

Final
Environmental Impact Statement

**Noxious and Invasive
Weed Treatment Project**

Gallatin National Forest

June 2005

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Noxious and Invasive Weed Control Project
Final EIS
Gallatin National Forest
Bozeman Montana

June 2005

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ABSTRACT

The Gallatin National Forest is proposing to expand its current integrated invasive weed control program to include weed control treatment on 13,260 acres that are currently at risk to invasive weeds. The purpose and need of the project is to prevent and reduce loss of native plant communities associated with the spread of invasive plants. Specifically, the purposes of this project are to treat weeds within the Gallatin National Forest, and to reduce the impact of weeds on other resources.

Four alternatives have been developed to achieve these objectives. Alternative 1 Proposed Action - would expand the current weed program to treat 13,260 acres of weeds with herbicides (both aerial spray and ground treatments), mechanical, cultural and biological control methods. Alternative 2 No Herbicides - would combine mechanical, cultural and biological methods to treat 10,434 acres of weeds, but would not use herbicides. Alternative 3 No Change from Current Action - would continue to treat 1,162 acres with herbicides (ground application only), mechanical, cultural and biological control methods. Alternative 4 No Aerial Application - would treat 13,106 acres with herbicides (ground application only) in addition the mechanical, cultural and biological control methods. All alternatives include prevention and education as important tools for weed control.

Noxious and Invasive Weed Control Environmental Impact Statement

Table of Contents

SUMMARY

INTRODUCTION-----	S - 1
PROJECT AREA-----	S - 1
PURPOSE AND NEED FOR ACTION-----	S - 2
PROPOSED ACTION-----	S - 2
SCOPE OF THE DECISION-----	S - 5
SIGNIFICANT ISSUES-----	S - 7
ISSUES AND ALTERNATIVES NOT STUDIED IN DETAIL-----	S - 7
BRIEF DISCUSSION OF ALTERNATIVES-----	S - 8
ENVIRONMENTALLY PREFERRED AND AGENCY PREFERRED ALTERNATIVE-----	S - 10
SUMMARY COMPARISON OF ALTERNATIVES-----	S - 10

CHAPTER I: PURPOSE AND NEED FOR ACTION

SUBSTANTIVE CHANGES BETWEEN DRAFT AND FINAL EIS-----	1 - 1
INTRODUCTION-----	1 - 1
DOCUMENT STRUCTURE-----	1 - 1
BACKGROUND-----	1 - 2
Invasive Weeds On The Forest-----	1 - 3
Ecological Impacts Of Invasive Plants-----	1 - 4
Integrated Weed Management-----	1 - 7
Choosing Management Techniques-----	1 - 7
Mechanical Treatment-----	1 - 7
Cultural Treatment-----	1 - 9
Range Management Consideration-----	1 - 10
Biological Treatment-----	1 - 10
Treatment with Herbicides-----	1 - 11
Weed Prevention-----	1 - 11
Monitoring-----	1 - 11
Comparison of Weed Management Methods-----	1 - 12
PURPOSE OF AND NEED FOR ACTION-----	1 - 13
PROPOSED ACTION-----	1 - 13
Authorizing Acts-----	1 - 13
Permits Required-----	1 - 14
SCOPE OF THE ANALYSIS-----	1 - 14
Impacts-----	1 - 14
Alternatives-----	1 - 14
Connected, Cumulative And Similar Actions-----	1 - 14
SCOPE OF THE DECISION TO BE MADE-----	1 - 15
Geographic Scope-----	1 - 15
Temporal Scope-----	1 - 15
Decision Framework-----	1 - 15

CHAPTER 2: ALTERNATIVES

SUBSTANTIVE CHANGES BETWEEN DRAFT AND FINAL EIS	2 - 1
INTRODUCTION	2 - 1
PUBLIC INVOLVEMENT	2 - 1
ALTERNATIVE DEVELOPMENT PROCESS	2 - 2
ISSUES USED TO EVALUATE ALTERNATIVES	2 - 2
Key Issue 1: Potential Effects of Herbicides on Human Health	2 - 2
Key Issue 2: Potential Effects Of Aerial Application of Herbicides	2 - 2
Key Issue 3: Potential Effects of Herbicide on Aquatic Resources	2 - 3
Key Issue 4: Potential Effects of Herbicide on Wildlife	2 - 3
ISSUES AND ALTERNATIVES NOT STUDIED IN DETAIL	2 - 3
ISSUES AND ALTERNATIVES CONSIDERED IN DETAIL	2 - 4
ALTERNATIVES CONSIDERED IN DETAIL	2 - 4
Alternative 1 – Proposed Action	2 - 4
Alternative 2 – No Herbicide	2 - 11
Alternative 3 – No Action, No additional Weed Treatment	2 - 11
Alternative 4 - No Aerial Treatment	2 - 11
ADAPTIVE MANAGEMENT APPROACH	2 - 12
ECONOMIC COMPARISON	2 - 14
FEATURES COMMON TO ALL ACTION ALTERNATIVES	2 - 16
MONITORING	2 - 17
ENVIRONMENTAL PROTECTION MEASURES	2 - 24
SUMMARY COMPARISON OF ALTERNATIVES	2 - 24

CHAPTER 3: AFFECTED ENVIRONMENT

SUBSTANTIVE CHANGES BETWEEN DRAFT AND FINAL EIS	3 - 1
INTRODUCTION	3 - 1
FOREST PLAN MANAGEMENT DIRECTION	3 - 1
AGENCY POLICY AND DIRECTION	3 - 2
LAWS AND REGULATIONS	3 - 2
ENVIRONMENTAL JUSTICE	3 - 3
NATIVE AMERICAN TREATY RIGHTS	3 - 3
VEGETATION	3 - 3
SOILS AND GROUND WATER	3 - 13
WATER QUALITY, FISHERIES AND AMPHIBIANS	3 - 16
WILDLIFE	3 - 24
WILDERNESS AND INVENTORIED ROADLESS AREAS	3 - 36
WILD AND SCENIC RIVERS	3 - 42
NATURAL RESEARCH AREAS	3 - 43
RECREATION	3 - 45
HUMAN HEALTH	3 - 46

