and received a report, "Human Milk Monitoring: Preliminary Results for Twenty-one Samples," dated 12/15/76. This study reported finding 1.3 ppt TCDD in human milk from one donor living near the Siuslaw National Forest. Milk from four other donors in the same general area did not contain detectable levels of TCDD with the limit of detection ranging from 0.6 to 1.6 ppt. The study also reported TCDD at 1.4, 0.9, and 0.6 ppt in human milk from three donors near San Angelo, Texas. Three other donors had no detectable TCDD with limits of detection ranging from 1.2 to 1.9 ppt. The authors emphasized (1) the report was preliminary, (2) additional field and control samples were being analyzed, and (3) only when results from those experiments are obtained would they contemplate publication.

The results from this study were reported in the press, causing substantial controversy regarding both the details of how the study was conducted and the significance of the findings. The controversy is not resolved. Copies of the report were sent by Harvard to EPA and FDA before the correspondence with Congressman Weaver in January 1977.

There are substantial questions about the sample collection methodology, the proximity of the reported values to the limits of detection, and use of an analytical method. Also questions remain about the standards for data evaluation which are different from those used by the EPA Dioxin Monitoring Committee.

EPA is currently monitoring for TCDD in human milk from several areas where 2,4,5-T is used in forestry. EPA and FDA have not taken any regulatory action because of the data reported by the Harvard scientists. For these reasons, we note the results of the study and await clarification of both the adequacy of the study and the significance of the findings by the scientific community and regulatory agencies.

Fate of TCDD in the Environment

Applications of 2,4,5-T containing up to 0.1 ppm TCDD would introduce small amounts of TCDD into the environment. As discussed with reference to 2,4,5-T and the environment, residues may be found in: (1) vegetation, (2) the forest floor, (3) forest streams, and (4) air.

Vegetation - Crosby and Wong (1977) have analyzed the persistence of TCDD as it occurs, in actual herbicide formulations, on leaves, soil, or glass plates. When exposed to natural sunlight, most or all TCDD was lost during a single day. This loss was due principally to "photochemical declorination." The herbicide formulation provides a hydrogen donor which allows photolysis to occur. Pure TCDD, as used in earlier experiments, would not have been subject to photolysis because a hydrogen donor was lacking. Despite the known persistence of pure TCDD, it is not stable in thin films as actually formulated when exposed to outdoor light.

Plant uptake of TCDD incorporated in soils does not appear to be significant. Soybean and oat plants took up only trace amounts of TCDD in the first 10 to 14 days after exposure to sandy soil containing 40,000 times the equivalent amount of TCDD contained in an application rate of 2 pounds per acre 2,4,5-T (with 0.5 ppm TCDD). No detectable TCDD was in the grain or beans at maturity, probably due to normal dilution by plant growth, including volatilization or photodecomposition from the leaf surface or metabolism. TCDD is not translocated from the point of application on the leaf surface to other parts of the plant and some is washed off with rain water (Isensee and Jones 1971).

There is variability in the calculations of toxic doses of TCDD in an acre of sprayed land. The largest number of toxic doses has been calculated by Streisinger (1976a,b). He believes there would be one toxic dose of TCDD in 0.3 - 0.6 acres of treated foliage, based on the toxicity of TCDD to guinea pigs. For a person to ingest this toxic dose, some mechanism for collecting and concentrating the herbicide from all contaminated surfaces (including all vegetation and soil) must exist to make this toxic dose available.

Although it is extremely improbable, if an individual did encounter a concentrated source of TCDD, it would not follow that all TCDD taken in would be stored completely. Ross (1976) details the process by which TCDD is stored, metabolized, and excreted:

> This is a dynamic process and at the same time that some TCDD is being stored, other TCDD is being metabolized and excreted. The higher the storage level, the more rapid rate of excretion. Every level of continous intake will finally reach a maximum level of storage, at which the excretion rate equals the rate of intake. The maximum storage level is nearly reached in 7 weeks and essentially complete in 12 to 13 weeks. This is well shown by Rose et al. (1976). When intake ceases, as it would if consumption of the hypothetical beef liver were paced at monthly intervals, excretion of TCDD or its metablolites continues and the maximum possible storage level is not attained. It has been shown that half the stored TCDD is excreted in from 15 to 30 days.

Soil - Earlier reports of laboratory data (Kearney 1976b) indicated that pure TCDD on soil surfaces could not be degraded by sunlight. Crosby and Wong (1977) have demonstrated that TCDD, as it actually occurs in formulated herbicide products, is rapidly degraded (about 15% in six hours) on the soil surface by the action of sunlight.

In five soils with widely varying characteristics, TCDD was found to be immobile, even when subjected to leaching (Helling 1973). The possibility of TCDD entering ground water is remote (Tschirley 1971).

If TCDD is incorporated into soil, it disappears slowly. About half the TCDD is lost after one year (Kearney 1973). It seems unlikely, however, that TCDD would be incorporated in soils under forest conditions, since it does not leach into the soil. TCDD is not produced from breakdown products of 2,4,5-T in soils (Kearney 1971) or in sunlight (Plimmer 1971).

Water - TCDD is nearly insoluble in water - 0.2 ppb (Dow Chemical Company 1970). For this reason, it would be expected to remain on the surface of plants and soil at the application site. Previously cited references indicate that TCDD does not leach in soils. Because it is immobile in soils, Kearney et al. (1973) concluded there would be "no ground water contamination problems." In the natural environment, any TCDD would be expected to be found associated with other constituents of the formulation which are less soluble in water. They would form a thin film on water surfaces. Such films are expected to be degraded by sunlight, much like thin films on vegetation or the soil surface. Residues might, therefore, be substantially less than would be indicated from research with pure laboratory systems, suggesting that TCDD would be only slowly degraded in water.

Air - Explosion of a chemical plant in Seveso, Italy, in July 1976 resulted in widespread contamination of the surrounding countryside with TCDD. The exact amount of TCDD released by the explosion has not been precisely determined. However, it is believed to be quite high. From this unfortunate incident, we are beginning to receive additional information regarding human exposure to TCDD. Hawkes (1977) reported that the pollution "is not as serious as some had feared." Although there have been serious cases of chloracne, most patients are expected to recover completely, and pregnant women exposed to TCDD contamination at a critical stage of pregnancy "have now had their babies without any higher than average incidence of abnormality." These observations are consistent with the health record of the many applicators and manufacturing plant workers who have been exposed to high levels of these materials at frequent intervals.

Field Burning - Although thermal production of TCDD from 2,4,5-T is chemically possible in the laboratory, the levels of TCDD which might be produced in the field through burning of 2,4,5-T treated vegetation are not expected to substantially exceed TCDD levels present from the original application of herbicide (Norris and Pierovich 1977). Laboratory experiments usually use closed systems and high concentrations of 2,4,5-T, where heating is prolonged and uniform, but without actual combustion.

Actual field burning conditions occur with a free exchange of air and temperatures above 1200°C are common. Under these conditons, complete oxidation of all carbon compounds, including 2,4,5-T, trichlorophenol, and TCDD are expected. Furthermore, under actual field conditions, the concentration of 2,4,5-T on vegetation decreases rapidly after spraying, reducing the possible amount of TCDD that might form if burning occurred.

An important consideration in this regard is the possbility of wildfire occurring in treated areas shortly after treatment with herbicides that contain TCDD. Fire records for areas in Region 9 where this type of treatment is carried out show that the possibility of wildfire occuring at any time is quite remote. Thus the chance of actually burning much of the area once a fire starts is also very small.

Some areas are purposely burned in order to remove enough of the logging residue and vegetation to plant a new crop of conifers. In order to do this, it is necessary to wait one to three months for enough drying to occur to permit effective burning. This is ample for the degradation of any significant amounts of 2,4,5-T that might be present (Norris et al. 1977a).

Bioaccumulation - Bioaccumulation means the uptake and at least temporary storage of a chemical by an organism. TCDD is present in such minute quantities in the environment that toxicity from primary exposure (that is, exposure resulting from indirect ingestion of vegetation or water, dermal absorption or inhalation is unlikely (Norris et al. 1977a). Concern for bioaccumulation is that it may be a mechanism by which organisms collect or concentrate TCDD from primary exposure. These organisms would then carry possibly toxicologically significant residues as food sources for other creatures.

For instance, the amount of TCDD required to produce harmful effects in humans is spread out over such an area that direct personal exposure to that amount is unlikely. But, if deer bioaccumulate TCDD as they feed, human consumption of these deer could conceivably lead to significant human exposure. The question is, then, does bioaccumulation occur, and if it does, to what degree? There are three ways to study this question: physical-chemical properties, laboratory studies, and environmental monitoring.

Physical-chemical properties are good indicators of the potential for bioaccumulation. Chemicals with low water solubility and high fat solubility have a strong potential for bioaccumulation. DDT is an example of a chemical which is low in water solubility (0.001 ppm) and is high in fat solubility (86,000 ppm in corn oil). DDT is known to bioaccumulate in exposed organisms. TCDD is low in water solubility (0.0002 ppm) but is also low in fat solubility (47 pmm in corn oil). The ratio of oil solubility to water solubility is 86×10^6 for DDT and 0.2×10^6 for TCDD. These physical-chemical properties suggest that TCDD would bioaccumulate in exposed organisms, but probably to a lesser degree than DDT. The degree of bioaccumulation depends on the magnitude and duration of organisms exposure.

Bioaccumulation can also be studied in laboratory animals or in small laboratory ecosystems. Several such studies have been done. Data from laboratory feeding studies of mammals and fish, and from laboratory-scale, aquatic ecosystems are pertinent.

In laboratory feeding studies with repeated exposure, Fries and Marrow (1975) report that after six weeks of exposure, rats reached a steady state which was 10.5 times the daily intake. Rose et al. (1976) also repeat steady state concentration in rats in seven weeks at little more than ten times the daily intake level. These data establish that in laboratory feeding studies, animals which ingest TCDD in their diet will accumulate TCDD in certain body tissues, at least for as long as exposure continues.

It is also clear, however, that TCDD is not irreversibly accumulated in these feeding studies. Piper et al. (1973), Allen et al. (1975), Rose et al. (1976), and Fries and Marrow (1975) all found a halflife for TCDD residence in the body which ranged from approximately 12 to 30 days. These data indicate that once exposure to TCDD stops, the body burden will decrease. In a feeding study with rainbow trout, Hawkes and Norris (1977) report limited and preliminary data indicating that, on a whole body basis, TCDD levels in fish are approximately of the same order of magnitude as the level of TCDD in the food which they consume.

Several laboratory-scale aquatic ecosystem studies have been conducted with TCDD. Matsumura and Benezet (1973) exposed several organisms in model aquatic ecosystems to TCDD. Unfortunately, in most of their studies, the concentration of TCDD in the water was substantially in excess of the limits of its solubility, preventing meaningful interpretation of the data. In one experiment, however, TCDD was adsorbed on sand in the bottom of the aquariums and Matsamura and Benezet found 0.1 ppb TCDD in water and 157 ppb in brine shrimp, to give a concentration factor of 1,570.

Isensee and Jones (1975) also used a laboratory-scale, aquatic ecosystem to study TCDD bioaccumulation i mosquito fish, fingerling, channel catfish, algae, duckweed, snails, and water fleas. TCDD was adsorbed on soil which, when equilibrated with the water, resulted in TCDD concentrations in water ranging from 1,330 to 0.05 ppt. Concentrations in excess of 200 ppt exceed the limits of water solubility for TCDD and prevent meaningful interpretation of those bioaccumulation data.

In experiments where the water concentration was less than 200 ppt, bioaccumulation ratios (that is, the ratio of the concentration of TCDD in the organism to the concentration of TCDD in the water) ranged from 2×10^3 to 63×10^3 They found a strong, positive correlation between the concentration of TCDD in tissue and concentration of TCDD in water for all organisms. Isensee (1977) recalculated this data from a dry weight basis to a fresh weight basis in order to make the data more comparable to other studies. He reports the average degree of bioaccumulation ranged from 2 to 7×10^3 times the water concentration of TCDD. The total amount of TCDD accumulated was directly related to the water concentration. Equilibrium concentrations in tissues were reached in 7 to 15 days. He reports TCDD bioaccumulates to about the same magnitude as many of the chlorinated hydrocarbon insecticides in model aquatic ecosystems.

These results from laboratory studies indicate that organisms exposed to TCDD in their diet or in aquatic ecosystems will bioaccumulate TCDD. The degree of bio-accmulation which occurs from the use of TCDD-contaminated herbicides in forest ecosystems depends on the magnitude and duration of organism exposure. In laboratory studies, organism exposure is assured through regular addition of TCDD to the food for feeding studies or in aquatic ecosystems. This occurs through the placement of a substantial reservoir of TCDD adsorbed on sand or soil, resulting in continuous release of small quanities of TCDD to water.

In the natural environment, several processes operate to reduce or eliminate TCDD exposure to organisms and thereby minimize the opportunities for bioaccumulation. Crosby and Wong (1977) report TCDD in herbicide formulations disappears rapidly from vegetation and soil when exposed to sunlight. This mechanism would markedly reduce or eliminate organism exposure through dermal contact with or ingestion of contaminated vegetation. In the aquatic environment, the likelihood of 2,4,5-T and TCDD entry to aquatic systems is slight, but if it does occur, chemicals in the water are rapidly diluted and carried downstream with streamflow. TCDD which adsorbs on sediments provides a reservoir of TCDD in the aquatic ecosystem studies. However, in the real stream system, TCDD liberated from the sediments is quickly moved downstream with streamflow. The opportunity is minimal for bioaccumulation by a particular organism.

The third approach to evaluating TCDD bioaccumulation is to look directly for evidence of bioaccumulation in the field. Several efforts in this regard have been made, but with markedly diffeent sophistication and sensitivity of analytical methods. For instance, Woolson et al. (1973) analyzed samples of eagle tissues from various regions in United States. No TCDD was detected. The minimum detection limit, however, was 50 ppb, which is not an adequate level of sensitivity to properly evaluate bioaccumulation of TCDD, considering the inherent toxicity of the molecule.

Young et al. (1976) studied the behavior and bioaccumulation of TCDD in animals from the Elgin Air Force Base site used for equipment development and testing for application of herbicides in Vietnam. The study area received massive applications (1,000 pounds per acre) of 2,4,5-T, much of which contained TCDD in excess of 1 ppm. Analysis of soil from the test site shows TCDD residue levels in the range of 10 to 1,500 ppt. Analysis of rodents, reptiles, birds, fish, and insects shows the presence of TCDD in tissues of at least some of the organisms involved in this test program. The results of this test substantiate the theoretical data and the data from laboratory tests which indicate that, if TCDD is available to organisms i the field, it will be bioaccumulated. The degree to which herbicide used at Elgin test site was contaminated with TCDD and the massive rates of application, however, make this data not directly applicable to the use of herbicides in forestry. It is useful to indicate TCDD does have a potential for bioaccumulation.

Other studies done in connection with the registered uses of 2,4,5-T for vegetation control have found relatively little TCDD in biological samples. In 1973-74, the Environmental Protection Agency, cooperatively with the Forest Service, conducted a monitoring program for TCDD in tissues of animals from several areas in western Oregon and Washington which had been recently treated with 2,4,5-T. The methodology employed at that time was not adequate to establish the presence of TCDD in these environmental samples, but was adequate to determine which samples did not contain TCDD in the low-to-middle part per trillion range.

Results of the monitoring program showed approximately 84 percent of the samples did not contain detectable levels of TCDD. The remaining samples are described by EPA as "minutely suggestive" for TCDD. In 1976, five of these samples were reanalzyed by two laboratories (participants in the dioxin monitoring program). Two did not contain detectable TCDD. EPA describes the results of analysis of the other three as follows: "Some of the samples analyzed in 1973-74 still appear positive for TCDD. Unfortunately, the results from the two laboratories participating in the confirmation vary widely. The confirmation analysis, therefore, still does not give a precise quantification of the amount of TCDD present. It does appear, however, that from a qualitative standpoint TCDD was present in a small percentage of the forest samples collected in 1973." Assuming three out of five samples (60%) which were possible positives in the 1973-74 analysis are, in fact, qualitative for TCDD, then 9.6% of the 1973 samples were positive for TCDD and 90.4% did not contain detectible residues.

The EPA beef fat monitoring program, which was initiated in 1974, has been completed. Samples of beef fat (85) and liver (43) from animals grazing in areas treated with 2,4,5-T have been analyzed for TCDD. Approximately 25 percent of these samples are from animals not exposed to areas sprayed with 2,4,5-T. EPA reports one sample shows a positive TCDD level at 60 ppt, two samples appear to have TCDD at 20 ppt, five may have TCDD level at the range of 5 to 10 ppt. EPA states, "The analytical method is not valid below 10 ppt." Of the 43 liver samples analyzed, one sample may contain TCDD, but the level is too close to the sample detection limits for quantitation. A fat sample from the same animal showed no TCDD residue. The results of the EPA beef fat monitoring study indicate bioaccumulation of TCDD in grazing animals is not sufficient to result in regularly detectable levels of TCDD greater than 10 ppt in beef fat and liver.

Newton (1975) reported on the analysis of livers from mountain beavers caputred 2 months after a forested area in western Oregon was treated with 2,4,-D and 2,4,5-T. Analysis of the tissues showed no detectable levels of TCDD with a minimum detection limit of less than 10 ppt. Mountain beavers normally consume large quantities of vegetation, thereby affording them substantial exposure to herbicide-treated plants. In addition, they are a burrowing animal which will put them in intimate contact with herbicide and TCDD present on the soil surface.

Shadoff et al. (1977) conducted a broad study to determine whether TCDD was accumulating in animals due to the use of 2,4,5-T in the mid-western United States. They did not detect any TCDD (detection limit which averaged less than 10 ppt) in samples of fish, water, mud, and human milk from areas in Arkansas and Texas.

Mesleson (1977), in a tentative and preliminary report to Oregon Congressman Weaver, indicated some samples of human milk from areas in which 2,4,5-T is used contained detectable levels of TCDD. Mesleson reported three samples out of six from Texas, and one sample out of five from Oregon contained detectable levels of TCDD. The levels of detection, however, were substantially below the 10 ppt level established by EPA in the beef fat monitoring progrm as the minimum acceptable, reportable level.

The results of these various tests indicate that, if TCDD is present in the environment in a form which is available to organisms, then bioaccumulation would occur if organisms are exposed. This concept is supported, both from an examination of the physical-chemical properties of TCDD, as well as by studies of its behavior in animals exposed through feeding studies or in laboratory model aquatic ecosystems. The degree to which bioaccumulation of TCDD occurs in the field is dependent not only on the physical-chemical properties of the compound, but also on the persistence and availability of TCDD in the environment. Mechanisms of degradation and dilution which operate in the natural enviornment reduce the opportunities for organisms to be exposed, and thereby reduce the degree to which bioaccumulation might occur.

Monitoring for TCDD residues in animal samples from areas where 2,4,5-T is used at normal rates of application tends to show little or no detectable bioaccumulation of TCDD. In the beef fat monitoring study, for instance, only three samples out of 63 contained TCDD at levels within the range at which the analytical method is valid quantatively. The EPA monitoring for TCDD, in animal samples from western forests conducted prior to June 1974, shows at least 84 percent of the samples do not contain detectable levels of TCDD (the other 16 percent require confirmatory analysis).

The study of TCDD residues in livers of mountain beavers from areas treated with 2,4,5-T shows no detectable levels of TCDD, with minimum detection limit of less than 10 ppt. A widescale monitoring of water, sediment, fish, beef, and human milk from areas in the midwestern United States where 2,4,5-T has been applied also shows no detectable TCDD residues at minimum detection levels which average 10 ppt. These monitoring efforts indicate that substantial bioaccumulation (sufficient to produce residue levels in excess of 10 ppt TCDD in the majority of the populaton) is not occurring in animals in or near areas treated with 2,4,5-T in current operational programs.

Cumulative Effects of TCDD - Some toxicologists interpret recent experiments with primates (Allen et al. 1977) as indicating that the effects of sublethal doses of TCDD may be cumulative and death results if a sufficient number of sublethal doses are received. Stated another way, these experiments may suggest that the lethal amount of TCDD in primates is approximately the same regardless of whether the dose is received all at once or in numerous small doses. If this is true, it means any estimate of an acceptable exposure level must assume additive effects over long periods. No chemical is known to have such properties.

A primate study by Allen (1977) used TCDD in the diet at 500 ppt. This is a level substantially greater than likely to be available to organisms in the forest, even immediately after application of 2,4,5-T. Norris et al. (1977) estimates initial TCDD residue levels on vegetation of 5 to 10 ppt immediately after application. Crosby and Wong (1977) report TCDD halflife on vegetation of only a few hours when exposed to sunlight. Therefore, the probability of chronic exposure to levels of 500 ppt TCDD is remote.) If the response of primates in Allen's study is proportional to the dose received, exposure to 5 ppt would permit survival for 100 times as long as reported by Allen. This would be well beyond the normal life span of primates.

Additional experimentation with primates is necessary to clarify the Allen finding. Chronic exposure at levels relevant to possible environmental residue levels is needed. Periodic exposure to higher levels (10 to 500 ppt), with periods of no exposure between, also need to be tested. The exposure level used by Allen may have overloaded or inactivated the detoxication and repair processes of organisms usually employed in responding to chronic toxic exposure. The exposure regimes described above would test this hypothesis.

Cumulative effects of TCDD have not been seen in other species. In guinea pigs, dose rates of 0.2 ug/kg weekly for eight weeks provided a total dose almost three times the LD_{50}, but no deaths occurred. Organ changes, while measurable, were not severe (Vos et al. 1973). Vos et al. (1974) also reported that rats accepted about three times the LD_{50} of 20 ug/kg over a 13-week period without lethality.

Experiments conducted thus far are not adequate to determine with any certainty that TCDD does or does not have cumulative effects in animals. The evidence to indicate possible cumulative effects comes from a single study with primates. Evidence opposing the cumulative effect theory comes from studies with guinea pigs and rats, and from the fact that no other chemical is known to have cumulative effects. The possibility of cumulative effect is important, and carefully designed experimentation is needed to clarify the point. However, there is insufficient evidence at this time for the Forest Serivce to determine that use of 2,4,5-T, as registered by EPA, would result in cumulative toxic effects from TCDD in people or animals likely to come in contact with spray materials.

<u>Summary</u> - Although there is not as much information on TCDD as on 2,4,5-T, some assumptions can be made from the foregoing references:

1. TCDD is rapidly broken down by sunlight on vegetation and the soil surfaces.

2. TCDD is not significantly translocated from contaminated soil to plants or from the site of application on the leaf surface to other parts of the plant.

3. A toxic dose of TCDD may be spread over as little land as one-third to one acre. However, this dose would have to be accumulated and concentrated (before decomposition could occur) from all contaminated surfaces within that 1/3 acre before it would be available.

4. TCDD is persistent when incorporated in soils, but is more likel to remain on the soil surface, since it is nearly insoluble in water.

5. TCDD residues are not expected in ground water because TCDD does not leach significantly in soil.

6. TCDD is not likely to be produced by burning under field conditions.

7. Humans exposed to substantial amounts of TCDD from industrial accidents have suffered chloracne, but apparently their offspring do not exhibit birth defects as a result of this exposure.

8. TCDD is not sufficiently persistent nor available to organisms in the forest for significant bioaccumulation to occur.

Although TCDD is distributed in the forest environment as a contaminant in 2,4,5-T, the amount of TCDD (0.1 ppm in 2,4,5-T) is so small and spread over such a great area that exposure to a toxic dose is highly unlikely. Additionally, TCDD as it occurs in actual herbicide formulations degrades rapidly (within a single day), further decreasing the possibility of contacting a toxic dose. Tschirley (1971) and the New Zealand Department of Health (1977) offer "worst-case estimations" supporting the remoteness of this possibility.

Conclusions

Based on the foregoing discussion and the data available at the printing of this statement, neither 2,4,5-T nor TCDD are believed to be harmful to humans when used as registered by the Environmental Protection Agency. However, it is important to understand that no one including the U.S. Forest Service, can guarantee the absolute safety of 2,4,5-T or silvex. The New Zealand Department of Health, in a report entitled "2,4,5-T and Human Birth Defects" (1977) has expressed this difficult position very well:

> It must be faced that there is no way in which any substance, including common foodstuffs, can ever be proved absolutely safe. To achieve such

a standard of proof would entail testing every person with every substance at every conceivable exposure level in every imaginable circumstance. Otherwise there is always the possibility of a single individual somewhere who will react adversely under certain conditions.

The best that can be achieved for any substance is a high degree of "assurance" of safety based upon a rational and experienced scientific judgment of the available evidence.

The accumulated data on 2,4,5-T and its TCDD contaminant are sufficient to give a very high assurance of safety in the normal use of this material. This belief is in accordance with the concensus of world-wide scientific opinion.

In the United States, this "high degree of assurance" is afforded by registration of 2,4,5-T with the Environmental Protection Agency for the uses designated in this environmental statement.

3. 2,4-D

2,4-D, like 2,4,5-T, is an auxin type herbicide. However, unlike 2,4,5-T, it does not contain the contaminant TCDD.

Acute Toxicity

Acute toxicity values for 2,4,-D are given in Table 12. 2,4-D is slightly less toxic than 2,4,5-T, with LD_{50} values ranging from 100 to 2,000 mg/kg. This data indicates that various species can tolerate residues (no effect level) of 500 to 1,500 ppm in their food (Norris 1976a). As will be discussed (Fate of 2,4-D in the Environment), these levels would not likely be found in a forest environment.

Additional data on the toxicity of 2,4-D to humans can be derived from several reported incidents of 2,4-D poisoning, therapeutic use, or experimental self-administration. These cases have been summarized by Dost (1977). Accidental poisoning with 2,4-D resulted in a range of symptoms, of which one of the most serious appears to be neural damage. A single suicidal dose, estimated to be 90 mg/kg of 2,4-D resulted in death (Nielsen et al. 1965).

Table 12 - Toxicity of 2,4-D

ACUTE TOXICITY OF 2,4-D

Oral Formulation	Organism	Dose	Effect	Reference
Alkanolamine	Chick	380-765 mg/kg	LD_{50}	Rowe and Hymas (1954)
Isopropyl ester	Rat	700 mg/kg	LD_{50}	Rowe and Hymas (1954)
Isopropyl ester	Chicks	1420 mg/kg	LD_{50}	Rowe and Hymas (1954)
Isopropyl ester	Guinea pig	550 mg/kg	LD_{50}	Rowe and Hymas (1954)
Butyl ester	Rat	620 mg/kg	LD_{50}	Rowe and Hymas (1954)
Butyl ester	Guinea pig	848 mg/kg	LD_{50}	Rowe and Hymas (1954)
Butyl ester	Chicks	2000 mg/kg	LD_{50}	Rowe and Hymas (1954)
PGBE	Rat	570 mg/kg	LD_{50}	Rowe and Hymas (1954)
Acid	Dog	100 mg/kg	LD_{50}	Rowe and Hymas (1954)
Acid	Chick	541 mg/kg	LD_{50}	Rowe and Hymas (1954)
Isopropyl ester	Rat	700 mg/kg	LD_{50}	Hayes (1963)
Unspecified amine	Mallard duck	2000 mg/kg	LD_{50}	Tucker and Crabtree (1970)
Acid	Pheasant	472 mg/kg	LD_{50}	Tucker and Crabtree (1970)
Acid	Mule deer	400-800 mg/kg	LD_{50}	Tucker and Crabtree (1970)
Triethanolamine	Swine	50 mg/kg	Anorexia in 1	Bjorklund and Erne (1966)
Triethanolamine	Swine	500 mg/kg	Probably lethal (Killed in a moribund state)	Bjorklund and Erne (1966)

(Continued)
Table 12 - Toxicity of 2,4-D

ACUTE TOXICITY OF 2,4-D

Oral Formulation	Organism	Dose	Effect	Reference
Butyl ester	Swine	100 mg/kg	No effect	Bjorklund and Erne (1966)
Triethanolamine	Chicken	300 mg/kg	Gastritis in 1	Bjorklund and Erne (1966)
Butoxyethanol ester	Oyster	3.75 ppm (96 hrs.)	50% decrease in shell growth	Bulter (1965)
Butoxyethanol ester	Shrimp	1 pp (48 hrs.)	No effect	Bulter (1965)
Butoxyethanol ester	Fish (salt water)	5 ppm	48 hr LC_{50}	Bulter (1965)
Butoxyethanol ester	Phytoplankton	1 ppm (4 hrs.)	16% decrease in CO_2 fixation	Bulter (1965)
Dimethylamine	Oyster	2 ppm (96 hrs.)	No effect on shell growth	Butler (1965)
Dimethylamine	Shrimp	2 ppm (48 hrs.)	10% mortality or paralysis	Butler (1965)
Dimethylamine	Fish (salt water)	15 ppm (48 hrs.)	No effect	Butler (1965)
Dimethylamine	Phytoplankton	1 ppm (4 hrs.)	No effect CO_2 fixation	Butler (1965)
Ethylhexyl ester	Oyster	5 ppm (96 hrs.)	38% decrease in shell growth	Bulter (1965)
Ethylhexyl ester	Shrimp	2 ppm (48 hrs.)	10% mortality or paralysis	Bulter (1965)
Ethylhexyl ester	Fish (salt water)	10 ppm (48 hrs.)	No effect	Bulter (1965)
Ethylhexyl ester	Phytoplankton	1 ppm (4 hrs.)	49% decrease in CO_2 fixation	Bulter (1965)

(Continued)
Table 12 - Toxicity of 2,4-D

ACUTE TOXICITY OF 2,4-D

Oral Formulation	Organism	Dose	Effect	Reference
PGBE[1/] ester	Oyster	1 ppm (96 hrs.)	39% decrease in shell growth	Butler (1965)
PGBE[1/] ester	Shrimp	1 ppm (48 hrs.)	No effect	Butler (1965)
PGBE[1/] ester	Fish (salt water)	4.5 ppm	48 hr LC_{50}	Butler (1965)
PGBE[1/] ester	Phytoplankton	1 ppm (4 hrs.)	44% decrease in CO_2 fixation	Butler (1965)
Dimethylamine	Bluegill	166 to 458 ppm	48 hr LC_{50}	Lawrence (1969)
Alkanolamine	Bluegill	435 to 840 ppm	48 hr LC_{50}	Lawrence (1969)
Isoocytl ester	Bluegill	8.8 to 59.7 ppm	48 hr LC_{50}	Lawrence (1969)
Butyl ester	Bluegill	1.3 ppm	48 hr LC_{50}	Lawrence (1969)
Isopropyl ester	Bluegill	1.1 ppm	48 hr LC_{50}	Lawrence (1969)
PGBE	Bluegill	2 ppm	48 hr LC_{50}	Hughes & Davis (1963)

[1/] PGBE is propylene glycol butyl ether

Chronic Toxicity

Chronic toxicity values for 2,4-D appear in Table 13. The doses range from 500 ppm to 2,400 ppm in the diet with the duration of the experimental feeding period ranging from 30 to 112 days for various animal species.

A single human ingested an experimental dose of 500 mg of 2,4-D daily for three weeks with no evident effect (Assouly 1951, as reported in Nielson et al. 1965). Seabury (1963) reports treating a patient with a terminal case of coccidoidomycosis with 2,4-D. Since 2,4-D is a synethetic plant hormone, it was hoped that 2,4-D might affect the fungal infection. At the time of the treatment, no other therapeutic agent was available. Dost (1967) summarizes the effects:

> In 24 treatments over a period of more than a month the dosage was raised to a final treatment of 3600 mg. No prior doeses, up to 2000 mg caused any response, but the final administration caused extreme quiescence, and fibrillation of muscles in the face and hands, followed by deep stupor and reflex failure. The patient recovered from the 2,4-D within 48 hours and died of the fungus disease about two weeks later.

Effect of 2,4-D on Reproduction and Fetal Development

Dost (1977) has reviewed the effects of 2,4-D on reproduction:

> As with 2,4,5-T, the possibility that 2,4-D has teratogenic potential was first studied by the Bionetics Research Laboratories study (Bionetics Research Laboratories, Inc., 1970). The data were suggestive that incidence of failed lower jaw formation was somewhat greater than that resulting from the DMSO carrier. Schwetz et al. (1971) measured teratogenic and fetotoxic effects of 2,4-D and two esters on rats. The higher daily doses (75 mg 2,4-D/kg; 75 mg propylene glycol butyl ester of 2,4-D/kg;87.5 mg isoocytl ester of 2,4-D/kg, each just below the maternal toxic dose) caused decreased fetal weight, subcutaneous edema, delayed bone ossification and wavy ribs. Most of these changes are fetotoxic rather than teratogenic. The last two are developmental effects but have no effect on survivability. No teratogenic responses were found at any dose.

Table 13

CHRONIC TOXICITY OF 2,4-D

Oral Formulation	Organism	Dose	Duration	Effect	Reference
Ethylhexyl ester	Sheep	250/mg/kg/day	17 days	Ill in 3 days 17 doses lethal	Hunt et al. (1970)
Ethylhexyl ester	Sheep & cattle	100/mg/kg/day	10 days	None to minor effects.	Hunt et al. (1970)
Not specified	Dog	500 ppm in feed	2 years	None	House et al. (1967)
Not specified	Rat	1250 ppm in feed	2 years	No effects on survival hematology or tumor incidence.	House, et al. (1967)
Not specified	Rat	500 ppm in feed	2 years	No effect in reproduction studies.	House, et al. (1967)
Alkanolamine	Chicken	100 mg/kg/day	10 days	No effect on weight gain.	Palmer and Radeleff (1969)
PGBE ester	Chicken	50 mg/kg/day	10 days	No effect on weight gain.	Palmer and Radeleff (1969)
PGBE ester	Cattle	100 mg/kg/day	10 days	No effect.	Palmer and Radeleff (1969)
Acid	Mule deer	80 and 240 mg/kg/day	30 days	Minor symptoms, no weight loss.	Tucker and Crabtree (1970)

Dost (1971) has summarized additional references:

> There is some difference in definition of teratogenic response among authors in the field. A variety of skeletal defects that do not interfere with postnatal survival were found by Khera and McKinley (1972); most effects observed were wavy ribs or fused sternum. The increased incidence of these changes were evident at doses as low as 25 mg/kg/day. 2,4-D teratogenesis was studied by Bage et al. (1973) but only in presence of 2,4,5-T. The mixture caused some teratogenesis, but was less effective than 2,4,5-T alone, so the impact of 2,4-D in the system was difficult to evaluate.
>
> Hamsters are subject to a teratogenic effect of high doses of 2,4-D. Collins and Williams (1971) found that 2,4-D from three different sources caused a low incidence of anomalies, usually fused ribs, at doses of 100 mg/kg/day through days 6-10 of gestation. There was no satisfactory dose response relationship. Dietary 2,4-D at 500 and 1000 ppm did not alter reproductive function in a three-generation, six litter study with rats. Percentage of pups surviving to weaning and weanling weight was decreased at 1500 ppm, however (Hansen et al., 1971).
>
> Sheep are apparently not subject to 2,4-D induced teratogenesis. Binns and Johnson (1970) administered 2 grams daily for 30, 60, and 90 days following breeding and caused no malformation. There were presumably 6 sheep per group but the number in this specific experiment was not stated....
>
> An interesting observation of 2,4-D distribution in mouse festuses has been made by Lindquist and Ullberg (1971). Labeled 2,4-D given late in gestation accumulated early in the yolk sac, passed on to the fetus and was almost completely elminated by 24 hours after administration. Distribution among tissues was non-selective, and concentrations tended to parallel those of the dam, perhaps explaining in part the lack of teratogenic effect.

Carcinogenic and Mutagenic Potential of 2,4-D

Dost (1977) has reviewed the literature pertaining to the carcinogenic and mutagenic potential of 2,4-D:

> Imnes et al. (1969) screened 120 compounds for tumorigenic properties in mice. 2,4-D and several of its esters were included; none caused tumor incidence. Apparently no other evaluations of cancer potential of 2,4-D have been made. A number of mutagenic screens have included 2,4-D, however. Jenssen and Renberg (1976) found that 2,4-D would not induce increased micronuclei in mouse bone marrow erythrocyte, but the compound did slightly depress mitotic activity. Sex-linked lethality assay of 2,4-D in male Drosophila was also negative for mutagenic activity (Vogel and Chandler, 1974). Styles (1973) treated rats with 2,4-D, then used serum from the animals in a host mediated assay with histidine-requiring S. typhimurium mutants. No effect of 2,4-D was evident. In a screen of 110 compounds with the "Ames test," using eight histidine-requiring mutant strains, Anderson et al. (1972) was unable to detect mutagenic activity by 2,4-D.

Fate of 2,4-D in the Environment

As detailed under a previous discussion on 2,4,5-T, application of a herbicide may result in residues on or in four components of the environment: Vegetation, soil, water, and air.

Vegetation - Morton et al. (1967) found the half life of 2,4-D to be between two to three weeks on forage grasses when applied at the rate of one pound per acre (Table 14). Norris and Freed (1966a, 1966b) applied three formulations of 2,4-D to bigleaf maple under laboratory conditions. Of the material absorbed, most remained in treated leaves. New growth, the stem, and roots contained translocated material in decreasing amounts in the order given. Differences between formulations were not significant, but differences in the amounts recovered from various sites in the plant may account for differential effects on plant foliage, stems, and roots. The amount of 2,4-D absorbed by the plant varied, but order of sites in which decreasing amounts of 2,4-D occurred was the same. Any residues not absorbed by the plant may be washed off by rain or fall to the forest floor when the leaf falls from the plant.

Table 14 - Residues of herbicide[1] in forage grass.

Time of Treatment (weeks)	Herbicide Residue 2,4-D[2]
	ppm
0	100
1	60
2	50
4	30
8	6
16	1
52	

[1] Rate of application - 1 lb/acre (1.12 kg/ha).

[2] Data from Figure 4 of Morton et al., 1967.

From: Norris, 1976a.

Soil - As previously discussed, four possible routes exist for decreasing the amount of pesticide in the forest floor: (1) Volatize and re-enter the air; (2) be adsorbed on soil particles; (3) be leached from the soil by water; and (4) be degraded by chemical or microbial means.

Phenoxy esters are probably rapidly hydrolized to nonvolatile forms (Norris 1974). Herbicide adsorbed to soil particles is not biologically available and the leaching process is slow (the dynamic nature of the adsorption/leaching process is detailed under Fate of 2,4,5-T in the Environment). Thus, as with 2,4,5-T, degradation is principally responsible for reducing the amount of pesticide in the forest floor. Norris (1966) investigated the degradation rate of two pounds per acre of 2,4-D applied to forest floor material from a red alder stand. The rate of degradation followed mixed order kinetics.

Norris and Greiner (1967) studied degradation of 2,4-D in the forest floor at the rate of three pounds per acre. They found that the type of litter (e.g., litter beneath red alder, ceanothus, vine maple, bigleaf maple or Douglas-fir) did not significantly alter the degradation rate of 2,4-D. However, the degradation rate for the same chemical form in high purity formulations was faster than that for commercial preparations containing impurities, emulsifiers, and solvents. The 2,4-D degradation rate was stimulated by simultaneous application of DDT but not affected by diesel oil. The authors conclude that persistence of 2,4-D "will not likely be affected by either chemical in field applications."

Norris (1970) also studied the degradation of several herbicides including 2,4-D, in red alder forest floor litter. At the end of the 35-day period, only six percent of the original two pounds per acre treatment could be recovered. Norris discussed 2,4-D degradation as follows:

> The influence of rate of application, presence of other herbicides, and pretreatment with insecticides on the persistence of 2,4-D was determined in the treatments indicated...With only one exception, no significant differences were found in 2,4-D recovery at 35 days.
>
> The percent recovery of 2,4-D applied at two rates is the same. That in the half life (time to 50 percent decomposition) is independent on starting concentration, suggesting that the rate of degradation follows the first-order rate law. However, the rate constant was found to vary with time, which indicates deviation from first-order kinetics in this test period. This result is not surprising considering the multiple and sequential reactions possible in a heterogenous system.

Newman and Thomas (1949) indicated that specific types of soil micro-organisms are responsible for 2,4-D degradation. Subsequent applications of 2,4-D to soil were less persistent than the initial application, indicating that a buildup of such organisms occurs and remains in the soil to speed up degradation of succeeding application of 2,4-D.

Water - Norris (1967) analyzed four 2,4-D treatment areas representing watersheds with different hydrologic characteristics. Streams within the watersheds were sampled for 2,4-D residues at various locations and points in time following application of two to three pounds per acre 2,4-D. Residue values for the various watersheds will not be given here. Norris was able to calculate the level of water intake that could be tolerated by a 150-pound person. Assuming that a person would respond in proportion to size the same way as a laboratory test animal (rat) would, and that a level of 100 times lower than the LD_{50} would not produce any noticeable effect on a person, then the individual would need to drink 671 gallons of water containing 2,4-D at 100 ppb to ingest 1/100 of the hypothetical LD_{50}. Norris concludes:

> It is clear from the calculated values...that man can tolerate the concentrations of herbicides in the water which resulted from the chemical brush control projects monitored in these studies. A similar comparison for chronic exposure to low levels is probably not possible.

> Of greater interest would be an expression of biologically safe level of herbicide. This is defined as that concentration of herbicide which could be tolerated for extended periods of time by nearly all members of the food chain with little or no apparent damage. On the basis of the data...and on the experience of the Ohio River Sanitation Commission, this level might be conservatively set at 100 parts per billion for the herbicides investigated in this program (Bond et al. 1959).

The following general conclusions for all herbicides can be on the basis of studies conducted thus far.

1. Some herbicides (a few ppb) may appear in nearly all streams which flow by or through treated areas.

2. The maximum concentration (5-85 ppb) is a function of the proportion of the watershed treated, the amount of live stream included in the unit, the ratio of the surface of the stream to its volume, and the degree to which brush overhanging the stream intercepts spray materials.

3. The length of persistence (usually a few hours, but it can be a few days) is a function of the hydrologic nature of the area treated.

4. Nearly all of the herbicide found in the stream results from the direct application of spray materials to the surface of the water.

The land manager concerned with the planning and use of herbicides should remember the three most important things learned from these research efforts:

1. Herbicides can be used safely in the forest in most instances.

2. Avoid the treatment of areas which have high water table.

3. When operating in areas which are particularly sensitive from a biological or public relations standpoint, stream contamination can be held to an absolute minimum by recognizing and avoiding those situations which lead to direct application to streams or surface water.

Air - No information relating to a human health hazard from 2,4-D suspending in the air from an application to forest land has been found. However, it is assumed that drift, regardless of the herbicide, could occur if reasonable precautions are not observed. Herbicide application controls as specified in Appendix A are observed in all Forest Service projects.

Summary - "Assuming that maximum herbicide residues in vegetation will approach 1-200 ppm shortly after application," (Norris 1974) accumulation of a toxic dose of 2,4-D does not seem probable. Given either the relatively high concentrations of 2,4-D in the diet or the extended feeding periods necessary to produce chronic effects (see 2,4-D Chronic Toxicity) in animals, and taking into account the two to three week half life of 2,4-D on vegetation, exposure to a chronic dose seems improbable.

Residues of 2,4-D on foliage are expected to remain for only two to three weeks and in soil for 35 days or less. Residues in water and air would not be expected to reach hazardous levels if careful application procedures are observed. Thus, residue levels resulting from the proposed applications of 2,4-D are not expected to reach or persist at levels previously given for acute or chronic toxicity. Finally, no carcinogenic or mutagenic properties apparently are attributed to 2,4-D.

4. 2,4,5-TP (Silvex)

Silvex is also an auxin-type herbicide. Silvex contains the contaminant TCDD, as does 2,4,5-T. TCDD will not be discussed again, in relationship to silvex, since it was discussed in relation to 2,4,5-T. Less information is available on silvex than for either 2,4,5-T or 2,4-D.

Silvex - Acute Toxicity

Table 15 gives LD_{50} values for various silvex formulations. LD_{50} values range from 600 to 2,140 mg/kg for various animal species.

Subchronic (90-day) feeding studies at six dosages (0, 10, 30, 100, 300, and 600 mg/kg body weight/day) indicated that 2,4,5-TP has no adverse effects, except a slight liver enlargement at dosages greater than 10 mg/kg/day. Mullison (1966) states"...the significance of liver enlargement in the absence of any pathological tissue alterations is questionable."

Mullison (1966) reported a 90-day study feeding of rats exposed to sodium salt of silvex at dosages rates of 1.0, 0.3, 0.1, 0.03, and 0.01 percent of silvex. Studies at 1.0 percent level were discontinued because rats would not satisfactorily accept their food. The results of these studies were: (1) Growth effects were noted at levels greater than 0.01 percent; (2) hematological measurements were normal at 0.3 and 0.1 percent levels; and (3) at least slight changes in kidney and/or liver weights were noted at all dosages.

Table 15
Mammals and Birds
Acute Oral LD_{50}
mg/kg of Body Weight

Aquatic Organisms
Acute LD_{50} Mg/l

Chemical	Organism	LD_{50}	Chronic Effects	No Effect Level	Reference
Phenoxy	**Mammals**				
2,4,5-TP (Silvex)					Rowe & Hymas 1954
acid	Rat	650.		PGBE 30 mg/kg	Rowe & Hymas 1954
butylester	Rat	600.		90 days	Rowe & Hymas 1954
PGBE ester	Rat	620.			Rowe & Hymas 1954
PGBE ester	Guninea pig	1250.	PGBE cow 25 mg/kg 20 doses		
PGBE ester	Rabbit	819.	PGbe sheep 25 mg/kg 10 doses		
	Birds				
PGBE ester	Chick	1190.			Rowe & Hymas 1954
acid	Mallard	2000.	33,700 mg/kg LD_{50}, 13 day dose minor effects House et al. 1967	500 mg/kg	Tucker & Crabtree 1970
PGBE ester	Chicken	2000.	25,000 mg/kg 10 doses wt. loss Palmer & Radeleff 1969		Mullison 1966
	Fish				
PGBE ester	Bluegill	25. mg/l 48 hr			Hughes & Davis 1966
isooctyl ester	Bluegill	5. mg/l 48 hr			Hughes & Davis 1966
potassium salt	Bluegill	83. mg/l 48 hr			Hughes & Davis 1966
BE ester	Bluegill	2. mg/l 48 hr			Hughes & Davis 1966
TE amine	Bluegill	20. mg/l 48 hr			Hughes & Davis 1966
acid	Bluegill	2. mg/l 96 hr			Surber & Pickering 1961
acid	Fathead minnow	7.5 mg/l 96 hr			Surber & Pickering 1961
PGBE ester	Chinook	1.230 mg/l 48 hr			Bond 1959
PGBE ester	Largemouth bass	3.500 mg/l 24 hr			Bond 1959
	Crustaceans				
BE ester	Crayfish	60. mg/l 48 hr			Sanders 1970
PGBE ester	Crayfish			100. mg/l	Sanders 1970
	Marine & Estuarine				
	Eastern oyster, egg	.0059 mg/l 48 hr			Davis & Hidu 1969
	Eastern oyster, larvae	.710 mg/l 14 day			Davis & Hidu 1969

Feeding studies using Kurosal® SL, a commercial product containing silvex were also made on beagle hounds. The test animals were fed dosages of 0.1, 0.03, and 0.01 (percent silvex) for 89 days. The test also included control animals. Evidence of adverse effects was observed at the 0.1 percent level (40 mg/kg/day). Mullison (1966) concludes:

> We may conclude that Kurosal® SL is moderate in repeated oral toxicity when fed as a part of the diet to male and female beagle hounds for a period of 89 days. No evidence of adverse effect was found at the 0.03 percent (13 mg/kg/day) level or below as judged by general appearance and behavior, growth, mortality, food consumption, hematological values, serum urea nitrogen and alkaline phosphatase determinations, final body and organ weights, and gross and microscopic examination of the tissues.

