MANAGING COMPETING AND UNWANTED VEGETATION

METHODS INFORMATION PROFILE

Herbicides

August 1994

There are five primary methods for treating vegetation: manual, mechanical, prescribed fire, biological, and chemical These profiles are intended to aid Forest Service project managers, workers, and the public in planning and performing vegetation management projects. Methods using herbicides are discussed here.

Herbicides may be used to control competing and unwanted vegetation in a variety of Forest Service programs. These chemicals kill plants by disrupting biochemical growth processes in a number of different ways.

All herbicides considered for use are registered by the U. S. Environmental Protection Agency. Registration includes EPA's determination that when used in the proper manner, the herbicide will not present an unreasonable risk of adverse effects to humans or to the environment. Registration is based on test data submitted by the manufacturer of the herbicide to EPA. Some persons question the validity and adequacy of the test data. Similarly, some question the adequacy of the standards used to determine "unreasonable risk."

Treatments must comply with the manufacturers' label restrictions and Forest Service administrative directions.

The herbicide as applied may include other chemicals called ingredients, in addition to the active herbicide chemical. Inert ingredients are chemicals added to the active ingredient to make the herbicide more effective when sprayed While inerts do not have plant-killing properties, they increase herbicide effectiveness by improving solubility or the ability of the chemical to stick to plants or to penetrate protective layers on plant surfaces. Other inert ingredients called adjuvants are sometimes added to limit unintended drift of a mixture when it is sprayed.

The mixture of active ingredients and inert ingredients is called the herbicide formulation. Manufacturers consider the inert ingredients of this mix proprietary information to be withheld from their competitors. These chemicals have, however, been disclosed to the Environmental Protection Agency which categorized them based on known potential for human health effects.

EPA classified all inerts into one of four general Herbicide Methods profile will also be revised categories, called "Lists. List one contains if significant new information about herbicides in chemicals of known toxic concern. List two general is published. contains chemicals of suspected toxic concern, which are highs priority for testing. List three contains inerts of unknown toxicity, ilel. EPA did not find enough infomration available on the toxic properties of List three chemicals to classify them on Lists one, two or four. List four contains chemicals of known nontoxic character, generally recognized as safe to humans.

Herbicides are usually applied as liquids mixed with water or oil carriers. A few herbicides are applied in solid form, usually as granules placed on the soil surface to be absorbed by plant roots.

Formulations of twelve herbicides can be considered for use in vegetation management projects in the National Forests of the Pacific Northwest Region:

Glyphosate
Picloram
Triclopyr
Atrazine
2,4-D
2,4-DP
Asulam
Simazine
Bromacil
Tebuthiuron 4.
Hexazinone
Dicamba

The behavior of each herbicide and its formu- 5. rations, as well as its effects on target plants and the environment, including human health, are different. The purpose of this discussion is to describe agency procedures and characteristics common to all herbicides.

The Pacific Northwest Region is publishing a series of Information Profiles on each specific Techniques herbicide permitted for use in the PNW Region. Each year a large number of scientific articles on Generally, there are four methods of applying specific herbicides are published in joumals and herbicides elsewhere. The PNW Region tracks and reviews these articles As significant new informationon on a specific herbicide appears, the PNW Region will revise the individual herbicide prof ile f or that herbicide to reflect the new knowledge. The general Herbicide Methods Profile will also be revised if significant new information about herbicides in general is published.

Implementation

Forests will actively seek opportunities to reduce past reliance on chemical controls. Herbicides will be employed only when other methods would be ineffective in meeting management objectives or would unreasonably increase costs.

Site-specific environmental, biological, sociological, and economic factors must be considered. The basic elements of site analysis, strategy selection, and design of herbicide projects

are:

1. management objectives, required mitigation measures, and anticipated resource output;

2. potential for adverse worker and public health effects;

3. risk of unacceptable environmental damage;

4. feasibility of the project, including logistical considerations such as the availability of money, people, time, and equipment; and

5. potential to develop strategies which will make future applications of chemicals unnecessary. This can be accomplished by incorporating modifications to “pest” habitat processes of some ecosystems.

Techniques

Generally, there are four methods of applying herbicides:

1. aerial application, using helicopter or fixed wing aircraft;

2. mechanical equipment, using truck-mounted or truch-towed wand or broom sprayers;

3. backpack equipment, generally a pressurized container with an agitation device;

4. hand application by injection, daubing cut surfaces, or application of granular formulations to the soil.