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

SUBSTANTIVE CHANGES BETWEEN DRAFT AND FINAL EIS	4 - 1
INTRODUCTION	4 - 1

DIRECT AND INDIRECT EFFECTS	4 - 1
SHORT TERM USE VS. LONG TERM PRODUCTIVITY	4 - 1
IRREVERSIBLE / IRRETRIEVABLE	4 - 1
ENVIRONMENTAL JUSTICE	4 - 2
ENERGY REQUIREMENT	4 - 2
ADVERSE EFFECTS THAT CANNOT BE AVOIDED	4 - 2
CUMULATIVE EFFECT	4 - 2
VEGETATION	4 - 2
SOILS AND GROUND WATER	4 - 15
WATER QUALITY, FISHERIES, AND AMPHIBIANS	4 - 21
WILDLIFE	4 - 26
WILDERNESS AND INVENTORIED ROADLESS AREAS	4 - 50
WILD AND SCENIC RIVERS	4 - 56
RESEARC NATURAL AREAS	4 - 57
RECREATION	4 - 59
HUMAN HEALTH	4 - 61
POSSIBLE CONFLICT WITH OTHER PLANS AND POLICIES	4 - 76

CHAPTER 5: CONSULTATION, REFERENCES AND GLOSSARIES

CONSULTATION	5 - 1
REFERENCES	5 - 2
LIST OF ACRONYMS	5 - 13
GLOSSARIES	5 - 14
INDEX	5 - 16

CHAPTER 6: RESPONSE TO COMMENTS RECEIVED

INTRODUCTION	6 - 1
LIST OF PEOPLE WHO COMMENTED ON THE DEIS, SUMMARY OF COMMENTS AND AGENCIES RESPONSE	6 - 1
COPY OF COMMENT LETTERS	6 - 27

List of Tables

Table 1. Decision Tree for New Weed Locations.	S - 6
Table 2. Gallatin National Forest Weed Treatment Priority Rating System.	S - 9
Table 3. Treatment Acres for all Alternatives.	S - 9
Table 4. Summary of Potential Impacts Between Alternatives.	S - 11
Table 1-1. Compares the relative limitations, management effectiveness, and approximate costs of the weed management methods used in the analysis	1 - 12
Table 2-1. Gallatin National Forest Weed Treatment Priority Rating System	2 - 5
Table 2-2. Invasive Plant Species List as of 2004, the list will change as new plants are as a threat to the ecosystem	2 - 5
Table 2-3. Treatment Acres for all Alternatives	2 - 6
Table 2-4. EPA Registered Herbicides Available for Control Alternative 1 and 4, Alternative 3 only used 2,4-D and Picloram.	2 - 7
Table 2-5. Herbicide Application Rates and Timing	2 - 8
Table 2-6. Decision Tree for New Weed Locations.	2 - 13

Table 2-7. Estimated Cost Comparison -----	2 - 14
Table 2.8. Summary of Annual Direct Noxious Weed Control Acres by Method-----	2 - 15
Table 2.9. Relative Cost per Acre by Alternative -----	2 - 15
Table 2.10. Summary of Annual Direct Noxious Weed Control Acres by Method (Budget Driven) -----	2 - 16
Table 2-11. Environmental Protection Measures-----	2 - 18
Table 2-12. Picloram Treatment Acres Thresholds in Sensitive Watersheds. -----	2 - 23
Table 2-13. Summary of Potential Impacts Between Alternatives. -----	2 - 24
Table 3-1. Category 3, 2, and 1 Weed Acreage on the Gallatin National Forest (infested acres not gross).-----	3 - 5
Table 3-2. Category 4 Noxious Weed, Watch Species, and Invasive Species Acreage on the Gallatin National Forest. -----	3 - 6
Table 3-3. Biological control agents released on the Gallatin Forest. -----	3 - 7
Table 3-4. Weed Occurrence by Habitat Type on the Gallatin National Forest. -----	3 - 8
Table 3-5. Acres on the Gallatin at Risk to Invasive Weeds, without Disturbance -----	3 - 9
Table 3-6. Commonly Used Herbicides. -----	3 - 10
Table 3-7. Description of sensitive plant habitat. -----	3 - 11
Table 3-8. Risk classes for herbicide/groundwater aquifer contamination. -----	3 - 15
Table 3-9. Montana Water Quality Human Health Standards for Herbicides (micrograms/liter) ----	3 - 16
Table 3-10. Optimal habitat attributes, from Gallatin National Forest Plan implementation guidelines, for streams within the analysis area. -----	3 - 18
Table 3-11. Summary of Road density, Stream Buffers, Road Stream Intersections, and sensitive species. -----	3 - 19
Table 3-12. Common Gallatin National Forest land management activities and associated levels of impacts. -----	3 - 20
Table 3-13. Priority birds species for conservation occurring on habitats most at risk for weed infestations on the Gallatin National Forest, from the Draft Montana Bird Conservation Plan -----	3 - 32
Table 3-14. Toxicity of herbicides proposed for use on the Gallatin National Forest. -----	3 - 34
Table 3-15. Summary of area of land in Wilderenss and Roadless Designation. -----	3 - 38
Table 3-16. Summary of mapped weed population in the Absaroka-Beartooth. -----	3 - 39
Table 3-17. Summary of mapped weed population in the Lee Metcalf. -----	3 - 40
Table 3-18. Summary of mapped weed population in the Hyalite Porcupine Buffalo Horn. -----	3 - 41
Table 3-19. Summary of mapped weed population in the Inventoried Roadless Area. -----	3 - 41
Table 3-20. Toxicity Categories for Various Types of Harmful, Acute Reactions. -----	3 - 49
Table 3-21. Human Hazards Based on Acute Toxicity Categories. -----	3 - 49
Table 3-22. Comparison of Harmful Chronic Effects. -----	3 - 49
Table 3-23. Effects of Drift Factors on Herbicide Drift. -----	3 - 52
Table 4-1. Alternative 1 Weed Treatment Range, Gallatin National Forest.-----	4 - 3
Table 4-2. Alternative 2 Weed Treatment Range, Gallatin National Forest.-----	4 - 5
Table 4-3. Alternative 3 Weed Treatment Range, Gallatin National Forest. -----	4 - 6
Table 4-4. Alternative 4 Weed Treatment Range, Gallatin National Forest.-----	4 - 6
Table 4-5. Determinations of effects of Alternative 1, 2, 3 and 4 to sensitive plant species. -----	4 - 14
Table 4-6. RAVE Risk Classes for the Entire Forest -----	4 - 15
Table 4-7. RAVE Risk Classes by Ranger District. -----	4 - 15
Table 4-8. Percentage of Existing Weed Area by Risk Class for the Forest. -----	4 - 16
Table 4-9. High RAVE Risk Class by HUC6 Watershed -----	4 - 16
Table 4-10. Gallatin National Forest watersheds (6 th code HUCs) that show some risk for exceeding 'safe' concentrations of picloram. -----	4 - 21
Table 4-11. Biological Evaluation Determination for Sensitive Species.-----	4 - 26
Table 4-12. Summary of the potential risk of toxic effects to wildlife resulting from herbicide use under each of the alternatives.-----	4 - 48