Chronic Toxicity

Mullison (1966) also reports two studies involving silvex fed to rats and beagles for two years. Dosage rates were 0.01, 0.003, or 0.001 percent Kurosal® SL for the rat study, and 0.019 percent for female beagles and 0.0056 percent for male beagles.

The results of the rat study were:

> The "no ill-effect" level for Kurosal® SL as judged from this study is 0.01 percent (100 ppm in the diet of rats for their lifetime of two years. Since the acide equivalent of this formulation is about 53 percent, this level of Kurosal SL is equivalent to the ingestion of 53 ppm, (2.6 mg/kg/day) of 2(2,4,5-trichlorophenoxy) propionic acid.

The results of the beagle study were:

> As judged from this study, the "no ill-effect" level for Kurosal® SL is 0.019 percent (190 ppm) for female beagle hounds, and 0.0056 percent (56 ppm) for male beagles when fed in their total diet for a period of two years. Since the acid equivalent of this formulation is 53.4 percent, these levels of Kurosal® SL are equivalent to the ingestion of 100 ppm and 30 ppm (2.6 mg/kg/day and 0.9 mg/kg/day) of 2(2,4,5-trichlorophenoxy) propionic acid (silvex), respectively. These results compare favorably with the 53 ppm, no effect level for silvex reported previously from a two-year dietary study in male and female rats.

Effects of Silvex Upon Reproductive Functions

The teratogenicity of silvex has been reviewed by Dost (1977).

> Silvex is teratogenic at high doses. Courtney (1975) found that 398 mg/kg/day, on days 12-15 of gestation, caused 3% cleft palate in the group given silvex in DMSO subcutaneously, and 7% where given orally in corn oil. Fetal mortality increased to 25% in the group treated subcutaneously.
>
> The Dow Chemical Co. has also conducted a series of teratology studies with silvex. Dose rates of 75, 100, and 150 mg/kg/day from day 6 to day 15 caused several cardiovascular anomalies; 50 mg/kg/day caused retarded ossification in the sternum and skull. (Thompson et al., 1972). The no adverse effect level was considered to be 25 mg/kg/day. The PGBE ester caused skeletal changes at an intake of 50 mg/kg/daily but no changes were found after 35 mg/kg/day (23 mg/kg silvex acid equivalent).

Carcinogenic and Mutagenic Potential of Silvex

No increase in tumors was found in mice fed a maximum tolerable dose rate of silvex, 121 ppm for 18 months (Innes et al. 1961). Point mutations were not detected when screening silvex against two strains of bacteria (Anderson et al. 1972).

Fate in The Environment and Risk of Human Exposure

Little specific information on residues of silvex in a forest environment is available. However, silvex itself is less toxic than 2,4,5-T. Both are closely related compounds and both contain the contaminant TCDD. The behavior in the environment and the risk of human exposure for silvex would be expected to equal 2,4,5-T.

Bailey et al. (1970) studied the movement and persistence of silvex in water and sediment under impounded conditions. Application of the PBGE ester of silvex was made at the rate of 9 kg/ha. Samples were taken 4, 12, 24, and 48 hours after treatment and analyzed for the presence of the PGBE ester of silvex. Although the concentration of silvex initially increased in water, by the end of three weeks the concentration had decreased to zero. Silvex and the PGBE ester of silvex can apparently be adsorbed by sediment particles. However, there was "essentially complete disappearance" of both at the end of five weeks. A 9 kg/ha dosage is a considerably greater dosage than would be applied to a forest site or than would be expected to enter a forest stream (based on a conversion rate of 1 lb/acre = 1.12 kg/ha, and the usual application rate of 2-4 lbs silvex per acre).

5. Atrazine

Unlike 2,4-D, 2,4,5-T, and silvex, atrazine is not an auxin-type herbicide. It does not contain the contaminant TCDD. The biological effects of atrazine as they relate to humans include data on the toxicity of atrazine.

The LD_{50} for several organisms has been established:

Table 16 - Atrazine LD_{50}

Species	Formulation	Oral Dosage LD_{50}	Reference
Albino rats	Technical	3,080 mg/kg	Geigy Agriculture Chemicals 1971
Albino mice	Technical	1,750 mg/kg	
Albino rats	80W	5.1 ± 0.4 g/kg	
Species	**Formulation**	**Dermal Dosage LD_{50}**	**Reference**
Albino rats	80W	9.3 ± 0.9 g/kg	Geigy Agricultural Chemicals 1971

Additional data on toxicity, provided by Geigy Agricultural Chemicals (1971), indicate that "There has been no evidence of toxicity in rats subjected to aerosol dust containing the equivalent of 1.6 mg/liter of technical grade atrazine."

The question of teratogenicity and carcinogenicity of atrazine has also been addressed, and "Long-term studies in rats and mice have revealed no carcinogenic and teratogenic effects either in the parents or progeny following long-term administration of atrazine," (Geigy Agricultural Chemicals 1971).

The Technical Panel on Carcinogenesis of the Secretary's Commission on Pesticides and Their Relationship to Environmental Health (Health, Education and Welfare) examined the available reports on tests of tumorigenicity conducted on about 100 pesticidal chemicals and assigned each of the pesticides to one of four groups: A, B, C, or D. Atrazine was placed in the group containing those pesticides for which the available evidence was considered insufficient for judgment (Group C). Atrazine was further placed in Priority Group C4, one of four priority groups in Group C. Priority Group C4 was characterized by "Tumor incidence not elevated in adequate studies conducted in one species only but current guidelines require negative results in two animal species for judgments of negativity," (U.S. Dept. of Health, Education, and Welfare 1969).

Chapter 8 of the Report contains information on tests run by the Bionectics Research Laboratories of Litton Industries with various pesticides and related compounds for teratogenic effects. "The Bionetics data were reanalyzed statistically to account for litter effects."

The data for atrazine was placed in a table containing data on "Tests which showed no significant increase of anomalies (with particular doses, solvents, or test strains)".

The data for atrazine were as follows:

Compound	Strains	Solvent	Dose per kg body weight	Increased Mortality (C57B1/6)	Total Number of Litters
Atrazine	C3H	DMSO	46.4 mg	--	6
Atrazine	C57	DMSO	46.4 mg	--	13
Atrazine	AKR	DMSO	46.4 mg	--	15

(U.S. Dept. of Health, Education, and Welfare 1969)

Current patterns of atrazine usage and its known fate in the various components of the environment, indicate that an accumulation constituting a hazard to any aspect of human health is highly unlikely.

Fate in the Environment

Kozlowski and Kuntz (1963) found that:

> When Plainfield sand to which atrazine, simazine, or propazine was surface-applied and leached, most of the herbicide remained in the first inch of soil regardless of whether two, four, or eight inches of water was used in leaching. However, some herbicides, especially atrazine, moved downward to a six inch depth. With increased amount of leaching more herbicide was translocated out of the first inch of atrazine-treated soil. Such an effect was not as apparent with simazine- or propazine-treated soil. The greater leachability of atrazine was probably related to its greater solubility. This study, which demonstrates the difficulty of removing triazine herbicides from upper soil levels even with large amounts of water, emphasizes the dangers of possible persistence and accumulation of triazine herbicides in forest nurseries, even in light sandy soils.

Atrazine is more readily adsorbed on muck or clay soils than on soils of low clay and organic matter content. The downward movement or leaching is limited by its adsorption to certain soil constitutents. Adsorption is not irreversible and desorption often occurs readily, depending on temperature, moisture, pH, etc. Atrazine is not normally found below the upper foot of soil in detectable quantities, even after years of continuous use.

The residual activity of atrazine in soil at selective rates for specific soil types is such that most rotational crops can be planted one year after applications, except under an arid or semiarid climate.

Atrazine will persist longer under dry and cold conditions or conditions not conducive to maximum chemical or biological activity. Broadcast rates needed in some of the heavier organic matter soils of the North Central states results in enough residue carryover, under some conditions, to injure small grains, alfalfa, and soybeans planted 12 months later. Plant removal and chemical alteration are also factors in dissipation.

6. <u>Dalapon</u>

Dalapon (2,3-dichloroproprionic acid) is a chlorinated aliphatic acid. It is particularly effective against grasses, but also controls certain dicotyledonous plants.

Dalapon is very low in acute oral toxicity to all mammals tested. The acute oral toxicity ratings ranged from an LD_{50}, of 3,860 mg of chemical per kg of body weight to an LD_{50} of 9,330 mg of chemical per kg of body weight. These concentrations are considered almost nontoxic. Dalapon has a dermal toxicity rating which is mildly irritating (Bailey and Swift 1968). The likelihood of human subjects, livestock, or wildlife ingesting sufficient amounts of sodium salapon to cause serious toxic effects is extremely remote.

The acute oral LD_{50} at 95 percent confidence levels for five different animal species for dalapon were as follows (Paynter et al. 1960):

Animal	Sex	LD_{50}
Rat	Male	9,330
Rat	Female	7,570
Mouse	Female	4,600
Guinea pig	Female	3,860
Rabbit	Female	3,860
Chickens	Mixed	5,660

No evidence has been found that dalapon sodium penetrates the intact skin in actutely or subacutely toxic amounts in rabbits (Paynter et al. 1960). Two dogs were each given sodium dalapon orally by capsule, five days a week during an 80-day period. Doses were 50 mg/kg per day for the first two weeks and then adjusted upward at weekly intervals to a maximum dose of 1000 mg/kg per day. Other than vomiting, the dogs were not adversely affected. During the autopsy the viscera and body cavities revealed no specific findings in either dog which could be associated with the oral administration of sodium dalapon (Paynter et al. 1960).

Ten male and ten female rats were maintained for 97 days on diets containing 0.0115 percent, 0.0346 percent, 0.115 percent , 0.346 percent or 1.15 percent of dalapon sodium. In the male rats there was no effect at the 0.115 percent level, which is equivalent to an average of about 115 mg/kg per day for young growing animals. In the female rat there were slight increases in average kidney weights at 0.115 and 0.346 percent levels. There was no evidence of adverse effects at the higher concentrations of 0.346 and 0.15 percent (Paynter et al. 1960).

Twelve dogs were divided into four groups of two males and one female. Each group was given 0, 15, 50, or 100 mg/kg per day of dalapon sodium by capsule, five days a week for 52 weeks. The test dogs exhibited normal behavior, gained weight, and exhibited outward reactions attributable to the test material. The animals on 100 mg/kg per day dosages showed an increase in average kidney weight. There was no significant difference in the tissues from the control dogs and the test dogs (Paynter et al. 1960).

Mature rats were given 5, 15, and 50 mg/kg of dalapon sodium per day. No adverse effects were reported except that at 50 mg/kg per day there was a slight average increase in kidney weight. Over a period of approximately 18 months, a total of 2,476 rats in 261 litters were involved in the experiment. The animals were given a diet containing 0.0, 0.1, or 0.3 percent dalapon sodium (Paynter et al. 1960).

Soil - Dalapon breaks down rapidly in soil, hydrolzes slowly in water, but is persistent in plants. Thiegs (1955) showed that the breakdown of dalapon in soils is due to micro-biological action. Dalapon was found to decompose most rapidly in warm, moist soils, whereas in cool or dry soils the herbicide remained for extended periods.

Day, Jordan, and Russell (1963) reported that Jansen found that soil fungi and a species of agrobacterium as well as certain pseudomonads, decompose dalapon in the soil. Dalapon may well be utilized by a wide range of soil microorganisms, since its addition to soils has been observed to have had a broad stimulating effect on soil microflora (Day et al. 1963, Fletcher 1963).

Day, Jordan, and Russell (1963) report on the persistence of dalapon under laboratory conditions in 43 soils collected from California citrus districts. The rates of decomposition of dalapon were highly variable among the soils studied, apparently due to differences in the population of soil microorganisms capable of decomposing dalapon. Decomposition of dalapon ranged from complete disappearance in less than two weeks to the retention of two-thirds of the added dalapon after eight weeks. The capacity of the soil to decompose dalapon was essentially random with respect to soil series, texture, cation-exchange capacity, total organic matter, and geographical source.

Plants - As dalapon enters the plant, it is moved about through the plant systems and may be excreted from the roots into the surrounding soil as dalapon. It apparently is not metabolized by the plant to any appreciable extent. Tests with carbon 14-labeled dalapon show evidence that dalapon is neither metabolized nor broken down by either susceptible or resistant plants, but remains in the plant tissue as dalapon (Leasure 1963).

Dalapon is readily absorbed through the roots, but seems to be more systemic in its action when applied to foliage. Dalapon is absorbed and translocated by plants. Once in the plant, it is relatively stable and not readily metabolized. Dalapon is transported readily in both phloem and xylem and has proved useful as both a foliar spray and a soil application for controlling susceptible weed species.

Water - Dalapon is apparently more persistent in water than in soil. Oxygen levels are lower and microbal populations are therefore different. Anaerobic species are favored in aquatic environments, whereas aerobes usually predominate in agriculture soils, particularly in the surface-soil layers. Most microorganisms that effectively decompose herbicides are aerobic (National Academy of Sciences 1968). Warren (1964) reports that dalapon will hydrolize slowly depending upon temperature unless some microorganisms are present.

Frank, Demint, and Comes (1970) provide data concerning the concentration and persistence of dalapon in irrigation water following tests on canal-bank treatments for weed control. On the canal where dalapon was sprayed directly on the water surface to provide a concentration of 100 ppb at the application site, it was calculated that the residue level would approach zero 20 miles downstream.

Frank, Demint, and Comes (1970) concluded that dissipation of freely water-soluble herbicides, not extensively absorbed from water solutions is affected principally by dilution. They also concluded that it is unlikely that illegal residues would be contained in crops irrigated with water containing the concentration of dalapon found in their study.

7. Dicamba

Dicamba is a broad spectrum herbicide useful for site preparation, right-of-way clearing, weed control, and other uses. The toxicity of dicamba to several species of animals has been investigated.

Rabbits and guinea pigs are twice as sensitive to dicamba as are rats. The oral LD_{50} was 566 and 1,068 mg/kg respectively. (Velsicol Chemical Corporation Bulletin 521-2)

Dicamba was fed for 13 weeks to male and female rats at the rate of 100, 500, 800, and 1000 ppm of the diet. Food consumption and growth rate remained normal, no deaths occurred, and pathology at the end of seven weeks was negative. At the end of 13 weeks, there was some liver and kidney pathology at the 800 and 1000 ppm level, but none at or below the 500 ppm levels. Rats fed at 5, 50, 100, 250, and 500 ppm of diet, and dogs fed at 5, 25, and 50 ppm of diet, sowed no apparent effects after two years of continuous feeding.

The dimethylamine salt of dicamba administered undiluted to the skin of rabbits and rats produced a very mild irritation when administered daily for two weeks. When diluted 1:40 in water, no irritation was observed even after 30 days. There was no evidence of systemic toxicity from absorption through the skin (Velsicol Chemical Corporation 1974). No evidence of toxicity due to inhalation has been noted. Rats on a diet containing 500 ppm dicamba for three or four months did not produce evidence of teratogenicity over a three generation study (Velsicol Chemical Corporation 1974).

Fate in the Environment

Vegetation - Dicamba is not very persistent in plant tissues. Dissipation can occur by metbolism within the plant, exudation from the roots, and loss from the leaf surface by washing, photodecomposition, or chemical decomposition (Velsicol 1969). Dicamba and its metabolites (5-hydroxy-2-methoxy-3, 6-dichlorobenzoic acid, and 3, 6-dichlorosalicylic acid) were dissipated rapidly from bluegrass and bermuda grass as shown in the following table (Velsicol 1969):

Period after treatment (days)	Dicamba (ppm)			5-hydroxy-2 methoxy 3,6-Dichlorobenzoic acid (ppm)			3,6 dichloro-salicylic acid (ppm)
	2 lb	5 lb	10 lb	2 lb	5 lb	10 lb	
7	51.1	86.2	250.0	33.6	19.3	135.0	negligible (less than 0.05 ppm) amounts in all cases.
14	24.4	51.8	96.0	14.5	34.7	33.5	
30	6.7	15.9	21.7	11.9	32.0	42.2	
60	4.0	4.5	12.5	9.7	11.9	25.3	

Similar dissipation patterns were found from green tissues of silver beardgrass, little, bluestem, dallisgrass, and sideoats grama (Morton et al. 1967). It should be noted that both metabolites of dicamba are of low order toxicity. Both metabolites are also herbicidally inactive.

Soil - Dicamba is relatively easy to leach from surface layers of soil. Comparatively, dicamba is considered one of the most mobile of the herbicides after it enters the soil (Velsicol Chemical Corporation 1971).

Dissipation of dicamba in the soil has been studied (Sheets et al. 1964, Burnside and Lavy 1966, Chirchillo 1968, Velsicol Chemical Corporation 1971). It was found that degradation by chemical and/or microbial action was most rapid when soils were at or near 80 percent field capacity and at 25° to 35° C. Under these conditions, breakdown of the chemical was complete within a time frame of one to two months. The rate of biodegradation increases with temperature; reaching maximum at about 28° to 35° C. At somewhere near 50 percent moisture biodegradation reached maximum and then declines with increasing moisture. These temperatures and moisture contents are conducive to bacterial action. Audus (1964) and Cain (1966) found that *Bacillus cereus* var. *mycoides* was capable of breaking down dicamba and stated that this bacterium is a common organism, found widely distributed in the soils.

Studies by Velsicol Chemical Corporation (1971) found that dicamba was rapidly broken down or leached to deeper layers of soil. There is some evidence that dicamba may be broken down by photodecomposition (Velsicol Development Newsletter Vol. 1 #2).

Water - Norris and Montgomery (1975) state that dicamba is one of the most mobile herbicides in soil. They add that entry into the soil profile reduces the probability of the herbicide entering streams by overland flow except during the first intensive storms after application.

Evidence obtained from stream monitoring, following an application of dicamba, leads Norris and Montgomery (1975) to conclude that dicamba posed no acute hazard to aquatic organisms or to downstream water users, and the short persistence of the herbicide in the water precluded chronic exposure. They stated that dicamba can be used for brush control on forest lands with little or no impact on aquatic environment, if direct application to surface waters is minimized by using appropriate spray application techniques.

Since the dimethylamine salt of the acid of dicamba is quite soluble in water, photodecomposition might be one of the few ways breakdown occurs in water. Uptake by stream or pond vegetation and ultimate metabolism by the plants would also contribute to clearing water of the chemical. Precautions should be taken to avoid contamination of waterways, ponds, or lakes (Velsicol Chemical Corporation, 1971).

8. Amitrole

Amitrole is also a broad spectrum herbicide like dicamba. It can be used for conifer release and site preparation. Like previously discussed herbicides, amitrole has been tested to determine its toxicity to rats.

Dietary levels of 1,000 and 10,000 ppm of amitrole administered to rats for 63 days resulted in altered body weight gain and fatty metamorphosis of liver cells (Weir et al. 1958). After 68 weeks of a two year feeding trial on rats, levels up to 50 ppm had no effect on females but males had enlarged thyroids. Poisoning symptoms have not been noted for pure amitrole. In the event of ingestion of amitrole-T, thiocyanate poisoning should be suspected. The acute oral Ld_{50} of NH_4SCN is 750 mg/kg (rats) (Weed Science Society of America 1967).

Amitrole has been suspected of being teratogenic and carcinogenic. Carcinogencity suspicions generated the "cranberry scare" of 1958 to 1959. Later reports, however, indicate that amitrole does not represent any unusual hazard (House et al. 1967). No teratogenic effects attributed to amitrole were found in treated hen's eggs (Dunachie and Fletcher 1970).

Amitrole is an antithyroid agent and has been tested for controlling hyperthyroidism. The stimulation of abnormal growth of the thyroid gland after feeding high dosages of amitrole has been construed as evidence of carcinogenicity. In chronic feeding studies involving exaggerated rats fed over a long period of time, thyroid tumors began appearing in rats fed at 100 ppm for 68 weeks (Weir et al. 1958).

Exposure to amitrole among Swedish workers has resulted in a significantly higher incidence of tumors and mortality. The effects described are similar to those described in animal experiments with amitrole. The investigators suggest that safety precautions be observed when working with amitrole (Axelson and Sundall 1974).

Fate in the Environment

Amitrole residues could not be detected two months after application of one to two pounds per acre on three soil types in Oregon (Norris 1970a). Amitrole was absorbed in red alder humus more rapidly than it was desorbed (Norris 1970a). After 35 days, recovery of amitrole from red alder forest floor material had dropped to 20 percent (Norris 1970b). The presence of 2,4-D or ammonium thiocyanate are not likely to influence the persistence of amitrole in the field (Norris 1970b). Degradation of amitrole proceeded at a near normal rate in steam-sterilized forest floor material despite nearly complete absence of biological activity (Norris 1970b).

Amitrole appears to become tightly absorbed to soil particles and can complex metals (Sund 1956). Amitrole disappears rapidly from soils; however, disappearance has been attributed to adsorption, microbial degradation, and nonbiological destruction as pointed out in a literature review by Carter (1969). Evidence indicates that nonbiological destruction is the most important cause of amitrole disappearance in soils (Carter 1969).

Water - Amitrole was not degraded by biologic action in river water, sewage, activated sludge, or anaerobic digestion tests (Ludzack and Mandia 1962). Amitrole interfered with nitrification in river water and activated sludge. Chlorination degraded amitrole to unidentified compounds. Studies of amitrole contamination in streams following aerial applications indicate that maximum residues occur immediately after spraying and decline rapidly (Marston et al. 1968, Norris 1967, Norris et al. 1966, 1967). A maximum concentration of 155 ppb at the downstream edge of a 100-acre unit treated at two pounds per acre was attained 30 minutes after application began (Marston et al. 1968). The concentration decreased to 26 ppb by the end of the two hour application and to non-detectable amounts six days after spraying. No amitrole was detected more than 1.8 miles below the sprayed area.

In another study, maximum concentration immediately downstream from the sprayed area was 422 ppb 0.17 hours after spraying and dropped to 6 ppb eight hours after spraying (Norris 1967). Residues did not persist into the next year and heavy rains six months after application did not introduce measurable amounts of amitrole into the same stream (Norris et al. 1966, 1967).

Norris (1971b) concluded that the relatively large doses of amitrole required to produce acutely toxic responses in most nontarget organisms are not likely to occur from normal chemical brush control operations on forest lands. The short persistence, lack of biomagnification in food chains, and the rapid excretion by animals prevents chronic exposure and, therefore, chronic toxicity.

9. Picloram

Picloram has the chemical name 4-Amino-3,5,6-trichloro-picolinic acid. It is usded for the control of annual and deep-rooted perennial weeds in noncropland and rangeland. Its primary forestry use is for site preparation.

Picloram has very low, acute oral toxicity. The LD_{50} values range from 2000 mg of picloram per kg of body weight in mice and rabbits, to 8200 mg of picloram per kg of body weight in rats. A single dose of up to 500 mg per kg gave no evidence of toxicity in calves. Picloram causes minimal skin irritation and is not likely to be adsorbed through the skin. Although the picloram dusts may be somewhat irritating, they are not likely to cause illness when inhaled. Picloram may cause mild irritation to the eyes, which heals rapidly, and results in no corneal injury (Weed Science Society of America 1967).

Chronic exposure to picloram shows little or no ill effects on test animals. Feeding studies conducted for 90 days with rats showed no adverse effects from dietary levels as high as 1000 ppm of picloram (McCollister et al. 1969). In long-term feedings, albino rats and beagle dogs were fed picloram at a rate of 15 to 150 mg per kg of body weight for two years. No observable adverse effects were noted in either species as measured by body weight, food consumption, behavior, mortality, hematological and clinical blood studies, or urine analyses.

Picloram apparently has no teratogenic effect. Albino rats fed picloram at various levels up to 3000 ppm showed no adverse effects in terms of fertility, gestation, viability, and lactation through three generations (McCollister et al. 1969). No information was found concerning the carcinogenicity of picloram.

The chemical was evaluated using the procedures established by the joint FAO/WHO Expert Committee on Food Additives. A 100-fold safety margin was used. The acceptable daily intake of picloram for man is calculated to be 1.5 mg/kg of body weight per day. A well-fed person in the United States would consume 0.1 mg per day if he ate meat from animals that grazed continuously on grasses containing 200 to 400 ppm of picloram. This is a fraction of the 90 mg/day that a 130-pound human could safely consume; representing a safety margin of 90,000 to 1 when compared to safe levels deomonstrated in laboratory animals (McCollister and Leng 1969).

Fate in the Environment

Vegetation - Residues of picloram in woody plants in tropical areas ranged from 31 to 687 ppm immediately after spraying two pounds of active ingredient per acre. This dropped to less than one ppm a month later (Bove and Scrifres 1971).

Soil - Studies of persistence of picloram in soils (Hamaker et al. 1967) have shown that with initial rates of one ounce and two pounds acid equivalent per acre, the time for decomposition to concentrations of 0.01 ounces per acre would be 4.5 months and 4.6 years, respectively. The half-life in soil of a herbicide may be a better measure of persistence. Half-life is the time that is required for half of the herbicide applied to the soil to be inactivated or to disappear. Picloram degrades in soils with a variable half-life of from 1 to 13 months (Goring et al. 1965). Most investigators agree that dissipation is accelerated at higher temperatures (Bovey and Scrifres 1971).

Norris et al (1976a) studied the leaching and persistence of picloram on powerline rights-of-way in the Pacific Northwest. The herbicides showed a rapid decline in concentration in forest floor and soil after application. Biologically significant residues were seldom present for more than 12 months after application. There was no leaching of herbicides below 30 cm in the soil and relatively little below 15 cm. When a forest floor was present, nearly all the detectable herbicide was present there.

Norris et al. (1976b) reported picloram applied to a southern Oregon hillside pasture was largely confined to the surface six inches of soil and the concentration declined rapidly with the time after application. Residues in the surface six inches averaged 60, 20, and 4 ppb picloram 9, 18, and 27 months, respectively, after treatment.

Water - Norris et al (1976a) reported no residue of picloram was found (minimum detectable level 0.1 ppb) in streams flowing across treated powerline rights-of-way despite intensive sampling with automatic equipment for periods in excess of six months after application. The authors conclude the lack of residues in stream water is consistent with the relatively short persistence and limited mobility of picloram in the environment.

Norris (1969) noted that in an area where 67 percent of a watershed was sprayed in August, residues up to a maximum of 0.078 ppm were detected after the initial one inch storm and they decreased thereafter. No residues were found after late October or where only a small portion of the watershed was treated.

Norris et al. (1976b) studied picloram outflow from a 16-acre hillside pasture watershed in southern Oregon. The entire watershed was sprayed in June with two pounds per acre picloram, including the stream channel. There was no water in the stream until October. The first two storms caused limited wetting of the stream channel and filled the pools, but caused no outflow from this gauged watershed. Maximum picloram concentration was about 0.1 ppm. The first water to flow from the watershed carried some picloram, but the concentration was low (20 ppb). No herbicide was detected after January.

About 0.28 percent of the picloram applied to the watershed appeared in streamflow during the three year study. The dry stream channel accounts for 0.21 percent of the area of the watershed. The authors concluded the herbicide outflow largely represented mobilization of residues applied in and near the dry stream channel.

10. Monosodium Methanearsenate (MSMA) and Cacodylic Acid

These two similar herbicides are used for thinning and plantation release. In contrast to the previously discussed herbicides, they are only applied by injection. The mode of action and dermal penetration of organic arsenicals and the fact that arsenic is one of the heavy metals poses more of a hazard to operators than many other compounds with similar LD_{50}'s. Special care must be exercised in providing personal protection.

The toxicity of MSMA, as expressed by the acute oral toxicity, is about the same in rats as cacodylic acid. The LD_{50} of technical grade MSMA (92.8 percent pure), is 1,400 mg/kg for male rats. The oral LD_{50} is 1800 mg/kg in rats and 700 mg/kg in mice (Dickinson 1972).

The LD_{50} for a person is estimated to be about 1800 mg/kg. The approximate dose necessary to cause the death of a 150-pound human is 120 ml or about 1/2 cupful (Washington Pest Control Handbook 1971).

MSMA is also known to be mildly irritating to the skin in rabbits, but the Washington Pest Control Handbook (1971) reports that cacodylic acid causes little or no skin irritation. No data on the chronic effects of MSMA was available. Both MSMA and cacodylic acid have similar potential to be either teratogens or carcinogens. The precise toxicity levels of cacodylic acid and monosodium methanearsenate in humans is not known. Both cacodylic acid and monosodium methanearsenate have a toxicity rating of four. The safe use of organic arsenicals depends on minimizing the exposure of anyone handling these chemicals.

Industrial Bio-Test Laboratories, Northbrook, Illinois, found that 50 percent cacodylic acid resulted in an LD_{50} of 1800 mg/kg in male rats and 1000 mg/kg in female rats. Technical grades of cacodylic acid (61.3 percent cacodylic acid) produced similar results, 1400 mg/kg in male rats and 1280 mg/kg in female rats (Ansul 1967).

Cacodylic acid is considered to be a teratogenic agent, as in MSMA. Early studies indicated arsenic to be a carcinogen but later studies failed to demonstrate arsenic-induced cancers. The Secretary's Commission on Pesticides has placed cacodylic acid in group C4 (not positive for carcinogenicity in one species). MSMA is placed in the same C4 group.

Laboratory tests for mutagenicity have shown cacodylic acid causes cell division when injected into mice. Significance of the findings to field exposure is not known.

11. Krenite

Krenite (ammonium ethyl carbamoylphosphonate) has a very low acute and chronic toxicity. The LD_{50} for the male rat is 24,400 mg/kg. It has a relative low acute inhalation toxicity (DuPont 1976). No long term feeding studies have been undertaken as Krenite is not registered for food crop use.

Fate in the Environment

Greenhouse soil disappearance tests with ^{14}C-labeled Krenite indicated about a 10-day half-life. Under field tests the half-life was about one week. Because of rapid degradation there was little or no downward movement of Krenite or its degradation products (Du Pont 1976).

Krenite is soluble in water but readily absorbed by soil particles. Therefore, it does not have the potential to run off into surface waters or leach into subterranian aquifers. It has a Freundlick K equilibrium constant on Keypart silt loam greater than 20, indicating a high absorption to the soil (Du Pont 1976).

12. Simazine

Simazine has low toxicity to animals and probably also to man, since there have been no reports of poisoning from ingestion. Neither have there been any serious eye or skin irritations reported from either experimental or commercial use, despite the fact that simazine has been in use since the late 1950's.

Acute Toxicity

The acute oral toxicity (LD_{50}) of simazine to rats, mice, and rabbits is in excess of five g/kg of body weight (Geigy Agric. Chemical 1970). Cattle fed 250 mg of simazine/kg of body weight as a drench showed poisoning symptoms after one dose, but survived three doses with 11 percent weight loss (Palmer and Radeleff 1969). The acute dermal LD_{50} to albino rabbits is greater than 10 g/kg. (Geigy Agric. Chemical 1970)

Chronic Toxicity

No sign of systematic toxicity was observed in rats when fed daily dosages of 100 ppm of simazine 50W in their diet. However, two yearling calves showed symptoms of poisoning after 3 and 10 doses of 25 mg/kg of body weight, while sheep fed the same amount of simazine for five weeks remained normal. (Geigy Agric. Chemical 1970)

Fate in the Environment

The half-life of simazine in soil varies indirectly with temperature (Burschel 1961). At 25°C, 50 percent of four ppm disappeared in 20 days, at 18°C in 39 days, and at 8.5°C in 140 days (Sheets 1970).

Soil - Simazine has little lateral movement in soil but can be washed along with soil particles. Leaching is limited by its low water solubility and adsorption to certain soil constituents. It is more readily adsorbed on muck and clay soils than in soils low in clay and organic matter (Weed Science Society of America 1974).

Water - The low to moderate mobility of s-triazines (of which simazine is one) reduces the possibility of contamination by vertical leaching to ground water. Surface movement is somewhat more likely on steep slopes when intense rainfall occurs immediately after application (Helling 1970).

Air - Simazine is more volatile from dry soil than from wet soil. Soil type and temperature, however, do not seem to affect the rate of volatilization of simazine (Kearney et al. 1964). The volatilization of simazine at 60°C was found to be 35 percent in 24 hours (Foy 1964).

13. Dichlorprop

Dichlorprop (2,4-DP) has the chemical name of 2-(2,4-dichlorophenoxy) propionic acid. Its primary forest use is for brush control along forest roads. It suse is very limited and, therefore, it is mentioned in this statement only as a basis for comparison with other herbicides.

Acute Toxicity

According to the toxicity summary for weedone brushkiller 170, the oral LD_{50} is 375 mg/kg of body weight. Toxicity via the inhalation route of dermal application is thought to be minimal. Slight to moderate occular irritation may occur from direct administration of the compound into the eye or conjunctival eye sac of rabbits (Amchem).

Chronic Toxicity

No sign of systematic toxicity was noted in rats fed 12.4 mg per day for 90 days.

Mutagenic Potential of Dichlorprop

Tests for point mutations were not detected when screening dichlorprop against two strains of bacteria (Anderson et al. 1972).

Fate in the Environment

The median tolerance limit (TLm) of bluegill sunfish to dichlorprop is as follows:

	Acid Equiv. 24 hours	Ppm 48 hours
Dimethylamine	165	165
Isooctyl ester	16	16
Butoxyethanol ester	1.1	1.1

(Hughes and Davis 1963)

In evaluating the effects of dichlorprop on fertilized fish eggs and fry, no reduction in the survival period of the fry was noted (Hiltibran 1967).

It has been observed in greenhouse studies that dichlorprop after 103 days restricted root growth of alfalfa seedlings (Burger et al. 1962).

III. FAVORABLE EFFECTS

A. Non-Living Components

Herbicides are effective and the results are long lasting. When compared to the other vegetation management alternatives, only herbicides can give lasting control of the pest plant's root system. The problem of sprouting or regrowth of pest plants can not be overcome without good root control Herbicides can give this control without disturbing the humus layer, accelerating erosion, or possibly reducing site quality through soil compaction. The diversity of vegetation and new stands of trees or grass encouraged by the selectiveness of many herbicides adds to the visual richness of the Eastern Region.

The use of manmade ponds for fishing and swimming is often possible only if unwanted algae and weeds can be controlled. Herbicides and algaecides are available that will allow control without harmful effects on the quality of the water.

B. Living Components

Long-term studies have shown that most hardwood and conifer species respond favorably to full release at the juvenile (5-10 years) stage of their growth and development. These responses are displayed by improvement in the rate of survival and the acceleration of individual tree growth. Survival among young hardwoods and pine has been increased by 15 percent to 20 percent through early release, with individual trees of other species growing 3-1/2-4 times taller than non-released individuals. Diameter growth is also improved on the released trees. Twenty-two years after treatment, 50-year old white pine trees in Minnesota had an average diameter 3.3 inches larger than those not released. Beneficial response to release is reflected in a greater net growth (total cordwood or cubic feet yield) than non-released stands. Spruce volumes can be increased 25 percent to 40 percent through early release. Most significant is the early development of a sawtimber component in the released stands as the result of improved height and diameter growth. This early development of sawtimber volume under certain growing conditions makes early release in pine a sound forestry investment.

Herbicide use helps man to continue the historical vegetation composition of many local forest areas. A heterogeneous forest has been found to be more resistant to insect and disease losses. In addition, plant diversity benefits many species of wildlife. Wildlife food sources can increase, as overhead canopies are opened up. Crowns of remaining mast producers are stimulated and production is increased. A greater variety of herbage becomes available to browsing animals. A number of insect feeding woodpeckers, cavity nesting birds, and small mammals benefit from dead trees left standing following the herbicide treatment. Wildlife openings once naturally created and maintained by wildfires can now be managed by using herbicides.

C. Social Economic Components

The labor savings made possible by the use of selective herbicides on right-of-ways for the control of woody species that would endanger powerlines, inhibit visibility, and present other safety hazards have allowed maintenance people to use a greater part of their budgets for providing better roads, railroad beds, and utility transmission systems. Besides being costly, other alternatives of brush removal involving repeated removal followed by stacking and burning, often resulted in escaped fires.

In timber management, a valuable wood resource can be established to supply the Nation's growing demand for wood fibers. In some cases, up to a 300 percent increase in high quality wood production will occur. This will aid the economic and social conditions of the local communities. Increased forest output will increase returns both to the Federal government and local counties from stumpage payments. Another favorable effect of herbicide use is the maintenance of a National timber supply which includes a continual, competitively available, renewable resource that requires minimal energy to go from raw material to end product. In contrast, alternatives to wood products are not renewable and conversion from raw material to consumer product frequently requires a lot of energy.

The use of herbicides to quickly and effectively manage vegetation frees available work crews for other needed projects. The National Forests have a long list of needed labor intensive work projects that can only be completed by crews using hand tools. These projects; hiking trail, camp ground, and picnic area construction; creating wildlife openings; thinning and pruning of trees, etc., have few if any alternatives to completion by hand work. Government efforts to employ people will produce the greatest benefits to the Nation if work is accomplished in those areas where alternatives to manual labor do not exist.

The aerial application of herbicides is less energy demanding than completing the same release with work crews using hand tools. A helicopter, while consuming 20-30 gallons of aviation fuel an hour, releases 50-100 ac/hour (about 2.5-3.3 ac/gal of fuel). In comparison, a crew of four people commuting to a work project in a car each day would complete about one acre of release for each gallon of fuel used. Accomplishing 10,000 acres of release work by helicopter could result in a substantial fuels saving.

Herbicides are making more animal protein available at a lower cost through improved pastures and rangeland.

As mentioned earlier, under the objective in Section I, favorable effects of herbicide use are protection and production orientated, resulting in improved economic welfare and community stability.

IV. SUMMARY OF PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

A. Non-Living Components

1. Air. Minor losses of herbicide will occur through volatilization. The amount of volatilization will be greatest with aerial methods of herbicide application. These losses can be greatly minimized, but not

completely eliminated. Once in the air, photo-alteration can alter the chemical makeup of the herbicide.

2. Hazardous Substances. The hazardous substance - 2,3,7,8 - tetrachloro dibenzo - p - dioxin (TCDD) - is present in 2,4,5-T and silvex. Pure TCDD is reportedly the most toxic synthetic chemical known. In laboratory tests, both TCDD and 2,4,5-T have demonstrated the biological potential for producing teratogenic and mutagenic effects and an increased tumor incidence. Risk to humans, while apparent, is not real, due to the minute volume of TCDD applied per acre and the near absence of human exposure to most treatment areas.

   Workers handling herbicides are exposed to safety risks normally associated with chemical use. The hazard is minimized through established safety practices and standards.

3. Land Ownership - Land Use. Adverse land use patterns of National Forest lands are not anticipated following herbicide use.

4. Soils. The forest soils can be a major receptor of herbicides. The amount of herbicide actually reaching the soil can be minimized, but not completely eliminated. The herbicides proposed for use have not been found to accumulate in the soil, leach out, or move overland abnormally.

   The possibility of an accidental herbicide spill during spray application or transportation of the containers always exists. If such a spill should occur, some concentrated herbicide could end up in the soil. The greatest volume, but the least concentration of herbicide, 5-10 percent, would occur from an accidental spray rig spill. An accident involving 30 or 55 gallon drums of pure herbicide would be the most adverse. The chance of such an accident is very minor.

5. Visual. Visual and aesthetic values are generally lowered during brown out; however, the effect is temporary and lasts only until leaf fall. A longer lasting visual impact is created by the standing dead trees that will remain for several years.

6. Water. Herbicides which vaporize during application or from vegetation eventually precipitate out, some directly into water. Such contamination will be of extremely low intensity, but unavoidable. Accidental herbicide entry directly into waters adjacent to forest treatment areas has not been found to exceed the EPA's potable water standards. Investigations have shown a 100-fold dilution rate, with downstream movement of 1

mile and a maximum possible human exposure level of 0.01 ppm for 24 hours when measured immediately downstream from a treated area.

With the decrease in vegetation on a treatment area, an increase in stream flow will occur. Small treatment areas make flow increase very minor. Flow will return to the before treatment levels in 1 to 10 years, depending on the amount of vegetation removed. This change in stream flow can also be beneficial and could be a goal of vegetation management.

Where the goal is conifer management, water quantity will be less than if the same area were in grass or hardwoods. Permanently foliaged conifers intercept, as well as transpire, more water than do deciduous hardwoods or grasses.

B. Living Components

1. Domestic Animals. No direct adverse affect to livestock is anticipated; however, an indirect effect may occur through changes in the palatability of poisonous or nitrate accumulating plants which may be consumed by livestock trespassing in sprayed areas.

2. Man. Individuals involved with manufacturing, handling, and applying the herbicides face the greatest hazards. A lesser risk exists for those who might accidently intake herbicide residues through forest water, fruits, berries, or meat of wild game or fish. No direct, unavoidable effects to man are anticipated when herbicides are used according to label use directions, safety precautions are taken, and standards established for reducing risks are followed.

   The noise made by mechanical herbicide applying equipment may annoy some people. There is also an odor associated with most herbicide uses that some people find offensive.

3. Soil Organisms. There is no evidence to indicate that the herbicides proposed for use, when applied at recommended rates, will have any lasting effects on soil organism populations.

4. Vegetation. Following herbicide use, there will be an immediate reduction in the number of plants within the treatment area. Some nontarget plants may be adversely affected. Endangered or threatened plants, if present, or their specialized micro-habitats, may be inadvertently damaged or destroyed as a result of herbicide use.

5. Forest Vertebrate Animals. Herbicide applications will occur on areas occupied or visited by a significant number of wildlife species. The major impact will be a long-term, subtle change in habitat. This habitat change will occur with any of the vegetation management alternatives considered and in the long run, is more adverse than any immediate effects of herbicide application.

   The activities of man and his equipment during herbicide application will disturb wildlife. Other treatment methods considered would have a similar effect, probably of longer duration.

   Direct toxic effects are not anticipated.

6. Forest Invertebrate Animals. A significant hazard to forest invertebrates is not expected as a result of our proposed herbicide use in the Eastern Region.

V. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY.

A. Non-Living Components

1. Air. Mature forests are low producers of oxygen. Decaying forests are oxygen consumers. Using herbicides to increase new stand growth, following the harvest of mature stands, may contribute briefly to local air pollution. The long-term affect, however, is an increase in the quantity of oxygen and the quality of the air.

2. Hazardous Substances. The benefits of herbicide use continue to be weighed against risk. It is well documented that many of the herbicides proposed for use can produce toxic effects in test animals. These tests should be used to show the potential risks involved with misuse.

   Such tests, however, bear little resemblance to field applications proposed for use in the Eastern Region. To achieve toxic dosages in tests, the testing techniques frequently involve high dosage rates, extended periods of exposure, forced feeding, subcutaneous injections, exotic solvents, and the use of inbred strains of laboratory animals. The small quantity of herbicide available at any one forest location, the scattered location of treatment areas, the short life of applied herbicides, and the type and frequency of human activity in the treated areas make the hazards of herbicide use under field conditions improbable. In addition, there are other sources of food, other than those treated with herbicides, available to wildlife.

3. Land Ownership - Land Use. Most rights-of-way, utility, and transportation needs are long-term. Periodic maintenance of vegetation using herbicides is necessary to protect the investment costs for establishing these land uses. The number of people benefiting from such facilities is great and the benefits long-term.

4. Soils. The use of herbicides has an indirect affect on the soil. The immediate effect is reduced vegetative cover. The long-term effect is usually a vegetative cover that better protects soil stability.

5. Visual. A direct result of herbicide application is a brown-out or dying of the treated vegetation. The visual signs of the foliage color change is only seasonal, while evidence of dead twigs and stems will be longer. Flowering plants soon cover many herbicide treatment areas. They in turn, give way to a richness of contrasting vegetation types that will long please the users of the National Forests. Many of the young pine stands and pastoral openings seen in the forests today are partially the result of herbicide use.

6. Water. The long-term affect of herbicide use on water is indirect. The kind of vegetation to which eventually occupies an herbicide treated area will affect water output. Grass stands will provide the most water outflow, followed by hardwoods, and finally conifer stands. Where no change in major vegetation type occurs, water quantity outflow is minor and can return to before treatment levels in 1 to 10 years.

   Application of approved algaecides and herbicides directly to water for weed control may necessitate closure of the water body to human, livestock, or irrigation use for a period of days. The results of treatment however, can make the water usable for a variety of activities which can be enjoyed for a period of months.

B. Living Components

1. Domestic Livestock. Most livestock operations are based on long-term management plans. A sudden consumer demand for more meat cannot be met until forage is available and animal numbers are increased. Maintenance of grazing areas in forage production contributes to the long-term livestock production needs of the Nation.

2. Man. The use of herbicides has freed man from the laborous and never ending task of removing pest plants by hand. Herbicides have greatly increased man's productivity, both on the farm and in the forest. A

decision not to use herbicides would not be an end to progress, but it would significantly reduce long-term agricultural and forest productivity.

3. Soil Organisms. The activity of most soil organisms is considered a benefit to plant growth. Some herbicide applications have been found to increase the number of active soil organisms.

4. Vegetation. The short-term effect of herbicide use on vegetation is a reduction in plant numbers. At times this reduction in plant numbers may be permanent and the desired result of the herbicide application. The majority of herbicide use is aimed at maintaining or increasing the production of desirable vegetation without inhibiting or destroying the land's ability to produce.

   When herbicides are used to reduce noxious or poisonous weeds on National Forest lands, they not only benefit the user, but also aid nearby landowners by eliminating a source of infection.