Advantages

The range of selectivity possible with the use of herbicides is wide. Some applications can target specific or even individual plants. Other applications can kill all vegetation on a site. The length of time a herbicide can control the growth of competing vegetation also varies.

Some chemicals will kill only above ground vegetation; others will kill underground root systems to reduce resprouting. Some remain temporarily active in the soil to reduce reinvasion of the target plants.

Most herbicide applications do not greatly disturb the soil or its protective organic cover. With aerial application, large areas may be treated quickly with a small labor force. This is a particular advantage for treatments using selective herbicides to release conifers because differences in dormancy between conifers and broadleaf plants allow a short time period for controlling broadleafs without damaging conifers.

Direct application costs may be low, although indirect costs such as mitigating measures may reduce cost-efficiency compared with other methods. Relatively few workers should be exposed to the potential health effects of the chemicals when they are applied in accordance with the safety precautions required in the Vegetation Management Record of Decision. Aerial application is not limited in feasibility or economics by inaccessibility or rugged terrain nearly as much as the other application methods.

Truck-mounted mechanical spray equipment has advantages similar to aerial application in timing, cost, low soil disturbance, and worker exposure. It is, however, a system limited primarily to treatment of roadsides and flat areas where there is access.

Hand application systems have a common set of advantages: targeting of individual unwanted plants is greater than with aerial and mechanical application, therefore effects on nontarget organisms and other elements of the environment can be reduced.

Disadvantages

Herbicides introduce foreign chemical substances into the forest environment. The reactions of these chemicals, whether on-site or off-site, can cause a variety of undesired effects. The principal causes of off-site effects are spray drift and water contamination.

Both direct and indirect effects on health and on the environment can adversely affect non-target organisms, including humans. These effects are unique for each herbicide and are discussed in detail in individual herbicide information profiles.

Selectivity and off-site effects vary among herbicide application methods. The size of the treatment swath, the speed of application, and the ruggedness of the terrain involved are factors affecting the ability to control herbicide placement. Spray nozzle designs can produce spray droplets which reduce drift. Drift control additives are also available. Spray control is difficult in aerial applications because the equipment produces wide swaths at rapid speeds. Spraying from truck mounted equipment is somewhat more controllable. Human-held applicators are best able to direct herbicides to individual plant targets, but more workers are potentially exposed.

Environmental Effects

There are general principles of biochemistry and physics which govern the interaction of any herbicide with components of the environment.

Each herbicide, however, is a distinct chemical with its own particular properties The individual herbicide information profiles describe how each chemical may affect the environment. The general dynamics and range of potential environmental effects are described below.

Soil

Persistence and Mobility: Though much of the herbicide falls on foliage, the soil is also a major receptor with any application method.

Factors determining the persistence of herbicides in the soil include the chemical properties of each agent, the weather, and the properties of the soil.

Soils high in clay and organic matter may retard or in some instances prevent the leaching of herbicides by providing sites for adhesion onto the surface of a soil particle, which is called adsorption. Soils with low pH tend to increase adsorption of herbicides; the degree of adsorption varies depending on the herbicide used. Conversely, abundant rainfall increases the possibility of herbicide movement by leaching or runoff.

The buildup of chemicals in the soil is a potential cumulative effect from the use of herbicides. This can occur if repeated applications occur before residues from the previous application decompose. An application of herbicide for release might follow an herbicide application for site preparation within two to eight years. Repeated applications within a single year, however, would be extremely rare. Over the course of a timber rotation (80 to 120 years) more than three applications to the same area would also be rare. There may be a greater potential for build up of herbicides in rights of-way, roadsides, and rangeland where repeated treatments might occur. Preventive and nonchemical corrective methods should be used to limit the need for repeated treatments.

The persistence of the specific herbicide used and its susceptibility to water transport, local climatic conditions, and the rate and frequency of application determine the potential for buildup of residues in the soiL

Microorganisms and Decomposition: Soil and the forest floor constitute an active biological system that decomposes herbicides. Most herbicide decomposition occurs as soil microorganisms metabolize or decompose the chemical in the soil ororganic matter. The environmental and human health effects of some decomposition products are not completely known.

Warmer temperatures during periods of adequate moisture generally favor decomposition by microbes; most herbicides appear to persist longer in cold, arid climates.

The direct effects on soil microorganisms of herbicide contact and metabolism have varied widely in experiments. Harmful effects on microbial populations have occurred in some cases, while in other cases, the herbicide has stimulated the organisms.