Table 4-13. Summary of the potential effects weed management alternatives on wildlife habitat under each of the alternatives.	4 - 49
Table 4-14. Summary of the potential disturbance and displacement effects on wildlife under each of the alternatives.	4 - 49
Table 4-15. Summary of acres by treatment type for Wilderness and Roadless areas.	4 - 51
Table 4-16. Comparison of Herbicide Toxicity.	4 - 65

List of Figures

Figure 1-1, Project Area Map	1 - 17
Figure 2-1, Alternatives 1 and 4, Boulder River and Deer Creek Area	2 - 26
Figure 2-2, Alternative 2, Boulder River and Deer Creek Area	2 - 27
Figure 2-3, Alternative 3, Boulder River and Deer Creek Area	2 - 28
Figure 2-4, Alternatives 1 and 4, Crazy Mountain Area	2 - 29
Figure 2-5, Alternative 2, Crazy Mountain Area	2 - 30
Figure 2-6, Alternative 3, Crazy Mountain Area	2 - 31
Figure 2-7, Alternative 1, Bridger Mountain Area	2 - 32
Figure 2-8, Alternative 2, Bridger Mountain Area	2 - 33
Figure 2-9, Alternative 4, Bridger Mountain Area	2 - 34
Figure 2-10, Alternative 3, Bridger Mountain Area	2 - 35
Figure 2-11, Alternative 1, Gallatin Mountain Area	2 - 36
Figure 2-12, Alternative 2, Gallatin Mountain Area	2 - 37
Figure 2-13, Alternative 3, Gallatin Mountain Area	2 - 38
Figure 2-14, Alternative 4, Gallatin Mountain Area	2 - 39
Figure 2-15, Alternatives 1 and 4, East Side Paradise Valley Area	2 - 40
Figure 2-16, Alternative 2, East Side Paradise Valley Area	2 - 41
Figure 2-17, Alternative 3, East Side Paradise Valley Area	2 - 42
Figure 2-18, Alternative 1, Gardiner Area	2 - 43
Figure 2-19, Alternative 2, Gardiner Area	2 - 44
Figure 2-20, Alternative 3, Gardiner Area	2 - 45
Figure 2-21, Alternative 4, Gardiner Area	2 - 46
Figure 2-22, Alternatives 1, 2, 3 and 4, Cooke City Area	2 - 47
Figure 2-23, Alternative 1, Madison Range	2 - 48
Figure 2-24, Alternative 2, Madison Range	2 - 49
Figure 2-25, Alternative 3, Madison Range	2 - 50
Figure 2-26, Alternative 4, Madison Range	2 - 51
Figure 2-27, Alternative 1, Hebgen Lake Basin	2 - 52
Figure 2-28, Alternative 2, Hebgen Lake Basin	2 - 53
Figure 2-29, Alternative 3, Hebgen Lake Basin	2 - 54
Figure 2-30, Alternative 4, Hebgen Lake Basin	2 - 55

Appendices

Appendix A –Best Management Practices for Invasive Weeds	A-1
Appendix B – Herbicide Safety Plan	B-1
Appendix C – Wilderness Minimum Tool Guidelines	C-1
Appendix D – Surface Water Quality	D-1

Appendix E – Ground Water Analysis	E-1
Appendix F – Biological Assessments	F-1
Appendix G – Aerial Spray	G-1

CHAPTER 1

PROPOSED ACTION AND ITS PURPOSE AND NEED

SUBSTANTIVE CHANGES BETWEEN DRAFT AND FINAL EIS

Added paragraph on page 1-3, that describes the effectiveness of past weed treatment efforts.

INTRODUCTION

The Gallatin National Forest (Forest) of the United States Department of Agriculture (USDA) proposes to implement specific invasive weed treatments on 13,260 of approximately 1.8 million acres of Forest land in support of the Gallatin National Land and Resource Management Plan (Forest Plan), U.S. Forest Service policy, and Executive Order 13112. The proposed weed treatment and management project is located on the Gallatin Forest, which is in parts of Carbon County, Gallatin County, Madison County, Meagher County, Park County, and Sweet Grass County, Montana (Figure 1-1). Proposed methods to control invasive weeds include a combination of ground and aerial application of herbicides, mechanical, biological, and cultural weed treatments. The proposed project area occurs only on National Forest lands. This document follows regulations as defined by the Council of Environmental Quality for implementing procedural provisions of the National Environmental Policy Act of 1969 (NEPA, as amended, 40 CFR1500-1508); US Forest Service Environmental Policy and Procedures Handbook (FSH 1909.15); and US Forest Service Handbook 3409 on Forest Pest Management.