   Long-term timber needs can only be met if an active timber management program is carried out today. It takes time to grow trees. Future demands must be predicted and actions taken now to meet those needs. We cannot wait for the demand for wood to develop and then start to grow the trees to supply the need. The time it takes to grow a crop of trees is just too long. The long-term benefit from vegetation management in plantations is increased production of the renewable natural resource - trees. A future generation will benefit, the same as we are benefiting now from reforestation efforts of 40-50 years ago.

   In treating some of the woody vegetation that has encroached on roadsides, trails, rights-of-way and wildlife openings with herbicides, future maintenance of these areas is more easily accomplished by non-chemical methods.

5. Forest Vertebrate Animals. Many wildlife species benefit directly from a disturbed forest. Wildlife populations can only be maintained if suitable habitat is available. Early successional stages of forest growth encourage wildlife diversity and abundance if properly interspersed with older growth conditions.

   Maintenance of young stands in a forest requires disturbance. Distribution of disturbance and diversity of vegetation are also important. Herbicides have been found to be useful in maintaining forest openings for wildlife and setting vegetation back to early successional stages. Long-term wildlife productivity on a forest-wide basis is maintained by annually creating a vegetation disturbance within a small pecentage of the forest cover type. In addition, dead trees, resulting from herbicide treatments, provide a long-term source of insect feed and den or nesting sites for a variety of forest vetebrates.

Weeds and algae can be deterimental to the fishery resource in a pond or lake. Through the use of herbicides or algaecides, the life of this resource can be greatly extended.

6. Forest Invertebrate Animals. Some research indicates that certain herbicides have an immediate and harmful affect on insects. The effects are short-term, however, with insect populations quickly regaining former numbers. Following some forms of herbicide treatment, many species of flowering forbs, flowering shrubs, and lush grasses will provide for increased insect populations for several years. Honey bee production has been known to increase. Insect feeding vertebrates find an available source of feed.

C. Social Economic Components

The knowledge that today's resource programs are producing for tomorrow's needs promotes community stability and encourages investments in long-term community growth.

Herbicides offer the most effective and least expensive means of protecting costly investments in road and utility rights-of-way and recreation and other physical developments from uncontrolled vegetation. The long-term benefits are measured in increased food, lower utility rates, available wood fiber, recreation opportunities, and improved wildlife habitat.

VI. IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

The results of herbicide use are not considered irreversible. It is not expected that any plant or animal species will be eradicated by the proposed use of herbicides. Some individual plants will be killed, reducing the total number of that species on the treatment area. Other plants will be partially affected, losing only part of their foliage or stems; as a result, they will suffer reduced growth. Occasionally one dominant use of the forest's resources has been established on an area and perpetuated through the use of herbicides. This commitment of land, however, can be altered should circumstances warrant.

The time, labor, herbicides, and petroleum products used and the vegetation killed are irretrievable.

VII. CONSULTATION WITH OTHERS

On October 30, 1973, a Final Environmental Statement, The Use of Herbicides in the Eastern Region, was sent to the Council on Environmental Quality. The statement contained in this text is a revision of the earlier statement. Scientific data, comments, and suggestions incorporated in the original statement have been used in the preparation of this Region-wide umbrella statement.

Since 1973, the Eastern Region's herbicide use program has been challenged in two lawsuits. Expert testimony presented during these hearings, along with Conclusions of Fact offered by the Federal Judges have helped shape the organization and content of this statement.

Other Forest Service Regions have filed final environmental statements on their use of herbicides with CEQ. The substance of these statements, as well as comments and suggestions offered during public review have been considered and used in this Eastern Region statement.

The site specific environmental analysis reports prepared for individual herbicide projects are an extension of this umbrella statement. The local site specific descriptions, local impacts, and economic analysis contained in the project analysis are made available for public review. They too have been considered when applicable to Region-wide use.

The agencies, groups, and individuals shown on the following lists have been requested to review and comment on this Draft Statement. See Appendix C

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IX. GLOSSARY OF TERMS

- Absorption - Penetration of a substance from the surface to below the surface.

- Acid equivalent (a.e.) - The theoretical yield acid from an active ingredient, on a per gallon basis, i.e., 4 lb. a.e. yields 4 lb. of active acid per gallon of solution. Not applicable to all herbicides, e.g., amitrole and atrazine.

- Active ingredient (a.i.) - The chemicals in a product that are responsible for the herbicidal effects.

- Acute toxicity - Poisoning by a single dose or dosages applied over a short period.

- Adjuvant - Substances which are added to spray materials to act as wetting or spreading agents, stickers, penetrants, emulsifiers, etc., aiding in the physical characteristics of the herbicide materials.

- Adsorbed (adsorption) - Adherence of a substance to a surface.

- Algicide - A chemical intended for the control of algae.

- Auxin - Plant growth hormone.

- Auxin herbicide - A herbicide that has an effect like a plant growth hormone.

- Benefit-cost ratio - The ratio between the economic benefits derived from a particular action and the cost of performing that action. For example, if it costs $1 to treat an acre and we find the economic benefit from that treatment has a value of $5, the benefit cost is 5:1.

- Biota - The animal and plant life of a region or period.

- Broad-leaved plants - Botanically, those classified as dicotyledons. Morphologically, those having broad, often compound, leaves.

- Browse - Any material that is browsed or fit for browsing. Feeding on buds, shoots, and leaves of woody growth by livestock or wild animals.

- Brush control - Control of woody plants.

- Carcinogen (carcinogenicity) - Any substance that produces cancer (the ability to produce cancer).

- Carrier - The liquid or solid material added to a chemical compound to facilitate its application.

- Cations - An electropositive ion (soil particle).

- Chromosomal - Pertaining to the small bodies within a cell which occur in definite numbers in the cells of a given species. These bodies are composed of genes which control cell activities.

- Chronic toxicity - The poisoning effects of a series of small doses applied over a long period.

- Co-Dominant (crown class) - Trees having their crowns in the upper canopy, but which are less free than the dominants.

- Concentration - The amount of active ingredient or acid equivalent in a given volume of liquid, or in a given weight of dry material.

- Contact herbicide - A herbicide that kills primarily by contact with plant tissue rather than as a result of translocation.

- Crop tree - Any tree forming or selected to form a component of the final crop. Generally, a tree selected in a young stand or plantation for carrying through to maturity.

- Cull - Any tree, or plant rejected for use because it does not meet certain specifications.

- dbh - Abbreviation for diameter breast height.

- Deciduous trees (hardwoods) - Those that lose their leaves during winter.

- Defoliator or Defoliant - A compound which causes the leaves or foliage to drop from the plant.

- Dermal - Through the skin, or by contact with the skin.

- Dicotyledonous - A plant having two seed leaves or cotyledons; the broad-leaf plants.

- Dilutent - A material, liquid or solid, serving to dilute a herbicide to field strength for adequate plant coverage, maximum effectiveness and economy.

- Dominant (crown class) - The trees having crowns in the upper most layers of the canopy, and which are largely free-growing.

- Dormant spray - A herbicide applied during the period following leaf-fall or leaf death and before bud break of evergreen trees.

- Drift - The movement of air-borne particles from the intended contact area to other areas.

- Ecosystem - The basic ecological unit, made up of a community of organisms interacting with their inanimate environment.

- Emulsion - The suspension of one liquid as minute globules in another liquid; for example, oil dispersed in water.

- E.P.A. - Environmental Protection Agency

- Ester - Formed by the reaction of the herbicide acid, such as 2,4-D plus and alcohol. This reaction takes place with heat, pressure, and in the presence of a catalyst, and is known as esterification.

- Foliage application - An application of a herbicide to the foliage (leaves, stems, shoots) of a plant.

- Forb - Any herbaceous plant that is not a grass nor similar to one; e.g., geranium, buttercup, sunflower.

- Forest type - A category of forest or forest land, cover type, stand type. A category of forest defined by its vegetation and/or locality factors.

- Formulation - A term used synonomously with the product. It contains the herbicide in a form that can be (1) dissolved or suspended in a carrier and distributed in solution or suspensions by sprayer; (2) distributed dry by dusters or spreaders; or, (3) easily vaporized for fumigation.

- FSM - Forest Service Manual.

- Gamma radiation - Penetrating rays emitted from radioactive material and reducing the energy of the cell nucleus.

- Girdle - Making more or less continuous incisions around a living stem, through at least both bark and cambium.

- Growing stock - All the trees growing in a forest or in a specified part of it and generally expressed in terms of number or volume. See crop trees.

- Habitat - The abode, of a plant or animal, as it relates to all the environmental influences affecting it.

- Herbaceous plant (Herb) - A vascular plant that does not develop wood tissue.

- Herbicide - A phytotoxic chemical used for killing or inhibiting (stunting) the normal development of a plant.

- Host plant - The plants for which the area is being managed. Those plants most favorable to man, and which man wants to see occupy the site.

- Karst topography - An irregular limestone region with sinkholes, under ground streams, and caverns.

- Leaching - Movement of a substance downward through the soil.

- LC_{50} - A lethal concentration rate at which 50 percent of the test animals will be killed. Usually expressed in ppm (See below) and usually used in testing of fish or other water animals.

- LD_{50} - A lethal dosage rate at which 50 percent of the test animals will be killed. Usually expressed in terms of milligrams of chemical per kilogram of body weight of the test animal (mg/kg).

- Low volatile ester - Chemically, an ester prepared with a heavy, molecular weight; alcohol, such as the butoxy-ethanol, iso-octyl, or propylene glycol butyl ether esters. Biolgoically, it is an ester which is less likely to injure plants by vapor activity, than a high-volatile ester.

- Mass median diameter - The drop diameter that divides the spray depositon distribution into two equal parts by mass.

- Mast - The fruit of trees such as oak, beech, sweet chestnut -- particularly where they are considered food for livestock and certain kinds of wildlife.

Metabolism - The sum of the processes concerned in the building of protoplasm and its destruction incidental to life.

- Merchantable - Of trees, crops, or stands, or a size, quality, and conditions suitable for marketing under given economic conditions.

- Mg/Kg - Abbreviation for dose in milligrams per kilogram of body weight of animal.

- Mg/Ml - Abbreviation for milligrams per milliliter.

- Microflora - Microscopic organisms belonging to the plant family.

- Micron (u) - A metric unit of length equal to 1/1000 of a millimeter or 1/1,000,000 of a meter. 1 inch equals about 25,400 microns.

- Mitotic - Cell division.

- Mutagen (Mutagenicity) - Any substance capable of producing genetic damage (The ability to produce genetic damage).

- Non-selective herbicide - One that is toxic to all plants.

- Non-target component or vegetation - Vegetation which is not expected or not planned to be affected by the treatment.

- Noxious weed - A plant defined by law as being especially undesirable, troublesome, and difficult to control. Definition of the term "noxious weed" will vary according to legal interpretation.

- Overstory - That portion of the trees in a forest that form the upper most layer of vegetation.

- Pathogen - The infective agent causing a disease, e.g. a fungus, bacterium, or virus.

- Perennial - A plant that lives for more than 2 years.

- Persistent pesticide - Persistency is dependent upon such properties as volatility and resistance to chemical breakdown.

- Pest plant - Any plant which injures man, his property, or which annoys him.

- Pesticide - Any substance or mixture of substances intended for controlling insects, rodents, fungi, weeds, and other forms of plant or animal life considered pests.

- pH - The chemist's measure of acidity and alkalinity. It is a scale in which the figure 7 indicates neutral; figures below 7 indicate acidity; and, figures above 7 indicate an alkalinity.

- Phenoxy herbicides - Formulations of 2,4-D, 2,4,5-T, and 2,4,5-TP.

- Phloem - The tissues of the inner bark. They are characterized by the presence of sieve tubes and transport foodstuffs.

- Phosphorylation - The process of converting into a compound of phosphorus.

- Photoaleration - Changed by exposure to sunlight.

- Photodecomposition - A process of breaking down a substance through reaction to light.

- Phtotoxic - Poisonous or injurious to plants.

- Post emergence - After emergence of specified weed or crop.

- ppb - parts per billion, e.g. 1 ppb might refer to 1 gallon of herbicide in 1 billion gallons of water.

- ppm - parts per million.

- ppt - parts per trillion.

- Precommercial thinning - Thinning out trees in a forest stand by other than a commercial sale.

Pre-emergence herbicide - A herbicide applied after planting the crop, but before the crop emerges above ground. The purpose is to kill weed seedlings that appear ahead of the crop.

- Rate - The weight of active ingredient or acid equivalent of a herbicide or volume of carrier applied to a unit area. (Usually expressed in lbs. of herbicide in gallons of carrier per acre.)

- Registered - Pesticides that have been approved for use by the Environmental Protection Agency or by the Department of Agriculture.

- Residue - That quantity of a substnce, especially of active pesticide, remaining on or in a surface or crop.

- Resistance - The degree to which a plant or animal species of plant or other tolerates a toxic substance.

- Roentgens - The unit used as a measure at radiation.

- Selective herbicide - A herbicide that will kill some plant species when applied to a mixed population, without serious injury to other species.

- Site preparation - The removal of vegetative competition or physical obstacles from an area scheduled for regeneration.

- Softwood - A conventional term for both the timber and the trees belonging to the botanical group gymnospermae (pines and spruces).

- Soil sterilant - A herbicide that prevents plant growth when present in the soil. Soil sterilization may be temporary or relatively permanent.

- Spot spraying or treatment - An application of pesticide to localized or restricted areas (generally a few square feet); this is different from a broadcast application (generally covering many acres).

- Sprout - Any shoot arising from a woody plant, but particularly from the base of a plant.

- Stomata - A minute pore in plant leaves through which gaseous exchange takes place.

- Succession - The gradual supplanting of one community of plants by another.

- Surfactant - A substance that reduces the interfacial tension between the surface of a droplet and the surface of the vegetation on which the droplet has landed.

- Systemic herbicide - A herbicide that travels to other parts of a plant, rather than staying where it was applied.

- Target component or vegetation - Vegetation which is expected or planned to be affected by the treatment.

- Teratogen (Teratogenicity) - Any substance capable of producing birth defects.

- Toxicity - Degree to which something is poisonous or physically injurious.

- Translocated herbicide - Herbicide movement within the plant from the point of entry.

- Travel Influence Zone - The travel influence zone is made up of lands bordering selected roads and trails which have significant recreation travel. It includes existing and potential recreational occupancy sites, and is wide enough to insure that the land can be managed for scenic quality.

- Vegetational succession - The order in which plants become established and grow in nature. Usually after a fire or other disturbance, simple annual plants become established first, then successively more complex and longer living plants take over.

- Volatile - A compound is said to be volatile when it vaporizes at ordinary temperatures on exposure to air.

- Volatility - The evaporation or vaporization (changing from a liquid to a gas) at ordinary temperatures on exposure to the air.

- Water Influence Zone - The water influence zone extends back from the water line of selected streams and lakes. It delineates land areas where the presence of water is a predominating factor and a major item of consideration when managing the area. It includes land areas suitable for recreational use or other development in connection with the utilization of water values. Streams suitable for boating and canoeing and waterfowl marshes are usually in this zone.

- Weed - A plant growing where it is not desired.

- Xylem - The principal strengthening and water-conducting tissue of woody plants.

X. APPENDIX - A

CONTROLS ON HERBICIDE USE

Basic authority for the use of herbicides is contained in legislation signed on October 21, 1972; the Federal, Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended. To insure that herbicide use is necessary and is accomplished in a manner that will achieve specific resource management objectives with the least potential hazard to all non-target components of the environment, the following controls were developed to mitigate adverse environmental effects identified in Section II (ENVIROMENTAL IMPACTS OF THE PROPOSED ACTION) of this statement:

When label directions are more constraining than those listed below, the label directions will be followed:

1. Air

   -- To minimize drift and volatilization, lessen the fall distance to 30-40 feet above the vegetation when aerially applying herbicides.

   -- Use ground spray application equipment that produces droplets larger than 200 microns mass median diameter.

   -- Use aerial spray application equipment that produces droplets larger than 400 microns mass median diameter.

   -- When reasonable, use thickeners or invert emulsion formulations for spray mixtures to minimize drift and volatilization.

   -- Avoid the aerial application of herbicides when a warm air inversion is present, as the drift potential is increased. Cold air inversions can help reduce drift.

   -- Always use the low volatile formulations of an herbicide.

   -- Apply aerial sprays only when the wind speed is less than 8 m.p.h., or less, if required by the label.

   -- Apply aerial sprays only when the temperature ranges from 50-85^{o}F. (measured 4.5 feet above ground level).

   -- Apply aerial sprays only when the relative humidity is above 50 percent.

2. Soils

-- To avoid contaminating areas not scheduled for treatment, the entire application system must be leakproof and have a positive shut-off mechanism capable of retarding drool.

-- When a range of application rates is suggested, use the lowest rate recommended for effective treatment with specific soils.

-- When the label's use directions allow the user a range of application rates (e.g., 1-3 gallons per 100 gallons of dilutent), maximum of 6 pounds active ingredient per acre, for one application of herbicide, will be used.

-- Waste herbicide containers will be returned to the manufacturer for re-use, properly incinerated (1,000°C for 2 seconds dwell time), or triple rinsed, crushed, and buried in a land fill approved for such disposal by either EPA or a local unit of government. Rinse solution will be added to the herbicide mixture and used as part of the herbicide application.

3. Water

-- Herbicides will not be applied within 50 feet of open water such as streams, ditches, lakes, and ponds; unless, the target pest is found in or adjacent to the water and the herbicides are approved by EPA for application to a water system.

-- For aerial and ground foliar spray applications, leave a minimum 100-foot buffer zone between the treatment area and open water. When the wind velocity exceeds 4 m.p.h. and is blowing toward private or other public lands or open water, consider increasing the buffer strip to at least 500 feet.

-- When treating slopes in excess of 30 percent, the width of the untreated buffer-strip will be doubled.

-- The water source providing water for mixing with herbicides shall be protected from herbicide contamination.

-- A water surveillance program will be used by each Forest. There will be periodical check to guarantee that guidelines used for herbicide applications are adequately protecting forest water sources so the herbicide levels do not exceed those listed in the National Interim Primary Drinking Water Regulations or permanent regulations.

-- Ferrying routes by helicopters rigged for applying herbicides will not cross lakes or ponds, and will avoid other open waters where practical.

-- There will be no fog or air turbulence present, nor will rain be expected on site within 2 to 4 hours.

4. Hazardous Substances

-- An area will be retreated, where needed, no sooner than 1 year for 2,4,5-T, and 3 years for cacodylic acid, picloram, and dicamba.

-- Only herbicides currently registered and labeled by the Environmental Protection Agency for the specific use proposed will be used, unless:

(a) An Experimental Use Permit is obtained from EPA under Section 5, Federal Insecticide, Fungicide, and Rodenticide Act, (FIFRA), as amended.

(b) A Special Local Needs Registration is issued by an individual State under guidelines contained in Section 24, FIFRA, as amended.

(c) Parameters, as outlined in the U.S. EPA Pesticide Enforcement Policy Statement No. 5 are met.

(d) Aerial application of herbicides whose labels bear no affirmative instructions for aerial application must follow the procedures established by US EPA Pesticide Enforcement Policy Statement No. 7.

-- The use of an unregistered tank mix will not be permitted unless it meets (a), (b) or (c) above.

-- All proposals for pesticide use on the National Forests of the Eastern Region will go through a review process which includes review by:

(a) Forest Pesticide Use Committee or Forest Pesticide Coordinator.

(b) Regional Chemical Use Committee.

(c) Pesticide-use proposals falling into one or more of the following categories must be reviewed by the field Pesticide-Use Coordinating Committee before being approved by the Regional Forester.

(1) Use of a pesticide (for a particular purpose or use in a particular way) not labeled under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

(2) Any application to water, or any application whereby the pesticide could reasonably be expected to get into water.

(3) Any use of a pesticide that can reasonably be expected to affect threatened or endangered species.

(4) Any program or project in which 640 or more contiguous acres would be treated as one application.

-- Proposed herbicide uses will be based on a prescription for each treatment area that evaluates and justifies the need for the treatment and considers alternative procedures, benefits, and possible adverse effects on the environment.

-- When not covered by an Environmental Impact Statement or approved Environmental Analysis Report, an environmental analysis and its documentary report will be made for herbicide uses affecting any resource, other land use activity, or the environment. When required, there will be provisions for advance review of pesticide projects by concerned Federal, State, and local agencies, and the general public.

-- Pesticides will be handled and stored in a manner which will safeguard public health and wildlife, prevent damage to plants, prevent soil and water contamination, and are in accordance with Federal, State, or local laws and regulations.

5. Social/Economic

-- When pesticides are required, those methods of application and formulations that will most effectively suppress the pest, are the most specific to target organisms, and have the least potential hazard to all non-target components of the environment will be recommended.

-- The use of controversial herbicides or controversial methods of application will be analyzed and reported to the public and other interested Federal, State, and local agencies, so they may review and comment on the action proposed.

-- The news media will be utilized at the local level to discuss pesticide-use issues and social concerns.

-- Results of herbicide efficacy and monitoring will be made available to the public.

-- Whenever reasonable, effective, safe, and integrated suppression measures that may utilize biological, cultural, and other techniques in place of, or in association with, pesticides will be recommended and used.

-- Legal clearances, as required by Federal, State, and local laws or regulations will be obtained before using pesticides (Section 24 regulations of amended FIFRA).

-- All personnel who handle or supervise the use of pesticides will receive training and/or certification.

6. Visual

-- If possible, treat aquatic weeds before heavy seasonal use starts.

-- Along easily viewed roadside and rights-of-way, treat hardwood brush at the youngest age possible.

-- Where aesthetic values are high, herbicide treatments should occur during the dormant season, using based spray or cut stump methods of application.

7. Landownership - Land Use

-- All uses of herbicides by permittees will follow the policies and guidelines established for National Forest use of chemicals.

--The Land Use Policies outlined in Secretary's Memorandum No. 1827 will be followed.

8. Man

-- A safety plan and job hazard analysis will be written for herbicide use. For each herbicide proposed for use, the safety plan should cover:

(a) First aid instructions

(b) Poison Control Center telephone number and evacuation procedures

(c) General safety information

(d) Storage

(e) Operational procedures

(f) Safety precautions:

- Accident prevention measures
- Transportation precautions
- Empty container disposal
- Spill clean-up plan.

-- The job hazard analysis and Occupational Safety and Health Act (OSHA) should be used to provide guidance on protective clothing and safety equipment needed for those handling and working with herbicides.

-- Applicators will be briefed before and during the use season about safe measures for handling, transporting, mixing, and applying herbicides; use of protective clothing and equipment; plus, the need for personal hygiene. Applicable safety measures will be used.

-- Persons applying restricted-use herbicides on National Forest lands will must meet State Pesticide Certification Plan or Government Agency Plan guidelines, as approved by EPA. (To be effective October 21, 1977.)

-- Certification of herbicide applicators used on National Forests will follow Federal, State, and local guidelines.

-- For aerial applications, an unsprayed buffer zone of at least 100 feet will be left adjacent to all private property, unless the private property holder agrees in writing to a lesser distance. Individual tree treatment methods may be used in this strip.

-- Projects will be carefully supervised to assure that stated precautions for herbicide use are being observed.

-- The herbicide 2,4,5-T will be limited to forest, pasture, and industrial sites, unless label restrictions are changed by the Environmental Protection Agency. It will not be used in recreation areas, water, around homes or offices, or on food crops (except rice).

9. Domestic Animals

-- Label instructions on allowing livestock to graze on areas following herbicide application will be followed.

10. Soil Organisms (RESERVED)

11. Wildlife

-- The project planners will review the list of endangered and threatened wildlife published in the Federal Register 40 (188): 44412-44429, September 26, 1975. (Memo to Forests, 2630, October 2, 1975), and take reasonable action to determine if listed wildlife occupy or frequent the proposed treatment area.

-- When available, Forest/State recovery plan for individual wildlife species will be reviewed.

-- "Unique" - Species identified in FSM 2622.4; State legislation; or species identified in Forest unit plans will be reviewed.

-- Management practices approved for the protection of active habitat sites for identified unique, threatened and endangered animals (FSM 2630) will be followed.

-- Critical habitats of endangered or threatened fish and wildlife species will be protected and enhanced where possible.

12. Vegetation

-- When planning for herbicide programs, all the plants on the Secretary of Interior's proposed list will be treated as though they were officially classified. Steps will be taken to assure their protection, until such time as their official status is determined.

-- When planning the use of herbicides, available information will be reviewed to determine whether or not known locations of sensitive plants occur in the immediate vicinity of the proposed project.

-- If known locations are identified within or in the immediate vicinity of the project area, a field reconnaissance will be made by a qualified Forest Service person or out-Service botanist to determine the distribution of the sensitive species.

-- When the actual distribution of the sensitive plant is determined, efforts will be taken to modify the herbicide treatment; or, the proposed treatment area will be dropped, so as to avoid jeopardizing the existence of the sensitive plant.

13. History and Archeology

-- The project planner will consult the National Register of Historic Places, to avoid treating recognized areas with herbicides.

-- Reconnaissance surveys will be conducted by the land manager where an inventory of cultural values is lacking.

-- Any Forest Service herbicide treatment proposed for a site listed in the National Register of Historic Places must be submitted to the National Advisory Council on Historic Preservation for review and comment, prior to approval of the project.

-- Broadcast herbicide treatments will be given to any location of known historic or prehistoric sites, buildings, objects, or properties related to American history, architecture, archaeology, or culture, such as settler or Indian artifacts, and protected by the American Antiquities Act of 1906 (16 USC 431-433), National Historic Preservation Act of 1966 (PL 89-665), Executive Order 11593 (1971), NEPA PL 91-190), or the Archeological and Historical Conservation Act of 1974 (88 Stat. 174).

To comply with FIFRA as amended, these guidelines will be reviewed on a timely basis and changed as needed.

DISCUSSION OF REVIEW COMMENTS RECEIVED ON DRAFT STATEMENT

Federal Agencies

1. U.S. Department of Agriculture, Agricultural Research Station, 14th and Jefferson Drive S.W., Washington, D.C. 20250

2. U.S. Department of Agriculture, Soil Conservation Service, 14th and Jefferson Drive S.W., Washington D.C. 20250

3. U.S. Department of the Interior Interior Building, Washington, D.C. 20240

4. U.S. Environmental Protection Agency 401 M. Street S.W., Washington, D.C. 20460

State Agencies

Through State-Federal Clearinghouse Coordinators

1. Illinois, Bureau of the Budget
   Springfield, Illinois 62706

2. Pennsylvania, Department of Environmental Resources
   P.O. Box 1467, Harrisburg, Pennsylvania 17120

State Department of Natural Resources

1. Maine, Department of Conservation
   Augusta, Maine 04333

2. Michigan, Department of Natural Resources
   Mason Building, Lansing, Michigan 48909

3. Minnesota, Department of Natural Resources
   Centennial Office Building, St. Paul, Minnesota 55155

4. Ohio, Department of Natural Resources
   Fountain Square, Columbus, Ohio 43224

5. West Virginia, Department of Natural Resources
   Charleston, West Virginia 25305

6. Wisconsin, Department of Natural Resources
   Box 7921, Madison, Wisconsin 53707

Organizations, Groups and Individuals

1. Coalition for Economic Alternatives
   Box 323, Ashland, Wisconsin 54806

2. Defenders of Wildlife
   1244 Nineteenth Street, NW, Washington, D.C. 20036

3. Environmental Defense Fund
   1525 18th Street, NW, Washington, D.C. 20036

4. Friends of the Earth
   620 C Street, S.E., Washington, D.C. 20003

5. The Izaak Walton League of America
   Suite 806, 1800 N. Kent Street, Arlington, Virginia 22209

6. Minnesota Herbicide Coalition
   110506 Windmill Court, Chaska, Minnesota 55318

7. The Wilderness Society
1901 Pennsylvania Avenue, N.W., Washington, D.C. 20006

8. Mason Carter, Head, Department of Forestry and Natural Resources
Purdue University, West Lafayette, Indiana 47907

9. Harvey Holt, Associate Professor, Dept. of Forestry
and Natural Resources
Purdue University, West Lafayette, Indiana 47907

10. Ms. G. Altonen
Duluth, Minnesota 55812

Companies

1. Consolidated Paper, Incorporated
Wisconsin Rapids, Wisconsin 54494

2. TSI Company
P.O. Box 151, Flanders, New Jersey 07836

APPENDIX - B

ENVIRONMENTAL ANALYSIS REPORT
REGION 9
NICOLET NATIONAL FOREST

ALTERNATIVE METHODS OF PLANTATION

RELEASE ON THE NICOLET NATIONAL

FOREST

FOR FISCAL YEAR 1976-1/4

PROJECTS

Prepared by the Staff of the Nicolet National Forest, May 1976

TABLE OF CONTENTS

I. ENVIRONMENTAL STATEMENT RECOMMENDATIONS

The applicability of the National Environmental Policy Act to this activity has been considered. The Council on Environmental Quality has set forth a number of considerations to guide Federal Agencies in following Section 102(2) (C) of the National Environmental Policy Act. Among them is the use of a broad-based impact statement as background to site specific environmental analysis. This format has been adopted by the Eastern Region. A final environmental statement, The Use of Herbicides in the Eastern Region, was submitted to the Council on Environmental Quality on October 30, 1973. This proposed project to use 2,4-D has been selected from several alternatives available. The analysis is contained in this report and does not indicate a significant environmental impact or high controversy. The reasons for this decision are based on the conclusions that the action will:

1. Cause no irreversible effects to the waters, air, soil, or quality of the human environment.

2. Promote a desirable long term change in the vegetation composition of the Nicolet National Forest that will aid local economic stability and help to offset the long-term National shortage of softwood timber.

3. Alter the habitat adversely for some species of wildlife, but beneficially for other species of wildlife.

4. Not adversely affect rare or unique plants or animals.

5. Be carried out well within the guidelines established in the final environmental statement on the Use of Herbicides in the Eastern Region. Constraints for this project meet or exceed all guidelines in that document.

6. Be the most desirable alternative from the stand point of efficiency and minimum environmental impacts.

While the use of 2,4-D may be subject to some concern, tests and investigations have not shown this herbicide to accumulate in the environment or contain the dioxin TCDD. The areas to be treated are small in size and widely scattered. Based on this analysis, I have determined that the requirements of the National Environmental Policy Act have been met. An environmental statement as described in Section 102(2) (C), has been prepared for the Eastern Region Herbicide Use Program and a statement dealing with these specific projects is not needed. This proposal to treat 340 acres of plantation using the methods and subject to the management constraints, described herein is approved.

Date

THOMAS A. FULK
Forest Supervisor

II. DESCRIPTION

A. Project Background

The 2,4-D herbicides are used in land management where their particular selective properties coincide with the desired changes in vegetation. The most common uses are suppression of broad-leaved plants in the presence of grasses, conifers, or certain legumes. The situations in which management objectives are served by this kind of selectivity are extra-ordinarily diverse. Each use of 2,4-D is governed by the known response to 2,4-D of each kind of plant present. Such general rules as "broad-leaved" plants are susceptible, while grasses and conifers are resistant" have important exceptions, and nothing short of a thorough knowledge of the responses of each kind of plant under prevailing conditions will make possible the effective use of 2,4-D.

The basic purpose of the conifer release program is the attainment of Forest vegetative cover type objectives. The Forest cover type objectives policy sets, as a goal, a fairly definite pattern of vegetative cover types, age classes and species mixtures, to be attained through long-term vegetative manipulation. This eventual vegetative pattern is viewed as the optimum situation obtainable on existing soil types, from a multiple-use land management standpoint. Several factors, primarily aesthetics, wildlife habitat, timber production, and land capabilities were considered by an interdisciplinary team in establishing these objectives.

The attainment of these objectives requires the maintenance of conifer cover types during the regeneration period. Conifer type maintenance necessitates the control of competing hardwood regeneration and brush, to release conifer seedlings. Conifer seedlings, being slower growing than hardwoods, are not able to compete successfully for light, moisture, and nutrients under growing conditions now found over most of the Nicolet National Forest. Establishment of conifer stands, therefore, requires management action to control competing vegetation until conifers dominate the site.

The Forest composition objectives for the Nicolet National Forest are covered in the following documents:

1. Timber Management Plan for the Nicolet National Forest, July 1, 1965 extended to June 30, 1973.

2. Environmental Statement for the Use of Herbicides in the Eastern Region, October 30, 1973.

The major effects of planned cover type manipulation are briefly outlined below:

   a. Favorable Effects.

(1) Improvement of wildlife habitat through an increase in Forest vegetative cover type diversity.

(2) Improved forest aesthetics by creation of a heterogeneous mixture of conifer and hardwood types.

(3) Increased forest resistance to insect and diseased losses through increased cover type diversity.

(4) Increase in forest fiber and economic yield through conversion of hardwood stands to higher yielding, higher value conifer types.

b. Adverse Impacts

(1) Increased fire hazard due to increased percentage of Forest in more flammable conifer types.

The prescribed conifer plantation release program for CY 1976 includes a total of 589 acres. Of this total, 249 acres are proposed for release using various individual stem treatments, and 340 acres are proposed for release using an aerial herbicide application. Prescriptions for various treatments are based on several factors; including, number and distribution of competing stems, size of crop trees, accessibility, and location of plantation in relation to wetlands, surface waters, and heavy public use areas or travelways.

B. Project Proposal

The project proposal is to release 340 acres of conifer plantation from competing vegetation. The 2,4-D herbicide ESTERON (R)99(R), Concentrate (EPA Registration No. 464-201-AA, Appendix F), a low volatile ester; is the chemical selected to accomplish the release. The herbicide will be diluted with water and applied at a rate of 8 gallons herbicide-water spray mix per acre.[2] Herbicide volume will be 3 quarts per acre. Application will be by helicopter equipped with a microfoil spray boom from an altitude of 50 to 60 feet above the vegetation. A 0.013 inch orifice nozzle will be used. A nozzle of this size produces droplets with a nearly uniform mass median diameter of from 1,500 to 1,700 microns. The purpose of having large droplets is to eliminate spray drift and to minimize volatilization. The proposed project is scheduled for completion between July 20, 1976, and August 20, 1976.

Controls on our use and measures to mitigate identified environmental impacts are listed in Section II-D.

C. Treatment Areas

Wildlife species on the Nicolet National Forest.

The Nicolet Forest is the home of many species of animals and birds. A partial listing of these species that might be found on the Nicolet is included in Appendix D. Wildlife species present on the Forest may or may not include the 10 areas to be treated with 2,4-D as part of their normal habitat.

An application of 2,4-D to these 10 areas will cause only a minor and short-term habitat change. This change will be the removal of the ingrowth of broad-leaved plants that have invaded these areas since planting. The major habitat change occurred at the time the mature timber was removed. We are now managing these sites as red pine and black spruce plantations. A herbicide manual or mechanical treatment now would create the same habitat change. If the 2,4-D treatment is successful, the change in vegetation will only be to take these 10 areas back to the vegetative condition that existed 4-5 years ago when they were planted. The total effect of treating 340 acres on the Nicolet National Forest will be to affect 0.05% of the total habitat available on the Forest.

The total effect on wildlife will not be a significant change. Rare or unique species identified as important to this project are the Northern Bald Eagle and the American Osprey. Nesting habitats adjacent to the spray areas have been identified and protected by flight restriction areas shown on the project maps. As discussed under environmental effects, there is no evidence that any individual animal would be psysiologically harmed by the content or amount of spray material to be applied to these areas.

See Appendix B for Vicinity Map and Appendix C for individual Area and Project Maps.

Area #1

Area 1 is located in the NE 1/4 Section 4, T37N, R16E, Forest County, Wisconsin. Area 1 is a 43 acre black spruce plantation. Thirty-eight acres are proposed for aerial spray to release the planted spruce from overtopping aspen and paper birch. The east side of the plantation area adjoins private land owned by Armstrong Creek Township. There are no residences on the private land. The private land is timber covered and used for production of forest products.

22

The north boundary of the spray area is approximately 100 feet south of private land. The owner of record is Wayne Vandermeulen. There is a seasonal residence located approximately 700 feet north of the spray area.

A 100-foot buffer area adjacent to private land on the east, and a wet bog on the southeast will be established to prevent any spray drift from getting onto private land or the wet area. The west boundary of the spray area is National Forest and is bordered by tall timber. A 100-foot area adjacent to the timber will not be sprayed to provide a safety buffer for the aircraft and pilot.

Soils on Area 1 are of the Stambaugh silt loam series.[30] These are deep, well-drained soils with medium infiltration rate and slow permeability. There is very little run off from these soils. Ground water is 5 or more feet below the surface. Slopes are less than 10 percent and little erosion will occur on this site.

Area 1 lies .75 miles northeast of Laura Lake, 1.2 miles northeast of Laura Gordon Campground, and 0.6 miles north of an unnamed pond. The closest permanent dwelling is 12 miles east of the spray area. Recreational use of the area is limited to very occasional visits by hunters during the fall.

The original timber on this area was believed to be a mixture of pine and hemlock. Poor quality aspen invaded the area following clear cutting in the early 1900's. The aspen was harvested in 1970, the site prepared by rock raking in 1971, and planted to spruce in 1972. Spruce produce softwood timber products.

This area has received no previous herbicide treatment.

This area will be sprayed from helipad B located on spray Area #3.

Area #2

Area 2 is located in the NE 1/4 of Section 4, T37N, R16E, Forest County, Wisconsin. Area 2 lies .12 miles west of Area 1. The two areas are separated by .12 miles of uncut timber.

Area 2 was cut in 1970, site prepared in 1971, and planted to red pine and black spruce in 1972. The north boundary of Area 2 is .12 miles south of private land and surrounded by uncut timber. Ten of the 20 acres of the plantation will be aerially sprayed to release planted trees from aspen competition.

The relationship of Area 2 to private land, water, residences, and other human activity is substantially the same as described for Area 1.

The helicopter spraying Area 2 will use helipad B located in Area 3.

This area has received no herbicide treatment in the past.

Area #3

Area 3 is located in the SW 1/4 of Section 7, T37N, R16E, Forest County, Wisconsin. Area 3 is a black spruce plantation of 52 acres, of which 44 acres are proposed to be released from overtopping aspen, willow, and several other minor broad-leaved species. The closest private land is southerly about .25 miles. It is owned by Consolidated Papers, Inc.[22] These lands are managed as commercial forest lands for timber production.

A 100 foot buffer area is developed around the lowland conifer stand on the south edge of this plantation. Also, the west edge of this plantation will not be sprayed to protect some planted wildlife shrubs. Within the plantation is one wet depression where standing water occurs at times of high rainfall. This area will not be sprayed.

Soils on Area 3 are of the Padus series.[30] These loams have a high infiltration rate and a rapid rate of permeability. Fragipans present in the underlying strata of these soils often restrict permeability in local areas. The water table is below 5 feet in nearly all this area.

Area 3 is .5 miles to a spring pond which flows to a stream known as West Branch Armstrong Creek. Rat Lake is .75 miles south of this area. The closest resident to this area is southeasterly 1.5 miles.

The original timber stand on this area is not known. It was harvest cut for aspen 15 to 18 years ago. A very low quality stand of aspen came back and developed pathological problems. Management decided to convert this stand to black spruce in 1972. In 1973, the area was prepared by rock raking and planted to spruce in the spring of 1974. Spruce management will fully use the capability of the site to produce softwood timber products.

This area has received no previous herbicide treatment.

This area will be sprayed from helipad B which is located at the southwest edge of this site.

Area #4

Area 4 is located in the SE 1/4 of Section 35, T39N, R15E, Florence County, Wisconsin. The 35 acre red pine and black spruce plantation will be sprayed to release the planted trees from aspen, red maple, and hazel competition.

Area 4 is surrounded by National Forest land. The closest other ownership is .25 miles south and owned by the State of Wisconsin. All other ownerships within .5 miles of Area 4 are used for commercial forest purposes. The closest residence is 1 mile south.

The nearest permanent water body is .38 miles southeast. There are no streams or wet areas immediately adjacent to this area.

Area 4 is located in a part of the Nicolet Forest that receives very light recreation use. This area would occasionally be visited by a hunter, but very few persons would use this area for other recreation activities.

Soils of Area 4 are of the Stambaugh silt loam series.[30] These are deep, well drained soils with a medium infiltration rate and slow permeability. There is very little runoff from these soils. Ground water is 5 or more feet below the soil surface.

The original timber on this area was believed to be northern hardwood - hemlock. The site was occupied by aspen and the poor quality residual hardwood following clearcutting in the early 1900's. Merchantable trees were harvested in the late 1960's. The site was rock raked in 1971, and planted to red pine and black spruce in 1972.

This area has not received a previous herbicide treatment. Approximately 70 acres of plantation, just south of Area 4, were sprayed with 2,4-D in 1973.

The helipad for Area 4 is on National Forest land, approximately 1,300 feet west of the spray area.

Area #5

Area 5 is located in the SW 1/4 of Section 8, T40N, R12E, Forest County, Wisconsin. Area 5 is a 40 acre red pine plantation. All 40 acres are proposed for release from aspen competition by aerial spray.

There is a privately owned tract of land approximately 150 feet east of Area 5. There are no buildings or occupancy on the private holdings. The land is currently forested. The owner of record is Dale Jewson. The nearest occupied dwellings are .75 miles southeast, 1 mile north, and 2 miles west.

There are no streams or wet areas within Area 5. The nearest permanent water body is .5 miles southwest. There is a wet marsh that comes within 150 feet of the spray area. The 150 feet of forested land between the spray area and marsh will provide sufficient buffer area to protect the wetlands.

Area 5 soils are mainly of the Crivitz loamy fine sand series[30] with a small area of Padus loam on the eastern part of Area 5. Crivitz soils are deep, excessively drained soils. They have high infiltration rates and rapid permeability. There is seldom any surface runoff. Padus soils are deep and well drained. Infiltration rates are usually high, permeability rapid, with no surface runoff.

Ground water in both soil types would be five or more feet below and the soil surface.

Original forst types on Crivitz soils were red and white pine. Original clearcutting in the early 1900's removed the pine types. These were replaced by aspen. The aspen stand was harvested in the late 1960's, the area rock raked and planted to red pine.

There is an osprey nest location approximately .25 miles southwest of the spray area. To prevent disturbance to any nesting birds, a flight restriction area has been established west of Area 5. The flight restriction area is shown on the map of Area 5 in Appendix C. The spray contract will prohibit the helicopter from flying over this area during spray operations or when coming to or leaving Area 5.

Area 5 is located approximately 3 miles south of Forest Service Kentuck Lake Campground, 2.5 miles north of Franklin Lake Campground, and 2.25 miles east of Anvil Lake Campground. While recreation use in this vicinity is heavy, few people have been observed using National Forest lands where spray Area 5 is located. Most recreation visits to this vicinity are to the many lakes of the area. There are no established hiking trails that would lead people to enter spray Area 5.

This area has not received a previous herbicide treatment.

The helipad for Area 5 is located approximately 300 feet north of the eastern edge of the area.

Area #6

Area 6 is located in the SW 1/4 of Section 7, T42N, R11E, Vilas County, Wisconsin. Area 6 is a 65 acre red pine plantation. Twenty-eight acres are proposed for aerial spraying to release the planted pine from overtopping aspen. The area is surrounded by National Forest lands. It is bounded on the east by a transmission line that is under special use permit to Wisconsin-Michigan Power Co. A private tract of 30 acres owned by Catherine Hunt is located 700 feet north and west of the spray site. No developments are located on this tract. The nearest full-time resident is located east of the site about 1 mile, near the shore of Lac Vieux Desert Lake.

The southeast corner of this site is within the seen area from County Trunk Highway E. For the traveler along this road, only a few seconds vision would be available at normal travel speeds for this highway.

Soils on this area are of the Vilas series.[30] Infiltration and permeability rates are very high on these porous soils. Water tables are usually below 5 feet in depth. Run-off is nearly non-existent on this soil type.

Area 6 is 1 mile west of Lac Vieux Desert Lake. The Wisconsin River is 400 feet from the northeast corner of this area.

The timber on this site was a mixture of jack pine, red pine, white pine, and aspen. It was harvest cut in 1969-1970. Planting of red pine was accomplished after a prescribed burn in 1971.

Herbicides have been used along the transmission line by the power company on the very east edge of this site. As a whole, herbicides have not been used on this site in the past.

This area will be sprayed from helipad G which is on the site.

Area #7

Area 7 is located in the SE 1/4 of Section 23 and the SW 1/4 of Section 24, T41N, R11E, Vilas County, Wisconsin. Area 7 is a 57 acre red pine plantation. Thirty-seven acres are to be sprayed to release the planted pine from aspen competition.

The nearest parcel of privately owned land is .37 miles west of Area 7 at the closest point. The owner of record is Waino Alinin. Current usage of the land is for forage crops and timber products. There is a permanent residence on the land.

Soils in Area 7 are of the Pence sandy loam series, Vilas sands, and Vilas loamy sands series.[30] Slopes are 10 percent or less. Pence series soils are deep and excessively drained. There soils have high infiltration rates and medium to rapid permeability. They drain quickly after rain, with no surface runoffs. The Vilas series are deep, excessively drained soils. The soils are porous and droughty, with a high infiltration rate and rapid permeability. Rainfall is absorbed with no runoff. Ground water would be 5 or more feet below the soil surface.

These dry sandy soils were originally pine lands. Area 7 was stocked with 70 year old jack pine prior to harvest in 1969. Area 7 was site prepared by prescribed burning and planted to red pine in 1971.

Area 7 is in two parcels. The west side of the eastern segment abuts a marsh - wetland. A 100-foot buffer strip will be left adjacent to the marsh to prevent any spray material from entering the marsh. There is a 600-foot strip of uncut timber on the east between the spray area and the Deerskin River, a cold water trout stream.

A small spring pond arises in the marsh between the two portions of Area 7. Water from the spring pond flows approximately .75 miles southeasterly and enters the Deerskin River. There is very little risk of contaminating the water with the spray due to the buffer strips and other control methods. The Forest hydrologist has recommended that this spring pond be tested for the presence of 2,4-D both before and after spraying. The objective of the water tests will be to test the effectiveness of the methods used to prevent 2,4-D from entering water bodies. Area 7 is the only site close enough to water to make testing worthwhile.

Area 7 is adjacent to Forest Road 2537. This road is maintained for public use, but is lightly used by the public. The nearest developed recreation area is Spectacle Lake Campground, 4 miles to the east and Anvil Lake Campground, 6 miles south. Some visitors use this area for access to the Deerskin River for trout fishing. Deer hunting use is relatively heavy in this part of the forest. Some berry picking may occur within Area 7. The greatest concentration of blueberry plants occurs in the western part of this area adjacent to Road 2537. This part of the area does not need spray to release the pine. Where the aspen stems are denser in the spray portions of Area 7, there are few blueberry plants.