Use of herbicides results in a pulse of dead organic matter on the site. The nutrient capital of the site remains essentially intact, although redistribution in the soil and remaining vegetation depends on the rate of decomposition of organic matter by soil microorganisms

Water

Herbicides may directly contact surface water via aerial drift, accidental spills, or surface runoff. Herbicides may indirectly affect surface waters by reducing riparian zone vegetation, leading to increased water temperatures and the loss of channel stability.

Unsprayed buffers buffers are left adjacent to live streams, lakes, and wetlands to reduce the possibility of direct contamination. No indirect effects on water quality due to the loss of riparian vegetation are expected with the use of these buffers.

Major factors influencing herbicide movement from an upland site to surface or ground waters include the herbicide's relative solubility in water, its resistance to adsorption by soil and organic matter, and its ability to persist intact until it reaches a water source. Mobility will be discussed in the information profiles for each available herbicide.

Of the four application methods, the aerial application of herbicides poses the highest hazard for surface water contamination. A relatively high concentration can result for brief periods from direct application or drift. Wet, marshy areas generally contain higher levels of herbicides for longer periods of time than do upland areas.

If applied to ephemeral stream channels, herbicides or their decomposition products may move into surface waters when rainfall occurs.

In addition *to* chemical mobility, other factors can influence herbicide activity underground and result in ground water contamination. For example, if soil microorganisms that decompose herbicides are absent, as in water-saturated soils, herbicides may persist longer than they would in unsaturated soils.

Accidental spills are another way herbicides can enter surface and ground waters. Potential cumulative and synergistic effects include increased sedimentation, changes in the quantity and timing of peak flows, and chemical contamination of surface and groundwater. This potential must be considered for the entire watershed involved.

Non-target Organisms

Risk: Both the inherent toxicity of a substance and the amount of exposure determine health effects.

Animals can be exposed by being sprayed directly or by coming in contact with vegetation, other animals, soil, or water that has been contaminated. Spray mist droplets or vapors can be inhaled. Animals can drink water contaminated by herbicides and eat treated vegetation. Herbicides that are applied in granular form could be eaten.

Herbicides available for use in the Pacific Northwest Region have shown relatively low acute toxicity in studies with laboratory animals. There is very little research and data for forest wildlife species or for livestock. Extrapolation from laboratory animals to forest and range animals involves broad assumptions and considerable variation in estimates of effects.

Sublethal effects of herbicide contact may occur for individual animals or for whole populations. Such exposure may reduce the animal's ability to avoid predation or to reproduce successfully.

Most of the available herbicides are soluble in water but not in fat. This diminishes the tendency to accumulate in the bodies of exposed animals, including terrestrial and aquatic wildlife and livestock.

Information needed in a site-specific environmental analysis to assess risk to wildlife includes:

1) inventories and life histories of the wildlife species found in the project area;

2) effects of the herbicide on target and nontarget plant species; and

3) the environmental fate of the herbicide.

Wildlife and Livestock: The potential exists for effects from herbicide application on both wildlife and livestock and their common habitat.

Plant species composition and distribution can be changed by herbicides. A direct effect might be the reduction of an animal's food source when forage plants are killed. The loss of vegetative hiding cover or migration in search of new forage could increase the vulnerability of a species to predation. Broad-spectrum herbicides affect many more wildlife habitats than selective substances.

Conversely, herbicides can improve the quality of forage forgraz ng animals by suppressing noxious weeds or less palatable species. Seeding of desirable species may be required to achieve lasting results of a positive nature.

Variation in the diversity of vegetation can produce subtle changes in the numbers and kinds of wildlife that use an area For example, treated brush species may be defoliated immediately, directly affecting wildlife which use it for forage or cover. The woody stems may continue to provide some nesting cover until they decompose, however.

The aerial spraying of herbicides for conifer release may increase browse rummage by deer, elk, rabbits, hares, and beaver. This is because the spraying will not displace these animals but will reduce their favored sources of food.

Cumulative effects may occur when herbicides persist in vegetation, soil, or water. Highly mobile or migratory wildlife species may be at greater risk because they can move from one treatment area to another and be repeatedly exposed.

Invertebrates and Microorganisms: Little is known about the effects of herbicides on insects and other invertebrates that are part of the food chain.