DOCUMENT STRUCTURE

The Forest has prepared this environmental impact statement in compliance with the National Environmental Policy Act and other relevant federal and state laws and regulations. This document is organized into six chapters.

Chapter 1 – Purpose and Need for the Action: This chapter includes information on the history of the project proposal, background information on weeds and weed treatments, purpose of and need for the project, and the agency’s proposal for achieving that purposed and need

Chapter 2 – Alternatives Considered: This chapter provides a detailed description of the agency’s Proposed Action and Alternatives for achieving the stated purpose. Alternatives are developed based on potential impacts resulting from implementation of the Proposed Action and issues raised by the public and other agencies.

Chapter 3 – Affected Environment: This chapter describes the existing environment that could be affected by the proposed weed treatment program.

Chapter 4 – Environmental Consequences: This chapter describes the direct and indirect impacts, commitment of resources and cumulative effects associated with the Alternatives.

Chapter 5 – Public involvement, References and Glossaries: This chapter identifies the steps taken to involve the public, and lists the preparers and agencies consulted during development of this Environmental Impact Statement. There is also a list of references cited in this document and a glossary of terms.

Chapter 6 – Response to Comments on the Draft Environmental Impact Statement: This chapter will contain responses to substantive comments, and will be completed after comments are received on the Draft Environmental Impact Statement.

Appendices:

- Appendix A – Best Management Practices for Invasive Weeds
- Appendix B – Herbicide Safety
- Appendix C – Wilderness Minimum Tool Guidelines
- Appendix D – Surface Water Quality
- Appendix E – Ground Water Analysis
- Appendix F – Biological Assessment
- Appendix G – Aerial Spraying

Additional documentation, including detailed analyses of the project can be found in the project file at the Hebgen Lake Ranger District West Yellowstone, Montana.

BACKGROUND

The Federal Noxious Weed Act of 1974 defines a noxious weed as a “plant which is of foreign origin, is new to or is not widely prevalent in the United States, and can directly or indirectly injure crops or useful plants, livestock or fish and wildlife resources in the United States, or the public health” (P.L. 93-629).

The Montana Noxious Weed Control Act defines a noxious weed as “any exotic plant species established or potentially could be established in the State which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses, and is further designated as either a state-wide or county-wide noxious weed” (MCA 7-22-2101).

Executive Order 13112 (1999) directs all agencies to prevent introduction of invasive species, provide for their control, and to minimize economic, ecological, and human health impacts that invasive species cause.

US Forest Service Manual 2080 defines noxious weeds as “those plant species designated as noxious by the Secretary of Agriculture or by the responsible State official. Noxious weeds generally possess one or more of the following characteristics: aggressive and difficult to manage, poisonous, toxic, parasitic, a carrier or host to serious insects or disease, and being non-native or new to or not common to the United States or parts thereof.” The Forest includes tall larkspur, native to this area, to be treated as a weed on some areas where it causes livestock poisoning.

As a point of clarification, the term “noxious weeds” are those plants listed by the Federal, State or Counties, while “invasive weeds” are exotic or poisonous plants that have been identified as plants of concern on the Gallatin Forest and will be treated in the same manner as noxious weeds. Together these species will be referred to as invasive weeds throughout the rest of this document and assessment. See Table 2-2 for a current list of weed species.

Invasive Weeds On The Forest

Federal and state laws define invasive weeds primarily in terms of interference with commodity use of land. However, impacts of invasive weeds on non-commodity resources such as water quality, wildlife, and natural diversity are also of concern.

Other potential environmental effects of invasive weeds include:

- Adverse influence on rare and sensitive native plant species;
- Detrimental impacts to wildlife, especially big game species that use foothill and mountain slopes as critical winter range;
- Degrade habitat for upland game bird and waterfowl;
- Degradation of water quality through increased soil erosion;
- Reduction on native plant communities and forage for wildlife and livestock; and
- Diminished quality of recreational and wilderness experience.

The Forest has been actively treating weeds since 1987 when a Forest wide EIS focused control on 1,082 acres of spotted knapweed and leafy spurge, with a combination of herbicides (2,4-D and picloram), biological control insects, cultural, and pulling. In 1992 the East Dam Spotted Knapweed EA, included an additional 80 acres and included the use of clopyralid. The weeds associated with these sites have been controlled, at a low-density level (documented by TERRA database), without notable effects to other resource concerns. The use of herbicides has been very effective in reducing the density of weeds, to a level where hand pulling is economically feasible on spotted knapweed. Likewise, biological control insects have been effective in reducing the density of leafy spurge. Over the last 18 years, the number of weed species of concern has increased substantially.

Weed specialists and botanists have conducted field inventories and mapped a total of 13,260 acres of invasive weeds throughout the Gallatin Forest. These surveys indicate there are at least 10,600 acres (gross area) of noxious weed species, 1,995 acres of invasive species and some 665 acres of concern tall larkspur. Some of the most prevalent weed species include: houndstongue which infests of 1,723 acres; Canada thistle on 1,774 acres; cheatgrass on 1,930 acres; spotted knapweed 1,485 acres; and musk thistle on 903 acres (based on 2002 inventory, all gross area measurement). Other established and widespread weeds include: oxeye daisy on 313 acres; leafy spurge on 208 acres; Dalmatian toadflax on 3,336 acres; yellow toadflax on 570 acres; and common tansy on 103 acres. Smaller patches of the following weeds were also inventoried and mapped: scentless chamomile; yellow chamomiles; white top; plumless thistle; diffuse knapweed; Russian knapweed; bull thistle; field bindweed; poison hemlock; orange hawkweed; black henbane; St. Johnswort; field scabious; sulfur cinquefoil; field pennycress; and meadow knapweed.

There are three additional species of invasive plants not yet detected on the Forest but are established in adjacent areas and could easily spread onto the Forest. These species include: yellow hawkweed, perennial pepperweed and tall buttercup. A few plants of dyers woad have been found on the Forest but were eradicated. The best management for these new species is prevention, early detection, and eradication. Smaller patches are more feasible to eradicate than larger infestations.