Area 7 will be signed along Forest Road 2537 with notices that the area has been sprayed with 2,4-D. This should alert all visitors to the area of the possibility of chemical residue on wild fruits.

The helipad for Area 7 is adjacent to the spray area on the north side. There has been no previous herbicide application on this area.

Area #8

Area 8 is located in the west 1/2 of Section 34, and SE 1/4 of Section 33, T37N, R12E, Forest County, Wisconsin. The plantation is 57 acres in size, of which 56 acres will be treated with herbicide to release red pine from aspen sprouts. The area is totally surrounded by National Forest land for a distance of .75 miles. Northwest of this site, Matt Zver has 91 acres of timbered land. The closest full-time resident is on the shore of Pine Lake, a distance of 1 mile.

The Wolf River is south and east of this site. Its flood plain is a bog and sedge ecotype of 100 feet in width. A heavy spruce stand adjoins the bog-sedge type grading to the high ground where the plantation is established. This spruce stand is from 300 to 1,000 feet wide between the bog-sedge and plantation.

Several wet areas exist in this plantation. A 100-foot buffer strip is proposed to avoid any herbicide from getting to the water.

Soils on Area 8 are of Pence-Crivitz series.[30] Infiltration and permeability rates on these soils are high. No runoff is expected to occur. Water tables are generally below 5 feet in depth. These are gently rolling soils and some grades of 15-20 percent occur for short distances. Erosion is negligible on this site.

The original forest on this area was a white pine type. It was clearcut in the early 1900's and following a burn, gave way to spruce-fir and low quality aspen. In 1971 and 1972, a harvest cut of all trees was made. The area was then rock raked in 1972, and planted to red pine and black spruce in 1973.

An active eagle's nest is present along the Wolf River, 1.2 miles north and west of this site. A flight restricted area will be adhered to north, west, and east of this site, so as to create as little disturbance of these birds as possible.

There has been no previous herbicide application to this site.

Area 8 will be flown from helipad J, which is located within the site.

Area #9

Area 9 is located in Section 10, T31N, R15E, Oconto County, Wisconsin. Area 9 is a 76 acre red pine plantation with 32 acres to be sprayed to release the planted red pine from aspen competition.

The nearest parcel of private land is 1 mile north and east of Area 9. The owners of record are F. J. and R. M. Hallada. The closest residence is 1.5 miles south.

The soils of Area 9 are Vilas sand and Vilas loamy sand series.[30] These are deep, excessively drained soils. Slopes are 15 percent or less. These soils are porous and droughty, with a high infiltration rate and rapid permeability. Surface runoff seldom occurs, and there are no drainage channels developed. These soils were originally pine lands. Following the original clearcutting at the turn of the century, the site was barren or occupied by poor quality aspen. Area 9 was planted to red pine during the Civilian Conservation Corps days in the 1930's. In the spring of 1961, the Civilian Conservation Corps planted red pine were destroyed by wildfire. Area 9 was replanted to red pine following the 1961 burn.

Hills Pond Creek is approximately 300 feet west of Area 9. Hills Pond Creek is a popular cold water trout stream. The 300 foot strip between Area 9 and Hills Pond Creek is a mixed stand of aspen and white pine and will not be sprayed. The stand of timber will serve as a buffer area between the spray area and the creek.

Area 9 is divided by Forest Road 2113 (Oconto County Trunk T). This is a heavily travelled road, leading to Boulder Lake Campground 4.5 miles south. Area 9 is crossed by forest visitors going to Hills Pond Creek for fishing, and is heavily used during the deer hunting season in November. Area 9 has very few wild berry plants and is not commonly used by berry pickers.

Dead vegetation will be visible from Forest Road 2113 following the herbicide spraying. At this location, however, Forest Road 2113 is a deep cut. The screening effect of the cut, and a few large conifers adjacent to the road, will soften this impact. Area 9 will be posted with public notice signs following herbicide application. These signs will notify the public entering the area that it has been treated with 2,4-D.

The helipad for Area 9 is located immediately adjacent to Area 9.

There has been no previous herbicide application to this area.

Groundwater for Area 9 is 5 or more feet below the surface of the soil.

Area #10

Area 10 is located in the NW 1/4 of Section 5 and NE 1/4 of Section 6, T31N, R15E, Langlade County, Wisconsin. Area 10 is a 20 acre red pine plantation. Twenty acres are proposed to be sprayed to release the planted pine from aspen sprouts. This site is totally surrounded by National Forest lands. The nearest private land is westerly of the spray area .5 miles. This land is subdivided into lots which are occupied by recreation residence. The land is timber covered for the most part. The nearest full-time resident is 2.5 to 3 miles distant.

Near the northeast corner of the spray area is a swampy area. A 100-foot buffer strip separates the treatment area from the swamp.

Soils in Area 10 are of the Vilas series.[30] These soils have a very high infiltration and permeability rate. Water tables are below 5 feet on nearly all locations of this site. Erosion from run-off will be negligible because of very gently rolling terrain, with no slopes exceeding 5 percent.

The original forest here was large white pine. Stumps are still present after the clearcutting and burning of the early 1900's. Aspen occupied this area until it was prepared for planting in 1972, and planted to red pine.

There has been no previous herbicide application to this area.

The area will be sprayed from helipad K, located close to Area 9.

D. Controls and Mitigations

1. To protect the air environment in the Nicolet National Forest, the following application practices have been adopted.

   -Limit the fall distance of herbicide from helicopter to vegetation to 50 - 60 feet.

   -Use spray equipment that is calibrated to produce large droplets, e.g. the microfoil boom with .013 inch orifice nozzle.

   -Use a low volatile chemical formulation of 2,4-D.

   -Spray only when the wind velocity does not exceed 5 m.p.h.

   -Spray only within a temperature range of 50-80^{o}F.

   -Spray only when the relative humidity is above 50 percent.

2. To protect the water environment in the Nicolet National Forest, the following application practices have been adopted.

   -No herbicides will be applied within 100 feet of open water such as streams, ditches, lakes, and ponds.

   -The water supply for mixing with the herbicide shall be from a domestic source and protected from back siphoning from the mixing tank.

   -Ferrying routes by applying helicopters will not cross lakes or ponds, and will avoid other open waters where practicable.

-No spraying when fog or air turbulence is present, or rain is expected on site within 2-4 hours.

3. To protect the soil environment in the release areas, the following application practices have been adopted.

   -Herbicide containers will receive a triple rinse, with rinse water being added to the spray mix, and the containers disposed of in accordance with Environmental Protection Agency requirements or in State land fills approved for such disposal.

   -To avoid contaminating areas not scheduled for treatment, the entire aerial spray system must be leak proof and have a positive shut-off mechanism capable of eliminating drool of the nozzles or clusters of nozzles.

4. To protect the wildlife environment in the release areas, the following practices have been adopted.

   -Review the list of endangered and threatened wildlife published in the Federal Register 40(188): 44412-44429, September 26, 1975 (memo to Forests, 2630, October 2, 1975). No endangered or threatened wildlife are in or near the treatment areas.

   -Review "Unique" species identified in FSM 2622.4; The Fairest One of All; State legislation; or, species identified in Forest Unit Plans. No unique species of wildlife are in the treatment areas. One osprey nest west of Area 5 will be protected by restricting the flight path of the helicopter to prevent flight over or near the nest.

   -We will follow management practices approved for the protection of active habitat sites for identified unique, threatened and endangered wildlife species. FSM 2633.4 (Appendix E).

   -Critical habitat for endangered or threatened wildlife species will be preserved and not modified.

5. To protect the vegetation environment in the release areas the following practices have been adopted.

   -Review the list of endangered or threatened plants published for Wisconsin in the Federal Register Vol. 40, No. 127 on July 1, 1975 (Memo to Forests 2600 Habitat, December 11, 1975). No endangered or threatened plants are in the treatment areas.

-Most endangered or threatened plant species are found in unique micro-habitats which can be learned and identified. Most such plants which might be on the Nicolet are bog species and would not inhabit these upland treatment areas.

6. To protect man the following application practices have been adopted.

-Only a 2,4-D currently registered and labelled by the Environmental Protection Agency for the specific use proposed will be used.

-The proposal to use the herbicide 2,4-D has gone through an established review process.

a. Areas are field surveyed by Ranger District staff.

b. Alternatives for those areas needing treatment considered.

c. A proposal for herbicide written based on area needs.

d. Nicolet National Forest pesticide use coordination review.

e. Forest Service Region Chemical Use Coordinating Committee approval.

f. An adequate Environmental Analysis Report be written, and approved by the Forest Supervisor, that is site specific and describes relevant information required for public and other agency understanding.

-Whenever reasonable, recommend and use effective, safe, integrated suppression measures that may utilize biological, cultural, and other techniques in place of or in association with herbicides.

-Obtain legal clearances required by Federal, State and local laws or regulations before using 2,4-D.

-Provide for adequate training of all personnel who handle or supervise the use of 2,4-D.

-Brief applicators before and during this project in safe measures for transporting, mixing, and applying 2,4-D; use of protective clothing and equipment, plus the need for personal hygiene will be thoroughly discussed.

-An unsprayed buffer zone of at least 100 feet will be left adjacent to all private property.

-Application will be carefully supervised to assure that all stated precautions for 2,4-D use are being observed.

-Areas being treated will be posted with signs advising the public that the area has been sprayed with 2,4-D (Appendix F). Signs will be left in place for 90 days following the applications of spray.

III. ENVIRONMENTAL EFFECTS

The herbicide 2,4-D has been widely investigated and studied by the scientific community. Many of these studies have been under forest conditions and methods of application proposed for use on the Nicolet National Forest. These studies, plus 25 years of use experience and observation by professional land managers, have been used to develop this section.

A. Non-Living Components

1. Air. The herbicide 2,4-D can enter the air systems and may contribute to air pollution. Entry may be in the form of vapors, droplets, or as photo-altered products. Volatilization and photo-alteration occurs both during 2,4-D fall from aerial applications and from the vegetationn surface. Droplets, vapors, and drift become pollutents as aerosols (mass median diameter less than 200 microns) captured and held aloff by the wind.

   Entry of 2,4-D into the air is determined by localized atmospheric conditions, droplet size, and herbicide formulation. Climatic parameters are wind-speed, temperature, light intensity, and humidity. Application equipment determines droplet size. A low volatile 2,4-D will reduce the chance for volatilization because of a heavier molecular weight. Herbicide loss can be lessened by reducing the fall distance (See Figure 1).

   There will be some odor from the application of 2,4-D. This odor will be noticeble only for a very few days and only for a very short distance from the application site.

   Minor air pollution from the helicopter engine exhaust will occur.

2. Hazardous Substances. The herbicide 2,4-D is listed in in the United States Department of Agriculture Handbook No. 332 (1969) as being only slightly toxic and mildly irritating. Dioxins have not been found in 2,4-D. The 2,4-D approved by the Environmental Protection Agency is found in all common weed killers sold to the general public for yard weed control.

3. Soils. The forest floor will be a major receptor of 2,4-D. Deposition may be direct, washed from vegetation by rain or excreted from vegetation. Once on the forest floor, some 2,4-D loss will occur by photo-alteration and through volatilization. The remainder will be washed by rainfall into the humus layer and lower soil layers. What happens to the 2,4-D after entry into the soil depends on a number of soil factors including organic content, moisture, aeration, temperature, iron oxides, pH and clay content. High organic matter, high pH, (neutral to slightly alkaline), high soil temperature, and high soil moisture all tend to reduce the life of 2,4-D in the soil. Soil micro-organisms also aid in breaking down the 2,4-D. After entry into the humus and soil layer, further movement is much reduced. 2,4-D is quickly degraded in 2-4 weeks, it does not accumulate in the soil. The herbicide 2,4-D gives non-toxic and naturally abundant end products, such as carbon dioxide, water, and chlorine.

   Adsorption and leaching also take place in the soil. Herbicide molecules attached to soil particles provide temporary soil storage for later release. The free and released molecules are subject to leaching and movement with soil erosion to water sources. The leaching of 2,4-D in the soil is a slow process and seldom penetrates more than a few inches into the soil.

   Soil loss by erosion rates up to 0.1 ton per acre per year from forest land and must be accepted as a normal geologic process. The rate probably varies from less than 0.05 to 0.3 ton per year, depending on geology, soil, climate, and vegetation. It is the most active where annual precipitation ranges from 15 to 30 inches per year.

   This might indicate a potential for soil bound herbicide molecules to move with soil erosion to surface water. However, most soil erosion in the undisturbed forest is not sheet erosion, but almost always originates in stream channels. On land sloping less than 35 degrees, there is no evidence that tree death accelerates soil erosion much above geologic rates.

Massive rainfalls, bare soils, or excessively steep slope, combined with soils containing 2,4-D molecules can be exception to this norm. The potential for surface water contamination resulting from erosion of soil containing 2,4-D is further reduced by leaving a buffer zone around water areas. These buffer zones serve as filter strips which trap sediment, should erosion occur.

Although the indiscriminate use of 2,4-D may result in environmental degradation, a review of the literature and results of 25 years of Forest Service herbicide applications in Wisconsin indicate that the risk to the soil within or adjacent to spray areas is minimal when 2,4-D is applied according to guidelines established for this proposal. This conclusion is based on the low toxicity of 2,4-D to other than target organisms and the relative immobility of 2,4-D in the soil, plus the rapid degradation of 2,4-D within the soil.

4. Visual. Visual impacts associated with using 2,4-D to control vegetation include dead leaves, dead branches and standing snag trees, and a change in vegetation contrast.

   The "brown out" caused by curing of the target vegetation following 2,4-D applicaton has an immediate and adverse visual impact. Visual and aesthetic values are generally lowered during brown out; however, the effect is temporary, lasting only until leaf fall.

   In the case of dead brush left from 2,4-D use, the visual signs may last 5 years or more.

   The objective of 2,4-D use is to create a vegetation change. This change can be both adverse and pleasing, depending on the thinking of the viewer. If the contrast in vegetation change looks artificial or out of place, the visual impact can be negative. At the same time, the diversity of vegetation and new stands of trees or grass, encouraged by spraying, add to the attractiveness of an area.

5. Water. No area of environmental concern has received as much attention as water quality and quantity. Water, especially the oceans, is the repository for pollutents washed from the air and soil. The waters associated with the Forests of Wisconsin are mainly head waters and known for their purity.

   Any 2,4-D found in the waters of Wisconsin Forests should be considered a contaminant. Certain concentrations of 2,4-D in water could adversely affect the potability of drinking water for man and animals, the food chain organisms in the aquatic environment, sensitive irrigated crops, and industrial and recreational uses of such water.

Entry of 2,4-D into the surface water may be direct, by over land washing of soil, air wash out, or ground water flow. Direct entry is mainly caused by an error in application or through drift. Concentrations may reach 1 ppm, but will be short term and local in nature.

Washing, as a source of contamination, can occur, but must overcome considerable resistance from forest vegetation and humus layers protecting the soil. Massive rainfalls immediately following an herbicide application, unprotected soils, steep slopes, and a short distance from treated soil to surface water all increase the chance of surface waters becoming contaminated from an herbicide treatment area.

Knowing that herbicides can enter the surface water needs to be related to what has actually occurred in field use. From 1972 to 1975, 13 separate water surface sites close to aerial applications of 2,4-D were monitored on National Forests in the Lake States. The surface waters included rivers, a pot hole, an impoundment and marsh. Eighty-two samples collected were tested. These samples were collected immediately after spraying; 4 hours, 24 hours, and 65 hours later; and, after the first rain. Only six samples showed detectable amounts of 2,4-D. The highest being 16.0 ppb (parts per billion) and showing up after a thunderstorm rainfall totaling .32 inches. This rain fell within 1 day of spraying. The water sample was collected adjacent to the treated area from an intermittent stream that was not protected and directly sprayed. This is still below the 20 ppb limit recommended for public water supplies by the Environmental Protection Agency, and much below the LC_{50} values for sensitive crustaceans and fish.

Measured concentrations were considerably less than the 24 hour LC_{50} (lethal concentration to 50 percent of test organisms) of .960 ppm for rainbow trout using a prophylene-glycol-butyl-ether ester of 2,4-D (U.S. Forest Service, 1973; after FWPCA, 1968). These results indicate that the aerial application of 2,4-D to sites treated on the Forest resulted in negligible contamination, and that controls over the 2,4-D aerial spray program have been adequate for avoiding surface water contamination. These controls will also be in effect during 1976, on the Nicolet National Forest.

A 100-fold reduction in herbicide concentration, with downstream movement of about 1 mile, has been observed in several tests, but it is difficult to give an exact rule of thumb because of the nature of the dilution process in forest streams. If we accept a 25-fold reduction in concentration over a mile of stream as a conservative estimate, maximum herbicide concentrations of 0.01 ppm observed at the boundary of a treated area and stream would be less than 0.01 ppm 1 mile downstream. Return to pretreatment levels will be obtained in less than 24 hours after application. Therefore, maximum possible human exposure levels might be 0.01 ppm (10 ppb) for 24 hours, if water for consumption is taken from the stream immediately downstream from the treated area. Of course, the more remote the treated area is from the stream, and the further the water to be drank is from the water entry point, the less likely the probability of detectable residue occurring (Abrahamson and Norris, 1976).[5]

Mullison (1970)[19] reviewed concentrations of herbicides found in water after spraying the adjacent upland. Detected concentrations were 0 to 70 ppb (phenoxys). Time for total disapperance ranged from 2 to 17 days (phenoxys). It is evident that precautions given on the 2,4-D label are adequate to allow the material to be used safely.

The effects of vegetation management on tiny headwater stream flow within the Nicolet National Forest may be measurable, but are seldom detectable when the far greater volumes of flow in large rivers are measured. Stream flow increases are proportional to area and severity of vegetation control. An increase in water quantity comes about as evaporation losses through vegetation transportation and interception decreases. Vegetation regrowth may return the area to before 2,4-D treatment transportation levels in 1 to 10 years, depending on the degree of control, making the increase in water quantity short lived as well as tiny. A minor long term water quantity out flow may occur due to a perpetuation of a specific vegetation type. Permanently foliaged conifers intercept as well as transpire more water than do deciduous hardwoods, while grass uses less than either kind of tree.[7]

Drs. Abrahamson and Norris (1976)[5] reported on the results of extensive water monitoring investigations following present-day forestry herbicide applications. Forest stream monitoring for several herbicides over extended periods of time has consistently shown that leaching of herbicides in forest soils have not resulted in detectable (less than 0.001 ppm) concentrations of herbicide in forest streams. Field testing on forest land has verified that overland flow of herbicides is restricted to localized events and that the overland flow has shown marked reduction in herbicide concentration in water as it moves over uncontaminated soil. These measurements were made immediately downstream from treatment unit boundaries and, therefore, represent maximum concentration in the stream system. When herbicide concentrations have been detected, more than 99 percent of all concentrations have been less than 10 ppb.

While the probability of the 2,4-D applied to these 10 areas reaching surface water is very low, one site will be monitored before and after treatment to test the effectiveness of the spray application control methods. (Refer to hydrologists recommendations, Appendix G). Water samples will be collected before spray application, immediately after spraying, 1 day after spraying, and as immediately after the first and second rains following spraying as possible. These samples will be tested for 2,4-D by the WARF Institute, Inc., Madison, Wisconsin. The results of the monitoring will be assembled in a report to the Forest Supervisor, Nicolet National Forest. This report will be on file in the Forest Supervisor's Office, Federal Building, Rhinelander, Wisconsin. The public may review the report after January 1, 1977.

B. Living Components

1. Domestic Animals. The impact of 2,4-D use around livestock and other domesticated animals is becoming well documented. The lethal does for various test animals and particular chemicals are known. The acute oral toxicity of a single does of the phenoxy herbicides to mammals ranges from 100 mg/kg to 2,000 mg/kg. (Cast Report 39)[6] Signs of poisoning include loss of appetite, loss of weight, weakness, lack of coordination, alterations of the liver and other internal organs, and in some instances defective offspring.

Since domestic grazing animals can tolerate up to 2,000 ppm of 2,4-D type herbicides continuously in feed, there is no hazard to animals from forage residue, even from treatment of ranges and pastures at exaggerated rates. No residues appear in the milk of cows consuming rations containing up to 300 ppm of 2,4-D. Similar effects have been found with swine, sheep, and other animals.

2,4-D is generally less toxic to birds than to mammals. The acute oral LD_{50} for poultry, mallards, and pheasants range upwards of 2,500 ppm and is typically greater than 5,000 ppm when fed in treated feed.[8]

A subtle effect of 2,4-D treatment to plants is the increase in potassium nitrate to lethal concentrations in nitrate accumulating plants. In some plants, such as

Canada thistle and smartweed or black cherry, the leaves may become toxic to herbivores if eaten in sufficient quantities. This may also be a natural occurring process that takes place in these plants as the vegetation goes dormant in the fall.[8,29]

2,4-D applications following label instructions approved by the Environmental Protection Agency have not proven harmful to domestic livestock. Instances have occurred, however, where there have been poisonings by the use of certain other herbicides or contamination from herbicide accidents. The herbicide most often associated with these accidents is 2,4,5-T and the dioxin that contaminates it. Reports of these instances help expose the perils of an accident, but should not be purported as examples of regulated use of 2,4-D.

2. Man. Hazards to man are most likely to occur from exposure to the concentrated 2,4-D before dilution. The principle routes of entry into the body of man are by skin absorption, oral ingestion, and inhalation. Diluted 2,4-D may cause painful, but temporary discomfort to the eyes. A massive dosage of 2,4-D received over a short period of time could cause death. The LD_{50} for a 150-pound person has been set at 500 ppm (500 mg/kg). Small doses, over a long period of time to pregnant women hold potential for inducing teratogenic effects in their babies. The greatest risk is to those people manufacturing and applying 2,4-D. A lesser risk exists for those who might intake 2,4-D residues through forest water, fruits, berries, or meat or wild game.

   Few studies of 2,4-D toxicity to humans have been made. The best we can do is project data compiled on other animals to people. The 2,4-D herbicides available for use in Wisconsin have been assigned a LD_{50} of 500 mg/kg, the toxicity for a 150-pound person.

   2,4-D toxicity to a human depends on a herbicide being present in or on an individual, in an active form, in sufficient quantity, and for a period of time to produce an effect. The chances of this combination of conditions happening with 2,4-D treatments proposed is slight. As an example, immediately following a 1973 spraying of 2,4-D on the Chippewa National Forest in Minnesota, the concentration of 2,4-D on raspberries was found to be 4,000 ppb. A 198-pound person would have to consume approximately 34,000 quarts of raspberries within a short period of time to receive a lethal dose of 2,4-D from these berries.

   Statistics for the years 1971-73, published by the National Agricultural Chemicals Association, show there were 13 fatalities from pesticides in 1971, 17 in 1972, and 10 in

1973. Of these, nine were from agriculture herbicides in 1971, five in 1972, and four in 1973. Cancer from herbicide use would be expected to be heaviest out where the chemicals are used, where herbicide use is regular, and where runoff from fields and forest might enter the waterways. The Sixth Annual Report of the Council on Environmental Quality published in December 1975, shows just the opposite. "Analysis county by county," it says, "reveals that a majority of the areas of high cancer mortality are located in the large cities." The report also shows a two-thirds decrease of stomach cancer in both males and females since recordkeeping started in 1930. A remarkable fact, considering some 40-odd years of American diets consisting mainly of pesticide-protected foods.

In the Total Diet Program of the Food and Drug Administration, grocery basket samples were collected in 30 different grocery markets in 30 different cities. The sample tests covered the period of August 1972, through July 1973. A variety of food classes was sampled. In all, 1,729 chemical residues of 40 different compounds were found. Only one, however, was a sample of 2,4-D (a residue of 0.014 ppm was found on a vegetable).

In earlier monitoring programs, from 1963 to 1969, the Food and Drug Administration found no residues of 2,4-D in 13,000 samples of milk and 12,000 samples of meat.

3. Soil Organisms. The soil contains a large and varied population of bacteria, fungi, actinomycetes, algae, protozoa, insects, earthworms, arthropods, and acarinids. The populations are measured in the millions. Their activity vary greatly with temperature, moisture, organic content, aeration, and soil texture. Soil organisms are beneficial to higher plants. They are essential for decomposing vegetative matter and aiding the nutrient cycle.

   2,4-D may have an adverse effect on some soil organisms. At the same time, some soil organisms are attracted to 2,4-D. The reaction of the soil organisms depends on the conditions found within the soil. There is no evidence to indicate that the 2,4-D herbicides used when applied at recommended rates, will have any lasting effects on soil organism populations.[9] Investigation of 2,4-D on penicillia mycelial dry weight and total nitrogen content have found both decreases and increases, depending on penicillia investigated and concentrations of 2,4-D used.[10]

   In another study of 2,4-D with soil microflora, it was found that soil microflora enzym systems adjust, either through mutation or selection (or both) to utilize 2,4-D as a food source. At first, the 2,4-D was slow to degrade. After 12 days, the degradation accelerated with no 2,4-D 6 days later. Successive additions of 2,4-D were completely degraded in 1 to 4 days.[11]

4. Vegetation

a. General. The herbicide 2,4-D is absorbed by plant foliage, roots, and soft stem tissue. Once absorbed, the 2,4-D moves within the plant along the pathways that carry food and water. 2,4-D tends to accumulate in the actively growing parts of roots and stems. As the herbicide distributes through the plant, the leaves and buds twist and curl, followed by malformed new growth of stems and leaves. Sensitive young plants may die in a few days. Hardy shrubs and trees may succumb only after weeks or months, or may survive without evident injury. The broad-leaved plants and forbs are more susceptible to the herbicide properties of 2,4-D than conifers and grass. Even within the hardwoods, a degree of selectivity exists with target plants like aspen, birch, hazel, and alder being susceptible and maple, raspberries, and cherries being more tolerant.

In 1973 and 1974, acreage totaling 9,934 acres were treated on the Chippewa and Superior National Forest, Minnesota, and the Ottawa National Forest, Michigan. The 2,4-D herbicide and application rate was the same as proposed for use in this project. The average percent control of the target species for all three Forests was:

Species	Percent Control
Aspen	70-90
Paper birch	90-100
Tag alder	90-100
Hazel	90-100
Sugar maple	50
Raspberry	50

Our purpose in using 2,4-D is to elicit a certain behavioral response from the vegetation. This response is measured by the immediate reaction of target plants to the herbicidal action of 2,4-D. The response is also measured by the long-term hardwood-conifer mix maintained within the Forest.

Very little of the 2,4-D reaching the vegetation is metabolized. Rain washes much of the 2,4-D left on the plant surface to the forest floor. Some 2,4-D may be passed through the plant and excreted by the roots into the soil. The remaining 2,4-D within the plant and any breakdown products will eventually enter the soil, either in leaf fall or decomposition of dead stems and roots.

The application of 2,4-D may adversely effect some nontarget plants. The degree to which this occurs varies with the susceptibility of non-target plants, the season of application, and how actively the plant is growing. Should the red pine and black spruce to be treated in this project not be completely "hardened off", this year's needle growth would be wilted by the 2,4-D. This condition is displayed by a drooping of the needles on affected trees. It does not bring about the death of the pines or spruce, and is not considered serious.

Following the initial loss in target plant numbers after the 2,4-D treatment, a new plant community will quickly appear. The new community will be different in size and age and may have a greater variety of plant species. The wildlife and bird populations should show a similar change. Desirable conifers, once in a subordinate position, can now move to a dominant position. It is the objective of vegetation management to maintain this new plant community when it consists of plant species desirable to the resource manager.

Favorable effects of herbicide use can be seen in the survival and growth of host plants. Wilde[20,21] calculated that pine plantations in Wisconsin require about 331 gallons of water to produce 2.2 pounds of merchantable wood, whereas evapotranspiration of ground vegetation consumes about 23.5 gallons of water per 2.2 pounds of over-dry tissue. In turn, each 2.2 pounds of weed bio-mass in the plantation throughout the years reduces wood production 0.15 pounds. Therefore, timber growth in plantations established in a heavy cover of shrubby plants may under produce more than 15 cords per acre over a 40-year rotation, or more than a 1/3 cord per acre per year. At current stumpage prices, obviously, weed control is an excellent investment.

In another Wisconsin growth study, diameter growth in a 7-year old Wisconsin red pine plantation increased 30 percent the first year after herbicide application, and 8 percent the following season. Height growth increased 13 percent the second year. Two years of shrub competition control in another red pine plantation increased growth by 300 percent.
In Minnesota, conifer plantation studies show more seedlings were killed by competing vegetation than any other factor.[12]

b. Endangered or Threatened Plant Species. Vegetation management by any of the methods available to us will probably affect endangered or threatened plants, if they are in the area being treated. Broadcast treatments are more likely to unintentionally damage unknown populations of such plants, than are selection methods of treatment. Herbicides are no exception. The sensitivity of all the plants is now known; we must, however, assume a 2,4-D program will have an adverse effect on them. The Endangered Species Act of 1973 directed the Bureau of Sports, Fisheries and Wildlife to publish a list of endangered and threatened plants. They have adopted the Smithsonian Institute's 1974 report on endangered and threatened plant species in the United States.

5. Forest Vertebrate Animals

a. General. A wide variety of wildlife species inhabit the National Forest land of Wisconsin. The survival needs of some species are very specific. Animals like the bear or skunk are adaptable to a wide range of foods, habitat conditions, and disturbance by man. Proposed 2,4-D applications will occur on areas occupied or visited by a significant number of wildlife species. The wildlife impacts of any 2,4-D application project will depend on the wildlife species present, the size of the area treated, and the long term resource management objective for the treated area. Routine activities of individual wildlife species may result in contacts with treated vegetation, soil, or waters, or ingestion of treated food. Such exposure under forest conditions has not proven hazardous to wildlife.

b. Mammals. A hazard to mammals could occur if they were exposed to an acutely toxic dose of herbicide. The acute oral toxicity of a single dose of the phenoxy herbicide 2,4-D to mammals ranges from 100 mg/kg to 2000 mg/kg, depending upon the test animal. 2,4-D is absorbed in animals after ingestion, transported via the plasma, concentrated in the kidneys, and rapidly eliminated in the urine.[6]

Deer allowed to browse 2,4-D areas sprayed to improve deer browse showed no preference for either untreated or herbicide-stimulated branch growth.[13] Test animals are often repelled by herbicide residue on their natural foods. When only limited areas are treated, as proposed in this project, very few animals will be forced to feed only on food contaminated with 2,4-D.

Investigators[14] found that deer exposed to feed treated with maximum field applications of 2,4-D did not accumulate significant amounts of herbicide. Forty-three days after exposure, the muscle tissue of the deer showed residue of 2,4-D at less than 0.006 ppm. This study, the U.S. Department of Health, Education, and welfare Food Basket studies of meat, fish, and poultry, and the Environmental Protection Agency supported beef fat monitoring programs all point out that herbicides proposed for registered use in the Nicolet National Forest are not contaminating meat used for human consumption.

The greater the number of plant species controlled at any 2,4-D site, the greater the habitat impact on wildlife occupying the area. The method of herbicide application, broadcast or selective, also influences this impact. The use of 2,4-D sets vegetation succession back to an earlier stage. Small mammals with small home ranges or very narrow habitat tolerances will be most affected by the thoroughness of individual herbicide treatments. Large mammals, like deer or bear, benefit the most as an improvement in food availability and food nutrition occurs within their home range.

One 19 year study[15] of selective vegetation management using herbicides showed a diversity of food plants useful to wildlife developed on the sample area following spraying. These plants included common herbs of the forest as well as invaders usable as food by many animals. Woody plants were found interspersed throughout the treated area. The taller woody plants were found to supply food throughout the year, and were of particular value as emergency food when deep snow covered the ground. The test area was heavily used by common wildlife species such as white-tailed deer, rabbit, and grouse. A special study made of the white-tailed deer showed a consistent and heavey use in all seasons, indicating that attractive food and cover had been developed.

A more subtle and long term impact of vegetation management is its affect on wildlife habitat. Vegetation management will affect the vegetative layering of the area treated and the species of plants making up the replacement community. Because the habitat needs of many wildlife species are very specific, some animals will be adversely affected while others will benefit. Investigators have found that as the vegetation replacement community becomes established, the original set of animal populations largely be replaced by a different set of lesser diversity. The replacement animals will have higher numbers of fewer species, many of them new to the sprayed area, but common to similar habitat types in the Nicolet National Forest.

Vegetation management using herbicides is the most effective vegetative control method we now have available for our use. Most species of vegetation, however, are only controlled for a period of time and shortly return to the treated site, unless periodically controlled or suppressed by host plants. Wildlife biologists, have long used knowledge of this fact to manipulate vegetation diversity and maintain wildlife openings with herbicides to benefit a variety of animals.

The activities of man and his equipment during herbicide application will disturb wildlife. Large animals will be able to leave the site temporarily, while small mammals will head for cover or go underground. This disturbance can have a serious impact if it occurs during mating or at birthing time. (Late July and August are not considered the normal season for these activities). The implication of using 2,4-D on total forest population distribution or concentration will be very local in nature and fluctuate only with changes in specific ecological niches, rather than any direct detrimental effect of the herbicides.

c. Birds. 2,4-D has been found to be generally less toxic to birds than mammals. The oral LD_{50} for these birds with herbicide treated feed is typcially greater than 5,000 ppm. Under field conditions, a bird would have to daily consume all the herbicide aerially applied to approximately 10 acres to duplicate the 5,000 ppm feed under controlled trials.

Young pheasants have an LD_{50} (Lethal dose for 50 percent of the organisms tested) of 472 mg of 2,4-D per kilogram of body weight (U.S. Forest Serivce, 1973 after Pimental). The LD_{50} for grouse, a common game bird on the Forest, is probably similar. Assuming an LD_{50} of 500 mg/kg for a grouse that weighs 1/2 kg., a grouse would have to eat 62.5 kg of raspberries contaminated with 4,000 parts per billion of 2,4-D to concentrate a lethal dose.

The large quantities of berries indicated above to reach lethal concentrations would also have to be consumed during a short period of time, since 2,4-D does not concentrate within the organism through time, unless exposure is constant. Obviously, the lethal concentrations would never be accumulated. Ingestion of lesser amounts may cause physiological responses relative to reproduction and fertility (loss of egg production in birds, and abortion in mammals). The effect on egg production in birds has potential for affecting very few species, due to the season of application. The doses required to produce these effects would probably not occur at the proposed rate of application.

Feeding trials found that 2,4-D, when fed at daily rates of 1,250 and 2,500 ppm, depressed mallard duck reproduction.

Bramble and Byrnes[15] found wild turkeys and ruffed grouse used 2,4-D treated areas. The young turkeys were attracted to the openings to feed on various insects more abundant on the grassy treatment areas than within the wooded areas. Ruffed grouse numbers were found on the edges within 150 to 200 feet of the study area, rather than on the area itself. This emphasizes the importance of using 2,4-D as a creator of edge effects.

Aqueous solutions of 2,4-D, equivalent to 10 times recommended field concentrations, were sprayed on fertile pheasant eggs preceding incubation. No treatments were found to cause any adverse effect on hatching success, incident of malformed embryos, or subsequent chick mortality relative to water-sprayed control eggs. Herbicide contamination was found to facilitate weight gain of roosters from 0 to 4 weeks of age, while hens failed to show a response. Residue analysis verified herbicide deposition on the shell and entry into the egg.[16]

The helicopter itself may disrupt nesting birds and other wildlife in the project areas. This would probably not be of significant magnitude to constitute an environmental consideration, except in the case of unique species such as eagles, ospreys, and herons that may be nesting in the vicinity of project sites. During the time of year of application, both of these species will have young in the nest near the fledgling stage of development. The helicopter could conceivably cause premature fledgling, or perhaps nest abandonment, if proper precautions are not taken.

Ferrying routes and treatment areas will be located a minimum of 20 chains (1/4 mile) from any known active eagle nest, osprey nests, or heron rookeries. This minimum distance may be increased for particular nests, based on topography and screening vegetation between the flight path and the nest site.

d. Fish and Amphibians. The toxicity of 2,4-D to fish is highly variable and affected by chemical formulation, water pH, temperature, water hardness, oxygen content, and dilutent rate. The lakes, ponds, and rivers of northern Wisconsin contain abundance and variety of both warm and cold water fish. These fish are important as a sports fishery.

For ESTERON 99 (propylene glycol butyl ether, ester) the LC_{50} at 48 hours of exposure for rainbow trout is 0.96 ppm[8] (one pound of herbicide on an acre-foot of water is equivalent to 0.370 ppm). These values are equivalent to treatments of 10 pounds of 2,4-D herbicide per acre in a pond 4 feet deep; much higher than the 3 pounds of herbicide allowed for application by the ESTERON 99 Concentrate label use directions for land vegetation treatments. The LC_{50} for bluegill to the same formulation of 2,4-D at 24 hours and 48 hours of exposure is 2.1 ppm[8], or about 23 pounds of herbicide per acre in a pond 4 feet deep. If an accident were to occur that required the dropping of a full 80 gallons of spray mixture into a lake or pond, the one acre - 4 feet deep concentration would be 2.8 ppm. This concentration would be quickly diluted by the number of acres in the body of water, photo decomposition, and micro organisms. There seems to be a considerable margin of safety considering the 2,4-D contamination concentrations we have found after forest herbicide treatments.

Schultz and Harman[17] investigated the effects on fish of 2,4-D applied directly to water. Rates used were 2, 4, and 8 lbs. per acre. Only 7 percent of the fish, analyzed 28 days or more after treatment, contained detectable 2,4-D residues, and only 1 percent (one fish) of those analyzed

56 days or more after treatment contained detectable residues. If tolerance levels are based on the level of parent compound only, it would appear that fish could be consumed one month after treatment. They also found little danger of bio-magnification of 2,4-D in the aquatic food chain. It was noted, however, that when fish were exposed to radiated 2,4-D radioactive compounds were ubiquitous in all fish tissues examined. Degraded 2,4-D products were also present for as long as 84 days after some treatments. Therefore, the identity and potential toxicity of these degraded products must not be overlooked.

The ester formulations of 2,4-D are often more toxic to fish than amine or metalicsulf formulations. This is probably due to the more effective penetration ability of esters.

The effects of 2,4-D use on amphibians has not been widely investigated. The major impacts would possibly be on frog egg and tadpole development.

e. Endangered and Threatened Animal Species. The Forest Service does not have direct authority for management of endangered and threatened animal species. Our major contribution to preserving any wildlife species appearing on State or Federal official lists is through the management of critical habitat. The U.S. Department of Interior, in consultation with the States, is charged under the 1973 Endangered Species Act with completing and maintaining official lists of wildlife species that are classified as endangered or threatened. The Forest Service has adopted these official lists and may expand them for Forest use to protect additional unique wildlife species. This proposed herbicide project has been analyzed for its impact directly to any animal species on an official list and the habitat loss or modification that might occur.

6. Forest Invertebrate Animals

a. General. The number of invertebrates per acre in a forest environment can only be guessed at. The number would be listed in the thousands. We are interested in the impacts of 2,4-D use on invertebrates, because invertebrates are an intricate part of a forest community. Invertebrates are also important because they serve as food for the vertebrates, and are thus an early indicator to potentially dangerous food chain build ups.

b. Insects. Several studies of how 2,4-D affects insects have been made. Most relate to the acquatic or soil life stages of the insect and not the adult stage. No significant hazard to insects is expected as a result of acute toxicity of this proposed herbicide use at the Environmental Protection Agency regulated application rates.

The following species of bottom-dwelling organisms were reduced by 50 percent or more after an applicaton of 2,4-D, ranging from 1 ppm: to 4 ppm: Mayfly nymphs, horsefly nymphs, common midges, phantom midges, biting midges, caddice fly, larvae, and water beetles. Smith and Isom (1962), in another investigation, concluded 2,4-D at low 1 ppb in water concentrations had little effect upon bottom insects.

Honey bees have responded in different ways to exposure to 2,4-D. One investigation showed honey bees to decrease by 22 percent following treatment of a field they were using with 3 pounds of 2,4-D per acre. However, dusting bees with 2,4-D did not cause any mortality.[18] It is not known if the toxicity observed in the field was due to 2,4-D dissolved in the nectar, or to the production of a toxic metabolite secreted by the plant into the nectar.

Benefits to some insects, especially honey bees, increase as plant succession is set back to conditions favoring flowering forbs. Other investigations have shown insect populations can increase following 2,4-D treatments, due to the increase in organic matter resulting from the decay of controlled plants.

Of mosquito larvae treated with 2,4-D at a rate of 100 ppm in water, about three-fifths fewer larvae as in the control reached the pupal State.[31] This study added further evidence that 2,4-D is relatively non-toxic to some invertebrate species

c. Crustaceans and Mulluscs. Detectable residues of 2,4-D do not appear in surface waters of the Nicolet National Forest, unless the chemicals are directly added to the water, or fall there incidental to spraying forest vegetation, or unless the chemical is added as a water treatment for the control of aquatic vegetation. Detectable 2,4-D residues are not expected to be found in the silt of forest waters either. In investigations outside the forest area where 2,4-D residues have been found in silt, it has been attributed to wind blown erosion from bare soil treated with 2,4-D. With the forest conditions and precautions taken in the Nicolet National Forest, it is not expected that crustaceans and mulluscs in or near the National Forest will be exposed to any residue from this herbicide project.

Should an accident during treatment happen or metrological conditions occur that would cause a 2,4-D contamination of forest water, the concentration in the water can be expected to fall below detectable levels in a few days. Such residues are diluted through stream flow, decomposed by sunlight, or destroyed by microorganisms.

Crawfish, mussels, and a wide variety of other crustaceans and mulluscs are not directly affected by the 2,4-D herbicides at rates approved for direct application to water for aquatic weed control. Concentrations of 0-50 ppb found from actual forest sampling in the Lake States, in the few samples where residue has been detected, are much less than the 0.185 - 0.462 ppm concentration approved for direct water application on some 2,4-D herbicide labels.

An adverse impact of a large accidental 2,4-D contamination to a lake or pond would be the effect plant vegetation decomposing would have on lowering the water oxygen content, even if the herbicide level itself was not high enough to cause crustacean and mullusc mortality.

d. Social Economic Component. The fact that 2,4-D is widely used on private rangelands and pasture, private forests, in a variety of utility and highway right of way uses, and on the home lawn is ample evidence that it is efficient and inexpensive relative to available alternatives. 2,4-D has not been found to have serious unintentional side effects when used in forest conditions following approved use directions. Where the control of vegetation is needed, herbicides usually have less harmful side effects on the environment than alternative methods of control.

The favorable effects of 2,4-D use are production and protection orientated. Improved economic welfare and community stability are the results. Public and private benefits are measured by increased timber volume and value.

Forest trees, in the form of timber products, are a renewable resource. They are also raw materials for use in later manufacturing processes. As raw materials, they are at the starting end of the production process, and money paid for them tends to stay in the local area more so than for communities based on secondary or later stages of manufacture.

The numbers of people needed for primary resource production, however, is not as great as the number of people required in secondary manufacturing processes.

Our aerial herbicide applications are the least labor intensive of the herbicide application methods used. Ground methods of application, especially cut surface and basal stem methods, employ more people. A reduction in use of herbicides and a move to more manual vegetation control would provide longer employment or increased employment needs for laborers and a favorable short term economic impact on the local community. A long term adverse local employment and economic effect would occur from a reduced usuable future resource availability. Nationally, the effects would be an increased cost to the taxpayer. Consumers would feel little impact under the assumption of constant total output. If a constant total output was not maintained, however, a strong increase in consumer price would occur with only a small decrease in output.

A long term economic benefit will result from growing black spruce and red pine on these sites. By age 40, if adequately released, these plantations will produce an estimated 36 to 43 cords per acre[27] of high value pulp and sawtimber, products worth about $3,600 to $6,450 based on current prices. This assumes the plantations are released to achieve 90 percent of their potential, and that red pine and spruce are of comparable value.

If unreleased, the areas will produce only about 13 to 25 cords per acre of mixed pine or spruce and lower valued aspen, worth perhaps $1,040 to $3,750 per acre during the same 40-year period.

Similar economic benefits were found in a Region-wide reforestation - TSI evaluation. The evaluations compared alternatives of growing one species of tree versus growing another tree species on the same area. Two cases, comparing growing red pine to a 100-year rotation vs. growing aspen for 35-45 years, showed the following when using stumpage rates current on the Nicolet. A similar comparison was made involving northern hardwood management.

	Site Index	Rate of Return
Planting red pine vs. aspen management	60	5.68%
Planting red pine vs. aspen management	50	5.22%
Planting red pine vs. northern hardwood management	50	4.78%

When the rate of return and benefit/cost analysis for releasing red pine on an acre of land was compared to not releasing that acre, the following was found:

	Age	Site Index	Rate of Return	Benefit/Cost at 7%
Release vs. no release	5 years	60	9.7%	2.37
Release vs. no release	10 years	70	9.55%	1.99
Release vs. no release	5 years	70	8.7%	1.75

Release of existing stands is a very desirable treatment from an economic standpoint.

An evaluation of a given timber management investment is based on the cost and benefits to be expected if a specific investment is made versus the costs and benefits to be expected if the investment is not made. The evaluation is then made of the net difference between the two timber management regimes, one with the investment to be evaluated and one without the investment. The rate of return shown is a "real" or noninflated rate. A 4.8 percent internal rate of return if inflated over a long term at 5 percent compares to a 10 percent rate.[28]

The economic and social effects of the production and manufacture of forest products on the Nicolet National Forest are of major importance to the communities found in or near the National Forest. To manage a part of the National Forest in high fiber yield red pine and black spruce will benefit the local economy and add to the social well being of the people living here.

IV. FAVORABLE ENVIRONMENTAL EFFECTS

A valuable wood resource will be established to supply wood-using industries in and near the Nicolet National Forest. Up to about a 300 percent increase in high quality wood production should occur. This will aid the economic and social conditions of the local communities. There will also be an increase in returns to the Federal Government and counties from stumpage payment.

Management of conifer stands will continue the historical vegetation composition of the northern Wisconsin area. The variety of vegetation will generally benefit most wildlife species. The variety will also provide an attractive and favorable contrast to the predominantly hardwood-aspen forest now found over most of the Nicolet.

The use of 2,4-D is effective and long lasting. When compared to many of the other alternatives available to us, it is less destructive and violent to the environment. The greatest saving of the public's tax dollar will be realized.

A heterogeneous forest has been found to be more resistant to insect and disease losses.

V. ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Minor soil contamination cannot be avoided. This contamination shall probably last for 2 to 14 weeks. This impact will not significantly affect soil biota.

As previously mentioned, there are aesthetic impacts which can be minimized but not eliminated. These are temporary, occurring primarily during the remainder of the summer of treatment, when the "brown-out" effect of dead leaves is visible.