Soil microorganisms have shown a wide range of responses to herbicide exposure in experiments. Some populations have increased, using the herbicide as an energy source. Others have declined when exposed to herbicides. Both wildlife species and their vegetative habitat may be affected if nutrient cycling performed by the soil microorganisms is altered by herbicides.

Aquatic Animals: The likelihood of exposing fish to toxic concentrations of herbicides from routine applications is low. Flowing water rapidly dilutes chemicals; in general concentrations are reduced below levels with an observable effect in brief periods of time and distance after they are introduced. Mitigation measures, such as the use of no-spray buffer strips along live waters, are designed to prevent entry of biologically significant quantities into the water. Excessive amounts may be introduced when there is an accidental spill or when unpredicted precipitation occurs during or just after herbicide application.

Compared with levels of herbicide which have had toxic effects on fish in laboratory experiments, concentrations measured during National Forest herbicide projects are thought to pose a low probability of reaching toxic levels.

Laboratory studies conducted on other aquatic organisms often show toxic effects at 1/10 to 1/ 100 of the concentration which can harm fish. Therefore, while fish species may not suffer direct toxic effects from a particular application, it is possible that their food sources could be reduced or eliminated.

Scenery

Landscapes which are varied in appearance and are viewed by many visitors are most sensitive to changes. Most areas treated by herbicides for release or site preparation have already been changed by timber harvest. There can be an adverse effect on visual quality, however, in using herbicides to control vegetation along roads.

Human Health Effects

This is a discussion of the possible human health effects associated with the application of herbicides. It describes the principles that govern both quantitative and qualitative risk assessment.

Recently, President Clinton has announced a reduction in the use of pesticides, with special concern for exposure to children. One of the ways in which forestry use of pesticides might affect dietary intake of pesticide residues would be in potential water contamination. Because of their smaller size, children might be exposed to a more significanpesticide load than adults drinking the same quantity of water.

Beginning in April, 1994, the Envnmental Protection Agency began to phase in new regulations called “WorkerProtection Standards. “ These regulations include worker and public notificiation requirements,additional label warnings, worker re-entry periods, and personal protective equipment requirements. The new standards are applicable to workers in most forestrelated applications.

Risk Assessment

In this process, risk is the likelihood of illness or injury based on the results of hazard and exposure evaluation. Hazard is the characteristic of an object or substance that can inflict injury or illness. Exposure is the opportunity to receive a dose, which is the amount of a potentially harmful substance actually encountered by an organism. How much, how long, and how often people are exposed all influence risk.

There are both quantitative and qualitative elements in the risk assessment done for the FEIS Managing Competing and Unwanted Vegetation.

Quantitative risk assessment estimates the risk of human health effects in terms of numerical probability. Data on toxicity gathered from scientific research is combined with probable exposure quantities that would occur during both routine herbicide application and in worstcase accident scenarios to produce an estimate of potential risk.

Qualitative evaluation looks at the adequacy, completeness, and uncertainty of the toxicity data in the quantitative risk assessment. From this an estimate of its reliability is made. Ratings were assigned in the FEIS based upon an evaluation of the data, methodology, conclusions, and consistency among available scientific studies.

The two types of risk assessment are complementary and each provides useful information. The FEIS used both quantitative and qualitative analyses to estimate the human health risks of alternatives but quantitative risk estimates need not be calculated for site-specific projects. Instead, planners must evaluate the project to determine circumstances which might expose either workers or the public to risks greater than those described in the FEIS. Then mitigation measures, from the FEIS and elsewhere, must be applied and their effectiveness estimated.

It is important to keep in mind, however, that each herbicide is a distinct chemical with its own particular properties. The individual herbicide information packages describe the kinds of toxic effects possible, the dose that might produce health effects, and the likelihood of such exposures occurring in typical National Forest operations.

Hazard

Conclusions about the toxic properties of herbicides are drawn from poisoning incidents, laboratory studies of human volunteers, laboratory studies of effects in animals, and studies of disease occurence in human populations linked to known chemical exposures.

Toxic effects from the active ingredient or the inerts in the herbicide formulation may be caused by a single dose or from a series of doses received over time. They can also occur from a combination of the active ingredient and another substance. This could include another herbicide, a carrier, or an inert used in the herbicide formulation.

Incidents of poisoning have shown that herbicides, including those available for use on National Forests, may cause severe, immediate reaction when received in high enough doses. Such doses, however, are usually the result of an accidental or suicidal ingestion of concentrate. Even in these cases, the herbicides have rarely been fatal. Reported immediate effects from operational exposure have been less severe. Effects have included nausea, dizziness, or reversible neuropathy.