Ecological Impacts Of Invasive Plants

Invasive plants can alter the structure, organization and function of ecological systems (Olsen, 1999), including soil, plants, and animal relationships (Kurz, 1995; Randal, 1996). Spotted knapweed dominance on many open timber and grassland communities on the Forest may be affecting soil properties such as microbial activity, nutrients and moisture, as well as increasing soil erosion. Native plant composition, diversity, species richness, and litter production are also affected. Changes in plant communities from native to non-native species impact wildlife species that depend on open timber and grassland for forage, and breeding and nesting habitat. Spotted knapweed is prevalent throughout the Forest and extensive research on this species has revealed numerous ecological impacts associated with its presence. A recent study has proven that spotted knapweed releases a phytotoxic chemical that inhibits the growth of Idaho fescue thus giving a competitive advantage to spotted knapweed (Harsh *et al.*, 2003). Other noxious weed species are expected to result in similar impacts to ecosystem processes. Examples of ecological impacts from spotted knapweed will dominate the discussion in this section, but this does not preclude the impacts caused by the presence other species.

Soil: Invasive plants can affect the structure of ecosystems by altering soil properties. Soil in areas dominated by invasive plants may have lower amounts of organic matter and available nitrogen than areas supporting native grasslands (Olson, 1999). Organic matter can be affected in various ways. For example, spotted knapweed has a deep taproot, which tends to decompose more slowly than the fine roots of native grasses, reducing the annual input of organic matter into the soil (Olson, 1999). Biologically active organic matter occurs within the top one to four inches of soil and may be more prone to loss even during minor run-off events. A study conducted by Montana State University (Lace *et al.*, 1989) found that runoff and sediment yield increase 56 percent and 192 percent, respectively, on spotted knapweed sites compared to sites dominated by native bunchgrass.

Soil nutrient levels may be affected by the presence of invasive species. For example, potassium, nitrogen, and phosphorous levels were 44 percent, 62 percent and 88 percent lower on soil from a spotted knapweed-infested site than from adjacent soil with a grass overstory in a study conducted by Harvey and Nowierski (Olson, 1999). Plants that reduce soil nutrient availability to very low levels have a competitive advantage over neighboring plants (Olson, 1999).

Soil microorganisms can either benefit or be impacted by the presence of secondary compounds produced by some weedy species. Most microbial populations adapt to secondary compounds by increasing their populations, thereby increasing the rate of breakdown of secondary compounds. Conversely, these secondary compounds may limit activity and growth of aerobic soil microbial populations, resulting in thick litter layers and slower nutrient cycling (Olsen, 1999).

Soil moisture can also be altered by the presence of tap-rooted weedy species. Tap-rooted forbs may reduce infiltration because they do not have dense, fine root systems of grasses, which contribute organic matter and enhance soil structure. Infested sites may also have more extreme temperature changes because of lower soil water content; poorer soil aggregation; and greater exposure of soil to direct sunlight (Olson, 1999). Water has a high capacity to store heat. By reducing soil water content in surface soil, greater evaporation enhances rapid heating and cooling of near-surface layers. This will increase runoff by lowering infiltration, again reducing thermal conductivity and capacity of the soil to store heat resulting in greater temperature extremes at the soil surface (Olson, 1999).

Native Plant Communities: Invasive plants have a variety of mechanisms giving them a competitive advantage over native species. For example: invasive plants can be alleopathic (contain compounds that suppress other plants); produce abundant seed; establish and spread in a wide range of habitats; grow rapidly; initiate growth earlier in the season and later in the season; exploit water and nutrients better; have no native enemies; and are not palatable to large herbivores. Once established, non-native plants threaten biological diversity of native plant communities and can alter ecosystem processes.

As mentioned above spotted knapweed is prevalent throughout the Gallatin National Forest. It occurs primarily on roadsides, on grasslands and open forest community types. Invasion of knapweed into disturbed and undisturbed native bunchgrass communities is well documented (Myers and Berube, 1983; Tyser and Key, 1988; Bedunah and Carpenter, 1989; Lacey *et al.*, 1990). As spotted knapweed and other invasive plants increase, cover of more desirable but less competitive grasses and forbs is significantly reduced, sometimes as much as 60 to 90 percent (Harris and Cranston, 1979; Bucher, 1984). A study conducted in Glacier National Park reported that spotted knapweed reduced the number and frequency of native species. In addition, seven species classified as “rare” and “uncommon” at the beginning of the study were not present three years later. These results suggested that spotted knapweed alters plant community composition (Tyser and Key, 1988).

Rare plants are particularly vulnerable to invasive plants (Rosentreter, 1994) however there is limited information on the impact of weeds on rare and threatened plant and animals. Sapphire rockcress is endemic to Montana and is listed as sensitive by the Forest Service (Montana Native Heritage Program, 2001). The plant is at risk because of livestock trampling and encroachment of habitat by spotted knapweed (Lesica and Shelly, 1991). Sapphire rockcress is subject to an increase risk of extinction since spotted knapweed reduces space available for seedling establishment (Elzinga, 1997).

Cryptogamic ground crust may also be impacted by spotted knapweed. This crust, which is composed of small lichens and mosses and commonly covers undisturbed soil surfaces, is important for soil stabilization, moisture retention and nitrogen fixation (Ryher and Skujins, 1974; Anderson *et al.*, 1982). Tyser (1992) compared a native fescue grassland site to one invaded by spotted knapweed in Glacier National Park. Study results indicated that the cryptogamic ground cover within spotted knapweed infested sites was 96 percent less than native fescue grassland site.