There will also be the habitat loss for certain wildlife species mentioned earlier in this report. This is a necessary trade-off in achievement of values associated with the composition objectives policy.

The potential always exists for accidental dumping of the herbicide due to a malfunctioning aircraft. The likelihood of this occurrence is minimized by careful inspection and certification of the aircraft.

There will be a slight and temporary odor from the herbicide. A minor amount of air pollution will occur from vehicle exhaust.

Minor amounts of volatilized herbicide may enter the atmosphere. Rates of dilution will be so great that effects on living organisms are not expected.

If there is a good blueberry or raspberry crop this year, the berries will most likely receive some 2,4-D residue. Treatment areas will be posted to notify people of the herbicide application.

There will be an expenditure of approximately $6,000 of public funds.

VI. ALTERNATIVES

A. Biological

1. Controls. Biological control of vegetation is a process featuring native animals, insects, diseases, and environmental changes. Releasing more of a plant's natural enemies against the host can increase the natural control. The objective is to regulate the density of the pest plants. An example would be controlled use of livestock to reduce competing grasses and forbs in plantations.

   Insect damage to plants may be in the form of defoliation, girdling, or sap removal. Common life forms of the attacking insects are larval and adult. The attacked plants are weakened or killed.

   Diseases are caused by living parasitic agents which live and feed on or in plants. They are most commonly caused by fungi, bacteria, viruses, and nematodes. Environmental conditions have to be right before infection occurs. Injury may be in the form of over developed tissues, stunting, lack of chlorophyll, incomplete development of organs, or death of tissue.

Biological control could also include non-living agents. These agents include such things as nutrient adjustments, extreme heat or cold, plant toxic chemicals other than herbicides, and not enough or too much water. These causes do not act like diseases in that the control is not passed from one plant to another.

Biological control holds promise for the future, but still needs research before becoming a reasonable alternative for use in the Nicolet's vegetation management program. Many problems with effective biological control still exist. A major disadvantage being how to contain biological agents within the 10 treatment areas. Spreading into adjacent areas, insect and disease populations could rapidly expand, attacking plants desirable for these sites. Another problem is the biological agent may not be sufficiently specific to the target plants and devastate other plants desirable as wildlife food or even the planted pine or spruce.

2. Evolution. In vegetative management, it is the resource manager's need to only control the growth of selective vegetation, not eliminate it. Reforestation is an example. Growth advantage is wanted for the planted trees. This advantage could be obtained through cultural improvement rather than pest plant control. Biological evolution of vegetation is a process futuring genetics, nursery practices, soil preparation for planting, and succession. The objective is to work through the host plants. Individual plant characteristics for tolerance and early fast growth can be identified and, through genetic breeding, passed along to progeny. Host plants bred for favorable growth characteristics could overcome the need for control of associated vegetation.

   A physiological shock is often exhibited by plants transplanted from a controlled nursery environment to an uncontrolled field situation. An adjustment in nursery soil nutrients and introduction of mycorrhizal fungi may reduce this shock and the resultant growth loss usually suffered by transplants. Host transplants conditioned for early fast growth could prevent better established plants from squeezing them out.

   Programs to reestablish vegetation usually require some type of site preparation to prepare the area for planting or seeding. Site preparation involves exposure of mineral soil by removal or repositioning of accumulated vegetative matter. The more complete the site preparation, the less chance of future need to control unwanted plants.

   Vegetative communities are never static for very long. Conditions are always developing for change, either toward climatic stands, or away from them. Where a vegetative community is at, at any time, determines the complex association of plants to be found in it, and what is to follow under given conditions. Based on sound ecological knowledge of natural succession trends, host plants could be matched to successional conditions rather than competing against them.

Better use of the host vegetation, like control of pest vegetation, holds promise for the future. Research and studies are underway, but findings are slow, due to the time involved in working with many forest plant species.

B. Fire

Fire, as a vegetative manipulator, has long been a part of the forest environment in northern Wisconsin. Used as a controlled and prescribed tool, fire is today a part of the vegetative management program in timber management.

The use of prescribed fire is limited by season of year, daily weather conditions, type of vegetation, terrain, local air quality standards, and available manpower and equipment needs. It can, however, be used for very specific treatments.

Some of the drawbacks to use of fire are:

1. High temperature in fires can not only consume the humus layer above the soil, but also parch the soil, decreasing its porosity and increasing the chance of erosion and excessive runoff.

2. Red pine and black spruce are not plant species with a high fire tolerance. For this reason, the use of fire is limited to non-selective uses. Fire cannot realistically be proposed for thinning or control of competing vegetation projects.

3. Hot fires often produce a vegetative change within the burn area. Plants native to the area, but long suppressed by successional change, are released to once again dominate the site.

4. At times, fire is not hot enough to control plants with well established root systems and prolific sprouting occurs after the fire.

5. The number of days fire can effectively be used are very limited. Some years they do not occur at all. And, when they do, the danger of wildfire will most likely be high reducing the fire fighters and equipment available for prescribed burning

6. Burned areas are unsightly to some individuals.

7. If prescribed burning conditions occur during the nesting or birthing season, fire will adversely affect many forms of wildlife.

Fire, although used in the Nicolet National Forest, is specific in its application for vegetative management.

C. Herbicides

Chemical control of vegetation involves the use of materials that cause a malfunction in plant growth processes. Entry into the plant may be through the foliage, stem, or roots. Herbicides, as these chemicals are called, may be selective or non-selective. The selective herbicides generally act on the broad-leaved plants, whereas most grass, coniferous trees and certain legumes are relatively resistant. The non-selective herbicides generally control all vegetative types.

Herbicides are preferred as an alternative because they have been found to be both effective and useful for vegetative management. Effectiveness is shown by a herbicide's ability to control a specific target pest or produce a wanted plant action. Usefulness is determined by the ability to apply herbicides according to the directions and cautions of the label without causing unreasonable adverse effects.

Today, herbicides are available for vegetative management programs in timber, range, wildlife, agriculture, recreation, and rights-of-way maintenance. The season of the year limits some methods of application; however, other methods are suitable in all seasons. The major advantages being lasting effectiveness and low cost.

It is becoming increasingly apparent that the hazards of non-herbicide use must include the effects of alternative techniques that are more violent and often more destructive to ecosystems. Selective herbicides, like 2,4-D, do not kill all vegetation or physically disrupt soil. The effects on wildlife are not physical, but related largely to habitat change and the ratio of favored food species available. These same habitat changes will occur with any method of conifer release used. Plantation areas treated with herbicides remain accessible to browsing animals. In contrast, areas strewn with heavy slash are only partially accessible, and by the time wildlife can move around, the browse has grown above their reach. Because of the minimum physical impact on an area treated with herbicides, many benefits occur that are not possible with the other alternatives considered:

-site protection is not removed

-cover and food still remain for wildlife

-nutrients are not removed or bunched

-microclimatic extremes are minimized

-new undesirable plants find it difficult to become established due to competition from vegetation on site.

When considering the economics of using herbicides, the costs generally run below the other alternatives available. Costs, however, are not the overriding consideration in preferring herbicide applications in selected areas. The environmental effects, social impacts, and combined resource objectives are reviewed.

If herbicides were not available, the cost of food, forest products, electric power, and transportation would be higher. Of the alternatives available, the use of herbicides has proven to be the most effective and longest lasting.

The use of herbicides has been controversial, especially the aerial application of 2,4,5-T. Much of the concern originated from publicity given to a chemical called Agent Orange and used in Viet Nam. Agent Orange contained an impurity; tetrachlorodioxin, more commonly known as TCDD or dioxin. The dioxin content now contained in 2,4,5-T has been reduced to a fraction of one percent of its original content. Dioxin has been found to be one of the most toxic chemicals known to man. Until new monitoring programs, capable of dioxin detection to 1 part per trillion, are analyzed, debates on the use of herbicides will continue. 2,4-D has not been found to contain any dioxins.

Eastern Region experience with herbicide use since 1950, has shown this method of vegetative management to be effective, of low cost, and when used in the forest at the registered dosage, does not constitute a hazard to humans, animals, or the general quality of the environment. Herbicide use still remains as a preferred method for most vegetative management.

Several methods of herbicide treatment are approved by E.P.A. registered labels for forestry application to release conifers. A variety of herbicides are also available. They include 2,4-D amines; 2,4-D + 2,4,5-T amines; 2,4-D + 2,4,5-T low volatile esters; 2,4,5-T low volatile esters; 2,4,5-TD (Silvex); cacodylic acid; dicamba; dicamba + mixes of 2,4-D or 2,4,5-T; ammonium sulfamate; picloram or mixes of picloram + 2,4-D or 2,4,5-T; and 2,4-D low volatile esters. Some of these herbicides are non-selective and must be applied as individual stem treatments, others are limited in their registration to the conifers they can be used with and the target pests they will control, and still others are limited in the method for which they can be applied. Some of these herbicides, e.g. dicamba, picloram, and 2,4,5-T are more persistent in the environment. An environmental assessment of the ecological effects of each of these herbicides can be found on Pages 33 - 53 of the Final Environmental Statement, The Use of Herbicides in the Eastern Region.

From over 20 years of herbicide experience, a knowledge of the conditions existing on this 340 acres, and a review of the E.P.A. registered labels available, we have considered the following herbicides and methods of application available as alternatives to consider.

1. Ground Application of Herbicides

   a. Mechanized Equipment. Broadcast Foliage Spray

      Herbicide release could be done by a tractor mounted power sprayer. A definite advantage would be better control of spray drift. Also, less chance of volatilization during droplet fall should exist.

      Terrain, soils, and access limit the opportunity for ground spray equipment. This alternative will not provide as even a rate of application as a helicopter, because of the difficulty of maneuvering equipment and maintaining a steady applcation rate. Some mechanical damage to the conifers being released will also occur from being run over by the spray rig. To provide the same degree of coverage to an acre of forest plantation, gound spraying will introduce 4-5 times as much herbicide as doing the work by an aerial application.

      Soil compaction would occur. Aesthetic impacts would be the same as with an aerial herbicide application.

      Costs are expected to vary from $35-$50, depending on the variable involved. These 340 acres are considered too rough to safely treat from the ground with mechanical equipment.

   b. Backpack Sprayers. Broadcast Foliage Spray

      This alternative makes use of small back carried spray equipment. The potential for off site contamination would be minimized.

      Where heavy brush and debris exists, this method would be difficult to use. Walking is difficult, the job is hot, body soaking from applied herbicide is a hazard, and personal fatigue and the possibilitiy of accidents are high. Aesthetic impacts would be comparable to an aerial herbicide application. The rate of herbicide application is difficult to control and the chance of missing areas in need of treatment is high.

      Costs are estimated to vary between $45-$70 per acre for this alternative.

c. Backpack Sprayers. Basal Spray

Herbicides can be applied to the base of the target species rather than applying it to the foliage. This permits application during a longer period of time, including the dormant period.

For this method of treatment, a more persistent herbicide like 2,4,5-T, dicamba, silvex or picloram works best. Basal sprays are also mixed with oil as a carrier, rather than using water.

Aesthetics would be comparable to other herbicide alternatives. Direct off site contamination would be reduced. The volume of herbicide would be greater than aerial application.

Costs including fuel oil, are estimated to vary between \$60-\$80 per acre for this alternative. Treating each individual stem when the target plants are less than 2 inches in diameter at the stump is difficult. Some stems would be missed, and a great deal of extra time would be needed to locate the pine or spruce and insure they were completely released.

d. Cut Stump Treatment with 2,4-D + 2,4-DP Following Hand Felling

The direct per treatment economic cost of this method is the highest of alternatives available; estimated at \$70-\$90 per acre. This price is based on the cost of cutting the brush or trees competing with the conifers, plus the cost of herbicide.

Herbicide use per acre in applying this method would be two to three times greater than the amount required for aerial treatment of the same area.

Applying herbicide to stumps after cutting would reduce the concerns of off site drift and volatilization.

This alternative would adversely affect many forms of wildlife, as the cut vegetation would create a barrier to travel. The other impacts would be comparable to those experienced with other herbicide use.

3. Aerial Spray

a. 2,4-D Low Volatile Ester (2 lbs. acid/acre) Applied as a Mixture with Water at 8 gallons per acre

This alternative would result in the application of 1/3 less herbicide per acre than the selected alternative, and about a \$2 per acre reduction in cost.

The period available for application at this 2 pound rate is shorter. Only the last 2 weeks in July and maybe the first week in August can be considered for making this treatment. Experience has shown that target species are more susceptible to 2 pound treatments during this short period; however, the conifer needles may not be hardened off and damage to the target species could occur. If there are delays due to helicopter availability, a lengthy court review, or adverse weather, the quality of the job will suffer. A re-spray or following-up hand treatment is more likely with this alternative.

b. 2,4-D Low Volatile Ester (3 lbs. acid/acre) Applied as a Mixture with Water at 8 gallons per acre

This is the alternative preferred and proposed for completion.

For the conditions existing on these 340 acres, we feel this is the best alternative available to us. Each area to be treated was individually surveyed with a series of 1/750 acre plots. The surveyor recorded the presence or absence of a planted tree. If a planted tree was present, the kind and amount of competing vegetation was also recorded. Mapping the location of the individual sample plots within the proposed treatment area presented the analyst informnation on the areas of heaviest and lightest density of competing vegetation.

From the above information, the analyst compared methods available and costs for different treatments. Estimates of cost for this alternative are $18 per acre. The period of effective treatment using 3 pounds of 2,4-D ranges from July 15 - August 31. The body of this analysis is built around the selection of this alternative.

c. Aerial Release with a 2,4-D Invert Emulsion (3lbs. acid per acre). Applied as a Mixture with Water at 15 gallons spray mix per acre.

Invert emulsions of 2,4-D are effective and meet all the standards to accomplish our release goals. This alternative is as good or better than the proposal, in reducing risk from drift.

The direct economic cost is estimated to be $28 per acre, or about $10 more than the proposal. The amount of helicopter fuel needed to apply the herbicide would be about double. Different spray and mixing equipment is required to handle this herbicide.

d. A 50/50 Mixture of 2,4-D and 2,4,5-T Low Volatile Ester (3 lbs. acid/acre). Applied as a Mixture with Water at 8 gallons per acre.

This alternative would do as good a job as the selected alternative in controlling the target species. The 2,4,5-T in this mixture would also give us effective contrtol of any maple, raspberries, and cherry species present on site. These three species, even though present, are not the major target species to be controlled. This alternative would also allow us to take advantage of the full treatment season available to us, including late August spraying should the conifers be slow in "hardening off."

The herbicide 2,4,5-T is more persistent in soils and water than is 2,4-D. The persistence is 3 to 6 months under forest conditions. Other environmental impacts with the use of 2,4,5-T are of more public concern than the use of 2,4-D.

The direct economic cost of the 2,4,5-T + 2,4-D mixture is more costly than 2,4-D alone. The total per acre cost of this alternative is expected to be about $24.

D. (Manual)

Manual methods of vegetative management include the use of hand operated tools such as the axe, brush whip, brush axe, chain saws, and brush cutters. Generally speaking, manual methods have little adverse effect on the environment. This method can be selective and accomplished with little visual impact in areas of concentrated public use. Control of areas treated can be exact, making this method suitable for use along streams, in recreation areas, and around buildings and wildlife projects. The season of year has little effect, unless it is snow depth in the winter. Long term local employment is possible.

The major disadvantges are high cost and ineffective results. It is not unusual for an acre of land to contain up to 20,000 hardwood stems. If stems were placed on a 2 foot by 2 foot spacing, 10,890 stems could be fitted to an acre.

Many species of woody vegetation are prolific sprouters. In young conifer plantations, the need exists for effective vegetation control. The cutting of the aerial portions of these plants does not reduce the number of stems that resprout the following year and in some species, there are substantial increases. The new height growth can exceed 3 to 4 feet in the first year. To annually or bi-annually crop these sprouts in a 300 - 400 acre program amounts to a major expenditure of tax dollars.

Manual labor projects can help a local economy, but it is often the local economy that makes labor intensive work impossible today. People are unavailable in many rural areas and are not willing to commute to rural areas to participate in hard physical labor under seasonal working conditions found in the Forest. Large scale projects are limited by Federal manpower authorizations and the time available to physically complete the work with small crews.

Experience has shown that heavy cutting of brush and cull trees in an area creates a mat of interlocked tree branches and stems impassable to many forms of wildlife.

The accident rate for people involved in woods work is high. The 1972-1974 severity rate, (day of lost work due to injury per 1 million man-hours of work), for the logging industry group was only exceeded by 16 of 207 industrial groups listed in the 1975 Work Industry Rates by the National Safety Council. Daily exposure to sharp cutting edges, rough terrain, climatic extremes, and physically demanding work make accident occurrence a major factor in discouraging use of physical labor crews.

Manual control methods, although a part of the regional vegetative management program, are limited by cost and effectiveness.

The direct economic cost of applying this method to areas prescribed for aerial spraying are estimated at $50-$60 per acre. Because this treatment is relatively ineffective, 5 to 10 consecutive yearly treatments may be required before these stands are able to adequately compete with on-site hardwoods. This would increase the total cost for treating these areas to $275 - $550 per acre.

When the distribution of competing hardwoods is uneven, or the number of stems per acre needing cutting is low, manual removal has been selected as the method of treatment. The buffer zones identified on the 10 aerial release areas will be treated using hand tools without herbicides. Additional areas identified as having a low number of stems per acre needing treatment will be treated with hand tools without herbicides. The total acreage to be accomplished during Calendar Year 1976 with hand tools without herbicides is 249 acres. The direct cost of treating these acres is estimated to be $35-$45 per acre. The lower cost is reflected in the fewer stems per acre needing treatment on many of the acres.

E. (Mechanical)

This method involves the use of motorized equipment to either push-pull or drive other pieces of equipment designed to treat vegetation. It involves the practice of bull dozing, shearing, discing, cultivating, chopping, or mowing.

Mechanical methods have the advantage of being able to alter the position or form of the vegetation. Dozer operated equipment can knock down or dig up vegetation to create openings; brushhogs and hydro-axes can grind up vegetation; and, discing or cultivating will bury vegetation. If done properly, the mechanical control of vegetation is suitable for use in visually sensitive areas. Large areas can be treated with minimum man-power needs and cost. Mechanical equipment also allows us to clean up accumulations of unwanted or unutilized vegetation, while leaving adequate root material to provide for vigorous responding.

Limits on the use of mechanical equipment are caused by rough terrain, erosive soils, steep slopes, winter weather, and wet soil conditions. Soil erosion and effects on water quality are the main environmental concerns. It is not always possible to be selective with mechanical methods, and the cost of treating small areas is excessively high. Mechanical methods will adversely effect wildlife requiring specific localized ecological niches.

Unless plant roots are completely dug out of the ground, the effectiveness of mechanical vegetation control is reduced. Mowing operations, followed by chemical treatments, have proven to be a combination of use where aesthetics are of major concern.

Mechanical plantation release of the 340 acres in this proposal was not seriously considered, because of the scattered layout of the areas, the rough terrain, and the difficulty of operating between the planted trees without creating unavoidable damage to the trees to be released. The direct cost for completing this proposal using mechanical equipment is estimated at $40-$50 per acre, if it could be done without destroying the red pine or black spruce.

F. No Cultural Treatment

No action should not be interpreted as a cessation of our reforestation program. No action is only the absence of treatment to established plantations. This alternative may be more favorable from a long-term wildlife and short-term economic standpoint. There would be no release costs. This would result in an immediate savings of approximately $6,000. No herbicide would be introduced into the environment. The habitat for wildlife now living within or using each treatment area would not immediately change due to this release. Of the 717 acres looked at for release needs during 1976, a total of 128 acres were identified as needing no treatment at this time.

An acre of forest land is limited in the amount of vegetation it can produce. With management, the proportion of growth in red pine and black spruce beneficial to man can be increased by freeing these conifers to utilize available nutrients, moisture, and space. This is the practice in timber management, by selective control of vegetation. Without selective control, growth will go into brush and trees of low fiber yield. Until new technology and methods to utilize brush and low fiber yield trees are developed, we either face a reduced timber supply or have to harvest increased acreage to supply existing demands.

Adoption of this alternative would forego the opportunity to change 589 acres from very low to much higher timber production. The result would be a long-term loss of timber production. Also, original establishment costs would be lost in proportion to growth and mortality losses.

The necessity for release is shown by experimental results on the influence of an overstory on growth of 10 to 25 years old planted red pine.[27] A 90 percent volume loss, 45 percent diameter growth loss, and a 50 percent height growth loss would be expected on plantations in urgent need of release.

In Lower Michigan, studies evaluated the effects of various degrees of overtopping aspen and scrub oak to growth of planted red pine. Growth was measured 5 to 15 years later. The results were that when a 30 square foot basal area hardwood overstory is retained, cubic foot volume growth is reduced to 20 percent of the maximum; the diameter growth is limited to 55 percent maximum; and, the height growth declines to 58 percent of the maximum.

The benefits of release were shown in experiments on the Chippewa National Forest in Minnesota. Prepared plots showed that failure to release red pine resulted in a reduction at the end of 5 years of 70 percent in survival; more than 90 percent in height growth; and, 99 percent in total dry weight.

These same adverse effects of no action can be expected on the Nicolet National Forest.

G. RADIATION

Gamma radiation on biomass production has been under study in northern Wisconsin (Zaultkovski and Salmonson, 1975).[26] Gamma radiation will directly affect ground vegetation by selectively killing or severely damaging radio-sensitive plant species, and indirectly by affecting tree canopies, thus changing the micro-environment in which the ground vegetation developes. Response to radiation treatments is slow; the first signs of damage not occuring until after about 2 months of irradiation.

Trees appear to be more radio-sensitive than ground vegetation. Other results indicate vegetation zonation results from the different radio-sensitivity of plants composing irradiated communities, the more closed the over-head canopy the greater sensitivity shown by the ground vegetation. Plants known to survive under harsh conditions are the least radio-sensitive.

The vegetation response to gamma radiation varies with the time of year, radiation dose, length of exposure, distance from the radiation received, and plant interphase chromosome volume. In the Solidago, it was found 90 percent of these plants treated with 105 roentgens, per 20 hour day, were effected while for other plants the 90 percent yield was about 2,000 roentgens per day.

Vegetation management in northern Wisconsin using gamma radiation is under study. Many more studies will need to be conducted before we will recommend radiation treatments as an alternative available for our use.

VII. RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE OF LONG-TERM PRODUCTIVITY.

Research indicates short-term environment impacts of 2,4-D as a potentially hazardous substance to humans, wildlife, soil, and water is very minor, when applied using the rates and methods outlined in this report.

The areas we propose to use 2,4-D in will not achieve their potential for timber production unless released. Brush and low quality, poorly stocked stands of timber will develop, wasting moisture and nutrients that otherwise could be available to produce wood fiber and other timber products needed by the American people in the future. Long-term productivity of timber products will be greatly increased through growing these 340 acres in more valuable species.

A reduction in quality of the biota is possible, if large areas are converted to solid conifers. However, in growing conifers these factors are considered, and adequate hardwoods left where soils or a need to maintain diversity of habitat exists. Conifers on the Nicolet are generally being grown where they grew naturally, before their removal by man.

VIII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

This proposal will use about 255 gallons of the herbicide 2,4-D. Fuel to operate the helicopter and ground vehicles needed in support of this project will be needed. The proposed program will result in no other irreversible or irretrievable commitment of resources when viewed from the long-term standpoint vital to sound renewable natural resource management.

IX. CONSULTATION WITH OTHERS

A. Environmental Impact Statement

In 1972 and 1973 draft and final environmental impact statements were filed with the Council on Environmental Quality. Public and other agency review was conducted according to Forest Service guidelines, developed in compliance with the National Environmental Policy Act. This herbicide program statement covered herbicide use in the Eastern Region of the Forest Service, which includes Wisconsin. It developed policies and guidelines, with public and other agency participation, which apply to all herbicide projects in the Region. This environmental analysis is a site-specific analysis which localizes the general regional guidelines, and which includes additional specific guidelines in response to conditions on each site.

A list of agencies, organizations, and individuals who reviewed copies of the environmental statements is in the Appendix as Item I.

B. Proposed Projects

The projects proposed herein for the summer of 1976, have been reviewed by 26 Forest Service specialists. Reviews consisted of field evaluations of individual herbicide use sites, as well as office reviews. A list of those participating in this phase of project development is included in this section.

In addition, the project proposal has been reviewed by the Eastern Region Pesticide Use Coordinating Committee. Membership of the Committee is also included in this section. This review evaluated the project proposal for compliance with guidelines developed in the environmental statement process (described above), and for compliance with requirements of the Federal Insecticide, Fungicide and Rodenticide Act.

Coordination with the State of Wisconsin has been accomplished by personal contact and through written requests for project reviews. Project descriptions and supporting data were sent to the Secretary, Wisconsin Department of Natural Resources, to District Directors, Northeast and North Central Districts, Wisconsin Department of Natural Resources, to the State Pesticide Review Board, and to the State Clearinghouse for review of Federal proposals. Public involvement in projects previously planned for 1975, revealed concern for use of 2,4,5-T, but little concern for the use of 2,4-D as proposed herein. This is substantiated by a relative absence of public concern for 2,4-D use during the past year by the Wisconsin Department of Natural Resources on State Forest lands. This has been true also, of projects implemented during the same year by private parties, by counties in county forests under WDNR guidance, and by other State agencies. Because these projects of other agencies are similar to those proposed herein, it has been determined that the use of 2,4-D is not an item of major controversy.

APPENDIX C

Partial List of Federal and State Agencies, Associations, and individuals that received copies of the Draft Environmental Statement for Review and Response.

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U. S. Department of Health, Education and Welfare

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*State - Federal Clearinghouse Coordinators (only States in R-9 with National Forests)

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Mr. William R. Bechtel, Cochairman
Upper Great Lakes Regional Commission
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American Conservation Association, Inc.
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American Scenic and Historic Preservation Society
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Boston, Massachusetts 02108

Appalachian Trail Conference
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National Council of State Garden Clubs, Inc.
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Illinois
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United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

In Reply Refer To: NOV 2 8 1977
ER-77/924

Mr. Steve Yurich
Regional Forester
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Mr. Yurich:

Thank you for your letter of September 21, 1977, transmitting for review and comment the Forest Service's draft environmental statement for the proposed Use of Herbicides in the Eastern Region. Accordingly, we have reviewed the statement and offer the following comments for your consideration.

General Comments

(#1) We find the draft statement to be rather comprehensive but makes some mistakes of omission as well as commission. Most of the document is concerned with the phenoxy herbicides and this is understandable. However, the proposal calls for the use of other herbicides as well. And, the use and effects of these other pesticides need to be addressed in a more detailed manner. A reprint, and an inclusion as an addendum, of toxicological data that has accompanied other Forest Service statements on the use of herbicides would be in order. Further, the large body of information concerning the effects of herbicides, published by the U.S. Fish and Wildlife Service, has been almost completely ignored.

(#2) Inasmuch as the environmental statement recognizes the controversial nature of the herbicides 2,4,5,-T and 2,4,5,-TP containing tetrachlorodibenzo-P-dioxin (TCDD) (p. 24, par. 5 and p. 41-51, item 2), the level of quality control used in the manufacturing process to minimize the potential for dioxin formation should be made known. Also, monitoring measures for water quality of streams draining herbicide-treated areas should be considered, especially where surface-water resources are used for water supply.

The environmental analysis report for Nicolet National Forest (app. B) carefully considers depth to ground water and soil depth and characteristics in planning the application of

herbicides (p. 110-117). However, we suggest that the section on controls and mitigations for such applications (p. 118) should include provisions for prompt remedial measures in the event of accidental spills. The much higher concentrations resulting from such spills are more likely to reach ground water and to persist during lengthy ground-
(#3) water movement toward locations of possible significant impact or release to a surface stream. We suggest also that controls on herbicide use (app. A) such as those under Water (item 4(1)) should include mention of types of environmental situations that will permit very rapid or almost instantaneous movement of herbicides into ground water - as in areas where the filtering effects of sufficient soil thicknesses will not be available. Examples would include not only features of a karst terrane such as caves and solution openings but also areas where rock fractures, lava tubes, very coarse gravel, or broken-rock fields are at or near the surface. Any such areas of appreciable size that are characterized by extremely large pore spaces should be isolated with buffer strips in the same manner as streams (p. 97). Monitoring or sampling of ground water or of surface water that can be affected by herbicides transported in ground water should involve proper allowances for delayed effects that may result from the customarily lower velocities of ground water.

Within the introductory part of the Description, the statement identifies recreational areas of concentrated public use (campgrounds, picnic sites, and swimming beaches) as
(#4) target areas for weed and vegetation control through the use of herbicides. These areas, which are targets for herbicide application, are the same areas where people will be eating, sleeping, drinking the water, and playing. While the draft addresses the environmental impacts of the proposed action on an individual subject basis, it does not address a synergistic effect on people who may be recreating during or immediately after a herbicide application. While this interaction, in all probability, will not cause fatalities, the draft statement suggests that the application of herbicides can cause physical stress to people, both internal and external. This concern should be analyzed and mitigating actions identified as appropriate.

Also, we are disappointed that the statement does not address a policy regarding the use of herbicides in the vicinity of
(#5) Natural Areas and other special recognized State and Federal areas. Such areas include components of the State Wild and Scenic River Systems, State Trail Systems, the National Wild and Scenic Rivers System, and National Scenic Trails within

the several States of the proposal area. Further, we recommend that all plant life within the designated boundaries of these special areas should not be disturbed; i.e., free of species composition manipulation. And, while we assume that future environmental statements regarding management practices for each national forest in the region will present detailed measures to protect these special areas, we recommend that the overall policy for the Eastern Region should be set forth in the final statement of this proposal.

Specific Comments

(#6) Page i, par. 2: If used according to recommendations, registration guarantees efficacy but does not guarantee "safety." At best, there is a tacit promise of minimum hazard.

(#7) Page ii, V, par. 1: All pesticides are, by their very nature, toxic to something. Herbicides are toxic to plants and, in sufficient quantity to fish, wildlife, and humans. To say that something is nearly non-toxic has, therefore, little meaning if the target organism(s) is not specified.

(#8) Page 10(4), par. 2: Aquatic herbicides may ameliorate or help control a situation but they do not "cure."

(#9) Page 19(d): Accidental importation rather than importance.

(#10) Pages 24-25: If use of 2,4,5-T is so controversial, why then continue to use it? Are there no reasonable alternatives?

(#11) Page 30,E.1: Silvex, as with 2,4,5-T, is made from 2,4,5-trichlorophenol. Is there no dioxin present in the technical material used?

(#11) Page 31, par. 5: Dicamba and picloram are not phenoxy herbicides, as implied here.

(#11) Page 31, par. 6: Reference is made to table 4. Tables 1-4 are poorly arranged: table 3, page 37; table 1, page 38; table 2, page 42; another table 3, page 55; table 4, page 59.

(#11) Page 31-32: As used here, "low mammalian toxicity" refers to oral lethal doses only. Oncogenicity at sublethal doses can be a toxic effect as well and it should be noted that arsenicals have been so implicated in epidemiological studies.

(#11) Page 31-33: Monuron is suspected of being tumorigenic and is being further tested.

(#11) Pages 33-34, 8: TCA is quite corrosive and reacts readily with protein. Decomposition produces chloroform and hydrochloric acid.

(#11) Page 34, 9: Pentachlorophenol is another phenoxy pesticide containing toxic chlorinated dioxins.

(#12) Page 43, par. 3: This paragraph is poorly phrased and creates misimpressions. TCDD is a tetrachlorodioxin arising from the loss of one chlorine from each of two molecules of the trichlorophenol used. Simple arithmetic shows that there are four chlorine atoms left. By the same procedure, condensation of 2,4-D loses 2 atoms of chlorine in the formation of the respective dioxin, a dichlorodioxin; therefore, one does not expect TCDD to be present. High temperatures and high pressures are optimal conditions for dioxin formation. Under less than optimal conditions, the amount of dioxin formed would be less but it is not an all or nothing process as implied.

(#13) Page 54, 7: Water., first paragraph, tenth line - Glyphosate is not presently registered for use in or around water.

(#14) Page 60, last par.: The comments about the incidence of cancer in cities vs. rural areas are naive. Potential sources of carcinogens in large cities are many and their contribution cannot be easily separated. One could speculate just as easily that the rural incidence is mainly from pesticides and might be even lower without them. Then, too, "as much as 50-70 percent of aerial applied herbicides lost" (page 38, A.1.) into the air system may be adding to the urban load.

(#15) Page 66, par. 3: This is a blanket blind indictment of herbicides and this document is not the proper forum for such statements. If they are indeed as hazardous as this statement would lead us to believe, then appropriate regulatory actions are in order. If other chemicals are teratogenic, carcinogenic or mutagenic to animals, then appropriate regulatory actions are in order, but this situation cannot be used to justify use of any hazardous agricultural chemical.

(#16) Page 77, par. 2: Until a material balance is available and an accounting made for the 50-70 % lost into the air, human risk assessment is not complete. Although the per acre volume of TCDD applied is small, the total volume of material used annually is very large. This material is extremely toxic - "the most toxic synthetic chemical known" - and requires a better accounting.

We appreciate the opportunity to review and comment on this program and hope that these remarks will be of assistance to you in preparing the final environmental statement.

Sincerely,

Acting
Deputy Assistant SECRETARY

Forest Service Response to Comments
by U. S. Department of the Interior

#1 Toxicological data on other herbicides has been incorporated in the Final Statement.

#2 The section covering the contaminant TCDD was completely rewritten.

#3 The points mentioned concerning the sample EAR will be considered in the evaluation of future project EAR's.

#4 No research has been accomplished relating to the combined effect of herbicide application and recreation activities.

#5 We feel the current USFS policy on pesticide-use management in conjunction with project EAR's provides the flexibility required to make sound land management decisions for the areas concerned.

#6 Original statement unchanged. See US EPA comment #4.

#7 Statement was clarified to show non-target organism to be man.

#8 Wording changed.

#9 Spelling corrected.

#10 2,4,5-T is just one of several herbicides available for use and herbicides are just one of several alternatives available to accomplish the desired objective. 2,4,5-T is included because even though it is controversial, it has not yet been proven to be unsafe to humans when used properly. Individual project EAR's will evaluate the target species, management objective, available alternatives to accomplish the objective, and the various impacts on the environment and the public. After this evaluation, then a plan of attack will be developed using the alternative selected.

#11 This section was rewritten. See section II. D.4. for a discussion of individual herbicide toxicity.

#12 This entire section was rewritten.

#13 Glyphosate reference was deleted.

#14 This section was rewritten.

#15 This is simply a statement of fact and this paragraph should not be read alone, but should be considered with the rest of the discussion under mammals.

#16 The amount of herbicide lost into the air can be and is minimized by the controls on herbicide use listed in appendix A.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF THE
ADMINISTRATOR

22 DEC 1977

Mr. Steve Yurich
Regional Forester, Eastern Region
U.S. Department of Agriculture
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Mr. Yurich:

The Environmental Protection Agency has received and reviewed the Forest Service's draft environmental impact statement (DEIS) on "The Use of Herbicides in the Eastern Region."

Our major concerns are the lack of sufficient information in the DEIS and the proposed use of some chemicals whose environmental impacts are not adequately known. A more in-depth explanation of these issues is found in our enclosed detailed comments.

Review of pesticide applicability and use is based on the appropriateness of the proposed project as it applies to specific pesticide products. The products proposed for use should be listed by their trade names, active ingredient chemical names and EPA Registration numbers. This is important since identical formulations of an active ingredient (representing numerous products) may be registered for many different use substitutions. This product information does not appear in this general EIS, thus making detailed review difficult.

Another major concern relates to usage of pesticides potentially contaminated with dioxins. EPA is currently reviewing, under the Rebuttable Presumption Against Registration (RPAR) process, the chemical and biological properties of these pesticides to determine their environmental impact. The results of this investigative process will determine allowable uses. If any changes from currently allowed uses result from this evaluation, these changes would have to be incorporated into a revised Forest Service herbicide program.

In addition to the two major concerns outlined above, we would like to bring to your attention the CEQ Guidelines for distribution of EIS's to EPA (Federal Register August 1, 1973 p. 20559). The Guidelines require EIS's on major program proposals or other major policy issues to be sent to the Director of the Office of Federal Activities. Following the CEQ procedures helps to assure a timely response from EPA.

These comments classify your DEIS as ER-2 (Environmental Reservations, Insufficient Information). The classification and date of our comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on proposed Federal actions under Section 309 of the Clean Air Act.

If I or my staff can be of further assistance, please call.

Sincerely yours,

Peter L. Cook
Acting Director
Office of Federal Activities (A-104)

Enclosure: EPA's Detailed Comments on "The Use of Herbicides in the Eastern Region"

EPA's Detailed Comments on the Draft Environmental Impact Statement "The Use of Herbicides in the Eastern Region"

(#1) 1. It was indicated in the DEIS that the document would be reviewed and amended as new results are determined from research on effects of herbicides. This continuing review function should also include new biological-control discoveries which may offer alternatives to use of herbicides.

(#2) 2. The Section on "Description of Herbicides Proposed for Use" (p. 30) includes an evaluation of each herbicide's mammalian toxicity. A similar evaluation for avian and aquatic species should be presented.

(#3) 3. There is an overall understating of the potential hazard to humans from some of the proposed herbicides, for example:

(p. 33) - Paraquat is classified as highly toxic, but no mention is made of the fact that there is no known antidote for ingestion of the chemical.

(p. 34) - Both Dalapon and TCA are referred to as having "very low mammalian toxicity". This only reflects their respective Oral LD_{50} values and does not consider the appreciable eye injury that could result from TCA contamination.

(#4) 4. Although technically accurate, the statement on page 41, "It is EPA that determines.... when used in accordance with widespread and commonly recognized practices." is misleading. We recommend that the following language be substituted for the paragraph on page 41: "Proof of safety of a properly registered pesticide is not the responsibility of the user. Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as amended in 1972, EPA has the responsibility to determine whether an herbicide or any other pesticide, when used consistent with its labeled directions will perform its intended function without unreasonable adverse effects on the environment, human beings, livestock, or wildlife."

(#5) 5. The bottom of Table 4 and the Toxicity Rating column on page 59 should be updated to include EPA standards as seen in 40 CFR 162.10(h) "Warnings and Precautionary Statements". Although Table 2, p. 42 gives the correct ratings, the old

USDA Agriculture Handbook, "Toxicity Rating System", does not reflect the criteria which will be used by EPA in registration to determine in which toxicity category a pesticide belongs.

(#6) 6. We do not see any indication of impacts which may result from "use inconsistent with label directions" in your draft statement; however, as you indicated in your summary, two phenoxy herbicides you propose to use, namely 2,4,5-T and 2,4,5-TP, may be contaminated with 2,3,7,8-tetrachlorodibenzo-dioxin (TCDD). Although many scientific studies have been completed on 2,4,5-T and other phenoxy herbicides, as well as on TCDD, questions remain unanswered about the possible impacts of the use of these pesticides. Research will have to be continued on all aspects of the toxicity, occurrence, and environmental fate of these pesticides and possible TCDD (dioxin) contamination until EPA determines that these pesticides used in accordance with labeled directions will not result in unreasonable adverse effects.

(#7) 7. The State of New Hampshire prohibits the use of 2,4,5-T in watershed areas. In the past, New Hampshire has required a permit be issued for all 2,4,5-T applications on rights-of-way by commercial applicators. Is there likely to be any conflict between U.S. Forest Service use proposals and existing State laws or regulations?

(#8) 8. In Appendix A, Controls of Herbicides Use (p. 96), it is stated that product label directions must be followed for that product's use. However, the controls listed in subsections 1. Air, 2. Soils, 3. Water, 8. Man, and 11. Wildlife of this appendix may or may not be adequate depending on the herbicide used. Due to the absence of a specific product list in the general EIS, the adequacy of the listed controls is not easily established. We believe the introductory paragraph should include a statement to the effect that the controls listed in Appendix A will be followed unless the label of the product being used specifies controls which exceed those in the Appendix. In this case, the product label specifications, and not the listed controls, must be the procedures followed.

(#9) 9. In Appendix A-4 on page 98, the EIS should state if any herbicide application will be made according to the procedures in EPA's Pesticide Enforcement Policy Statement #7 (PEPS 7). PEPS 7 covers EPA's stance on the aerial application of registered pesticides. On page 36 it is stated that only helicopters will be used for the aerial applications. We feel that the Forest Service should be aware of EPA's definition of the Terms, "aircraft," "airplane," and "aerial" as they are used on pesticide product labels so that products labeled appropriately can be obtained for helicopter use. The terms are defined as follows:

Aircraft - any machine supported for flight by air, including both airplane and helicopter.

Airplane - A powered, fixed-wing, heavier-than air aircraft.

Aerial - pertaining to, or used for, against, or in aircraft.

Accordingly, application by helicopter is consistent with directions for use which include the terms aerial and aircraft.

10. On page 99, under Project Monitoring, the following statement appears: "Results of herbicide efficacy and monitoring will be made available to the public." Monitoring activities are also mentioned on pages 55, 56 and 97. We
(#10) assume, based on these comments, that some project monitoring program is planned. The subject EIS, however, does not describe the mechanics of this aspect of the project. The Final EIS should describe the monitoring programs being planned to identify adverse effects and to determine project accomplishment levels.

11. The FEIS should also describe in greater detail the effects of the proposed program on adjacent private landholdings. This
(#11) analysis is particularly important for eastern forests which are frequently interspersed with private inholdings.

Forest Service Response to Comments
by Environmental Protection Agency

#1 This subject was addressed by the DEIS on page 1 under section I.A.

#2 This section was rewritten. Herbicide toxicity is discussed in section II. D.

#3 See response #2.

#4 Original paragraph deleted and recommended language was substituted in section II. B. 2.

#5 Table 3 was substituted to reflect the relative toxicity of herbicides to people. Table 4 now indicates the toxicity rating in easily understood terms.

#6 The impacts resulting from "use inconsistent with label directions" are impossible to evaluate because of the infinite number of ways various products can be misused.

We wholeheartedly agree that scientific research relative to all aspects of pesticide use should be continued.

#7 We do not anticipate any conflicts at this time.

#8 Statement of clarification was added.

#9 Paragraph (d) was added to call attention to EPA PEPS #7.

#10 The mechanics of the monitoring program can best be discussed in the individual project EAR's because the complexity of the monitoring will depend on the complexity of the project.

#11 Rather than discuss general impacts, it was felt the individual EAR's could better cover any possible impacts more specifically for the private landholdings involved.

STATE OF ILLINOIS
EXECUTIVE OFFICE OF THE GOVERNOR
BUREAU OF THE BUDGET
SPRINGFIELD 62706

December 12, 1977

Mr. Steve Yurich, Regional Forester
U. S. Department of Agriculture
Eastern Region Forest Service
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Mr. Yurich:

RE: Draft Environmental Impact Statement for Vegetation Management Using Herbicides, DEIS #77-09-271

Pursuant to the National Environmental Policy Act (NEPA), OMB Circular A-95 (revised) and the administrative policy of the State, the referenced subject has been reviewed by the appropriate State agencies. No comments were made on the referenced subject.

Thank you for your assistance.

Respectfully yours,

T. E. Hornbacker

T. E. Hornbacker, Director
Illinois State Clearinghouse

TEH:mc

STATE OF MAINE
DEPARTMENT OF CONSERVATION
AUGUSTA, MAINE 04333
TEL. 207 289 221

November 21, 1977

MEMO TO: Steve Yurich, Regional Forester, Eastern Region, USFS

FROM: Richard Barringer, Commissioner RB

SUBJECT: USFS Herbicides DEIS

While we do not expect National Forest lands in Maine to be significantly affected by herbicide use, we appreciate the opportunity to comment on the DEIS.

Herbicides are a management tool of increasing importance in Maine forests. Two major Maine paper companies are employing herbicides to release softwoods from hardwood competition by aerial spraying on thousands of acres each year; other owners are considering major herbicide programs. Our own Service Forestry program conducts a few small herbicide release treatments each year; we also use small amounts of herbicide for Ribes control work. In addition, there are ongoing private and public right-of-way management programs. For these reasons, we find the up-to-date review provided by this EIS to be especially useful.

We suggest that adding the answers to the following questions will improve the usefulness of the statement:

(#1) 1. How many acres (of the 45,000 total) per year are treated for each of the various management objectives listed in pp. 2-10? Are increases planned?

(#2) 2. What typical dosages and intervals of application (annually? once in a rotation?) are associated with the different uses of herbicides?

(#3) 3. In what specific forest types and conditions will herbicides be used for timber management? These details should be listed in the EIS if the potential use of herbicides in a particular area is to be determined.

(A further problem is that the material on timber costs and benefits of herbicide treatment is scattered throughout the statement and not well interpreted. For example, the ad hoc citations on p. 65 do not help the reader assess the costs and benefits of spraying in a realistic situation, since costs are omitted and atypical cases (four years of complete control) are cited. In contrast, the cases on pp. 137-8 are more useful, although their service should be cited.)

4. National Forest proposed uses of herbicides are undoubtedly a small proportion of the totals being used in wildland areas yearly; can an estimate of this percentage be obtained?

The statement at a number of points asserts that herbicide use, by making more timber available, will improve local economies and community stability. We do not see this as a likely outcome in Northern New England, because the incremental timber output will be small. Further, the prinicipal problems of local communities are lack of markets, poor utilization, and lack of management on private lands. We doubt that more timber production will solve any of these problems.

Thank you again for the opportunity to comment. We would like to receive six copies of the Final EIS.

md

Forest Service Response to Comments
by State of Maine - Department of Conservation

#1 See Table 1 for breakdown of acres by management objective.

#2 Dosages and intervals will be dependent upon the chemical being used, the area being treated, and the target species. These and other items will be fully evaluated in the project EAR.

#3 Individual EAR's will determine the use of specific herbicides within the Forest types and conditions of the Eastern Region. Herbicides will simply be one method available to accomplish the silvicultural objective. The EAR process will determine the method to be used.

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING, BOX 30028, LANSING, MICHIGAN 48909
HOWARD A. TANNER, Director

December 8, 1977

Mr. Steve Yurich
Regional Forester
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Mr. Yurich:

The Department has reviewed the federal draft environmental impact statement on the Use of Herbicides in the Eastern Region prepared by the Department of Agriculture, Forest Service.

In general, the Forest Service in our opinion has provided an incomplete assessment in complying with the requirements of Section 102(C) of the National Environmental Policy Act of 1969 (83 Statutes 852, 42 U.S. Code Annotated sections 4321-4347). One of the recurring questions concerning the adequacy of environmental impact statements addressed by the courts and various reviewing agencies has been the meaning of the directive in NEPA for federal agencies to comply with the spirit of the act "... to the fullest extent possible". Study of the legislative history of the act has generally shown that this directive is to be interpreted as a strong mandate to do a detailed assessment of environmental impacts and to produce a document which will allow for objective decision-making.