Longer term effects might include permanent damage to the nervous system, a reduction of reproductive success, damage to developing offspring, and the production of heritable mutations. Damage to the liver, kidneys and other organs, damage to the function of the immune system, and cancer might also occur.

Studies of toxic effects to reproductive systems have concentrated on females. The Forest Service is uncertain whether those herbicide ingredients identified as reproductive toxins may also affect male workers who are exposed.

The effects mentioned above have been shown for a number of the available herbicides in laboratory animal studies. It is therefore assumed that they might occur at some dose levels in humans. This assumption is supported by suggestive evidence from studies of occupational exposure.

There are no available human studies establishing heritable mutations associated with the use of herbicides. Laboratory studies constitute the best information on mutagenic potential; none exist for some of the herbicides.

Forest Service risk analysis made a worst case assumption that these herbicides can cause mutation. Herbicides found to pose the most significant risk of cancer are believed to be most likely to cause mutation in worst-case situations.

The Forest Service gave the EPA a list of all herbicide formulations permitted for use by the FEIS. The EPA has identified formulations which contain inerts on List 1 and 2 for which data demonstrated (List l)or suggested (List2) adverse health effects. The ester formulations of 2,4-D and triclopyr, which contain kerosene, were cited. Diesel oil, used as an herbicide carrier, is similar to kerosene in chemical structure and was also cited.

All other inerts and carriers in formulations available for Forest Service use are classified on Lists 3 or 4. EPA did not have data which, in its judgement, demonstrated or suggested toxicity to humans. List 4 inerts are The two categories included in this finding are chemicals for which there are data supporting a general finding of safety; and List 3 inerts are of unknown toxicity. Others disagree with these EPA findings. They maintain that for some inerts other than kerosene and diesel data exist which demonstrate or suggest toxicity to humans.

Inert ingredients in herbicide formulations and their effects will be discussed in the individual herbicide information profiles.

Synergistic effects are consequences which are different from and can be more severe than the sum of those predicted for each element, i.e. one plus one can equal three. One ingredient, for instance, may be a cancer initiator, another a cancer promoter. T. ikewise, a solvent may dry the skin, allowing enhanced passage of another ingredient across the skin into the body.

It is not known whether the various ingredients in an herbicide formulation can act synergistically to produce toxic effects. Toxicity testing of formulated herbicide products has been limited to some direct observable effects: poisoning, skin and eye irritation, inhalation of vapor or mist. Without complete testing, the possibility that the formulation is more toxic than the tested active ingredient can neither be discounted nor assumed.

Exposure

Two human populations, workers and the general public, may be exposed during herbicide applications.

Workers, especially mixer-loaders and backpack sprayers, are directly involved in treatment operations. They can be exposed to herbicides by contact with spray, splashing, spills, leaking equipment, or by entering treated areas.

Forest visitors and near by residents may be exposed to herbicide drift, to vegetation with herbicide residues, and to accidental spraying. They could also eat food or drink water containing herbicide residues.

Exposures and resulting doses for key workers and for possible public contact were estimated for routine operating conditions and conceivable worst case accidents. Because no analysis of herbicide spraying could consider every contingency typical situations and worst-case scenarios were used to model exposures.

For example, the highest plausible accidental dose to the public for most herbicides would be from drinking water from a pond which has been seriously contaminated by a truck spill. This scenario was used for each herbicide considered in the FEIS to calculate potential exposure.

Risk

Risk analysis performed for the FEIS estimated the probability of receiving a dose that would exceed the margin of safety from herbicides in both typical forestry operations and when accidents occur.

Both the toxicity of the chemical and the amount, duration, and frequency of exposure are taken into account when determining the margin of safety. A single dose received by a worker spilling spray over the entire upper body, for instance, may cause fess adverse health effects than repeated exposures to lesser amounts of an herbicide.

Margins of safety compare the predicted exposure and dose to the largest dose that had no health effect in laboratory animal studies. The categories for exposure and associated margins of safety are as follows:

Exposure Risk	Calculated Margin of Safety
High	Less than 10
Moderate	Between 10 and 100
Low	Between 100 and 1,000
Negligible	Greater than 1,000

Information packages for each herbicide indicate the margin of safety for each type of possible health effect.