Cheatgrass is becoming a concern on the Gallatin Forest because of its reputation for altering fire regimes. Cheatgrass is commonly associated with disturbed areas, such as recently burned rangeland and wildlands, roadsides, and eroded areas. However, cheatgrass also invades communities in the absence of any type of disturbance. Cheatgrass seedlings usually germinate with fall moisture, and the root system continues to develop throughout the winter producing an extensive root system by springtime. This well-developed root system is ready to exploit available spring moisture and nutrients before native species are able to germinate. Cheatgrass typically dries out and disperses seed by mid-June. The ability of the plant to dry completely, accumulate litter, and its fine structure makes cheatgrass extremely flammable. Cheatgrass invasion has increased the frequency of fires from one every 60 to 100 years to once every three to five years on millions of acres of rangeland in the Great Basin (Whisenant, 1990). The high frequency of fire has eliminated native shrub communities (Randall, 1996). Rapid growth and vigorous reproduction assure cheatgrass dominance.

Wildlife Habitat: The introduction of exotic plants influences wildlife by displacing forage species, modifying habitat structure (such as changing grassland to a forb-dominated community), or changing species interactions within the ecosystem (Belcher and Wilson, 1992; Bedunah, 1992; Trammell and Butler 1995). Exotic plants on the Gallatin Forest have started to invade important big game winter ranges, reducing forage available for over-wintering animals. On the Lolo National Forest, forage availability was identified as the most limiting factor for over-wintering elk and deer populations. Forage that is low in nutrients also hinders elk and deer because they metabolize fat at an accelerated rate to stay warm in colder temperatures (Thomas, 1979).

Unlike elk and deer, bighorn sheep are relatively non-migratory (USFS, 2001b). They spend most of the year on low elevation big game winter ranges, which are often associated with talus slopes. Additional demands are placed on the forage base because they are non-migratory and forage yearlong on some ranges. Yearlong foraging makes bighorn sheep more dependent on high quality forage on low elevation big game winter ranges than elk and deer (USFS, 2001b).

A study conducted by Thompson (1996) on the Three-Mile Wildlife Management Area suggested that elk are not obligate grazers and may lose foraging efficiency where knapweed dominates native ranges. Although elk can incorporate spotted knapweed into their diets, they have been observed using areas with a low relative abundance of knapweed more frequently than infested areas. Thompson (1996) concluded that management practices affecting vegetation on winter ranges are likely to have profound impacts on ungulate foraging efficiency during the season when energy balance is especially critical.

Elk migration patterns may be altered due to the presence and dominance of spotted knapweed (Thompson, 1996). In general, use of spotted knapweed by wildlife and livestock is highest during the spring and early summer when plants are green and actively growing in the rosette and bolt stages (USFS, 2002). Spotted knapweed can have about 18 percent crude protein early in the season, but nutritional value decreases and fiber content increases later in the season (USFS, 2002a; Fletcher and Renney, 1963). Although spotted knapweed infestations are considered more detrimental to elk than deer, Guenther (1989) found that the plant was not detected in mule deer diet even though it was common on winter ranges.

Spotted knapweed is not considered food forage, even though the plants can contain high amounts of crude protein. The bitter-tasting compounds such as sesquiterpene lactone, and catechin, found primarily in the leaves reduces palatability (USFS, 2002). Even though animals may ingest spotted knapweed, the secondary compounds in the forage may affect rumen microbial activity (Olson, 1999), thereby reducing forage intake, or may cause general malaise resulting in aversive post-ingestive feedback.

Humans: Spotted knapweed has direct and indirect effects on humans. Beekeepers value spotted knapweed because of the quality of honey produced from its flowers. However, the flowers are also pollen sources, which produce positive allergic skin tests and are a significant allergen causing allergic reactions (Olson, 1999). People residing in knapweed-infested areas are treated for a variety of knapweed allergies ranging from skin hives to knapweed-induced asthma attacks. Some individuals are required to carry artificial adrenalin kits and take weekly allergy shots (Olsen, 1999).

Integrated Weed Management

Integrated weed management as defined by Sheley *et al.* (1999) is the “application of many kinds of technologies in a mutually supportive manner. It involves the deliberate selection, integration and implementation of effective weed control measures with due consideration of economic, ecological, and sociological consequences.” The integrated weed management approach developed for this Project does not center on treatment methods but rather on a multi-faceted strategy that includes education, inventory, ecological impact and risk assessment, prioritizing treatment areas, choosing management techniques, evaluating the program through monitoring, and adapting as the program evolves. Sheley *et al.* (1999) described the overall goal of integrated weed management as “maintaining or developing healthy plant communities (restoration) that are relatively weed resistant, while meeting other land-use objectives such as forage production, wildlife habitat development, or recreational land maintenance.”

Key components of integrated weed management program include:

- Preventing encroachment into non-infested sites;
- Detecting and eradicating new introductions;
- Eradicating small populations within or adjacent to high valued areas (such as wilderness, sensitive plants, and key wildlife habitat);
- Containing large weed populations;
- Re-vegetating when necessary; and
- Properly managing competitive vegetation (Goodwin and Sheley, 2001).

A successful program consists of a sustained effort, constant evaluation, and adoption of improved strategies as they arise.

The goals of implementing the various element of integrated weed management are to:

- Increase public awareness regarding impacts of noxious weeds to resource values;
- Limit weed seed dispersal from roads and trails;
- Contain neighboring weed infestations; and
- Minimize soil disturbance.

Choosing Management Techniques

Selection of weed management tools is not a choice of one tool over another, but rather selection of a combination of tools that would be most effective on the target species for a particular location. Reliance on one method or restricting the use of one or more weed management tools may prove less effective. Effectiveness and applicability of each tool varies and depends on weed biology and ecology, location and size of the infestation, environmental factors, management objectives, and management costs.