In this regard, the draft EIS as prepared falls short of fulfilling the requirements of the "spirit" of NEPA. This document is a persuasive argument for the use of herbicides in vegetation management in the eastern region. It is not an objective assessment of herbicide usage and alternative methods of vegetation control as tools in a forest management project. It specifically downplays the long-term environmental consequences of herbicide use.

Detailed comments are attached for your consideration. We hope these comments will aid in strengthening the final document as a rational decision-making tool when deciding upon the various vegetation management strategies to use in national forests. We appreciate the opportunity to provide comments.

Sincerely,

Howard A. Tanner

Howard A. Ta
Director

MICHIGAN THE GREAT LAKE STATE

Attachment

R1026 10/76

DEPARTMENT OF NATURAL RESOURCES

Comments on

DRAFT FEDERAL EIS ON

HERBICIDES IN THE EASTERN REGION

1. In general, the Forest Service has complied with the specific five-point requirement set forth in the National Environmental Policy Act of 1969. The outline of the report is structured such that the major chapter headings correspond to the five specific mandates outlined in Section 102(C) i-v of NEPA. The Forest Service has developed their environmental impact statement within this format and has done a commendable job of expanding upon the basic outline to include other facts germane to the issue.

2. Certain inconsistencies in the report and the general bias toward herbicide use as the best tool for vegetation management are cause for criticism, however. The main statement in the introduction of the document stresses that when alternative methods of vegetation management are technologically available and economically feasible, that
(#1) they will be preferred over the use of herbicides. If this is indeed the prevailing opinion of the Forest Service, it is strange that the rest of the document is so overtly biased toward herbicide use for vegetation management. Alternative methods of vegetation control have their disadvantages emphasized while their advantages over herbicide use receive minimal comment. The net result is that the draft EIS is largely a promotional document supporting herbicide use and is not the objective review of alternatives which the "spirit" of NEPA seems to require.

3. Specific points which should be revised in the final statement are as follows.

Page 9 In mentioning that herbicides will be used to optimize Kirtland
(#2) Warbler habitat in Jack Pine stands, no consideration is given to the residual effects of the herbicides on the warblers or their food items.

Page 12 We disagree with the statement that "erosion and stream sedimentation hazards are insignificant except in small areas" of the Lake States region.

Page 13 We assume that the reference to "bald express" in the text
(#3) is meant to be bald cypress (Taxodium dysticum). No scientific name was listed in the text.

Pages 22-27 The initial alternatives on earlier pages listed specific advantages and disadvantages of a particular method which allowed easy comparison. I would suggest that the other alternatives follow this format.

Pages 30-82 The Forest Service has done a good job of reviewing the herbicides to be used and the methods of application. Certain public health and environmental hazard assessments of the chlorophenoxy herbicides and their contaminants deserve a more detailed assessment. Recent litigation regarding the use of phenoxy herbicides on the Siuslaw National Forest has required that the Forest Service perform a thorough analysis of specific environmental consequences (428 Federal Supplement

(#4) 908, 1977). In particular, the deficiency in the EIS with respect to the potential effects on human and animal health of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) was mentioned. The case decision written by District Judge Skopil reiterates the points made by the Administrator of the EPA in his order issued November 4, 1971. We believe that those facts concerning 2,4,5-T and TCDD should be included in the final EIS. They are listed below:

a. A contaminant of 2,4,5-T--tetrachlorodibenzoparadioxin (TCDD, or dioxin)--is one of the most teratogenci chemicals known. The registrants have not established that 1 part per million of this contaminant--or even 0.1 ppm--in 2,4,5-T does not pose a danger to the public health and safety.

b. There is a substantial possibility that even 'pure' 2,4,5-T is itself a hazard to man and the environment.

c. The dose-response curves for 2,4,5-T and dioxin have not been determined, and the possibility of 'no effect' levels for these chemicals is only a matter of conjecture at this time.

d. As with another well-known teratogen, thalidomide, the possibility exists that dioxin may be many times more potent in humans than in test animals (thalidomide was 60 times more dangerous to humans than to mice, and 700 times more dangerous than to hamsters; the usual margin of safety for humans is set at one-tenth the teratogenic level in test animals).

e. The registrants have not established that dioxin and 2,4,5-T do not accumulate in body tissues. If one or both (or some breakdown product) does accumulate, even small doses could build up to dangerous levels within man and animals, and possibly in the food chain as well.

f. The question of whether there are other sources of dioxin in the environment has not been fully explored. Such other sources, when added to the amount of dioxin from 2,4,5-T, could result in a substantial total body burden for certain segments of the human population.

g. The registrants have not established that there is no danger from dioxins other than TCDD, such as the hexa- and hepta-dioxin isomers, which also can be present in 2,4,5-T, and which are known to be teratogenic.

h. There is evidence that the polychlorophenols in 2,4,5-T may decompose into dioxin when exposed to high temperatures, such as might occur with incineration or even in the cooking of food.

i. Studies of medical records in Vietnam hospitals and clinics below the district capital level suggest a correlation between the spraying of 2,4,5-T defoliant and the incidence of birth defects.

j. The registrants have not established the need for 2,4,5-T in light of the above-mentioned risks. Benefits from 2,4,5-T should be determined at a public hearing, but tentative studies by this agency have shown little necessity for those uses of 2,4,5-T which are now at issue." Dow Chemical Company v. Ruckelshaus, 477 F.2d 1317, 1320-1321 & n.14 (th Cir. 1973).

Pages 30-34 The aquatic toxicity data for herbicides is largely ignored. No mention is made of specific directives to avoid spraying herbicides over wetlands or surface waters.

Page 31 The cumulative effects of the buildup of arsenicals in forest soil are not addressed.

Page 80 I would suggest that mention be made of the fact that the immediate effect of reduced vegetation cover could be increased soil erosion given the right combination of topography, soil type, and rainfall.

4. The Department prefers emphasizing prescribed fire over herbicides wherever possible, but we do find that for small-scale selective treatments, in inaccessible locations and in rocky terrains, pelletized Tordon herbicide is the best option.

5. Department staff through experience gained from many years of herbicide application has come to the conclusion that broad-scale aerial application does not accomplish the goal of woody species control. Tree kill is spotty, sprouting of many species is tremendously stimulated, and many desirable broad-leaf herbs are killed over large areas. For large opening developments such as sharptailed grouse management areas, we much prefer a combination of mechanical control and prescribed fire. We continue to use Tordon for small opening creation and maintenance.

6. We find no argument with the EIS description of herbicide impact on wildlife. Toxicity is very low for both mammals and birds, and the
(#4) disruption of herbicide application has merely a temporary effect, but additional data on 2,4,5-T, as indicated earlier, is necessary in final draft.

In general, the Forest Service has done a commendable job of complying with the requirements of the National Environmental Policy Act in the preparation of this impact statement. With these specific additions, the document should better serve the spirit of NEPA of 1969.

Forest Service Response to Comments
by State of Michigan-Department of Natural Resources

#1 The method of vegetative management to be used on a particular site will be more thoroughly evaluated through the use of site specific EAR's.

#2 This consideration will be evaluated during the preparation of the EAR for the site or project.

#3 Change was made.

#4 The sections discussing the description of herbicides and herbicide toxicity have both been extensively rewritten.

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
CENTENNIAL OFFICE BUILDING · ST. PAUL, MINNESOTA · 55155

DNR INFORMATION
(612) 296-6157

November 18, 1977

Mr. Steve Yurich, Regional Forester
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Steve:

We have reviewed the Draft Environmental Statement, "The Use of Herbicides in the Eastern Region", and find the document to be complete and objective in its treatment of the subject.

As the improper use of herbicides may have serious consequences in any environment, it is imperative that they be expertly and completely evaluated prior to determining if their use is warranted.

The revision of the Draft Environmental Statement is a necessary on-going project as new research data and methods and techniques of vegetative management become available.

Specific comments on the document are as follows:

Page 8 - The second sentence of the paragraph entitled, "Tree Nurseries", appears to have a word or words left out.

Page 96 - Controls on Herbicide Use - The controls listed included 8mph wind speed as the maximum allowed to avoid drift. In the past we have used a maximum allowable wind speed of 6 mph before suspending aerial herbicide applications.

Page 60 - The first paragraph contains the apparent typographical error of the word, "pound".

Thank you for the opportunity to review this document.

Sincerely,

Raymond B. Hitchcock For

James L. Brooks, Acting Director

JLB:RBH:REH:bs

cc: Bill Berndt

THE OHIO DEPARTMENT OF
NATURAL RESOURCES
Memo

TO: Steve Yurich, Regional Forester
U.S. Department of Agriculture

DATE: October 13, 1977

FROM: Charles E. Call, Chief
Division of Reclamation

RE: Comments on "The Use of Herbicides in the Eastern Region".

Recommend use of biological agents as a means of vegetation management:

1) Forest land accounts for a large amount of acreage which would require a large amount of herbicides being spread over a wide area.

2) There appears to be some doubt as to what the total affects of herbicides might be.

3) Use of biological species as a means of natural competition is a more natural way of altering an ecosystem.

CEC:DLP:vsa

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF ENVIRONMENTAL RESOURCES

P. O. BOX 1467

HARRISBURG, PENNSYLVANIA 17120

In reply refer to
RM-F FM-O

November 3, 1977

Mr. Steve Yurich, Regional Forester
USDA, Forest Service
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Mr. Yurich:

I have had various members of the staff of the Bureau of Forestry review the Draft Environmental Statement for vegetation management using herbicides that you sent to the Bureau for review and comment. I am pleased to report that this careful review showed no errors, emissions or inconsistencies in the Statement.

I would like to commend you and your staff for a careful and comprehensive review of all aspects of the use of herbicides in forestry in the Eastern Region. The information provided in this Draft Environmental Statement will be most helpful to the Bureau of Forestry. Herbicides, properly used, are a most valuable tool. They must be available to the forest land manager if he is to do his job properly and efficiently. The Draft Environmental Statement should do much to insure the continued availability of herbicides for use in forest land management.

Sincerely yours,

R. R. Thorpe, Director
Bureau of Forestry

STATE OF WEST VIRGINIA
DEPARTMENT OF NATURAL RESOURCES
CHARLESTON 25305

DAVID C. CALLAGHAN
Director

November 14, 1977

Mr. Steve Yurich, Regional Forester
U. S. Forest Service, Eastern Region
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Mr. Yurich:

RE: Herbicide DES

The West Virginia Department of Natural Resources has reviewed your Draft Environmental Statement entitled "The Use of Herbicides in the Eastern Region" and finds the document to be complete and technically accurate. The Department's comments, dated October 13, 1972, on the earlier draft appear to have been adequately considered and incorporated into this revision.

Page 100 of Appendix A includes "empty container disposal" as a safety precaution. To our knowledge, no formal disposal procedure has been developed in West Virginia.

The opportunity to provide further input is appreciated. Please advise if additional information would be beneficial.

Sincerely,

David C. Callaghan
Director

DCC/dbj

STATE OF WEST VIRGINIA
DEPARTMENT OF NATURAL RESOURCES
CHARLESTON 25305

DAVID C. CALLAGHAN
Director

October 6, 1977

Mr. Steve Yurich, Regional Forester
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Mr. Yurich: Re: 8420 (8540)

Reference is made to your letter of September 21 concerning Public Law 91-190 with summary of the Environmental Impact Statement attached.

For your information, the Department of Natural Resources has assigned all EIS reviews and comments to the Environmental Review Team of which Mr. H. G. Woodrum is Chairman. I am forwarding your letter to him for action.

I am sure a copy of his comments will be forwarded to you.

Sincerely yours,

Asher W. Kelly, Jr.
State Forester

AWK:bmw

cc: H. G. Woodrum

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Anthony S. Earl
Secretary

BOX 7921
MADISON, WISCONSIN 53707

November 18, 1977

IN REPLY REFER TO: 1600

Mr. Steve Yurich, Regional Forester
U. S. Forest Service, Eastern Region
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Mr. Yurich:

Re: 8540 - Draft Environmental Statement, The Use of Herbicides in the Eastern Region, USDA-FS-R9-DES-ADM-77-10

The Department of Natural Resources has completed an interdisciplinary review of the Draft Environmental Statement for the proposed use of herbicides in the eastern region and submits the following comments and concerns for your consideration.

The Department has no major objections to the draft statement. However, final judgement on the proposal's environmental effects in Wisconsin will be withheld since this generic statement must be followed by the site specific Environmental Analysis Report as mandated by the Consent Decree of January, 1977. The Department may, at that time, furnish specific comments on the various sites to be treated with herbicides and the kinds of herbicides used.

The uses of the herbicide 2,4-D for vegetation control and/or alteration of vegetative stands are accepted practices which result in the least physical disruption of the treated sites. The foregoing statement would not apply should herbicides be used such as 2,4-5-T, which contain the TCCD dioxin contaminant.

We take this opportunity to make the following specific comments on the draft statement:

(#1) 1. While the statement reads "only 0.4% of the total forest is to be treated," this does not give the whole picture. Some data should be presented on the cumulative totals of treated areas (over a 10- or 20-year period), especially for red pine plantation release.

There is some apprehension among DNR wildlife biologists on the adverse impacts of red pine plantation release on such wildlife as deer and ruffed grouse.

(#2) 2. On page ii, the last paragraph appears to be biased. The remarks on page 24 and the top of page 25 appear to be more accurate.

(#3) 3. On page V, under "Wisconsin," change C. D. Besadny to J. R. Huntoon.

4. On page 8, bottom of page, the term "opening" should be described in the glossary.

5. On page 17, under Control, "biological" would be a better term than "natural" vegetation control.

6. On page 20, we feel the term "genetic" control is more appropriate than "evolution."

(#3) 7. On page 75, the first sentence should read "Herbicides are effective and the results are long lasting. (As it reads, it says that the herbicides are long lasting.)

(#3) 8. On page 82, the third line should read "insect feed."

In summary, we have no substantive reasons for objecting to the generic Environmental Statement. We would appreciate receiving eight copies of the Final Environmental Impact Statement and look forward to reviewing the site specific Environmental Analysis Report when it is completed. In the future, I would appreciate your sending me all copies of Environmental Impact Statements and Environmental Assessment Reports since this Bureau is responsible for coordinating the review of these documents.

Thank you for the opportunity to review and comment on this document.

Sincerely,
Bureau of Environmental Impact

James R. Huntoon

James R. Huntoon
Director

Forest Service Response to Comments
by State of Wisconsin/Department of Natural Resources

#1 See Table 1 for the proposed average annual use during the life of this statement.

#2 Last paragraph on page ii was revised.

#3 Suggested changes were made.

Box 323
Ashland, Wisconsin 54806

COALITION FOR ECONOMIC ALTERNATIVES

November 29, 1977

Steve Yurich
Regional Forester
Eastern Region
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Mr. Yurich:

The Coalition for Economic Alternatives, a private community development corporation, has reviewed your Draft Environmental Impact Statement entitled "Use of Herbicides in the Eastern Region". Attached please find our comments and suggestions as included in three statements, one, a paper titled "Hooked on Drugs: A Biosocial Analysis of the Use of Pesticides", two, a summary of the scientific literature demonstrating the toxicity of the herbicides 2,4-D and 2,4,5-T, and three, "Specific Comments on USDA Forest Service Environmental Statement".

Sincerely,

Kent Shifferd, Ph.D.
Co-Director

John C. Stauber
Co-Director

HOOKED ON DRUGS: A BIOSOCIAL ANALYSIS OF PESTICIDE USE

Kent D. Shifferd, Ph.D.

America is hooked on drugs. Both American agriculture and silviculture are dependent on large amounts of herbicides and insecticides. Our farmers and our foresters argue that these are essential management tools. And why not? These chemical pesticides are in use all over the world. The average citizen can buy them at hardware and drug stores. They are used on lawns and home gardens. Moreover, they have been around for a long time with no apparent human health problems. The present family of biocides were developed during World War Two and and have been in commercial use for twenty years. They are used by trained professionals in forestry and agriculture and all the formulations currently in use have been registered by the Environmental Protection Agency. They were developed by scientists working in public universities, colleges and in corporate laboratories and they are sold on the open market in accord with our free enterprise system. The men and women who developed them had the public good in mind. They wanted to end hunger and resource shortages around the world. It seems that these herbicides are the tools of the good guys. And, finally, all who use these tools point out convincingly that they have become an integral part of our economy and, if suddenly pulled out, would cause great dislocations. Farmers would go broke. Food would cost more. The cost of producing timber would go up.

In the face of such seemingly reasonable arguments, how can anyone be opposed to the controlled use of a particular herbicide? How can they be opposed to herbicides and insecticides in general? And, assuming that we as a nation wanted to break our habit, how could we do so without severe social and economic dislocation?

This is a volatile issue. Tempers flare. Opponents seldom listen. It is particularly important to remain calm. One way to remain calm is to get back from immediate cases and remind ourselves of some points on which both sides can, perhaps, agree. First, the herbicides and insecticides whose use we are debating have not been around as long as the average American has been alive. We have lived without them. Civilization has existed without the current crop of pesticides. Both agriculture and forestry have met their goals in the past without them, and, if we ended their use sometime in the future, on some gradual, phase-out program, agriculture and forestry and civilization would surely go on.

My second reminder is that these are all poisonous substances. No one disagrees with that. No one can find a medical doctor who would advise him to eat a spoonful of 2,4-D. These are "economic poisons" and their lables carry standard warnings against ingestion, exposure to eyes and skin. What we are debating is whether these poisons can be controlled in their use so that they poison only the target species. The issue is whether they can be confined to certain areas in the biosphere and to certain time periods, and if non-target species will be affected. So we all agree that these substances are harmful to some life forms (if they were not, we would not use them). And we all agree that man can be harmed by them under certain conditions.

My third reminder is about research. Science is an on-going enterprise. No scientist believes that research into the aetiology of disease is finished; no ecologist believes that research into the interconnections between life forms is finished. Research into the toxicity of these substances is going on today. The techniques are becoming more and more sophisticated. Researchers are just beginning to see active amounts of these new elements, amounts measured in parts per billion and even parts per trillion. (The original research on TCDD dioxin, a deadly contaminant of 2,4,5-T and Silvex, was carried out at parts per million levels, too crude an analysis to detect lethal doses of the substance.) Some of the new research does indicate danger to human health. At the least, we can all agree that the jury is still out.

My fourth point is about the various interest groups surrounding this issue. There are several kinds. The first kind are those people who are trapped into using these economic poisons. Farmers are in this category. Faced with poor returns on their investment and high labor costs, they cannot break even, under present conditions, without using chemical herbicides. It is important for environmentalists to communicate to farmers that we don't want to ruin them. It would be foolhardy to propose an immediate ban on all agricultural uses of herbicides. (Agriculture has trapped itself into drug use, quite innocently, by devising methods for increasing world food production which, in part, let world population reach higher and higher levels which in turn increased demand for higher yields per acre, which brought on the demand for current agricultural technologies. The intention was highly moral. The result has been tragic--we have a heavy-handed agriculture, in environmental and energy terms, and more starvation than was previously the case.) No one gloats over a tragedy. Federal foresters are trapped too.

In the 1960's Congress required them to increase their production of saw timber, and yet, requires them to hold down costs. Under some accounting systems the immediate dollar cost of hand release is higher than the cost of using herbicides. Put between the rock and the hard place, foresters turned to herbicides as a means to achieve an end. Perhaps habitual use has worked a subtle change in a few minds, and some foresters now defend herbicides from a philosophical point of view, treating them as ends in themselves, to be defended whatever the risk and whatever the alternatives. Another form of entrapment is a narrow, specialized point of view, one that considers only the goal to be achieved and a single technology to achieve it. It is more socially efficient to make analyses at the other end of the scale, and, taking into account economic, social and material resources, to make allocations based on a broad assessment of regional needs. Generally speaking, practioners in forestry and agriculture are concerned only with maximizing output from minimal input. They have little practice in visualizing alternatives to their current technique. Finally, with regard to interest groups surrounding this issue, there are the manufacturers and the environmentalists. It is difficult for environmentalists to be objective about themselves. Perhaps there are some who are in this debate for the glory of it, and for whom obscure psychological rewards balance the long hours after work and the frequent excursions into one's own wallet. The rewards for the manufacturers are not at all obscure. They are profits. big profits. The herbicide industry is a growth industry. It is an ancient principle of law that no man shall be a judge in his own case. The testimony of those who stand to make a profit is inherntly suspect. Environmentalists, whatever their psychological rewards might be, speak for the inarticulate, for the children forthe future and the creatures without language.

As a last reminder, I would like to introduce the evolutionary perspective, the long-term view. This is pertinent because the ways in which we modify the biosphere constitute an evolutionary test for all organisms including man. All living creatures, including ourselves, have only come to be what we are over immense periods of time. The physiology of individual species, including body chemistry, and their ecological relationships, are adaptations to ancient environments. As these environments changed naturally some creatures adapted and others became extinct. The pace of natural change was incredibly slow. Even when man came on the scene and invented agriculture, change was slow and it was not chemically profound. Man did not alter the environment at the molecular level. Let's just take one example. If our atmosphere had evolved with cyanide gasinstead of oxygen,then (all other factors being constant), humantypes would have evolved with a tolerance to cyanide gas. But the atmosphere as it actually evolved, did not contain cyanide and that is why we cannot breath it without an extreme reaction (death). It was not present in the environment to which we are an adaptation and so we are not prepared by natural selection todeal with it. The same laws are operating in the case of phenoxy herbicides. When new, synthetic elements are introduced into the biosphere they constitute an evolutionary test for many species. The results of these tests will not be known for generations. The new herbicides and pesticides constitute an evolutionary test for many species including our own. Over 5,000 different agents, formulated into more than 40,000 combinations, compose the current crop of pesticides. (These are just a fraction of the 500,000 synthetic compounds that have been introduced into the biochemical environment since 1850.) Together they represent a new chemical environment for the earth. Very little research has been doneon their individual biotic impacts Once released into the environment they combine, change and recombine. Almost no research has been doneon this synergistic activity or its biotic impacts. We just do not know what is bubbling in the chemical soup we have brewed, nor do we know what its future impacts will be. We do not now know which species will adapt to it and which will become extinct. The point of this is that farmers and foresters who conclude that since phenoxy herbicides have been used for twenty years and, therefore must be safe, ignore the lessons of evolution. Twenty years may be a lone portion of a man's life, but it is an insignificant moment of time compared to slow moving evolutionary processe which formed our body chemistry and the ecological balances which sustainlife. Twenty years is nothing -- human evolution has been in process 100,000 times longer than twenty years, the evolution of the cell more than a million times as long. We must keep in mind a sense of perspective, and it is natue's long range perspectives and the perspectives of our grandchildren that we must keep in mind as we make decisions affecting basic life processes.

The biosphere is a complex and dynamic place. The laboratory, in contrast, is a simple place. In the lab each animal species is tested for the direct effects of a toxic substances, and perhaps a dozen different species are tested. But "out here" in the biosphere are more than a dozen species. For example, there are over 40,000 species of wasps. Each has its own niche and they are related to each other and to a million other species by a web of pathways not yet fully explored. Along these pathways travel the creations of man. They travel in i teamounts, but in the biosphere, minute amounts ofcertain substance can be potent. We are dealing on the mollecular scale here. What is learned in the laboratoryis only the crudest approximation of what happens out here. Living systems are far more responsive and sensitive than are laboratory test systems. In short, there are many more surprises waiting out here than in the laboratory. One reason for this is that all creatures share the same fundamnntal biotic structures -- the cell. The cell is the basis of life. Today we are pouring unfamiliar compounds into the web of organic pathways and waiting to see where they will turn up, that is, in whose cells they will temporarily lodge. Chlorinated hydrocarbons have turned up in the fatty tissues of Eskimos, concentrated there by biomagnification to levels a thousand times greater than the levels in the surrounding environment. There are countless examples of leakage out of the system where the original application took place. That is because all systems are interlocked by the movement of air, water and animals. Biotic systems are not closed systems, they are throughput systems. It is difficult to control leaks in a throughout system with its thousands of input and output flues. And when leaks do occur it is nearly always a surprise to the specialists and the managers, and their first response, frequently, is to deny it. And so we have to be on the watch for miner's canaries.

In the old days, when the workers went down into the mines, they took a live canary. When the bird started to sicken, they got out fast. The birds were less tolorant of toxc mine gases than were the men and served as advance warn ing of a hostile environment. Wildlife in general serves that functiontoday. Bees and aquatic birds seem to go first but we are not heeding the warnings. Our failure to heed warning signs is partly the reult of the fact that no one is minding the store. There are still too many specialists and not enough generalists.

Isn't the EPA minding the store? Haven't they regist=ered herbicides and pesticides currently in use? Yes, they have, but consider the magnitude of their problem. There are over 40,000 different formulations of herbicides and pesticides. EPA's information about these materials and its evaluation procedureshave received a very low mark from Senator Kennedy's Senate investigating committee. EPA officials admit that most of the information in their files was supplied by the manufacturers. Their files were found to be in disarray, their test programs inadequate and actual misinformation and faulty data by the committee. EPA is currently struggling with the issue of reregistering all of these substances. They agree that it must be done but haven't yet decided on the basic approach they want to take. Just to give one pertinent example, a contracted study done for the federal government in 1963, showing that 2, 4-D caused tumors in rats was either supressed or lost for years and was not made public until this year. The conclusions of the Kennedy subcommittee on administrative practice and procedure does not instil confidence in EPA's record of minding the store.

In short, we are creating an environmental soup of herbicides and pesticides and other potent compounds. We have many specialists in the use of individual ingredients, but no chef. And no doctor, either. The medical profession is ill-equipped to diagnose pesticide poisoning. The very idea of tracing clinical symptoms to minute amounts of pesticides and herbicides, parts per billion, and parts per trillion, is a new idea in the medical profession. The laboratory equipment for such analyses is not available in doctors offices or even in most laboratories in the nation. Again, the problem is very complex. Countering simple assertions about the safety of herbicides requires that one think about less-than-simple phenomena, such as genetic variation. The molecular structure of DNA contains thousands and thousands of possibilities, so that the body chemistry of no two individuals is alike even in the same species. (The range of variations within a species is frequently greater than the range of variations across species boundaries). The chemical balance which maintains the health of the cell is a balance of many variables, a dynamic balance that changes in each individual throughout his lifetime. Recall that we have added to this dynamic natural system some 500,000 new compounds, and their decay products and recombinations and then compute the number of possible impacts, that is, the range of impacts a single compound or its decay products in combination with others, might have on unique individual organisms, and you have a statistician's nightmare. It is nearly impossible to single out which compound or combination is causing illness in a particular human being. But it is no surprise that the National Cancer Institute has concluded that 90% of all cancers are environmentally caused. So, with regard to disease and herbicides, no one is looking in any systematic fashion. Most doctors don't know what to look for and don't have the equipment anyway. Moreover, the patient could not devote the resources necessary to trace down the poisoned needle in the haystack. We simply do not know, and we have no way of knowing what part of our upward spiraling rates of cancer, heart disease and other illnesses are caused by the herbicides. We do know that these herbicides are in the air we breath, in mother's milk and, at autopsy, can be found in our organs. You will recall that they are in use everywhere. So were lead in paints, tetraethyl lead in gasoline, endrin, DDT, Dieldrin, thalidomide and hundreds of other toxic substances until we learned, too late for some people and animals we valued, that they were harmful. If I may indulge in a redundancy, they were not proven harmful until they were proven harmful by testing on the public. Early warnings were ignored. Information was surpassed. Manufactureres were indignant and experts pooh-poohed the evidence.

But what would we ever do without them? Herbicides are an integral part of our economy. It would collapse without them. We don't know any other way (which does not mean there aren't other ways). The first step is to sort out the solutions from the problem. If we were to suddenly cease using all herbicides and pesticides the result would be large losses in agriculture (as much as one third of the annual production) and smaller losses, but real ones, in forestry. The shock to farm income and farm families would be unacceptable. But viewing the present system without herbicides and pesticides does not constitute an alternative system. Depriving the system of a component on which it is overly dependent is no alternative. It does not represent another way of doing things; it just represents not doing them. And so, even while the drug is poisoning the addict and producing unwelcome side affects (inquilines), it would not be wise to withdraw cold turkey. We must pursue a step by step policy. We must pursue a gradual phase-out and phase-in of less harmful substitutes. We must fund basic research into new methods of pest control and crop management, while old methods, going back to the pre-pesticide era, are employed. Individuals whose livelihoods are threatened by this phase out program have a right to be compensated at public expense (just as the public is now compensating the victims of environmentally induced illness in the form of higher taxes and higher insurance and medical costs). And we must look for slack in other parts of the system, that is, we must be more efficient at resource conservation and production so that we do not need herbicides to overproduce for wasteful patterns of consumption. And we must start somewhere.

In principle we should start with those uses which could be ended without undue harm to individual family income and livelihood. The Forest Service use of herbicides is one such place. The economic gains to be realized by current investment in the present system of management by herbicides will not be realized until the period 2020 to 2070 A.D. These gains, in the form of timber and employment, will not accrue to families now living. Even if this pine were not released, the theoretical effect on the national economy one hundred years from now is so minimal as to be incalculable. But assuming we want to continue the release policy, the extra dollar cost of releasing by hand (whatever it turns out to be, and we do not yet know what it will be) represents only a small fraction of the annual budget of the Chequamegon National Forest, a tiny fraction of the total Forest Service budget. Moreover, it will be spread evenly among tons of millions of taxpayers. (The Forest Service accepts far greater losses each year.) Put in perspective, the added dollar costs are minimal and are spread extremely thin. But even this minimal cost to the local forest need not be sustained. There is slack in the overall man-environment system. Both money and labor are now being wasted. Money is being spent, workers are idle, and labor intensive jobs are going begging all because of inefficient management in our social system. Moreover, there are newly available state and federal funds for manpower programs. We have dollars, jobs and workers groping around in the dark for each other. What we need is a sound management approach, and we can begin here. This is an economic alternative that calls for cooperation between the state and federal people, and local citizens. Moreover, it provides a free market opportunity which keeps federal dollars here, in this region. The herbicide approach takes federal expenditure out of the region, to down-state or out-of-state spraying firms and to chemical corporations.

The herbicide-pesticide issue is complex. It is not what it seems on the surface. Our economy became hooked on these substances incrementally and without systematic assessment. We were driven into it, in part, by pushers with powerful economic assets and incentives, in part, by an idealism ignorant of ecology and systems analysis. Getting off, kicking the habit, will have to be done gradually, using a mix of old and new substitutes to achieve the same levels of satisfaction by means that are more consistent with our molecular make-up and our evolutionary constraints. We need to design our economic activities in accord with nature simply because, over the long run, that is the most efficient way. The Chequamegon Forest is a good place to start. The potential losses that might be risked are very small and exist far out in the future. Whereas the potential gain is great. What we might learn here, working together could have application on a wide scale. The Chequamegon could become a leader, a model for national design bringing together various social and economic elements in a soft systems approach to timber production, an approach that has greater economic benefit for the local area. This is what we mean by our slogan, "Hire people, not poisons". The Coalition for Economic Alternatives is a non-profit corporation interested in economic growth in this region, not in growth that relies on hard systems with their external diseconomies that strip our wealth and leave us poorer and more polluted in the long run, but in soft-systems growth that make possible a sustained yield of economic satisfaction and environmental quality for local people.

Literature Summary

1. Norback, et al on TCDD and OCDD

   "Tissue Distribution and Excretion of Octachlorodiberyo -- p-Dioxin in the Rat", Toxicology and Applied Pharmacology, 32, 1975 330-338.

   Summary of physiological results of administering TCDD to subhuman primates & results of factory workers exposed. Skin diseases in workers: ulcers, liver disease and mortality in primates. On rats teratogenic effects and fetal mortality. Hemorrhage, liver disease, lymph disease and heart disease in chickens. OCDD less toxic than TCDD. Embryotoxic at 500/mg/kg/day OCDD tends to be excreted more readily than TCDD which is, instead, absorbed into body tissue.

2. Earth News, Feb 22, 77. Harvard Medical Reséarchers found traces of dioxin in Mother's Milk in Waldport, Oregon.

3. J.P. Van Miller, R.J. Marlar and J.R. Allen, "Tissue Distribution and Excretion of Tritiated Tetrachlordibenzo-p.-Dioxin in Non-human Primates and Rats". Food and Cosmetics Toxicology, 14, pp. 31-34.

   Summary of known effects in non-human primates. "acne, alopecia, gastric hyperplasia, ulceration, atrophy of bone marrow and hepatocellular changes". compared to rats, primates absorb most of the TCDD into their skin and muscles rather than into their livers. TCDD is not easily metabolized in either case and remains in the body for long periods of time.

4. J.R. Allen, J.P. Van Miller and D.H. Norback, "Tissue Distribution, Excretion and Biological Effect of ["C] Tetrachlorodibenzo-p-dioxin in Rats"

   Summary of earlier research on effects includes retarded sexual development and inhibited immunological responses.

5. Highman, "Strain Differences in Histopathologic, Hemotologic and Blood Chemistry Changes Induced in Mice by a Technical and a Purified Preparation of 245-Trichlorophen-oxyacetic Acid." Journal of Toxicology, 1: 1976 1041-1054.

   Lesions in mouse heart tissue "are due primarily to 2,4,5-T rather than contaminants".
   53-82% of tests samples became moribund at 120 mg/kg of 2,4,5-T. Others showed blood chemistry changes and anemia.

   Found major differences in results w/different strains of mice and different colonies of same strain.

11

NCTR strain of mice showed illness and death at dose level at or below 60 mg/kg 245-T. CRBL mice were able to tolerate 2x the dosage and showed lower incidense of lesions.

The lesions were due primarily to 245-T rather than to benzine derivative contaminants found in technical (i.e. commercial) preparations.

Evidence of bladder abnormalities suggests carcinogenic potential

6. N.P. Goldstein et al "Peripheral Neuropathy after exposure to an Ester of Dichlorophenoxy-acetic Acid" Journal of American Medical Association, Nov. 7, 1959. pp. 1306 ff.

"Severe sensory and motor symptoms necessitated hospitalization of three patients, a 52-year-old man, a 50-year-old woman, and a 65-year-old man. In each case the disorder began some hours after the use of preparations of dichlorophenoxy-acetic acid (2,4-D) to kill weeds; the symptoms progressed through a period of days until pain, paresthesias, and paralysis were severe. Disability was protracted, and recovery was incomplete even after the lapse of years. There was little doubt that the neurological damage was done by the percutanescus absorption of spilled 2,4-D. The electromyographic examination supported the diagnostis of peripheral neuropathy. Since there is no antidote or other specific treatment for2,4-D poisoning, this herbicide should be used with caution."

7. Kennedy/Hessel "The Biology of Pesticides"

"The first reports that Carbaryl, along with 2,4-D and 2,4,5,-T is capable of causing birth defects and reducing litter size in laboratory animals---it certainly seems advisable for pregnant women to avoid all contact with pesticides." p. 95. John Holdren and Paul Ehrlich, Global Ecology, N.Y. Harcourt, Brace, Jovanivich, 1971.

Goldstein "Peripheral Neuropathy"

Acute neurological damage persisting over years from spilling 10% solution on skin. Loss of weight. Loss of motor abilities, pain, nausea, rash, sensory deficit, loss of some reflexes, depression, vertigo, subcutaneous itching.

Doses in animals caused diarrhea, rigidity, cronic tremor coma and in some cases death.

"No antidote is known and there seems to be no specific treatment for neuropathy if it developes." p. 1309

8. Dr. Jacqueline Verett, Federal Food and Drug Administration

From: Dr. Jacqueline Verrett, Food and Drug Administration

"Dr. Verrett of the FDA has found that dioxin causes birth defects in chickens and hamsters at levels 100,000 to 1,000,000 lower than the amount of thalidomide causing defects in the same animals systems. Fed to female guinea pigs at the incredible figure of dose-to-body-weight of 0.6 parts/billion, bioxin killed 80% of the animals."

9. Environment, July/August, 1970

"...subsequent tests showed that dioxin did indeed cause birth defects in animals. ...Subsequent tests also showed that purified forms of 2,4,5-T and of some forms of 2,4-D caused birth defects in animals." (Bionetics Study done under contract to the National Cancer Institute)

10. Harvest of Death, Neilands, et.al.

"Evidence is now available implicating 2,4-D and 2,4,5-T in the deaths of over 100 reindeer and many mis-carriages during the fifth month of pregnancy of these animals in Swedish Lapland, in May, 1970. This case is particularly disturbing because the herbicide treatment occurred the previous summer. Vegetation contained 25 ppm 2,4-D and 10ppm 2,4,5--T.

"From elsewhere it is known that exposure to 2,4,5-T or 2,4-D reduces both egg production and poultry weight. (A reference to a report by N. Dobson in "Agriculture", London, "61", page 415, 1954-55)

"Though field data are meager, 2,4-D may also affect certain animals indirectly because of its effect on plant metabolism. It has been shown that certain plants such as sugar beets after treatment with relatively low amounts of 2,4-D may accumulate abnormally large quantities of nitrates in their leaves."

11. Matthew J. Meselson and Robert Baughman, Harvard University, Prehearing Statement, E.P.A. FIFRA Dochet #295

"We have analyzed samples of fish and shrimp from South Vietnam, collected in rivers and estuaries draining areas heavily sprayed with the herbicide n-butyl 2,4,5-trichlorophenoxyacetate. These samples contain up to several hundred ppt of TCDD. No TCDD above the sensitivity limit of about 3 ppt was found in control samples.

Our results suggest that TCDD may be quite stable in the environment and that it may accumulate in food chains. although further research is needed to quantify these statements. Nevertheless, it becomes of interest to consider what accumulated dose to an individual (expressed as ppt of his body weight) could result from a given average concentration of TCDD in the diet. As an example, we consider life-long exposure for a 50-year old person consuming five times his weight in food each year. The accumulated dose will depend on the biological half-life of TCDD and the average concentration in the diet as shown in the table.

Unfortunately, neither the biological half-life nor the range of present dietary concentrations is known. However, limited experiments suggest that the biological half-life for lethality is not less than two years in monkeys.[2,4] Also, pilot studies by EPA indicate that levels of about 1-40 ppt of TCDD appear in fat and liver of sheep and cattle grazed on land treated with 2,4,5-T containing 0.04 ppm TCDD.[5] Thus, for exposed populations dietary levels in the range in the table cannot reasonably be ruled out. Depending on the biological half-life, this could result in accumulated doses of the order of 10 ppt or more of TCDD as a result of the use of 2,4,5-T containing 0.1 ppm TCDD.

From the existing toxicological data, it is not possible to say that such accumulated doses are or are not hazardous. Short term doses of a few hundred ppt and a few thousand ppt have been found toxic to the immune systems of guinea pigs and mice, respectively,[6] and are lethal to guinea pigs.[7]"

12. Professor Theodore Sterling, "Man Against Himself: Biological Dangers from the Use of Herbicides," Humanist in Canada, #36.

It is often stated that the attack on 2,4,5-T was part of the anti-Vietnam war movement, and that attempts to obtain reasonable regulation of phenoxy herbicides are at bottom political, anti-Vietnam, anti-American, or pro-communist activities. These claims are sheer nonsense. The fact that 2,4,5-T was a teratogen (i.e. a malformer of babies like Thalidemide) was determined quite independently of, and before, reported damage to Vietnamese babies.
In 1969 the U.S. National Cancer Institute tested a series of common household chemicals. One of the chemicals tested was 2,4,5-T. Of the 120 household chemicals in the first screening trials, some 20 were found to be carcinogens. One of them turned out to be an effective teratogen - that one was 2,4,5-T. Only after the National Cancer Institute's discovery of the teratogenic properties of 2,4,5-T, was attention given to reports of still-births and malformations that were coming out of South Vietnam. The U.S. Army sought to arrest such loose talk by appointing an investigating

14

committee. That committee found no evidence of a rise in the incidence of malformation in South Vietnam. However, an impartial commission appointed by the American Association for Advancement of Science found a definite increase in malformations and still-births in those regions of Vietnam that had been subjected to heavy defoliation. These findings then, combined with a series of experiments definitely established that 2,4,5-T was a teratogen and led to the cancellation in 1971 of the registration of 2,4,5-T and a ban of its use in granular forms around households and on food products. The cancellation was fought bitterly by some of the industry, especially by the Dow Chemical Corporation. In the fall of 1971, Dow Chemical managed to get a court order reversing the cancellation of 2,4,5-T because of technical errors committed by the Environmental Protection Agency from holding public hearings. In 1974, when 2,4,5-T related dioxins were discovered to persist in shrimp caught off the South Vietnam coast, some three years after all defoliation had ceased, public hearings were again ordered by the courts in 1974. These were again postponed because of industry pressure to collect more data about the spread of dioxins among the animal and human population of North America. As no additional data is needed to determine that 2,4,5-T is a serious hazard, the story of ALDRIN and DIELDRIN is just being repeated with phenoxy herbicides - except the game is played now for higher stakes than before.

13. "Report of the Secretary's Commission on Pesticides", H.E.W. 1969.

"Without dioxin, 2,4,-D causes birth defects in animals and chromosome aberrations, abnormal mitosis and affects nucleaic acid synthesis in plants."

14. Prevention Magazine, Nov. 1971, p. 3.

1971 - eggs sprayed - pheasants, partridges - 2,4-D - By 19th day of incubation, 155 of 201 partridges (grey) embryos had died, 43% of red-legged partridges and 77% of pheasants, "Most of the surviving birds were partially or totally paralyzed. They had fused cervical vertibrae, permanent contracted claws, colorless feathers, underdeveloped testicles and abnormal ovaries." Similar results w/ducks and quail.

15. Staff report to U.S. Senate Subcommittee on Administrative Practice and Procedure" (Investigation of EPA), p. 15

A. Two year rat and dog study showed "increased tumor formation in the rats"

B. An independent pathologist concluded that 2,4-D is carcinogenic in rats"

15

16. The Dioxin Story Lon W. House, Environmental Research Assist Institute for Policy Studies, Portland State University, Portland, Oregon pp. 5-68.

"Phenoxy herbicides have been used in Pacific Northwest forests for some 20 years. In 1974 the EPA laboratories in Prine, Florida analyzed animal specimens obtained from various areas treated with herbicides. Several of these specimens were from the Siuslaw National Forest of the Central Oregon Coast Range. This area has had one to two percent of the total area of the forest sprayed with herbicides. EPA found positive TCDD levels in specimens obtained from this forest in the following amounts: 83 and 133 per trillion (ppt) in wrens, 13 ppt in Stellers jay, and two 14 ppt in deer mice. TCDD was also found in three specimens from other Pacific Northwest forests, and in several animals from Virginia right-of-ways (two shrew samples showed TCDD levels of just below 400 ppt).[12]

In late 1976 milk samples collected from women living near the forest were analyzed at Harvard University in laboratories of Drs. Meselson, Baughman, and O'Keefe, who are collaborators in the EPA monitering program. The technique utilized was neutral extraction/high resolution direct probe mass spectrometry, which is considered accurate by the investigators down to 0.4 parts per trillion from milk samples. TCDD was found in concentrations as high as 1.5 ppt in milk of nursing mothers living near the Siuslaw National Forest. TCDD was also found in mothers milk from San Angelo, Texas, living near rangeland sprayed with 3,4,5-T.[13]

Toxicity

TCDD is commonly referred to as the most toxic chemical ever synthesized by man. The acute lethal toxicity (LD_{50}) for chickens, mice, rats and guinea pigs is in the dose range of 1 to 20 micrograms per kilogram body weight. The LD_{50} for guinea pigs is 0.0000006 g/Kg[15]. Dr. Wilbur McNulty, chairman of the Pathology Laboratory at the Oregon Primate Center, started TCDD toxicity tests with Rhesus monkeys in 1975. Upon learning how potent TCDD is on monkeys, he discontinued his laboratory tests until a properly isolated facility could be constructed. Dr. McNulty states TCDD is almost too toxic to test under laboratory conditions, that a speck seen only through a microscope was fatal to a monkey in less than two weeks. "We used only 20 parts per billion parts solution, and placed it in their food. It is the most toxic chemical we know."[16] A level of 2 parts per billion was lethal in 76 days.

TCDD causes congenital abnormalities (fetal deaths, cleft palate, kidney and liver abnormalities) in rats[17]

16

and mice.[18] The no-effect dose for fetal effects in rats was 0.03 micrograms per kilogram. Dr. Neuberg states: "This is by far the smallest effective dose of any teratogen known today"[19]"

TCDD is stable in the environment. About 50 percent of the amount applied to soil remains after one year.[20] Given the dissolution of dioxin in a light-transmitting film, the presence of an organic hydrogen donor (such as a solvent or pesticide), and ultraviolet light, photochemical dechlorination appears to be the primary mode of environmental degradation of TCDD.[21] However, TCDD photo-decomposition is neglible in aqueous suspensions and in wet or dry soil.[22] TCDD is fat soluble, and has been shown to accumulate in the liver and fat of rats.[23] Biological magnification has been demonstrated in a study conducted by the Air Force in which various species of rodents and birds were observed to contain levels of dioxin higher than levels in the environment.[24] In these aspects TCDD is similar to other chlorinated hydrocarbons (such as DDT).

While the effects of TCDD on test animals has begun to be established, the threat of human contamination via herbicides has not been analyzed. There have been no long-range epidermiological studies of the possible long-range effects of herbicides on human populations. However, in a project conducted by the EPA on workers who apply herbicides, a marked increase in the amount of chromosomal abnormalities was observed during the spraying season.[25] Dr. McNultley states: "Until better information is available it is my opinion that the deliberate environmental distribution of TCDD or products known to contain TCDD at any level causes a serious threat to human and animal health"[26]

EPA

17. Biological concentration

The eastern oyster concentrated 0.1 ppm of butoxy-ethanol ester of 2,4-D in water to a level of 18.0 in itself during 7 days, as measured by 2,4-D disappeared from the bodies of the oysters.

Esters of 2,4-D accumulated in sunfish after exposure to sublethal concentrations in both laboratory and field tests (Cope, 1965b), and the fish sampled from a reservoir with 1 ppb showed an uptake of 2,4-D to a maximum of 150 ppb (Smith and Isom, 1967)

Within an hour after being treated with 2,4-D at a rate of 100 lb/A, the concentration of 2,4-D in reservoir water was about 1 ppb (Smith and Isom, 1967). Mussels (primarily Elliptio crassidens) exposed to the water for 96 hours concentrated the 2,4-D: 2 samples of mussels had an average of 380 ppb and 700 ppb of 2,4-D in their tissues. Asiatic clams concentrated 2,4-D to less than 140 ppb.