Quality of Information on Health Effects

A separate analysis evaluated the quality of the data that had been used to estimate toxicity, human health risks, and margins of safety. This analysis rated the data for each chemical/health effect combination based on the number of studies, the scientific quality of the studies, and the consistency of the results. Some of the data did not meet current scientific standards. The overall quality of the data for each health effect was categorized for its reliability as a predictor of dose and effect. During the public comment period, evidence was presented which, if subsequently substantiated, would suggest that the risk is higher than the calculated margin of safety indicates.

Risk to the Public and Workers

Only people who are actually exposed to herbicides by being in or near an area where herbicides are, or have been recently applied, or who are involved in an accident, are at risk.

In general, the greatest risk is for backpack sprayers followed by aerial mixer/loaders and hackand-squirt workers.

The risks that were calculated did not consider mitigation measures to protect workers and the public. These protection measures, which are listed below, were designed to reduce the risks identified in the risk assessment. With these extra restrictions and precautions in effect, exposure of workers and of the general public and the risk of adverse effects may be reduced below the levels indicated in the FEIS.

Cumulative Effects

Members of the general public are not likely to receive repeated exposures to the same herbicide due to the remoteness of most treatment units, the widely spaced timing of treatments and the use of a variety of herbicides. Workers, especially herbicide applicators, are at a higher risk of repeated exposure.

Most vegetation treatments employ only one herbicide but combinations are sometimes used. These mixtures require approval by the Environmental Protection Agency, which recommends adding the predicted effects of the herbicides together.

It is possible that two or more herbicide chemicals may interact to cause a health effect greater than expected from adding the health effects of each separate chemical together; this enhanced interaction is another form of synergism, which was described above Factors that influence the potential for synergistic effects from separate herbicide exposures include the persistence and routes of degradation of the chemicals in the environment and in the human body. Synergism is unlikely from exposure to herbicides applied in separate projects because herbicide residues do not persist in the human body for long periods of time, and most herbicide residues do not long persist on treated sites. Conclusive examples of synergism involving the 13 herbicides approved for use in the FEIS have not been documented but 8 cannot be discounted as a possible occurrence.

Sensitivity

Unusually sensitive individuals may experience effects even when applications are well within the safety margin. Mitigation measures call for public warning for visitors and nearby residents who are particularly susceptible. Sensitive forest workers will be assigned to other tasks.

Children can be particularly susceptible to herbicides for physiological reasons including smaller body size, incompletely functioning immune systems, rapidly dividing cells which increase susceptibility to cancer, thinner bloodbrain barriers, and immature reproductive systems.

Measures for Reducing Effects on the Environment and Human Health

1. Down-stream water users and adjacent landowners who could be directly affected by chemical drift, stream transport, or an accidental spill, will be notified (normally 15 days) prior to the chemical application.

All applicable state and federal laws, including the label linginstructions of the Environrnental Protection Agency, will be strictly followed.

3. The herbicides amitrole, diuron, dalapon,, and fosamine will not be used in the Region's vegetation management program

4. Any employee not wishing to be exposed to glyphosate, dicamba, tebuthiuron, triclopyr, simazine, bromacil, atrazine, or 2, 4-D will be given alternate work assignments.

5. All workers on herbicide application projects will be informed of any known potential human health impacts from the herbicides to be used, and will be provided with copies of the relevant Methods and Information Profiles.

6. Where practical and effective, pre-mixed formulations and expose-reducing equipment will be used

The herbicide atrazine will not be applied aerially.

8. Diesel oil will not be used in herbicide applications, except as an adjuvant (not to exceed 5 percent of spray mixture).

9. Kerosene will not be used in herbicide applications, except as an inert ingredient in the ester formulation of triclopyr.

10. Herbicides will be applied within the prescribed environmental conditions stated on the label, in the environmental assessment, and in issued permits. This includes considerations of wind speed, relative humidity, air temperature, chemical persistence, and time since the last rainfall when determining the timing of applications in relation to drift reduction.

11. Use herbicide formulations that contain only inerts recognized as generally safe by EPA, or which are of a low priority for testing by EPA. Use of other inerts (identified by EPA as a high priority for testing or those that have been shown to be hazardous) requires full assessment of human health risks incorporated into the NEPA decision-making process.

1 2. Protective clothing will be worn by all workers (both Forest Service employees and contract workers) involved in herbicide mixing, loading, backpack applications, and hackand-squirt applications. Where specific items of protective clothing are optional, they must be on the work site at all times during application in accordance with the requirements of the Amended Record of Decision, dated February 27, 1992.