Mechanical Treatment

Mechanical weed management methods can be effective on small infestations. Hand pulling and hoeing are the oldest and most traditional weed management methods. These methods are labor intensive and relatively ineffective for management of large, dense infestations of perennial noxious weeds. Best results are achieved when the entire root is removed. This not always possible when treating deep rooted or rhizomatous, since hand pulling often leaves root fragments that generate new plants. Hand pulling also causes disturbance that may increase susceptibility of the site to reinvasion (Brown *et al.*, 1999; Duncan *et al.*, 2001). While this control method is

effective on single plants or relatively small infestations, it is not economically feasible on large, well-established knapweed infestations (Brown *et al.*, 1999). In addition, hand pulling plants that contain toxins or skin allergens can expose individuals to their poisonous effects (DiTomaso, 1999). Hand pulling trials that were constructed near spotted knapweed infestations in western Montana and diffuse knapweed infestations in west-central Colorado found this treatment to be 35 percent to zero percent effective, respectively. The treatments were completed twice per year for two consecutive years and were found to significantly increase bare ground and were also the most expensive (Duncan *et al.*, 2001). European beach grass was hand pulled on the Oregon Dunes National Recreation Area and was found to be labor intensive, costing nearly \$3,500 per acre for one treatment (Pickart, 1997).

Test plots established on Blue Mountain (Lolo National Forest) and the Lee Metcalf National Wildlife Refuge near Stevensville, Montana, measured effects of hand pulling on spotted knapweed. On the two sites spotted knapweed covered 76 percent and 53 percent, respectively. Average pulling cost for the two locations was calculated at \$8494 per acre per year and is used to estimate and analyze pulling costs (USFS, 2001b). Hand pulling provided 100 percent flower control and 56 percent plant control at Blue Mountain, but increased bare ground from 2.7 percent to 13.7 percent during the first year after treatment (Brown *et al.*, 1999).

Mechanical treatments such as tillage are most applicable to tap-rooted weed species; this method can be used on small acreages, level terrain, and infestations that are “tended” or visited on a regular basis in order to remove new germinant and re-sprouts as they occur. Tillage removes all vegetation and must be combined with seeding or planting of desirable species. Although mechanical treatments can reduce seed production for the treated season, invasive weed seeds may remain viable in the soil for several years (Davis *et al.*, 1993; Selleck *et al.*, 1962). Re-infestation of a site from residual seed, especially when disturbed, will often occur without continued follow-up treatment.

Mowing or cutting is more effective on tap-rooted perennials such as spotted knapweed compared to rhizomatous perennials (Brown *et al.*, 1999; Maxwell *et al.*, 1984; Scholes and Clay, 1994). Cutting or mowing plants can reduce seed production if conducted at the right phenological stage. For example, a single mowing at late bud growth stage can reduce the number of seeds produced by spotted knapweed (Watson and Renny, 1974). Mowing can also weaken the competitive advantage of weeds by depleting root carbohydrate reserves. Because of large carbohydrate reserves, mowing must be conducted several times a year for consecutive years to reduce the competitive ability of the weed. Cost of mowing twice a year (on terrain conducive to mowing) is approximately \$200 per acre (based on 1998 dollars).

Because invasive weeds flower throughout the summer, it is difficult to time mechanical treatments to prevent flowering and seed production. Repeated mechanical treatment too early in the growing season can result in a low growth form that is still capable of producing flowers and seed (Benefield *et al.*, 1999; Goodwin and Sheley, 2001). Mechanical treatments on some rhizomatous weeds, such as leafy spurge, can encourage sprouting and result in an increase in stem density (Goodwin and Sheley, 2001).

Mulching with plastic or organic material can be used on relatively small weed infested areas (less than ¼ acres), but will also stunt or stop growth of desirable native species. Mulching prevents weed seeds and seedlings from receiving sunlight necessary for survival, and can smother some established weeds. Although hay mulch was used in Idaho to reduce flowering of Canada thistle (Tu *et al.*, 2001), most rhizomatous perennial weeds cannot be controlled by this method because extensive root reserves allow re-growth through or around mulch.

Cultural Treatment

Cultural methods of noxious weed management are generally targeted toward enhancing desirable vegetation to minimize weed invasion. Planting or seeding desirable species to shade or out-compete weeds, applying fertilizer to desirable vegetation, and controlled grazing are common cultural treatments.

In most cases, endemic native species do not appear capable of out-competing invasive weed. On appropriate sites, herbicide application after weeds have emerged, followed by tillage and drill seeding, can be an effective treatment for establishing desirable species (Sheley *et al.*, 1999). This process, however, can lead to increased soil compaction (DiTomaso, 1999), and cannot be conducted on steep, remote, and rocky sites characteristic of most sites on the Forest.

When seed is introduced to a site by non-natural means (e.g., seeing by humans), there is a risk of introducing non-native and/or invasive species. Use of certified weed-free seed reduces this risk. The magnitude of the risk varies and may be determined by seed source, cleaning practices, and other factors. Certified weed free seed has tolerances for certain weed species and is only certified free of certain weed species (Montana Weed Act Section 4.12.3010-11).

Invasive weeds are often able to establish and occupy a site relatively quickly after introduction because native species are typically slower to germinate and establish. Seedling establishment of native species depends on proper seeding depths, soil, adequate soil moisture, prior removal of as many invasive weeds as possible, and often exclusion of livestock (Goodwin and Sheley, 2001). Selection of a native versus non-native seed mix depends on management objectives. If the objective is naturalness in a plant community dominated by less competitive species, native mixes would be used. Non-native species may be more appropriate where erosion control and competition with invasive weeds are the objective. A compromise is to include short-lived, non-native, less dominant species mixed with native seeds. On many Forest sites, there is adequate residual native and desirable vegetation under the invasive weed canopy such that re-vegetation is not necessary. Once the invasive weeds are removed, individual vegetation can respond and often results in a dense, competitive, and desirable vegetation communities.

Grazing can be an effective management tool on several weed species. Since grazing animals prefer certain forage, selective use of forage can shift competitive balance of plant communities (Crawley, 1983; Lukan, 1990). For example, goats and sheep have been used in various areas for controlling knapweed and leafy spurge. Controlled, repeated grazing of spotted knapweed by sheep has been found to reduce the number of one and two year old spotted knapweed plants within an infestation (Olsen *et al.*, 1997). Appropriate grazing by animals preferring weeds can shift the plant community toward more desired grasses (Lacey *et al.*, 1989). Conversely, grazing can also selectively reduced grass competitiveness, shifting the community in favor of weeds (Svejcar and Tausch, 1991).