17

Ecological Effects of Pesticides on Non-target species, Executive Office of the President, Office of Science and Technology. June, 1971

18. 2,4-D Lodges in bottom sediments

2,4-D appears to degrade rather rapidly in water. For example, the concentration dropped from 1,000 ppm of application rate to 10 ppb within 30 days (House et. al. 1967). However, significant concentrations of 2,4-D (58.8 ppm) were recorded and isolated from sediment samples removed from a reservoir some 10 months after treatment (Smith and Isom, 1967).

Ecological Effects of Pesticides on Non-target species, Executive Office of the President. Office of Science and Technology.

19. Dioxin lodges in fatty tissues and can build up over time. Bill Hollyer "The War on 2,4,5-T" in Environmental Action, Nov. 5, 1977, pp. 12-13.

"Dow Chemical produced one of the three sets of laboratory analyses showing tumors in animals fed 2,4,5-T. EPA is bound by federal law not to reveal the results of the Dow study beforehand - but officials there are planning to include them in the notice to ban, according to Holloway.

Two other studies also not available to the public are earmarked to be part of the notice.

One of them was carried out by scientists at the Labratoire de Genetique, Fondation Curie, in Paris. It involved feeding mice water containing 80 parts per million (ppm) of 2,4,5-T over a 300-day period. The results show a number of "rare tumors" as well as evidence of leukemia.

"In 2,4,5-T treated mice a significant increase in the incidence of neo-plastic lesions (tumors) was found," the report said. It concluded: "In view of these facts we feel that the carcinogenesis observed in our experiments should be attributed to 2,4,5-T per se."

Dr. Frederic Kutz, a senior biochemist at EPA who has been conducting experiments on wildlife, explains the process by which dioxin enters the human system. Dioxin is not soluable in water but can be carried long distances from a sprayed area. What happens, Kutz says, is that when 2,4,5-T is used in a National Forest or rice field, run-off containing dioxin is washed into streams and water-ways. It then enters the food chain in fish and wildlife that feed in the lakes and marshes, and some eventually ends up in the ocean to be eaten by shellfish and other organisms.

But while dioxin is not soluble in water, it is soluble in fatty tissue. When cattle feed on sprayed rangelands, dioxin is able to enter their systems. Because dioxin can lodge in fatty tissue, and because it is not washed out through excretion, the poison builds up over time. Holloway's studies of dioxin levels in beef liver and beef fat would seem to validate this claim, Kutz said.

The final link in the regulatory process is for EPA to show that once humans eat fish or beef tainted by dioxin, the substance lodges in them as well, where it could potentially cause birth defects or other problems.

18

EPA has scheduled tests of mother's milk to begin in California before the end of [illegible] before the results from this series are known, however, 2,4,5-T will [illegible] the market, according to Holloway.

The cancer findings are significant because without them, Holloway said he wasn't sure that EPA could produce a ban on 2,4,5-T [illegible] on the basis of the [illegible] liver and fat data, even with positive results from the mother's [illegible], banning the herbicide could take years.

[illegible] according to [illegible]. "There [illegible] level causes some level of [illegible]."

20. Patient Earth, J.Harte, R. Socolow, p. 147

2,4-D and 2,4,5-T may accumulate in soils under relatively anaerobic conditions.

A buildup of phenoxyacetic acids could cause crops to accumulate nitrate in quantities as to be toxic.

Nitrate forms nitrite in animal cells which causes methemoglobinemia (deviation of the blood oxygen-transport system caused by chemical modification of the hemoglobin)

21. Chemical Villains , J. Berry, D. Osgood, P. St. John p. 156

2,4-D has caused irritation of the eyes and gastrointestinal disturbances

decays rapidly in soil (30-60 days) but is known to last up to 10 months in low-oxygen water.

indirect effects on small animals and birds by destroying habitat

indirect effects on fish - kills weeds - the decomposition uses the oxygen in the water - reduction or elimination of dissolved oxygen - suffocation.

There is some evidence that 2,4-D is carcinogenic - it is known to produce chromosomal aberrations in plants at 10 ppm (changes are inherited)

22. Affidavit - As much as 60% of spray materials can drift one mile from target area.

STATE OF WISCONSIN)
) SS.
COUNTY OF DANE)

I, Kenneth Ragland, being first duly sworn, depose:

1. I am employed by the University of Wisconsin-Madison as an associate professor of mechanical engineering.

2. I specialize in the area of fluid dynamics and atmospheric dispersion of air pollutants.

3. I am informed that the United States Forest Service proposes to apply herbicides from helicopters, with the helicopters flying at a level of approximately 50-60 feet above the trees, at an air speed of

35-45 m.p.h., and with a nozzle size of approximately 0.13 inch. In addition, I understand that the nozzle pressure will be approximately 2 pounds per square inch, and that the wind speed, presumably measured at ground level, will be less than 8 m.p.h.

Based upon the above information, it is my opinion to a scientific certainty, that there will be a loss of at least 5 to 15 percent of the herbicide materials from the area of intended application, and that these materials will drift to areas as far as a mile from the intended sites of application. See, e.g., Van Valkenburg, Pesticide Formulations (197?) at 330.

4. In order to determine the precise magnitude of the material that would be lost, and the extent of the transport of this material away from the intended sites, it is necessary to know, for each individual site, the following information:

(a) The precise speed and altitude of the aircraft;

(b) The precise viscosity, surface tension and chemical content of the spray involved;

(c) The precise engineering details as to the nozzle in question;

(d) The speed of the wind at the height of the aircraft, and the stability of the atmosphere at the time of the flight, as this will predominantly govern the extent of the transport of the materials.

5. In addition, the following factors are also important: the pressure of the micro foil boom, the temperature of the spray, the size and engineering details of the control orifice, the volume of materials pumped, the turbulence of the downdraft and updraft caused by the helicopter, and the effect of its interaction with the spray mist.

6. Without a detailed analysis of the above described factors, it is possible to determine with precision the percent of the materials that will be lost by drifting away from the intended area, or the extent of the surface area of land and water that will be covered by this unintended drift. This detailed analysis is very important, because it is clear from the literature that under unfavorable conditions as much as 60 percent of materials sprayed by helicopters can be transported onto areas away from the target sites.

Kenneth Ragland

Subscribed and sworn to before me this 19 day of July, 1974

Notary Public, State of Wisconsin
My commission is permanent

23. World Health Organization Warning, reported in CATS Newsletter, Vol. 2 #1, p. 2

World Health Organization warned in 1975 "women in their reproductive years and particularly pregnant women should be excluded from contact with 2,4,5-T

24. Dioxin the most toxic man-made chemical

Dr. Diane Courtney was quoted in the Oregonian as saying that dioxin invariably occurs in 2,4,5-T, that it is the most toxic man-made chemical, that it is harmful in amounts to small to measure.

Quoted in CATS Newsletter, Vol. 2, # 1

25. Meselson, 1973: Dioxin has been found in soil samples and in foods in Vietnam and the U.S. and in the soil it is found 10 years after application.

In 1973, dioxin was found in birds and small animals along rights-of-way in Virginia and in the Siuslaw National Forest here in Oregon. This sampling was conducted by the EPA, but the EPA never released the data.

EPA sponsored studies have turned up dioxin in beef cattle in several states and in human breast milk in Oregon and Texas.

One of the few studies done on human spray applicators, by Yoder, Watson and Benson, 1973, shows "a marked increase in the frequency of chromatid lesions. This trend was especially noticeable among workers exposed to herbicides." The herbicides included 2,4-D and 2,4,5-T. In the introduction this study mentions another, similar finding: "Increased aberations of lymhocyte chromasomes have recently been reported in a group of Michigan fruit producers involved in heavy pesticide spraying."

26. CATS Newsletter, Vol. 2, #1

Dr. Logan Norris of the Forestry School in Corvallis has stated that one single molecule of dioxin can cause a birth defect. This makes it obvious that there is no safe dosage level

Janicki, 1972: Leukemia has been found to be more prevalent in areas sprayed with herbicides.

Perera, New York Times, 1972: A five-fold increase in liver cancer has been found in areas of Vietnam sprayed with 2,4-D and 2,4,5-T. These two herbicides form the infamous Agent Orange, the defoliant used in Vietnam until an international protest stopped it.
There has also been an increase in chromosomal abberations including those of Mongolism (Ton That Tung, 1970).

Dr. Charlotte C. Taylor: "I have collected over 100 cases of illness in which 2,4,5-T was shown or suspected to be a factor. High levels of 2,4,5-T have been found in people over wide areas surrounding the forests which have been sprayed. After exposure to 2,4,5-T, people seem to be more sensitive to other chemicals, perhaps because of liver damage."

21

Buu Hoi, 1972: In animal studies dioxin causes extensive damage to the heart and lungs and all vital organs.

W.P. McNulty, M.D., Chairman of the Laboratory of Pathology at Oregon Regional Primate Research Center, mentions, in addition to some of the data we have mentioned above, damage to the immune system as a result of exposure to dioxin. He also states that monkeys are several times more sensitive to dioxin than are mice, rats, rabbits and dogs, and that there are strong similarities in the responses of monkeys and humans. He warns us that, 'until better information is available, it is my opinion that the deliberate environmental distribution of TCDD (dioxin, or products known to contain TCDD at any level causes a serious threat to humans and animal life." McNulty also warns us of the effect of bioconcentration of TCDD, which means that animals higher on the food chain, such as humans, which eat contaminated prey, develop increasingly high concentrations of dioxin in their bodies.

27. One of the few studies done on human spray applicators, by Yoder, Watson and Benson, 1973, shows "a marked increase in the frequency of chromatid lesions. This trend was especially noticeable among workers exposed to herbicides." The herbicides included 2,4-D and 2,4,5-T. In the introduction this study mentions another, similar finding: "Increased aberations of lymhocyte chromasomes have recently been reported in a group of Michigan fruit producers involved in heavy pesticide spraying."

CATS Newsletter, Vol. 2, # 1

28. Proposed testimony of Wilbur P. McNulty, Jr.

A dietary level of 20 ppb for young male rhesus monkeys was lethal in 12 days. 2 ppb killed in 76 days. The toxicity of TCDD for rhesus monkeys is roughly 1 ug/kg body weight.

29. Testimony of Eloise W. Kailan

p. 4
reduced resistance to infection is a known effect of TCDD exposure

p. 13
"...when picloram and 2,4-D interact, they potentiate their own individual adverse effects."

"These herbicides are enzyme inducers meaning that they affect the liver's function to detoxify and remove a wide variety of subsequently administered chemical substances..."

SPECIFIC COMMENTS ON "USDA FOREST SERVICE ENVIRONMENTAL STATEMENT - THE USE OF HERBICIDES IN THE EASTERN REGION"

John C. Stauber
Co-Director

1. We are assured that "any herbicide used will be registered by the E.P.A. as being safe to the environment, human beings, livestock, and wildlife."(Page i) In no way does an EPA registration mean that the registered herbicide is "safe"; on the contrary, these substances are registered precisely because they are all poisons.

(#1) Furthermore, recent government reports have shown that the effectiveness of the E.P.A. in protecting the public from the hazards associated with herbicides is extremely lax. In a report to Congress, December 4, 1975, by the Comptroller General of the United States, entitled "Federal Pesticide Registration Program: Is It Protecting The Public and the Environment Adequately From Pesticide Hazards?", General Accounting Office (GAO) found the following conditions.

"Safety and efficacy data has not been submitted to support marketing many pesticides. (Safety data include information on cancer, genetic changes, birth defects, and reproduction.) Safety and efficacy data is not required for the pesticides as marketed, only for individual active ingredients. Reviews of inert ingredients (such as vinyl chloride) are not subjected to the full range of safety testing. Many labels do not comply with requirements. Pesticide residue tolerances are not monitored or reviewed. The safety of pesticide residues in some foods has not been determined. Statutory registration requirements are not carried out on a timely basis."

In December 1976, the United States Senate Committee on the Judiciary completed its subcommittee hearings on "The Pesticides". An excerpt from that report states: "A clear example of EPA's failure to evaluate data resulted in the agency's determination that there was 'sufficient' data for 'full' reregistration of the pesticide 2,4-D. On April 8, 1976, EPA mailed reregistration guidance packages to manufacturers of 670 products containing 2,4,-D for which more than 45 residue tolerances have been granted on such foods as dairy milk, eggs, poultry, meat, corn, apples, vegetables, and citrus fruits. The guidance packages cited a 2-year rat and dog feeding study performed by FDA in 1965 as sufficient to satisfy the 'chronic' safety testing requirements for reregistration. Yet, a summary report on the study in EPA's files stated that there was 'increased tumor formation' in the rats. John M. Carley, Manager of the Reregistration Task Force, stated that he doubts that the summary report was even read in the preparation of the guidance packages. An independent pathologist, who reviewed the raw data on the study at the request of subcommittee staff, concluded that 2,4-D is 'carcinogenic (cancer-causing) in rats.' "

2. On page ii, we are assured that "25 years of proper herbicide use by the Forest Service in the Eastern Region have produced no known health problems in Forest Service personnel, herbicide applicators, or local Forest

(#2) residents." However, on page 58 the EIS states that "Few studies of herbicide toxicity to humans have been made." No where in the EIS is there a single reference to any actual studies done in the Eastern Region to uncover any potential health problems in personnel, applicators, or local residents.

3. The EIS states on page 24 that "The TCDD dioxin content now contained in 2,4 has been reduced to a fraction of 1 percent of its original content." What the EIS fails to acknowledge is that before the TCDD contaminant was even
(#3) recognized, tens of thousands of gallons of extremely dirty 2,4,5-T were sprayed over thousands of acres of National Forest land in the Eastern Region. For instance, according to information contained in the 'Environmental Analysis Report' for herbicide use on the Chequamegon National Forest in 1977, some 6,407 acres of the Washburn District were sprayed with 2,4,5-T, alone or in combination with 2,4-D, between 1960 and 1973. Yet, there has never been released a description of the areas where this contaminated 2,4,5-T was used. Nor has there been any effort to ascertain what damages may have done to the environment or human health by the dioxin present. Nor has any testing been done to ascertain whether dioxin might still be present in soil or vegetation on these areas. A more telling and important assessment of those effects of past misuses of 2,4,5-T by the Forest Service would be the sort of study conducted by Meselson in the Suislaw National Forest, which detected levels of TCDD dioxin in samples of mother's milk in areas where 2,4,5-T had been used by the Forest Service.

4. Presently I am a partner under contract with the Forest Service to do manual release work in the Chequamegon National Forest, Hayward District. So it is with first hand experience that I say the EIS assessment of manual release is simply unimaginative and misleading.

"Generally speaking, manual methods have little adverse effect on the environment. This method can be selective and accomplished with little visual impact... . Long term local employment is possible." (EIS, page 25). This statement is a precise summation of major advantages of manual release..

"The major disadvantages are high cost and ineffective results." "... finding people to work at physically demanding jobs is a problem." I can not agree with these statements. The cost of hand release on the Chequamegon National Forest averages less than $30 per acre. An extremely difficult site might cost $50 to $70 per acre. One person with a saw and brush ax can do, on the average, from .75 to about 3.0 acres of manual release per day, depending on site conditions and specifications. I do not agree that "it would require a minimum of 10 people working a full year to clear 1,000 acres of heavy brush with hand tools." Nor is it necessary for a "specially funded public employment program" to replace herbicide release with manual methods. Ten people working a full year clearing heavy brush would be able to clear a minimum of 2,000 acres with hand tools. They could do it best on a contractual bidding basis; there would be no need for a new government employment program.

The EIS statement that "Many National Forest areas have a limited labor supply" does not square with the EIS's depiction on pages 14,15 and 16 of the areas of the Eastern Region as being generally economically depressed. The problem is not the availability of the labor force. Unemployment is high in the areas of the Eastern Region. The problem is in the decision of the Forest Service to discourage labor intensive methods. The Forest Service does a very poor job of advertising bidding opportunities.

In assessing the cost to the taxpayer of herbicides vs manual release many factors not considered should be examined. Herbicide release has certain hidden costs which are born by the public. One is the cost of lengthy court suits, as the Forest Service attempts to pursue an unpopular policy. Another is the cost of preparing lengthy Environmental Impact Statements and Environmental Analysis reports. Another hidden cost that is difficult give an exact figure to but could probably be measure in the hundreds of thousands of dollars is the damage done to the public image of the Forest Service by its insistence on using herbicides. As the EIS recognizes on page ii, "Public objection to herbicide use continues to be an issue." In pursuing an unpopular policy the Forest Service is doing great damage to its careful public relations campaigns. In the public eye, such slogans as "Give a hoot, don't pollute" become nothing but ironic hypocrisy.

As the EIS states, the accident rate for those of us who work in the woods is indeed high. Speaking personally, I feel much safer facing the risks from a saw or ax, which I can prepare for, than the risks posed by a carcinogenic herbicide.

The Forest Service would actually be doing a better job of saving the taxpayer's dollar by making the switch away from herbicides to a more labor intensive approach. In doing so, the government would be making a small but important move toward addressing the great national problem of unemployment.

Although resprouting is a problem in the use of manual methods, the EIS discussion does not represent the difficulties fairly. Every site is unique. It is not possible to know how effective manual release will be until it is done. There is no reason to assume that manual release will have to be done "annually or biennially", as the EIS states. One advantage to manual release is that often it is unnecessary to release all of a site. The hand operator, being intelligent, is able to do a selective job on the site. The spraying of herbicide simply effects the entire site.

Finally, according to Professor Orie L. Louks, who teaches forest ecology at the University of Wisconsin - Madison, and who personally visited many sites scheduled for herbicide release by the Chequamegon National Forest in 1974, most of the sites needed no release at all.

5. On page 27., the EIS fails to mention mechanical weed harvesting as an alternative to the use of aquatic herbicides. Such an alternative is employed by the city of Madison, Wisconsin, because of public opposition to using herbicides in the lakes surrounding the city. The weeds and algae that are harvested are then made available to the public for use as garden mulch.

6. It is unfortunate that the Forest Service has adopted the standard industry arguments in its discussion of the dioxin contaminant in 2,4,5-T. (EIS, page 43-51.) Because of the extreme toxicity of dioxin, there is simply no justification for allowing it into the biosphere. Thomas Whitesides, writing in the July 25, 1977 issue of "The New Yorker" responds well and to the point:

"The government itself appears to have accepted the assurances of the Dow chemical people and other herbicide manufacturers that the dioxin contaminant in 2,4,5-T, once laid down, is degraded and effectively destroyed by the action of sunlight and of soil bacteria. Yet if the contaminant is in fact so handily decomposed in this manner, one wonders how to account for the results of an analysis of samples taken in 1975 of the fatty tissues of cattle that grazed on western rangeland that had been sprayed with 2,4,5-T during the previous year, for the samples showed significant levels of dioxin - levels of up to sixty parts per trillion. How is it that from grazing land sprayed with this allegedly innocent herbicide the government permits the distribution to the American dinner table of meat that has been contaminated with measurable amounts of one of the most toxic substances known to man? It is not as though the government were unaware of such findings, or of their significance, for the very studies that produced these findings were conducted under the auspices of the E.P.A. And a memorandum dated August [illegible], 1975, gives these observations of the dioxin-study program coordinator in the E.P.A. Office of Pesticide Programs concerning the significance of the findings: 'Studies including teratogenic and other toxicity effects indicate that the residue levels mentioned above may present a health hazard to man based on the application of normal margins of safety.'

"Almost incredibly, the E.P.A. people still cannot make up their minds. The issue is completely stalled, and action on it is blocked. In the meantime, Dr. Patrick O'Keefe and Dr. Matthew Meselson at Harvard have obtained several samples of mothers' milk from Texas and Oregon, and subjected them to analysis for possible dioxin content. The preliminary results of this latest study indicate the presence of dioxin in parts-per-trillion amounts in some of these samples. The potential significance of these findings concerning a substance with a demonstrable capacity for inflicting relentlessly cumulative damage can be indicated by the fact that a nursing infant consumes about one-tenth of its entire body weight in maternal milk <u>each day</u>. All in all, if one considers what is already known about the nature of dioxin, the indications from such studies that this almost incomparably toxic substance not only has entered the human food chain but may have invaded the maternal milk supply is surely a cause for swift and drastic action by our government,"

7. The "favorable effects of herbicide use" listed on page 74 of the EIS would also occur if the release were done manually. It is false to imply that manual vegetation control would result in a "reduction of usable resources and future availability.". The same degree of release can be achieved by either method.

8. The assertion that "aerial application of herbicides is less energy demanding than manual release (EIS page 76) fails to take into consider tion the fact that the herbicide itself is a petroleum product,. and that a great deal of energy goes into its production.

Forest Service Response to Comments
by Coalition For Economic Alternatives

#1 Proof of safety of a properly registered herbicide is not the responsibility of the user. Under FIFRA as amended in 1972, EPA has the responsibility to determine whether a herbicide, when used consistent with its labeled directions, will perform its intended function without unreasonable adverse effects on the environment, human beings, livestock, or wildlife. The Forest Service cooperates with the EPA to provide data when needed.

#2 There have been no reported health problems, however, it is also true there have been no research studies for this purpose.

#3 The amount of 2,4,5-T used is grossly overstated and it is only an assumption that it was "extremely dirty."

Defenders
OF WILDLIFE

November 25, 1977

Mr. Steve Yurich, Regional Forester
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Mr. Yurich,

The following are comments from Defenders of Wildlife, a national, non-profit, conservation organization upon the Draft Environmental Statement "The Use of Herbicides in the Eastern Region." Eastern Region Forest Service, U.S. Dept. of Agriculture FS - R9 - DES - ADM - 77 - 10. We request that this letter be included in the hearing record.

In preparing this response, we have consulted with Frank E. Egler, Ph.D., eminent vegetationist, Aton Forest, Norfolk, Connecticut.

Our overall reaction is that this Environmental Statement is mis-titled. It should read "The Aerial Use of Herbicides, etc." Although "selective" application is mentioned, it is suggested only for small tracts exposed to public view. It is our belief that the primary failing of this EIS is that it does not give proportionate attention to all the possible alternatives for long-time, economically-sound forest management. Why is there a total absence of experience and information gained from Forest Service Experiment Stations for this territory, although industry research is well-represented? We refer specifically to Eastern Region policy publications which do not recommend aerial spraying. The method is certainly not recommended by the scientific community. According to Dr. Egler, "I know of not one single research publication that adequately reports upon past such aerial spraying (although the chemicals have been in use for over three decades), with long-term results and logical predictions within the scope of full vegetation potentialities, that would justify these 'management procedures.'"

The Description of Herbicides proposed for use on pages 30-34, along with the methods of application, 34-37 only serves to underline the potential dangers in use by anyone less than a scientist.

The section on Environmental Impacts of the Proposed Action, 37-74, has been written entirely defensively, considering that detailed research has been done in this field. Hazards and accidents do occur as an irreconcilable element of our technological age. In the field of herbicides, flight operators and manufacturers are subject to their own accidents and hazards which should not be confused with those of the National Forests, themselves.

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Pages 63-65, "Environmental Impacts....on General Vegetation" is totally inadequate, with writing that is often misleading. There is no mention, for example, of herbicide effects on herbicide-sensitive legumes, important in grazing. Here, as in the next "Favorable Effects," the reader is never informed about the many disadvantages of chemical control. The idea is promulgated that herbicides help wildlife and diversify vegetation. "Completely to the contrary, aerial spraying of Eastern forests is done mainly to convert to pure conifers -- notoriously a 'desert' for wildlife, comparable to the pure climax (sic) hemlock forests of the wilderness, that lumbermen never tire of denouncing." (Dr. Egler)

In Summary of Probable Adverse Effects Which Cannot Be Avoided, 71-79, we come to a memorable understatement: "some non-target plants may be adversely affected." There has been no research on the non-target species and this is quite unacceptable.

As to Consultation With Others, 83, the reference to the Council on Environmental Quality is flagrantly misleading. Dr. Egler tells us "In 1974 the Forest Service Northern Region sent out a release titled 'Projects Using Certain Herbicides OK'd by CEQ.' The CEQ informed me that '<u>under no condition has CEQ ever approved herbicides or projects</u>' (underlining theirs)".

Controls on Herbicide Use, 96-104, makes the reader wonder if so many controls are necessary, how can any spraying be done? When asked about the effort to provide an unsprayed buffer zone of at least 100 feet from private property, Dr. Egler responded, "I should think this regulation would lead to endless lawsuits. I have known volatility from ground-sprayed brush to carry half as far, and spray from an up-held knapsack sprayer nozzle to go farther, while the operator lit a cigarette. Helicopter spraying is somewhat less precise. An unexpected updraft could move the spray for thousands of feet."

We would like to conclude our statement with a significant admonition from one of the country's leading experts on the use and effects of herbicides. Says Dr. Egler, "Aerial spraying is a soothing, short-term Band-Aid technology, easily and cheaply applied, understandably promoted by economic interests, unsubstantiated by scientific research and contrary to present legislation that governs the usage and management of our federal National Forests for multiple uses, including but not limited to wildlife, recreational, scenic and wilderness values."

(#1) Thank you for the opportunity to comment on your proposal. We look forward to seeing major revisions in it, based on reactions from the public.

Sincerely,

Cherie Mason

Cherie Mason
Field Representative
Great Lakes States

Forest Service Response to Comments
by Defenders of Wildlife

#1 Based on comments received from reviewers of the Draft EIS, substantial modifications were made to the following sections:

I. E. Description of Herbicides.

II. B.2. Human Health.

II. D. Herbicide Toxicity.

Environmental
Defense
Fund

1525 18th Street, NW, Washington, D.C. 20036 • 202/833-1484

December 23, 1977

Steve Yurich
633 West Wiscon sin Avenue
Milwaukee, Wisconsin, 53203

Dear Mr. Yurich,

It has recently been brought to my attention that there is a misstatement of fact in my comments on the Environmental Impact Statement which we sent to you on November 18, 1977. Somehow, footnote 1 on page 12 was added to the text without my knowledge. I would like to delete this sentence. If it is possible, would you please make the correction ?

Thank you very much for your cooperation.

Yours truly,

Stephanie G. Harris

Stephanie G. Harris
Research Associate

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Environmental
Defense
Fund

1525 18th Street, NW, Washington, D.C. 20036 • 202/833-1484

November 16, 1977

Steve Yurich
Regional Forester
633 West Wisconsin Ave.
Milwaukee, Wisconsin 53203

Dear Mr. Yurich:

Please find enclosed the EDF comments on the environmental impact statement for the use of herbicides in the eastern region.

Yours truly,

Stephanie Harris

Stephanie Harris
Research Associate

SH/jkr
Enc.

Comments of the Environmental Defense Fund
On the Environmental Impact Statement
(USDA-FS-R9-DES-ADM-77-10)
For the Use of Herbicides in the Eastern Region

Introduction

This environmental impact statement (EIS) suffers from severe deficiencies in its treatment of the impact of herbicide use on human health. The same techniques are used in this argument as were employed in the EIS for herbicidal use in the western region (upon which we commented on July 8, 1977): namely, improper deemphasis of the possibility of human exposure to tetra-chloro-dibenzo-dioxin (TCDD), the toxic contaminant of the herbicide 2,4,5-T. Each EIS cites inadequate studies which not surprisingly failed to find TCDD in the food chain or the environment either because it was not being looked for (i.e., the presence of only 2,4,5-T was under question), or because of the use of insensitive analytical techniques which could not detect levels of TCDD at small yet toxicologically highly significant levels. The Forest Service completely ignores the recent findings of Dr. Matthew Meselson of Harvard University that TCDD was identified in human breast milk donated by women who lived in areas which had been sprayed with 2,4,5-T. This proof of human exposure contradicts the Forest Service's assertions of improbability of finding TCDD in the environment, and thus of human exposure.

We would like to focus our comments first on the significance of TCDD in human breast milk, and then deal with specific statements in the EIS which we believe to be either false, misleading, or contradictory. The following comments on human health effects are excerpted from the July 8, 1977 EDF comments referenced above, which are equally pertinent here.

Human Health Effects

In the course of the trial in Citizens Against Toxic Sprays, Inc. (CATS), et al. v. Bergland (Civil No. 76-438 (D. Oregon, Mar. 7, 1977), it was publicly revealed that 2,3,7,8-tetrachlorodibenzodioxin (TCDD), a contaminant of 2,4,5-T, Silvex, and other phenoxyacid herbicides, had been found in human breast milk in areas of the United States which had previously received treatment with these herbicides. The laboratory of Dr. Matthew Meselson at Harvard University had identified TCDD in the fat portion of human breast milk ranging from 10 to 40 parts per trillion. While the Forest Service questions the validity of the data, Dr. Patrick O'Keefe in the Meselson laboratory maintains that there is unequivocal qualitative evidence of the presence of TCDD in breast milk, even if the quantitation is still difficult at lower levels.

The conclusions which can be drawn from the analytical data are clear: 1) there has been human exposure from the use of 2,4,5-T in the past; and 2) there is a very significant risk to the health of nursing infants ingesting TCDD. The EIS states on page 40:

> Although some organisms can concentrate TCDD, the probability of receiving and accumulating a toxic dose is rare because, as previously quoted CAST reports indicate, "... there is no substantial supply of the chemical in the environment subject to accumulation."

If indeed this statement is correct, it becomes very difficult to explain how the TCDD entered the human milk. While the EIS states that 2,4,5-T residues would not be expected to accumulate on vegetation, in wildlife, or in water, it does not deal adequately with the environmental fate of TCDD. Dr. Patrick O'Keefe stated in his testimony (in <u>CATS, Inc. v. Bergland</u>) that "TCDD has been found in a number of environmental samples and the potential for the entry of higher levels of TCDD into the food chain exists as a consequence of forest burning operations." (p. 10). The TCDD which contaminates the 2,4,5-T concentrates in the fat of animals and thereby bioaccumulates up the food chain. TCDD residues have been found in the fat of animals of prey (e.g., shrews, deer mice) as well as herbivores (e.g., beef cattle). Human beings, being omnivores, can ingest TCDD residues in beef and the meat of wild animals (e.g., deer, elk) as well as in forest vegetation (e.g., berries). Also, the TCDD contaminates water used for drinking purposes. Human beings can also be exposed to TCDD by the air drift of the herbicide during spray operations as well as the possibility of being directly sprayed due to a faulty warning system. Besides the TCDD which is released to the environment as a contaminant of the herbicide, there is also the potential for the formation of TCDD at 10,000 times the naturally occurring level due to burning of vegetation contaminated with 2,4,5-T, according to the testimony (in the <u>CATS</u> case) of Dr. George Streisinger of the University of Oregon. Obviously, there are many potential routes of exposure to TCDD so that it should come as no surprise that TCDD is being stored in human fat and then mobilized during lactation.

TCDD has been characterized by many scientists as the most toxic small molecule ever synthesized by man. A level which causes no physiological response in animals has yet to be determined -- even the smallest doses ever tested have caused some adverse reaction. Besides causing overt signs of poisoning (e.g., chloracne, loss of hair, growth inhibition, kidney and thyroid disorders, and atrophy of the thymus leading to immunosuppression) TCDD also causes birth defects and gene mutations.

Dr. Wilbur McNulty, Jr., of the Oregon Regional Primate Research Center, stated in his testimony (in the CATS case) that "the toxicity of TCDD for rhesus monkeys is roughly of the order of 1 microgram (ug) per kilogram (kg). The 'no-effect' level for acute or chronic ingestion is, of course, completely unknown but is bound to be considerably less than the lethal level." Dr. James Allen, of the University of Wisconsin, also found that rhesus monkeys receiving a dose of 1 ug/kg demonstrated over 50% mortality and 100% morbidity. Death was caused by severe blood loss due to a decrease first in red blood cells, then by a decrease in circulating white cells and platelets. Two out of 3 pregnant monkeys aborted, indicating severe fetotoxic effects. Even at a dose of approximately 0.1 ug/kg, minimal physiological effects (e.g., loss of hair, swelling of eyelids) were observed. (Allen, J., Fd. Cosmet. Toxicol., to be published).

The amount of TCDD being ingested by a nursing infant can be calculated by taking the maximum amount of TCDD found in the milk fat, multiplying by 4% to convert to a whole milk basis, and multiplying by 150g milk ingested by an infant per kg body weight per day. This equals 0.24×10^{-3} ug TCDD/kg body weight/day. If it is assumed that an infant nurses for 6 months, then the total accumulated dose would be 0.043 ug/kg. Comparing this to the data of McNulty and Allen we see that the nursing infant is receiving about one two hundredth of the amount which was shown to be lethal in monkeys or one twentieth the dose which caused minimal physiological effects in monkeys. A "safe" human dose is usually calculated by multiplying the dose which causes no physiological effect in the most sensitive species by a safety factor of at least 100 to account for differences in sensitivity to the chemical between test animals and man. In this case it is obvious that a safety factor of only about two and one half exists between the human dose and the dose which caused minimal physiological effects in the monkey. Because a no-effect level has not yet been determined due to the extreme toxicity of TCDD, a true "safe" level cannot be calculated for man.

Furthermore, Allen and coworkers found that almost one half (28 out of 60 animals) of Sprague-Dawley rats fed TCDD for 18 months in doses from 5 ppb to 1 ppt developed tumors at various sites compared to no tumors (0 out of 50 animals) in the controls (Allen, J., Chemosphere, to be published). Because a safe level of a carcinogen cannot be established, it is not possible to postulate a "safe" level of TCDD for man.

Therefore, it must be concluded that the nursing infant ingesting TCDD in breast milk is indeed at risk. Symptoms of TCDD's toxic effects on the infant might include: subcutaneous edema, swelling of eyelids, conjunctivitis, isolated acniform lesions, loss of weight, and early signs of anemia. Also, the risk of cancer in later life is increased because of ingestion of TCDD.

Specific Comments

1. On p. 43 of the EIS it is stated that the no-effect level for embryotoxicity of TCDD is 0.00003 mg/kg/day, while on
(#1) p. 44 the EIS says that animals would not reach the lowest LD_{50} (0.0006 mg/kg) if they ate all of the TCDD covering an acre. This does not mean, however, that the amount of TCDD ingested would still not be greater than the so-called no-effect level for embryotoxicity.

2. Regarding p. 44, the analysis for TCDD in a laboratory
(#1) test of decomposition of TCDD due to sunlight failed to measure the TCDD at low enough levels. Page 44 concludes that the TCDD has broken down entirely under simulated conditions of exposure to sunlight whereas the level of detection was as high as 0.5 ppm. With a chemical which is still toxic in the parts per trillion range, a measurement in the parts per million range is not only irrelevant and inconclusive but also misleading if any conclusions are drawn from this test as they are here.

3. In studying the biosynthesis of chlorodioxins by chloro-
(#1) phenol condensation in the soil, no TCDD was found, but the

Forest Service fails to state what the detection level of TCDD was (p. 44). If it was as insensitive to low residues as all of the other tests mentioned, then the conclusion that there is no biosynthesis of TCDD may well be erroneous.

(#1) 4. The measurement of TCDD in soil after heavy application of 2,4,5-T is discussed on p. 45 without stating what period of time had elapsed after the application of the herbicide and before the analysis for TCDD was carried out. Also, the detection level of TCDD was 1 ppb, which is still too high a level to predict whether or not the soil contains harmful amounts of TCDD.

(#1) 5. The statement of p. 45 that TCDD does not biomagnify is seemingly contradicted on p. 46 which states that TCDD has been found to bioaccumulate in algae, snails, and fish, and has been found in samples of animal and bird tissue taken from sprayed areas. (Certain of the animals sampled were predators, like shrews). It is not surprising that TCDD was not found in the bald eagle carcasses studied as the detection level was 0.05 ppm (the EPA found TCDD in the wildlife samples in the parts per trillion). Also, it is not stated how the eagles were chosed for the study and whether they were from areas which had received application of 2,4,5-T.

(#1) 6. Pages 47 and 48 seem to either be missing or the pages have been misnumbered.

(#1) 7. Page 49 points out that heating confined 2,4,5-T up to 400°C. for up to 43 hours would convert 0.13% of the 2,4,5-T to TCDD. This is a very important point of information as these temperatures can be reached by forest fires. In fact, vegetation which has been killed by 2,4,5-T would be likely to catch on fire either accidentally or on purpose in order to clear the area. Thus, generation of TCDD should be expected from such fires.

8. The Forest Service seems to assume that there is a
(#1) threshold level of TCDD when it says on p. 50: "At the present levels of 0.1 ppm dioxin in 2,4,5-T, there is virtually no way anyone would be exposed to enough TCDD to exceed the rate needed for measureable effect." It proceeds to compare the amount of TCDD needed for an acute toxic reaction to the amount of TCDD which is present in water; this fails to take into account the infinitesimally smaller amounts of TCDD which could cause adverse chronic reactions, such as carcinogenicity, mutagenicity, or teratogenicity.

9. The Forest Service concludes on p. 51 that TCDD is not
(#1) being found in the environment on the basis of the results of the Food and Drug Administration's (FDA) analysis for 2,4,5-T residues in food over a four-year period. Even if 2,4,5-T is not found in food, this does not preclude the possibility of finding TCDD, a much more persistent chemical and one which is more likely to be present. Furthermore, the FDA usually uses a multi-residue analytical method for phenoxyacid herbicides which is not very accurate and which they readily admit cannot give good quantitative data.

10. It is not enough to measure 2,4,5-T residues in food;
(#1) rather, TCDD should be measured as well. Thus, when the Forest

Service states that 2,4,5-T was not found in cow's milk (p. 57) this by no means indicates that harmful residues of TCDD were not present.

11. Page 60 presents a very important piece of information which is seemingly ignored in the conclusions of the EIS; namely, that chromosomal abnormalities were found in herbicide applicators. This should be included in the overall discussion of risks of the use of these herbicides as it indicates that there
(#2) is a mutagenic effect of these chemicals on persons of high exposure and thus a potential mutagenic effect on the general population in the sprayed areas. Furthermore, this raises the possibility of carcinogenicity of these compounds, particularly since Allen, et al. have found that TCDD is carcinogenic in rats (see p. 5). Because mutagenic chemicals are very frequently also carcinogenic, a severe threat to the local population could very well be posed by the widescale spraying of these hazardous chemicals.

12. The Forest Service presents a ludicrous argument on p. 60 trying to prove that there is no increase in cancer within
(#2) populations exposed to 2,4,5-T spraying. They argue that the National Cancer Institute's county-by-county cancer maps indicate, in the words of the Council on Environmental Quality: "a majority of the areas of high cancer mortality are located in large cities." The implication from this apparently exonerates 2,4,5-T from any guilt of causing a high cancer mortality rate because it is not used in large cities. This argument is fallacious on two grounds: 1) the statement says the majority

and not all of the cancer hot-spots are in large cities, hence an isolated instance of increased cancer incidence in forest areas sprayed with 2,4,5-T could still have occurred and this statement would not be contradicted; 2) the latency period for cancer is often as long as twenty or thirty years so that it is probably too early to begin looking for cancer increases due to 2,4,5-T exposure. Also, the Forest Service asserts that the decrease in stomach cancer rate should indicate that the pesticide residues on food are not causing any carcinogenic response in human populations. There is no reason to believe that if indeed these chemicals did cause human cancer that the site would be the stomach (e.g., the Allen rats developed tumors of various sites from the ingestion of TCDD).

13. Page 61 cites the findings of the FDA's Total Diet
(#2) Study which found few herbicide residues in the marketbasket survey of foods. As has been mentioned previously, the recovery of these chemicals is very poor; negative results of such analyses are highly suspect and prove little.

14. The Forest Service says on p. 62 that the toxicity of 2,4,5-T has not been the basis for legal rulings against the Forest Service in the National Environmental Policy Act (NEPA)
(#2) cases which have been brought. While technically true, this statement is misleading. Courts have never found it necessary to pass judgment on substantive issues because of procedural inadequacies in the environmental impact statements.

15. A ridiculous paragraph is included in p. 66 which should be eliminated. It reads:

> Controlled feeding trials and laboratory tests have shown some herbicides to be toxic, teraogenic, carcinogenic, or mutogenic (sic) to mammals. The same results can be produced with a variety of other
(#3) chemicals. LD_{50} rates have been established for most chemicals available to man. The dosage rates used in controlled experiments are not reached under conditions found within normal forestry herbicide application.

First of all, what difference does it make that other chemicals as well as herbicides have been found to cause acute and chronic toxic effects? This certainly does not mean that herbicides can be considered safe -- just because other chemicals are also unsafe. It is true that LD_{50} rates have been established for most chemicals, but this in no way means that these chemicals are safe.

Secondly, animals are fed high doses for three reasons: to compensate for the short life span of animals compared to humans; to compensate for the very fast metabolizing and excreting of chemicals by animals compared to humans; and to compensate for the relatively small number of test animals used compared to the number of human beings exposed to the chemical. High doses are essential to increase the percentage of animals getting cancer so that it will show in the small number of animals, usually 50, used in tests.

(#4) 16. Page 67 says that deer did not accumulate 2,4,5-T, but no mention is made of accumulation of TCDD.

17. The Forest Service admits on p. 74 that there would be
(#5) a favorable economic impact on local communities if manpower were used to clear the forests instead of using chemicals; however, they then imply that there would be a later decrease in

usable resources which would cause a long-term adverse effect on the community. There is no reason why there should be a decrease in usable resources if the forest were properly managed or why this decrease should occur only if chemical treatment is substituted for by manpower.

Conclusion

Despite ample evidence of the hazards posed by phenoxyacid herbicides in general and 2,4,5-T, Silvex, and other TCDD containing herbicides in particular, the Forest Service continues the unconscionable use of these chemicals over tremendous land areas and thus exposes large segments of the population to all of the deleterious effects of these chemicals. The argument that the decision of safety rests with the Environmental Protection Agency (EPA)[1/] and not with the Forest Service is false because in fact the NEPA requires the Forest Service to balance the benefits against the risks in the writing of the EIS. The only way that it can be concluded that the risks do not far outweigh benefits is to downplay the risks by incomplete citations from the large body of literature which now exists or by drawing misleading conclusions. In fact, the Forest Service has done both in this EIS.

The evidence of hazard of 2,4,5-T is clear: 1) 2,4,5-T cannot be produced without some contamination by TCDD; 2) TCDD persists in the environment and bioaccumulates; 3) TCDD is

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1/ In fact, EPA has issued a rebuttable presumption against any registration of 2,4,5-T!

present in human tissues (i.e. breast milk), hence there is positive evidence of exposure; 4) TCDD is one of the most toxic compounds ever synthesized by man and can cause a variety of adverse physiological reactions including birth defects and cancer. The continued registration of this compound by the EPA is appalling , but even worse is the continued use of the chemical by the Forest Service for large scale spraying operations.

The alternatives to the use of such hazardous chemicals are the use of manpower or machinery. While this might be more expensive in the short-term, there will be a positive economic benefit to the community as well as decreased government monies being spent on welfare and unemployment payments.

In sum, the Environmental Defense Fund opposes the use of the phenoxyacid herbicides by the Forest Service in the eastern region and believes that the EIS is incomplete and misleading, particularly in the section dealing with the impact on human health.

Sincerely,

Stephanie Harris

Stephanie Harris
Research Associate

Forest Service Response to Comments
by Environmental Defense Fund

#1 The entire section on TCDD was rewritten and incorporated in another section of the statement.

#2 The entire section on Human Health was rewritten so as to present more current information.

#3 The paragraph was modified to eliminate the reference to other chemicals.

#4 This particular research was searching for 2,4,5-T and not for TCDD.

#5 The use of manual labor would provide some favorable short-term economic benefit but the inefficiency of manual labor would result in adverse long-term effects due to a loss in the timber resource and resultant increase in prices.

FRIENDS OF THE EARTH

620 C STREET S.E. WASHINGTON, D.C. 20003

(202) 543-4313

DAVID BROWER, President

November 4, 1977

Mr. Steve Yurich
Regional Forester
633 West Wisconsin Avenue
Milwaukee, Wisconsin

Dear Mr. Yurich:

The following is our response to your request for comments on the draft environmental statement, "The Use of Herbicides in the Eastern Region". Our conclusions are supported by the attached reports and material.

Quality hardwood produces a better return per acre per year, contrary to the assertion of the draft statement.

(1) The draft statement basically outlines a program whereby hardwoods in the National Forests will be killed by aerial spray of herbicides in order to make it possible to grow "more profitable" softwoods. Timber spray projected will account for 29,465 acres out of a total of 43,695 treated by herbicides proposed for the entire Eastern system.

Yet, the draft statement offers no proof that softwoods are indeed more profitable than hardwoods. We think that the draft statement does not meet the requirements of the National Environmental Policy Act until this is done, since this is the underlying assumption of the entire program.

(#1)

Mohasco, Inc. of New Amsterdam, New York, a major and dominant producer of household furniture in the United States did a quick survey of their hardwoods needs and prices for the benefit of Friends of the Earth, Inc.

It is fair to say that they were quite surprised at the interest of the Forest Service in eliminating hardwoods from the National Forests, because hardwoods are their main furniture wood, and because hardwoods have been in relatively short supply in the past few years.

Contrary to the Draft Statement's Conclusions, Hardwoods Offer an Equal or Greater Yield Per Acre Per Year

Attached to this letter is a broadbrush breakdown of furniture hardwood needs by Mohasco, and impressions of price provided to us by Mr. Robert Cortelyou, Vice-President in charge of the furniture division.

The impact of the Forest Service upon the supply of hardwoods can be substantial. For example, Mohasco was rather taken aback by the recent decision of the Forest Service to discontinue "cruising" for downed hardwood in Appalachia. As a result of this decision, prices jumped on hardwood.

We also consulted with a commercial timber tract operator and timber consultant from southern Maryland. Both were of the opinion that quality hardwoods brought a greater or at least equal return per acre per year than softwoods. Of particular importance was walnut.

Friends of the Earth would suggest that the government should be in the business of producing quality hardwoods on the eastern forests, rather than softwoods. This incidently makes a better recreational use possible for the National Forests.

This would make the use of herbicides applied by airplane completely undesirable.

Unlawful uses of herbicides proposed:

(2) The draft statement does not validly meet the requirements of the National Environmental Policy act for a second reason. The proposed uses of herbicides by the statement proposes uses that are contrary to the label and therefore, unlawful uses.

a. You are proposing the use of 2,4,5-T and Silvex on land that is required by law to be multi-dimensional in use, including recreational uses.

Yet, 2,4,5-T is banned for recreational, aquatic, or home uses for good reason related to dioxin content.