13. Public notification will be used for all applications requesting that people who know or suspect that they are hypersensitive to herbicides contact the Forest Service to determine appropriate risk management measures.in accordance with the requirements of the Amended Record of Decision, dated February 27, 1992.

14. Workers should wear a clean set of clothes daily, and should have a complete change of clothes available et the work site in ease of accidental exposure.

15. An emergency eyewash unit and other washing facilities with an adequate supply of soap and uncontaminated water will be available at each work site.

16. Workers (both Forest Service and contract) who know that they are hypersensitive to herbicides will not be used in application projects. Workers who display symptoms of hypersensitivity to herbicides during application will be removed from the project.

17. Precautions will be taken to assure that equipment used for storage transport, mixing, or application will not leak

herbicides into water or soil.

1 B. Areas used for mixing herbicides and cleaning equipment shall be located where spillage will not run into surface waters or result in ground water contamination. Whenever practicable, mixing areas and heliports will not be located within watersheds which provide domestic or municipal drinking water or which supply fish hatcheries or irrigation needs.

19. Drift of herbicide vapors or sprays will be minimized to within the prescribed buffer strip boundaries. The goal is to optimize droplet size to meet control requirements and to reduce risk of contamination due to drift. For aerial applications, fine droplets will be kept to a minimum by techniques such as: 1) reducing boom pressure; 2) increasing orifice size; 3) orienting nozzles parallel to the ground; 4) using specialized boom and nozzle designs; and 5) thickening the spray mixture by addition of various foaming agents, thickening polymers, or invert emulsion carriers.Specific direction on drift control measures, calibration, and characterization of aircraft is contained in handbooks such as the Siskiyou National Forest Aerial Applicators Handbook (April 1982), the Gold Beach RangerDistrict Aerial Implementation Plan (Spring 1983), and the Region 5 Handbook on Aerial Application of Herbicides (June 1983). These are on file in the Regional Office in Portland, Oregon. Current technology in aircraft and guidance systems, aerial delivery systems, aerial spray models, aerial calibration, microsite weather, and quality control is provided to Forest Service personnel in training sessions.

20. Buffers are required along streams, open water, and wetlands. Local conditions may require an expansion of the minimum widths given below. The buffer width for lakes and wetlands is wider then streams because of the high water table surrounding these areas. Large quantities of herbicides can be flushed by a rise in the water table. There is also less opportunity for chemical dilution and mixing in lakes and wetlands than in flowing streams.Buffers are determined by the possible modes of chemical transport to surface waters (direct application, deft, overland flow, subsurface leaching, and mobilization in ephemeral stream channels), as well as protection of riparian vegetation.Buffers should be designed to:Prevent direct application to open water. Truck mounted spray rigs will have an on/ off switch inside the vehicle which the driver can operate at stream crossings.Reduce drift into surface water. The acceptable amount of drift reachings waters will be determined for each proposed project based on the sensitivity of the water body including the rate of flow and the nature and amount of downstream use. Operational considerations, including topography, existing vegetation, environmental conditions, and mode of application will be incorporated into the establishment of .buffer strips. The buffers will be marked prior to spraying to be visible to applicators in aircraft, in vehicles, or on the ground. The following unsprayed widths will be maintained and may need to be expanded depending on local conditions.

- For aerial application, 200 feet horizontal distance around wetlands and lakes.

For aerial application, 100 feet along all flowing streams (Class I through IV).

For other than aerial application, 50 feet along all flowing waters. A distance less than 50 feet may be considered depending on site specifications such as slope, soil, climate, and risk of contamination.

The following items will be considered in project-level analyses and may result in expansion of the buffer widths: 1) the possibility of significant rainfall within the next 60 days, 2) topography adjacent to surface water, 3) soil infiltration capacity; 4) amount of ground cover, 5) flow obstructions that retard overland flow; and 63 herbicide persistence and mobility. The value of the water for fisheries and domestic, municipal, industrial, and agricultural uses will also be considered.

Reduce the risk of subsurface leaching and mobilization due to a rising water table. Considerations include: 1) depth of water table; 2) soil permeability; 3) possibility of a rise in the water table; 4) leaching within the 60 days following application; 5) herbicide mobility and persistence; and 63 the downstream water use.

Minimize the introduction of chemicals into ephemeral streams. Consider the time since the last rainfall, the chance of significant rainfall in the 60 days following chemical application, soil moisture, slope, downstream water use, and the mobility and persistence of the herbicide.

Protect riparian vegetation from the toxic effects of the applied herbicides. Considerations include: 1) the value of the riparian vegetation for stream channel stability and stream shading; 2) the availability of large woody debris input for fish habitat and to support the aquatic food chain; 3) the value of riparian vegetation for terrestrial wildlife; and 4) the toxicity of the herbicide to riparian plant and animal species.

19. Aircraft operators shall shut off herbicide applicators during turns and while over open water, residences, and sensitive sites.

20. Appropriate management of streamsides along dry ClassIV streams will be determined during the project-level environmental assessment. Predicted rainfall,downstream uses and values, vegetative and soil conditions, and wildlife habitat will be evaluated.

21. When transporting more than 120 gallons of herbicide concentrate or 2,000 gallons of mix on forest roads within municipal, fish hatchery, or irrigation supply watersheds, a pilot vehicle will be used. Truck drivers shall be briefed on all haul route hazards, defensive driving, and the project safety plan. They must also be familiar with the Spill Incident Response Plan.Both worker and public exposure monitoring is required for all herbicide application projects. Pertinent details will be documented including herbicides used, land area treated, date and times of applications, people involved, and mitigation measures followed.

23. Monitoring must be planned as an integral part of the overall vegetation management project. Monitoring will be conducted as described in the Region 6 Water Quality Monitoring Guide for Pesticide Detection (R6-WS-040-1980). Monitoring of a spray operation will be conducted to determine if mitigation measures are being observed, are effective in maintaining water quality, and are in compliance with state water quality standards and pesticide label requirements. The potential for contamination of aquifers used by fish or for municipal water or irrigation will be considered in the project level Environmental Assessment.

24. Herbicides will be applied in accordance with Forest Service Manual 2150 (PesticideUse Management and Coordination). This identifies the authority for Forest Service use of pesticides (the Federal Insecticide, Fungicide, and Rodenticide Act) and establishes the objectives and responsibilities of managers on all administrative levels. It describes the requirements for environmental documentation, safety planning, and training.

25. Forest Service Handbook 2109.11 (Pesticide Project Handbook) will be used to direct project planning. This establishes procedures to guide managers in planning, organizing, conducting, and reporting pesticide use projects. It also describes the requirement for a post-treatment evaluation report and the pesticide-use report.

26. Standards and guidelines in Forest Service Handbook2109.12 (Pesticide Storage,Transportation, Spills, and Disposal Handbook) will be met. This defines standards for storage facilities, posting and handling, accountability, and transportation. It covers spill prevention, planning, cleanup, and container disposal requirements.

27. Forest Service Handbook 2109.13 (Pesticide Project Personnel Handbook) will be used to define responsibilities and personnel needs, training, and experience needed for large scale aerial or ground application projects.

28. Project safety will be guided by Forest Service Handbook 6709.11 (Health and Safety Code Handbook, Chapter 9). This directive establishes the basic safety rules, as well as storage, transportation, and disposal safety aspects. References and publications to aid in worker safety training are also identified.

29. Individual National Forests will provide guidance for large and complex projects, as appropriate. This will be in the form of Forest Application Hand books, Project Safety Plans, Environmental Monitoring Plans, Public Contact Plans, or Law Enforcement Plans. This

is where specific requirements for equipment standards, training and quality control, and safety needs are identified for project implementation. Special measures such as spray drift control technology, water monitoring standards, calibration of equipment, and on-site weather limitations are prescribed. These documents also define coordination needs with support organizations and facilities.

30. Pesticide ApplicatorLicensing end training will be used as a quality control measure. The Pacific Northwest Region will continue to utilize the programs administered by the Departments of Agriculture in Washington and Oregon. Training and testing of applicators covers laws and safety, protection of the environment, handling and disposal, pesticide formulations and application methods, calibration of devices, use of labels and data sheets, first aid, and symptoms of pesticide exposure.

31. Material Safety Data Sheets will be posted at storage facilities and in vehicles, and will be made available to workers. These provide physical and chemical data, fire or reactivity data, specific health hazard information, spill or leak procedures, instructions for worker hygiene, and special precautions.

32. Care will be taken to avoid skin contact with diesel oil and kerosene. If contact does occur, affected skin areas should be promptly washed with soap and water, and soaked clothing will be changed.

33. The burning of vegetation in the same year in which it has been treated with herbicides is prohibited.