(#2) It is a matter of fact that every square inch of National Forest land is used for recreation such as hunting, and this fact is not at all diminished by the separation of the National Forests into general use zones. The dioxin in 2,4,5-T and Silvex is picked up by wild animals and this chemical is passed on to the consumer who eats the animals (or fish). Use of 2,4-5-T under the circumstances would be contrary to the label and unlawful.

b. You have not limited the use of 2,4-D to non-volatile types. It is also quite clear that it is impossible to use volatile (low or high) 2,4-D without violating the label instruction against drift. No user can prevent this chemical from evaporating and drifting many miles to other properties.

As a result of contamination of more than 4,000 square miles with 2,4-D with air concentrations of 5 to 10 parts per billion, grape growers have lost 20 to 50 percent of the 1977 crop and growers of broadleaf crops have lost yield. The State of Washington has banned the use of high volatile 2,4-D and restricted the use of low volatile 2,4-D.

Friends of the Earth has requested the Environmental Protection Agency to remove volatile 2,4-D from the market since it is impossible to use lawfully in compliance with the label restriction against drift. (See attached letter.)

c. The plans of the Forest Service to use 2,4,5-T in wildlife areas is irresponsible, and again a violation of the label.

Statement not correct about herbicides never found in food. **(#2)**

(3) The draft statement pointedly notes that no herbicide material has ever been found in food. This is incorrect.

Measurements of mother's milk in Texas and Oregon have shown up to 40 parts per trillion in milk fat of dioxin. This is an extremely serious matter, since such dioxin levels can cause severe damage to children.

The Forest Service has been partly responsible for getting these mothers into such deep health problems.

(#2)

(4) The draft statement does not describe how spray drift from the herbicide program is going to be kept from private property surrounding the National Forests. The Forest Service in the eastern region has been responsible for a very serious violation of label requirements, recently written up in Organic Gardening. We are enclosing a copy of that article.

In summary, the draft statement fails to meet the requirements of the National Environmental Policy Act, and proposes the unlawful use of herbicides. We hope that you will rethink your program.

With best regards,

Erik Jansson

Erik Jansson
Research Associate

c. Secretary Robert Bergland
c. Rupert Cutler
c. Dave Ketchem
c. Tom Barlow, Natural Resources Defense Council
c. Maureen Hinkle, Environmental Defense Fund
c. Jeffrey Knight, F.O.E.
c. Rita Molyneaux, National Parks and Conservation Assoc.
c. Linda Billings, Sierra Club

c. Enforcement, E.P.A.
c. Edwin Johnson, Dep. Ass. Admin. Pesticides Programs
c. Council for Environmental Quality

FRIENDS OF THE EARTH

620 C STREET, S.E., WASHINGTON, D. C. 20003

(202) 543-4313

DAVID BROWER, *President*

INVENTORY OF HARDWOOD REQUIREMENTS BY MOHASCO, INC.
for FRIENDS OF THE EARTH, INC.

Source: Mr. Robert Cortelyou
Vice-President in charge of the Furniture Division
Mohasco, Inc.
Amsterdam, New York 12010

Oak: Prices for oak were up 30 percent last year, but we can get a supply of it. In the South, supplies are tight but available. The price trend has flattened this year.

Elm: Supplies tight but quantities available.

Sapgum or Tuplo: Quantities are available.

Walnut: We are always looking for walnut, and this is an ideal tree for the private grower to make money with. Prices are stable now in Appalachia with normal inflationary increases.

Ash: A little sticky in supply this year. The price is presently $100/1000 board feet premium over oak.

Maple: The Japanese practically bought the entire supply in the past years to build bowling alleys.

Popular: Good supply with normal pricing.

Forest Service response to comments
by "Friends of the Earth"

#1 Data was misinterpreted. Although 29,465 acres are estimated for Timber Management activities, only 7,000 - 9,000 acres are estimated for aerial spraying. (TABLE 1). In addition, nowhere does the DEIS state that the Forest Service is interested in eliminating hardwoods from the National Forests. In fact, walnut plantings are treated with herbicides to reduce grass competition thus promoting better growth.

#2 These statements are all subject to individual interpretation. We feel we have met the requirements of NEPA.

November 29, 1977

Mr. Steve Yurich, Regional Forester
United States Forest Service
633 W. Wisconsin Avenue
Milwaukee, Wisconsin 53203

Re: Draft Environmental Statement on the Use of Herbicides - Eastern Region

Dear Mr. Yurich:

By date of November 18, 1977, Kathy Barton of our National Staff responded to the above notification of intent, circulated to me, and I imagine others in the Izaak Walton League.

I would urge that the Regional Office very closely review and attempt to meet the spirit and content of Kathy Barton's review.

The issues she raises are, I believe, very germaine to the document that was circulated and to the issu with which we're involved. To continue on the basis of intent that one perceives in reviewing the document will only further muddy the issue and embroil the region in difficulty.

Aside from the comments that Kathy has made, I'd like to provide added emphasis if possible, for the need to consider alternatives. All of the agencies when asked to consider alternatives (human labor in releasing, et cetera) have indicated that even with today's increased cost of chemicals, that this is still too expensive an alternative. I would suggest that it is my basic feeling that these arguments are flayed by the very fact that they consider only the "known" costs and do not consider the cost to the USFS of the defense around the Nation of the Herbicide Applications and other non-measured costs. It may well be that the Forest Service could convince the Administration or the Congress that a larger operating budget today may very well be justified in some areas of the Region from an overall point of view.

I do hope that the Regional Office will review Miss Barton's statement and that at least some of the imput will be reflected in the Final Statement.

Sincerely,

David F. Zentner, Member IWLA Executive Board

THE IZAAK WALTON LEAGUE OF AMERICA
INCORPORATED

November 18, 1977

Steve Yurich, Regional Forester
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

RE: Draft Environmental Statement on the Use of Herbicides in the Eastern Region

Dear Mr. Yurich:

We have reviewed the Draft Environmental Statement on Herbicide Use in the Eastern Region of the U.S. Forest Service and find it to be too general to properly inform the public about USFS policies on and plans for herbicide use in the eastern region. The intended use of individual herbicides and implications of such use are discussed only in general terms. Although the Service plans to prepare individual environmental analyses on some specific herbicide application projects, the League believes that a more comprehensive initial description of herbicide use for the entire region is necessary to provide an overview of total planned use.

This DEIS is inadequate in several respects. The major omissions we have noted are:

(1) the DEIS does not set forth a clear policy statement or set of policy guidelines on herbicide use;

(2) it does not provide sufficient specific and comprehensive information on the total herbicide program in the eastern region;

(3) it is not clear in what instances the public will have the opportunity to review proposals for specific herbicide applications;

(4) it does not describe research activities or suggest a program for initiating or continuing research; and

(5) it does not adequately discuss alternatives to herbicide use and completely fails to suggest alternatives to phenoxy herbicides.

In addition:

(6) the League opposes the proposed use of phenoxy herbicides.

(1) Policy Guidelines. This impact statement should, as should any programmatic statement, begin with a clear, specific statement of policy. The control guidelines in Appendix A provide only a partial statement of policy. They are often too general and ambiguous to provide specific guidance in making difficult policy decisions.

For example, the first paragraph under number 5, "Social/Economic Controls," states:

> When pesticides are required, those methods of application and formulations that will most effectively suppress the pest, are the most specific to target organisms, and have the least potential hazard to all non-target components of the environment will be recommended. (p. 99)

Clearly there are cases where no one chemical will meet all three of these
(#1) criteria, but no policy is set that indicates where the trade-off between the method "that will most effectively suppress the pest" and "have the least potential hazard" should or will be made. In such cases, this "guideline," in fact, provides no guidance. Moreover, there are no clear guidelines to determine when a pesticide will be required in the first place.

The policy guidelines should provide answers to such questions as: Under what circumstances will herbicides absolutely not be used? Will primary consideration be given to pest control or environmental effects? What alternatives will be considered before a decision is made to use herbicides? When will the public be notified of a particular planned herbicide action?

The National Park Service prepared an environmental assessment on "Pest Control in the National Park System, " in May 1977, which is a programmatic statement similar in scope to this USFS herbicide DEIS. Its policy statements and guidelines on pages 1 - 4 and in Appendix A could serve as a partial model for this Forest Service statement.

(2) Specific and Comprehensive Information. The DEIS does not discuss many aspects of herbicide use in specific terms and examples, making it
(#2) difficult for the public to evaluate these uses. Vital information missing from this statement includes: Which herbicide is to be used on what target? How much will be applied in what areas for what purpose? In what situation are particular alternatives possible? How does the future program compare with past practices? How often are applications necessary for different situations?

Much of this information could be easily included in graphs or charts. A chart listing, for 1976, a particular herbicide, where it was applied, how many times it was applied there in one year, what its target was, what the vegetation management objective was, how large an area was treated, and how much was applied would help give a good overall description of the type and extent of herbicide use in this region. Such information would particularly help the public to determine how necessary or appropriate each use was. A short dixcussion of any major anticipated changes for the future should follow such a chart, or be included elsewhere in the report. Again, the NPS Pest Control Assessment (Appencix C) could serve as a model for organizing this information.

(3) Advance Public Notification. Inclusion of more specific information in the DEIS would not substitute for the preparation of individual environmental analyses on specific actions. Notifying the public of specific planned uses provides the public the best opportunity to examine and evaluate the necessity, goals, and possible effects of such uses.

(#3) This DEIS does not, however, indicate in what instances the public will receive advance notification of an herbicide application. Appendix A control guidelines state only that the public will be notified "when required" or in "the use of controversial herbicides or controversial methods of application." The final EIS should list the exact circumstances under which the public will receive advance notification of herbicide application.

We suggest that, at a minimum, the USFS should notify the public and solicit comments on any proposal that falls into the categories listed on page 98 of the DEIS--those proposals that must be reviewed by the field Pesticide-Use Coordinating Committee before being approved by the Regional Forester. These are:

(1) Use of a pesticide (for a particular purpose or use in a particular way) not labeled under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

(2) Any application to water, or any application whereby the pesticide could reasonably be expected to get into water.

(3) Any use of a pesticide that can reasonably be expected to affect threatened or endangered species.

(4) Any program or project in which 640 or more contiguous acres would be treated as one application.

The public should also be notified in advance of any proposal to use a phenoxy herbicide.

(#4) (4) Research. Several kinds of research are necessary to improve the herbicide program: monitoring of effectiveness and environmental effects of herbicide use; development of more specific and/or less harmful herbicides; experimentation with methods of control other than herbicidal; and in some cases examination of the source of imbalance in the system which necessitates control measures and research to determine how to restore that natural balance so that control is no longer necessary.

It would be helpful if the statement included a brief summary of the kinds of research that are being conducted. In addition, it should designate areas in which alternatives to traditional methods will be tested.

(5) Alternatives to Phenoxy Herbicides. Although this DEIS spends many pages discussing phenoxy herbicides, it completely fails to mention what less controversial and better-researched herbicides could be used as substitutes. Nor does it specify for what exact purposes these herbicides
(#5) are to be used. The discussion of TCDD is clearly a justification for its use rather than an examination of its effects and possible alternatives.

The final EIS should discuss: (1) the specific purposes for which these chemicals are to be used; (2) the available alternatives, chemical and other; and (3) the advantages and disadvantages of using these alternative herbicides compared to the phenoxy herbicides.

(6) Use of Phenoxy Herbicides. The Izaak Walton League at this time opposes the use of the phenoxy herbicides. We disagree with the approach and substance of the Forest Service's statement that "the present data support the contention that there is no reason to believe the proper use
(#6) of 2,4,5-T...is exerting any toxic effect on the environment or any hazard to human reproduction." (p.51) We believe the present data do indicate that 2,4,5-T has a toxic effect on the environment, particularly through bio-accumulation, and may pose a hazard to human reproduction and health.

Statements in the DEIS itself indicate that research has not yet shown these herbicides to be safe; important research into the actual hazards of TCDD are ongoing. For example:

> The EPA is conducting sensitive chemical testing to determine whether TCDD is getting into human foods or can be found in humans. (p.45)
>
> EPA will review these data [TCDD levels in beef fat and liver] and extrapolate the levels found to various toxic effects observed in various animal feeding studies. (p.46)

Further, the DEIS admits that TCDD can bio-accumulate in algae, snails, and fish (p.46), but attempts to negate this fact by stating that "a literature review reveals that accumulation in food-chain organisms has not been observed to a significant degree in nature." It should be obvious that research in this area is not far enough advanced that a literature review can be considered reliable and conclusive evidence.

During the period when EPA is researching these chemicals to determine if they are safe, we should proceed with the assumption that they are not safe. Ignorance is not an acceptable justification for using potentially hazardous chemicals. To continue using these herbicides under the assumption that the future will show they have no effect could have tragic consequences if the future shows this assumption to be wrong.

The proposal to continue use of phenoxy herbicides, and the other inadequacies of this DEIS seem contrary to the change in USDA attitude toward chemical uses expressed in Secretary Bergland's remarks to the National Agricultural Chemicals Association last September. The Secretary lamented the practice of using poorly tested chemicals and indicated the need for change, saying, When they began being used heavily, we did not give enough thought to the eventual consequences to the environment and to people. Their side effects and their long-term impact were often unknown or ignored.

But over the years we have learned that there are dangers. Sometimes our learning has been painful.

Now we must adjust.

The producers and users of chemicals must adjust, and the Department of Agriculture must adjust.

One such necessary adjustment on the part of the USDA is a decision not to use the potentially harmful phenoxy herbicides.

The Secretary also quoted the draft statement on integrated pest control which states that the USDA will "give special emphasis to the development and use of alternative tactics in integrated pest management systems." Vegetation management should receive the same consideration, but unfortunately in this DEIS little attention is given to the use of alternative tactics.

In summary, the Izaak Walton League urges the US Forest Service to prepare an addendum to the DEIS, or rewrite the DEIS, to include the types of information we have suggested here. Most important, this DEIS, which serves as the base for the future USFS vegetation management program in the eastern region, should clearly establish USFS policy on herbicide use--a policy that should reflect the more environmentally concerned approach recently advocated by Secretary Bergland.

Thank you for the opportunity to review this statement.

Sincerely,

Kathy Barton

Kathy Barton
Environmental Assistant

Forest Service Response to Comments
by The Izaak Walton League of America

#1 The Forest Service policy on pesticide-use management is well documented in directives issued by the Washington Office.

#2 This type of information will be included in the site specific EAR's prepared for each proposed use of herbicide.

#3 Public notification and involvement is part of the EAR process and will be accomplished on an individual project basis.

#4 This aspect is beyond the scope of this statement.

#5 The discussion of herbicides was modified in the Final Statement. Site specific EAR's will discuss the various alternatives available for vegetation management.

#6 The phenoxy herbicides are currently registered for forestry use by the EPA and as such, should remain available as an alternative.

Minnesota Herbicide Coalition

— For Integrated Brush-Control Management

MEMBER ORGANIZATIONS

Minnesota Environmental Control Citizens Association
Don Covill Skinner, President

Clear Air-Clean Water, Unlimited
Rodney Loper, President

Virginia Sportsman's Club
Ervin G. Denzler

Minnesota Conservation Federation
Milton Pelletier

Friends of the Earth, Minnesota Chapter
Dana Mcdill

United Northern Sportsmen
Duluth, MN

Northern Environmental Council
Barbara Clark

Wildlife and Pesticide Task Force
Harriet Lykken

Marion Vertnik,
for the people of Britt, MN

Harmon Seaver Defense Fund
for the people of Cook County, MN

Mt. Iron Sportsman's Club

November 26, 1977

Mr. Steve Yurich
Regional Forester
Forest Service USDA
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Comments of the Minnesota Herbicide Coalition on the draft environmental statement, "The Use of Herbicides in the Eastern Region", USDA - FS - R9 - DES - ADM - 77 - 10 September 19, 1977

In reviewing the adequacy of the draft environmental statement (DES) I have referred to the Rules and Regulations for Preparation of Environmental Impact Statements issued by the President's Council on Environmental Quality contained in Volume 38, No. 147 (Wednesday, August 1, 1973) of the Federal Register (40 C.F.R. Section 1500). Specifically Section 1500.2 (b) (3) states that:

"In particular, agencies should use the environmental impact statement process to explore alternative <u>actions that will avoid or minimize adverse impacts</u> and to evaluate both the long- and short-range implications of proposed actions to man, his physical and social surroundings, and to nature". "...to restore environmental quality <u>as well as to avoid or minimize undesirable consequences for the environment</u>".

We feel that the use of herbicides in the Chippewa and Superior National Forests of Minnesota presents an unacceptable risk to human health, that it endangers our wildlife and the quality of our environment.

Twin Cities Coordinator:

Donna M. Waters
110506 Windmill Court
Chaska, MN 55318

Phone: (612) 646-0559
or 448-4514

Comments on specific herbicides:
(I) 2,4,5-T, 2,4,5-TP (Silvex) and TCDD

The draft ES states on page 77, in the "Summary of Probable Adverse Environmental Effects Which Cannot Be Avoided", that: "The hazardous substance - 2,3,7,8 - tetrachloro dibenzo - p - dioxin (TCDD) is present in 2,4,5-T and silvex. Pure TCDD is reportly the most toxic synthetic chemical known. In laboratory tests, both TCDD and 2,4,5-T have demonstrated the biological potential for producing teratogenic and mutagenic effects and an increased tumor incidence. Risk to humans, while apparent, is not real, due to the minute volume of TCDD applied per acre and the near absence of human exposure to most treatment areas."

(#1) This last statement that the risk to humans, while apparent, is not real...is clearly false. In the course of a trial, (Citizens Against Toxic Sprays, Inc. (CATS), et al. v. Bergland, Civil No. 76-438 (D. Oregon, Mar. 7, 1977), it was publicly revealed that 2,3,7,8-tetrachlorodibenzo-p-dioxin, (TCDD), a contaminant of 2,4,5-T and Silvex, had been found in human breast milk in areas of the United States which had previously received treatment with these herbicides. The laboratory of Dr. Matthew Meselson at Harvard University had identified TCDD in the fat portion of human breast milk ranging from 10 to 40 parts per trillion.

Dr. Patrick O'Keefe stated in his testimony (in CATS, Inc., v. Bergland) that "TCDD has been found in a number of environmental samples and the potential for the entry of higher levels of TCDD intothe food chain exists, as a consequence of forest burning operations." (p. 10). The TCDD which contaminates the 2,4,5-T concentrates in the fat of animals and thereby bioaccumulates up the food chain. TCDD residues have been found in the fat of animals of prey (e.g. shrews, deer mice) as well as herbivores (e.g. beef cattle). Human beings, being omnivores, can ingest TCDD residues in beef and the meat of wild animals (e.g. deer) as well as in forest vegetation (e.g. berries, mushrooms, herbs). Also, the TCDD contaminates water used for drinking purposes. Human beings can also be exposed to TCDD by the air drift of the herbicide during spray operations as well as the possibility of being directly sprayed due to a faulty warning system. Besides the TCDD which is released to the environment as a contaminant of the herbicide, there is also the potential for the formation of TCDD at 10,000 times the naturally occurring level due to burning of vegetation contaminated with 2,4,5-T, according to the testimony (in CATS case) of Dr. George Streisinger of the University of Oregon. Obviously, there are many potential routes of exposure that TCDD so that it should come as no surprise that TCDD is being stored in human fat and then mobilized during lactation.

The conclusions which can be drawn from the analytic data are clear: 1) there has been human exposure from the use of 2,4,5-T in the past; 2) there is a very significant risk to the health of nursing infants ingesting TCDD.

(2) 2,4-D

(#2) In the discussion of the effects of 2,4-D on man and his environment the Forest Service has failed to mention studies that have indicated biological concentration of 2,4-D in aquatic organisms. Ecological Effects of Pesticides on Non-Target Species, a publication of the Executive Office of the President's Office of Science and Technology, June 1971, authored by David Pimental cited two such studies: "Esters of 2,4-D accumulated in sunfish after exposure to sublethal concentrations in both laboratory and field tests (Cope, 1965b), and the fish sampled from a reservoir with 1 ppb showed an uptake of 2,4-D to a maximum of 150 ppb (Smith and Isom, 1967)."

Senator Edward Kennedy's Staff Report on The Environmental Protection Agency and the Regulation of Pesticides, December 1976, p. 15, cites a study performed by the FDA (Food and Drug Administration) in 1963 and 1964. This study; "Pathological Changes in Rats Fed 2,4-Dichlorophenoxy Acetic Acid for Two Years", was reviewed by an independent pathologist who concluded that 2,4-D "is carcinogenic (cancer-causing) in rats."

In view of the studies (cited above) (indicating bioaccumulation and carcinogenicity) and because of the findings of 2,4-D in water, soil, and animal samples taken from the Chippewa and Superior National Forest in Minnesota during the 1977 Herbicide Spray Programs, (Monitoring Report, FY 1977 Aerial Herbicide Project, Chippewa National Forest and Water Quality Monitoring of the 1977 Aerial Herbicide Program, Superior National Forest), we feel that the continued use of 2,4-D presents an unreasonable risk to the populations of Minnesota living in or near our national forests, endangers our wildlife and degradates the quality of our forest environment. We therefore recommend that the use of 2,4-D for conifer release be discontinued.

Alternatives to Herbicides

Manual release and the use of mechanical devices are feasible alternatives to the use of herbicides for conifer release. Both of these alternatives or a combination of the two would serve to create more jobs. These alternatives would minimize undersirable adverse impacts and fullfill (#3) the guidelines of the CEQ "to restore environmental quality as well as to avoid or minimize undesirable consequences for the environment". We feel certian that there are adequate numbers of unemployeed people in northeastern Minnesota willing to work at physically demanding jobs such as manual conifer release and that this would help the local economy. We are also willing to work with the Forest Service to further this alternative.

Currently, in Wisconsin, 300 acres in the Chequamegon National Forest are being released by manual methods on an experimental basis to determine cost-effectiveness. The cost is running $25 - $34. an acre depending on the terrain.

Conclusion

The Minnesota Herbicide Coalition feels that the use of herbicides in the eastern region is ill-conceived and that this practice presents an unreasonable risk to human health, while endangering our wildlife and the environmental quality of northern Minnesota. We feel that manual release and mechanical devices offer a feasible alternative to the use of herbicides while benefiting the local economy.

Donna M. Waters

Donna M. Waters
Coordinator,
Minnesota Herbicide Coalition

Forest Service Response to Comments
by Minnesota Herbicide Coalition

#1 Federal regulation agencies have the data from this and similar studies and have not taken any regulatory action on it. It would be inappropriate for us to further restrict the use of 2,4,5-T on the basis of the quoted study because of the uncertainty which surrounds it.

Studies are currently under way by EPA to look for TCDD in human milk. We will carefully watch for the resolution of these issues.

#2 The Environmental Protection Agency is constantly evaluating test data pertaining to pesticides and has the responsibility for determining if any unreasonable adverse effects from their use will occur. It would be inappropriate for the Forest Service to remove that responsibility from EPA.

#3 The Forest Service does consider manual release and there are many instances in which manual release is selected.

Although there may be many unemployed people capable of doing manual release, past experiences in trying to obtain this help has proved unrewarding.

The Wilderness Society 1901 Pennsylvania Ave., N.W., Washington, D. C. 20006 (202) 293-2732

November 18, 1977

Mr. Steve Yurich, Regional Forester
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Mr. Yurich:

Man-made herbicides are deliberately introduced into the environment as a killing agent to perform various beneficial functions. The use of these herbicides for vegetation manipulation in National Forest activities is of deep concern to members of the Wilderness Society. For your consideration, we submit our thoughts pertaining to the use of herbicides in the Eastern Region of the Forest Service, USDA, as proposed in the Draft Environmental Statement.

Public objection to herbicide use persists in being an issue due to emerging data that supports the citizens' fears that the widespread use of highly toxic chemicals causes serious problems for man and his environment. When a citizen reads sentences such as the following found on pages 43 and 44 of the DEIS, he is wary of herbicide usage: "Some scientists have called TCDD the most toxic chemical known to man".; It is not known if TCDD is mutagenic or carcinogenic as well".; "At this time, there is no basis for concluding that humans are more or less sensitive to dioxins than are test animals".

Throughout the DEIS it is stated that the herbicides will be managed and stored in a manner which will safeguard public health and wildlife, prevent damage to plants, prevent soil and water contamination, and used in accordance with Federal, State or local laws and regulations. These stated assurances do not allay the citizens' fears. The citizen knows that reaction to exposure of harmful herbicides can include damage to skin, eyes, the central nervous system, and the respiratory tract. Also, he knows that improper application because of failure to follow instructions on herbicide labels or ignorance of herbicide or pesticide hazards causes most of the incidents of illnesses. Citizens will continue to object to the usage of toxic substances until it can be conclusively proven that the substances do not harm man and his environment.

Present studies and investigations of specific dioxins support the contention that there is no reason to believe that proper use of 2,45-T by the Forest Service will exert any toxic effect on the environment or man. While we know immediate hazards of herbicide usage, we do not know enough about long-range effects. Herbicides do not break down readily. They can remain in the environment for long periods, and can move through the food chain by the process of bioaccumulation. The replacement of the original set of an animal population in a sprayed area by a different set with lesser diversity also concerns us. It causes us to ask the questions: "Should use of vegetation management be allowed where it adversely affects even a minimal community of animals?"; and "Will the continued use of herbicides eventually cause unknown or long range depletion of wildlife species and their habitats"?

The unknown problems and impacts connected with the use of herbicides, urge us to request that an accelerated and comprehensive research be conducted by The U. S. Forest Service into biological control or biological evolution of vegetation in the Eastern forests. We concur with the sentence in the Introduction which says, "When alternative methods of vegetation management are technologically available and economically feasible they will be preferred over the use of herbicides". Please consider this sentence when you write the Final Environmental Impact Statement and conduct annual reviews on the use of herbicides in our National Forests.

The Society looks forward to reviewing and commenting on the F.E.I.S.

Sincerely,

Grace Pierce

Grace Pierce

PURDUE UNIVERSITY DEPARTMENT OF FORESTRY & NATURAL RESOURCES

November 23, 1977

Steve Yurich
Regional Forester
633 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

RE: Comments on U.S.F.S. Environmental Statement Draft: the use of herbicides in the eastern region

Dear Mr. Yurich:

It appears that this draft statement covers all imaginable topics, sometimes repetitiously. The attached copies of selected pages have some indicated corrections; generally involve misspelled, misnamed or cancelled products.

Additional comments as follows:

(#1) Page 36 - The last paragraph on this page precludes the use of "mist" as a viable foliage application technique. I would consider it a mistake to arbitrarily rule out a specific technique, i.e., the mist blower from the eastern quarter of the U.S. This application technique has proved to be very effective in southern forestry although some of the initial research was conducted in the northeast. Although it is not used in the eastern region to any great extent at this time, there are areas where it probably could be used, particularly in the coniferous forests in the northern part of the region.

(#2) Page 37 - The discussion on soil treatment uses granules and pellets as synonymous terms when they are in fact distinctly different types of formulations in the herbicide trade. The paragraph also refers to a figure 2 which was never found. (#3) The Table 3 on this page also appears to go without any particular discussion. I would prefer to see some elaboration on the nature of management activity and the type of herbicide used. The table breaks out the various growth regulator herbicides into distinct categories and distinct acreages. The other herbicides are lumped by a rough "mode of action" category. Why apply organic arsenicals

Forestry Building
West Lafayette, Indiana 47907

as a foliage treatment for ten acres of forest road, trail and facilities and 100 acres of range? I doubt that picloram will be used as the pure product but rather in combination with phenoxy herbicides. How do the picloram treated acres fit with the phenoxy treated acres? Where or why treat 155 acres with mytotic poisons for timber management and only 25 acres with soil applied inhibitors? Do these uses cover plantation establishment? The table does not define the actual uses or use situations of the herbicide program, nor the herbicides involved.

(#4) Page 38 - The first paragraph indicates that 50 to 70 percent of aerial applied herbicides are lost. On page 41, citing the CAST Report, it is possible to deposit 97 to 99 percent of the released spray within the target area. With improper application it would be possible to lose all of the aerially applied herbicide. I would think it would be in your best interest to emphasize the degree of accuracy possible with best available technology and equipment.

(#5) Page 41 - I do not understand the proposed concept of biological volitalization discussed in the second paragraph. It is difficult to conceptualize the difference between biological volitalization and regular volitalization.

(#6) Page 43 - The second paragraph discussing dioxins seems to be an overstatement appearing to implicate all phenoxy herbicides as being contaminated with dioxins.

(#7) Page 52 - The last paragraph states that undisturbed forest soils tend to be acid, low in organic matter, have a cool temperature, and are dry, all of which favors slow breakdown. I would suggest emphasis on the humus layer and moist surface horizon which would contribute to herbicide adsorption and rapid decomposition.

(#8) Page 54 - The first paragraph discussing water lists five specific herbicides. I think it would be in your best interest not to limit yourselves specifically to these herbicides, particularly since simazine is not on the list. Secondly, it would appear this list would preclude the use of new herbicides which could become registered in the future. The second paragraph in this same topic states that any herbicide found in the waters of the eastern region forests should be considered a contaminant. That statement suggests that use of any herbicide for aquatic weed control is to, in effect, contaminate the water. The water is already contaminated with a particular pest and the herbicide application is an effort to remove the undesired contaminant. I think it's an unnecessary overstatement.

Steve Yurich
Page 3
November 23, 1977

Page 61 - The fourth paragraph discusses the ADI of picloram
for humans and the related calculations. The whole paragraph
(#9) is apparently referenced to Emmingham, 1971. Knowing Emmingham
and the nature of his Master's work, that citation is a gross
and complete error. Someone should thoroughly check reference
citations throughout the report.

Presumably some editor will review the final draft statement to see that figures and tables are properly referenced, are properly titled and sequenced in keeping with the body of the report. Although the completeness is apparently there, the statement does need some final editorial dressing to enhance the overall presentation.

(#10) Page 96 - I think some of the proposed controls on herbicide
use are overly or unnecessarily stringent.

Page 98 - The proposals for pesticide use on national forests
in the eastern region does not allow any ready outlet for
cooperative research efforts. Since almost all research efforts,
particularly those similar to what we would be involved in,
constitute the use of a pesticide in an unlabeled manner, these
(#11) guidelines require a pesticide use proposal to be reviewed by
the field Pesticide-Use Coordinating Committee with final approval
by the Regional forester. This policy does not make allowances
for small research plots and has effectively killed any research
effort that we would undertake on U. S. Forest Service lands.
To me this is an unfortunate example of overkill.

Sincerely,

Harvey A. Holt
Associate Professor of Forestry

HAH:ng

enclosures

cc: M. C. Carter, Head
Dept. of Forestry & Natural Resources

in the plant, the leaves and buds become twisted and curled, followed by malformed new growth of stems and leaves. Sensitive young plants may die in a few days, while hardy shrubs and trees may succumb only after weeks or months. Some plants may survive without evident injury. The phenoxy herbicides appear to enter plants in an imperfect and uncontrolled way, and alter the growth process normally governed by the natural hormones. The herbicide is interferes with cell division and enlargement, food utilization, and a wide array of other vital plant processes. Exactly how they work is not known, and indeed the exact workings of natural plant growth regulators are equally obscure. Phenoxy herbicides are far more toxic to green plants than to animals, because the elements that have growth regulating ability in plants do not act the same way in animals.

Because their effect on the plant is "systemic" rather than "contact," phenoxys are effective even when only part of the plant is treated. As a result, low pressure and low volume sprays can be used.

Effects on plant growth may be seen after doses far below the lethal dose. This creates a potential problem with spray drift to susceptible vegetation.

Some growth regulators are quite mobile in soil, others are very stable.

With the exception of dicamba and picloram, phenoxy herbicides have short half-lives and do not persist long in the soil.

All have low mammalian toxicity (Table 4). Dioxin contained in 2,4,5-T and 2,4,5-TP has a high mammalian toxicity.

2. Organic Arsenicals

MSMA (Monosodium methanearsonate)
Cacodylic acid
DSMA (Disodium methanearsonate)

These herbicicdes have low mammalian toxicity (Table 4), and are translocated in both xylem and phloem.

3. Photosynthetic Inhibitors

atraxine (AAtrex®)
simazine (Princep®)
monuron (Telvar®)
diuron (Karmex®)
linuron (Lorox®)
bromacil (Hyvar x®)

The evolution of oxygen during photosynthesis is stopped rapidly in susceptible plants once these agents have entered a plant. In resistant plants, the effect on photosynthesis is much less and is temporary.

They have no direct effect on root growth. All can be absorbed by the roots and most are absorbed by leaves, but leaf adsorption varies greatly between compounds.

All of them move primarily in the xylem. Therefore, perennials are controlled only by root applications, not by foliage sprays.

When post-emergence sprays are used, thorough wetting of the foliage is important, since there is little downward translocation and the action is of a "contact" rather than "systemic" type. Surfactants or oils are often added to increase foliage action.

In general, these compounds are moderately to highly resistant to movement in the soil, but this varies with the compound, soil, and rainfall. Persistence in the soil varies from a few weeks to over 2 years, depending on the herbicide, amount applied, climate, and soil.

All have very low mammalian toxicity.

4. Mitotic Poisons

trifluralin (Treflan®)
DCPA (Dacthal®)
Sodium metaborate tetrahydrate (Ureabor®)

These stop the growth of roots and/or shoots of germinating seeds or small seedlings. Established annuals and perennials are killed in only a few special cases. These herbicides are highly selective between species.

Translocation occurs primarily in the xylem and is often poor. Therefore, they must be applied so they make contact with susceptible parts of the plant.

All have low mammalian toxicity.

5. Soil-Applied Inhibitors of Seedling Root and/or Shoot Growth

dichlobenil (~~Carson~~ Casaron®)
diphenamid (~~Dymid,~~® Enide®)

Included in this category are several chemical groups, the modes of action of which are not known. However, they are all soil-applied herbicides that inhibit the growth of roots and/or shoots of seedling plants. Some of them also inhibit the buds of certain perennials. They all have low mammalian toxicity.

6. Chlorophyll Inhibitors

amitrole

This herbicide is very soluble in water.

It is translocated in both xylem and phloem and moves throughout the plant. It interferes with pigment formation in the leaves, and new growth becomes almost white. Amitrole persists for several months in some perennial plants and new buds produce white leaves.

It is not very selective.

Because it is rapidly inactivated in the soil, it is used entirely as a foliage spray.

Acute mammalian toxicity is very low. However, it has been reported to have carcinogenic properties; therefore it is registered only for non-food crop uses.

Amizine® - A mixture of amitrole and simazine, it gives residual weed control for several months besides controlling the weeds present at time of spraying.

7. Free Radical Formation

diquat (Ortho Diquat)
paraquat (Ortho Paraquat)

These are very soluble in water.

They are strong cations.

They enter the foliage very rapidly (rain after 30 minutes does not affect results). Plants are killed quickly, usually within 1 or 2 days. Death is due to cell membrane destruction. Action is much more rapid in bright light than in weak light or in the dark. Usually plants are killed so rapidly that there is little translocation.

They show very little true selectively.

They are strongly absorbed by clay colloids and, therefore, have little or no activity in the soil.

Mammalian toxicity is high for paraquat and moderate for diquat. Fish toxicity is low for both.

8. Interfere With Protein Metabolism

dalapon (Dowpon®)
TCA

Very soluble in water.

Dalapon enters the plant either through the roots or foliage, while TCA utilizes mainly the roots, However, action takes place in the foliage in both cases.

Dalapon is translocated in both the xylem and phloem, while TCA is mainly in the xylem.

Because of the characteristics listed above, dalapon is used mainly for foliage sprays and TCA for soil applications. They are not absorbed by soil colloids and leach readily in all soils. Normal soil life is limited to a few weeks under warm, moist conditions. They are used primarily to control annual and perennial grasses.

Very low mammalian toxicity.

9. Miscellaneous

- alkanolamine salts (DNBP)? — Is this dinoseb?
- pentachlorophenol
- copper sulfate (Algacide)
- stoddard solvent
- potassium endothal (Algacide)
- glyphosate (Roundup®)
- ammonium sulfamate
- monobor-chlorate
- ammonium ethyl carbamayl phosphonate (Krenite®)

Glyphosate (Roundup®) - A herbicide that shows a great deal of promise for grass and weed control in forest plantations. It is applied to the foliage and kills annual plants as well as many perennials. It is translocated readily and has very little activity in the soil. Mammalian toxicity is very low.

Krenite® - Absorbed by the foliage and stems, it causes little, if any, visible effect on the foliage. This herbicide prevents refoliation the following spring. It is neither an eye irritant nor a skin sensitizer. And, it is readily absorbed by soil particles and decomposed quickly by soil microorganisms. It has very low mammalian toxicity.

Pentachlorophenol - This herbicide has high mammalian toxicity. It does not translocate, but kills by contact action.

Stoddard solvent - It causes very rapid destruction of the plant cell membrane.

F. METHODS OF APPLICATION

In order to be effective, a herbicide must enter the plant and move to the site of action. Entry may be through various parts of the plant: leaves, roots, seedling shoot before emergence, or above-ground stem. Entry may also be forced, as when the cut-surface method of application is used. Penetrating agents or penetrants may be added to the herbicide to improve its penetration of the plant foliage or stem surface. Before a herbicide can enter the foliage, the cuticle or wax surface must be penetrated. Some entry may take place through the stomata on the under side of the leaf.

control of aquatic weeds where herbicides or algacides are introduced into the water through a boat bailer or surface spray.

4. Soil Treatment - This involves application of a herbicide, liquid or granular in form, to the soil. Granules are a type of formulation in which the active ingredient is mixed and pressed with an inert carrier to form a small pellet that can be distributed on the soil. As the granules slowly decompose, the herbicide is released into the soil. Other soil treatments with liquids act as soil sterilants, and when present in or on the soil, prevent the growth of plants (Figure 2).

G. REVIEW OF PLANNED USES

TABLE 3 - PROPOSED AVERAGE ANNUAL HERBICIDE PROGRAM

Forest Management Activity / Method of Application	Totals	MODE OF ACTION: Growth Regulators: 2,4-D	2,4,5-T	other 2,4-D/2,4,5-T	Picloram	Dicamba	Organic Arsenicals	Photosynthetic Inhibitors	Mitotic Poisons	Soil Applied Inhibitors	Chlorophyll Inhibitors	Free Radical Formation	Interfere w/ Protein Metabolism	Misc.
a. Forest Road, Trail and Facilities	2,400*													
Basal Stem		5	10	-	300	-	-	-	-	-	-	-	-	-
Cut Surface		30	110	-	15	-	-	-	-	-	-	-	-	-
Foliage		985	110	200	10	-	10	-	-	-	300	-	30	35
Soil Treatment		-	-	-	-	-	-	25	-	-	-	-	-	-
b. Range	792													
Basal Stem		30	105	-	30	-	-	-	-	-	-	-	-	-
Cut Surface		100	30	-	-	-	-	-	-	-	-	-	-	-
Foliage		-	30	100	30	-	100	-	-	-	25	-	26	-
Soil Treatment		-	-	-	110	-	-	40	-	-	-	-	-	-
c. Recreation	100													
Basal Stem		-	-	-	-	-	-	-	-	-	-	-	-	-
Cut Surface		-	-	-	-	-	-	-	-	-	-	-	-	-
Foliage		15	-	-	-	-	-	-	-	-	5	-	-	60
Soil Treatment		-	-	-	-	-	-	-	-	-	-	-	15	5
d. Special Uses	4,126													
Basal Stem		165	585	-	840	35	-	-	-	-	-	-	-	-
Cut Surface		-	-	-	-	-	-	-	-	-	-	-	-	-
Foliage		135	260	65	520	450	-	-	-	300	-	520	-	-
Soil Treatment		-	-	-	-	-	-	-	-	-	-	-	-	-
e. Timber Management	29,443													
Basal Stem		400	595	-	1,320	-	-	-	-	-	-	-	-	-
Cut Surface		8,000	1,080	-	1,340	-	2,070	-	-	-	-	-	-	-
Foliage		20,960**	1,630	-	-	-	-	-	-	-	40	30	200	-
Soil Treatment		-	-	-	25	-	-	930	135	25	-	-	-	75
f. Wildlife	5,530													
Basal Stem		-	1,005	130	35	-	-	-	-	-	-	-	-	-
Cut Surface		30	-	25	90	-	-	-	-	-	-	-	-	-
Foliage		-	-	-	25	-	-	-	-	-	-	5	-	-
Soil Treatment		-	-	-	4,040	-	-	-	-	-	-	-	-	36
Totals	42,095*	21,883	3,630	520	5,450	585	2,180	990	135	585	370	545	330	130

*Figures are in acres treated.
**Includes annual aerial spray program of 7,000-9,000 acres.

II. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

This section is an analysis of both the anticipated favorable and possibly adverse impacts of herbicide use in the Eastern Region, as they may affect the local, regional, national, and international environment. The environment, in this case, includes not only the natural environment, but the social and economic environment as well.

Planned measures to minimize and mitigate adverse environmental impacts of herbicide use, including specifications and standards necessary to maintain and protect environmental quality, are found in Appendix A under Controls on Herbicide Use.

PURDUE
UNIVERSITY DEPARTMENT OF FORESTRY & NATURAL RESOURCES

November 17, 1977

Mr. Steve Yurich
Regional Forester- Eastern Region
Forest Service, USDA
630 W. Wisconsin Avenue
Milwaukee, Wisconsin 53203

Dear Steve:

I appreciate the opportunity to review your draft environmental statement on the use of herbicides in the Eastern Region. I apologize for being so late in my response, but I find that everything I do these days is at, or beyond, the deadline.

I believe your environmental statement is well written and thorough in the scope of its' coverage. However, I believe the statement could be strengthened by a more specific discussion of the benefit-cost ratios. On a number of occasions I have been involved with groups preparing statements concerning the use of herbicides in forestry. Uniformly, these statements are lacking in concise descriptions of the economic impact on timber production and the wood-based industry if currently used herbicides were not available. At several points in your statement (e.g., page 21, page 26, page 29, page 137, page 138), valuable data is presented on the economic impact. However, I would suggest that this type of information be expanded and summarized for the entire Region.

For example, in the appendix B, the Nicolet report indicates that conversion of aspen or northern hardwoods to pine or spruce plantations, followed by release using herbicides, can increase the per acre value of the saw timber and pulpwood produced by $2,500 or more. But there is no indication of the total number of acres in the Nicolet National Forest scheduled for this treatment. I would like to see a summary of the total benefits to be derived from timber management goals on each of the eastern national forests, the economic impact of achieving or not achieving these goals, and the costs of achieving these goals with and without herbicides. To this summary could be added the non-timber goals and the cost of achieving these goals with or without herbicides.

I realize the difficulties involved with preparing summaries of the type I am suggesting. I suspect that many of our eastern

Forestry Building
West Lafayette, Indiana 47907

Mr. Steve Yurich
November 17, 1977

page 2 -

forests are in the process of re-drafting their long-range management plans in view of the new Forest Management Act. How can one calculate the benefit-cost ratio for the use of herbicides in type conversion before plans have been finalized on the extent of type conversion to be achieved? But I believe that a decision will have to be made by the Executive branch or the Congress in the near future concerning the use of herbicides on both public and private land. I fear that these decision makers may be forced to act without the benefit of a full and complete assessment of the economic impact of their decision.

Yours truly,

Mason

Mason C. Carter
Professor and Head of Department

MCC:jh

Forest Service Response to Comments
by Purdue University-Department of Forestry
and Natural Resources

#1 The reference to aerosols and mists was deleted.

#2 Figure reference was corrected.

#3 The elaboration of Table 1 will be handled on an individual Forest basis through the use of environmental analysis reports.

#4 Paragraph was changed to reflect more current information.

#5 Confusing sentences were deleted.

#6 This section was completely rewritten.

#7 Original paragraph was unchanged.

#8 The points brought out were clarified in the Final Statement.

#9 This entire section was rewritten and references checked.

#10 These controls were developed to mitigate adverse environmental effects and we feel they are entirely workable in the field.

#11 We disagree! Research has not been "killed." The pesticide-use proposal is not that difficult to complete and could simply become a part of the research proposal.

C O N S O L I D A T E D   P A P E R S ,   I N C .

TIMBERLANDS OFFICE
WISCONSIN RAPIDS, WIS. 54494
715 • 422-3144 / 422-3261

November 3, 1977

Mr. Steve Yurich,
Regional Forester
633 West Wisconsin Avenue
Milwaukee, WI 53203

Dear Mr. Yurich:

I would like to comment on the Draft Environmental Impact Statement concerning the Use of Herbicides in the Eastern Region of the Forest Service.

Our company owns and manages the forests on approximately 244,000 acres in Wisconsin. We are within a continuing program to regenerate nonproductive land and to increase the productivity of low productive land. To do this, we are converting low productive hardwood sites, marginal aspen sites, and brush areas to pine sites and plantations, primarily red pine but also jack pine. Because of root sprouts, stump sprouts, and seeding in of deciduous species, a large majority of our newly established plantations require at least one release treatment to ensure that the pine will not be suppressed. We believe that phenoxy herbicides properly applied is the most efficient and economical method available to us. Most of our herbicide treatment work is done by aerial application or backpack mist blowers, but we also do some basal spray application work.

I would like to support the contents of the Draft Environmental Impact Statement. The only exception that I have is that application of phenoxy herbicides in a mist form using backpack mist blowers is not considered. We believe that application of phenoxy herbicides using backpack mist blowers will cause no environmental harm when applied under controlled conditions. Using backpack mist blowers allows us to treat small areas and perimeters that cannot be aerially treated or ground sprayed.

Thank you for this opportunity to comment.

Yours very truly,

CONSOLIDATED PAPERS, INC.

D.G. Hartman

TSI COMPANY
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25 IRONIA ROAD
FLANDERS, NEW JERSEY 07836
(201) 584-3417

December 9, 1977

Steve Yurich
633 West Wisconsin Ave.
Milwaukee, Wisc. 53203

Dear Mr. Yurich:

I have reviewed the "draft" Environmental Statement on the use of herbicides in the USFS Eastern Region. I know that the deadline is past and I appologize for not responding sooner. Regardless, I would like to call your attention to the fact that EPA requires that herbicides be labelled for specific forestry applications. This means that the product cannot legally be used in forestry applications unless labelled for that purpose.

On page 59, the report lists various herbicides, some of which are not legal to use because of lack of specific instructions for forestry use on their labels.

For example, Ansar, Daconate and Phytar 560 are all illegal to use because of lack of forestry instructions on the labels. I have enclosed the proper forestry labels for MSMA and Cacodylic Acid. As far as I know, SILVISAR is the only brand of the above active ingredients formulated and labelled specifically for forestry use.

It might be wise to check your entire list with regard to the above because I know of several instances where field work was curtailed because of use of improperly labelled herbicides.

Sincerely,

Robert W. Smith
Robert W. Smith
General Manager

RWS/cls

Enclosures

☆U.S. GOVERNMENT PRINTING OFFICE: 1978—753-839