Use of grazing animals as a weed management tool must be based on selecting the appropriate grazer (cattle, sheep, or goats) for the target weed. Managers must also determine when, how much, and how often to graze animals to have maximum impact on the weeds with minimum impact on desirable species (Olsen, 1999). Use of grazing animals as a weed management tool on roadsides, trailheads and larger infestations on the Forest is limited due to factors associated with maintenance and management of the animals. A long-term commitment to small ruminant grazing is necessary for effective weed control and achievement of desired results. Invasive weeds can compensate quickly after the grazing pressure is removed because of their dormant

seeds in the soil, and because they can rapidly increase flower stem and seed production once grazing pressure is removed.

Range Management Considerations

It has already been noted that many of the grasslands proposed for weed treatment still have relatively viable native plant communities intermixed with the weed invaders. Grasslands are dynamic plant communities that are constantly being shaped by the process of succession (Sheley *et al.*, 1999). Successful grassland restoration should complement successional processes. Grassland species evolved with grazing, and in many cases, grasses require defoliation every two to four years to remove old stems that shade plants and hinder growth. Defoliation methods, such as grazing, mowing or burning stimulate grass growth and enhance its competitive ability. However, proper grazing management is essential in maintaining long-term objectives for weed management. Most weedy species are well adapted to invade heavily grazed areas, allowing competitive advantage.

Grazing animals can be used to assist in weed control efforts, but in most cases will not eradicate mature infestations when used alone. Sheep and goat grazing is being considered under all alternatives however there are some major concerns. For example small ruminant animals are at risk to predation from wolves and bears, there is the risk of transmitting disease from domestic sheep to bighorn sheep, and there is insufficient experience with these types of grazing operations. Initial use of sheep and goats will require mitigation measures to ensure that predation and disease transfer do not occur. Also, both the animals and the experience will need to be gained from commercial practitioners.

Grazing management considerations are important in assisting with the restoration of native grasslands. Timing and frequency of cattle grazing can be adjusted to minimize impact on grasses (Sheley *et al.*, 1999). Permittees are authorized to graze livestock on National Forest System lands by permit. The General Terms and Conditions of the grazing permit, part 8(b) and (c) allow for annual adjustments as deemed necessary by the Forest, to coincide with resource protection measures. This would include restoration measures essential for achieving long-term effectiveness of weed treatment programs.

Biological Treatment

Biological weed management is the deliberate use of natural enemies (parasites, predators, or pathogens) to reduce weed densities. Natural enemies and competitive vegetation prevent weed species from dominating other species. Non-native invasive weeds are such a problem, in part, due to the lack of natural enemies.

Biological management is self-perpetuating selective, energy self-sufficient, economical, and well suited to integration of an overall weed management program (Wilson and McCaffrey, 1999). Management with biological agents is a slow process that does not achieve eradication. Biological agents may be ineffective if they are not integrated into other strategies. Biological management may also not be appropriate against weeds closely related to beneficial plants because the natural enemy may be unable to discriminate between related plant species (Duncan *et al.*, 2001). About 29 percent of the biological management efforts in the United States have demonstrated some level of success (DeLouch, 1991).

A weed infestation may increase in density and area faster than the newly released biocontrol agent population; therefore, other control methods must be used in conjunction with the release of

biocontrol agents. The perimeter of the infestation may be sprayed to keep the weeds from spreading. As biocontrol agents increase in density and begin to occupy more area, herbicides may be used for occasional spot treatments.

Treatment with Herbicides

Use of herbicides for invasive weed treatment involves application of products developed, labeled and produced to treat weed species at certain stages of plant growth. Herbicides considered in this analysis include: 2,4-D, chlorsulfuron, clopyralid, dicamba, glyphosate, hexazinone, imazapic, imazapyr, metsulfuron methyl, picloram, sulfometuron methyl, and triclopyr. Several herbicides are considered because they vary in effectiveness on different invasive weeds.

The length of time each herbicide controls invasive weeds varies with the type of herbicides, environmental conditions, and target weeds. Some herbicides control weeds for a short time, while others can provide several years of control from one application. The U.S. Environmental Protection Agency approved herbicide labels include safe handling practices, application rates, and practices to protect human health and the environment. A description of herbicides including copies of labels, susceptibility of weeds to different herbicides, Material Safety Data sheets, and guidelines proposed for use on the Project are contained in the Project File. More information on herbicide labels can be found at <http://www.cdms.net/manuf/manuf.asp>.

Weed Prevention

Preventing introduction and spread of weeds is one objective of the integrated weed management program on the Forest. The Northern Region of the Forest Service has incorporated the Guide to Noxious Weed Prevention Practices (Appendix A) into the Forest Service Manual 2080, for use in planning forest and wildland resource management activities and operations. The Forest Service Manual 2080 assists manager and cooperators in identifying weed prevention practices that mitigate identified risks of weed introduction and spread for projects and programs. Factors critical in a prevention program include:

- Limiting weed seed dispersal occurring from vehicles and equipment traveling forest roads, and people and livestock traveling forest trails;
- Containing neighboring weed infestations;
- Minimizing soil disturbance;
- Detecting and eradicating newly established weeds;
- Establishing competitive desirable vegetation; and
- Managing forage, including re-vegetation and shade management.

In addition, the Forest depends on public education and weed prevention programs to deter establishment of new weed species such as dyers woad, perennial pepperweed, yellow star thistle, rush skeleton weed, and tall buttercup. Weed education programs have helped raise public awareness about invasive weeds and what steps can be taken to help reduce the spread of existing weeds and establishment of new invaders.

Monitoring

Monitoring is the collection of data to determine effectiveness of management actions in meeting prescribed objectives. Monitoring focuses on:

- The density and rate of spread of invasive exotic plant species and the effect these aggressive plants have on natural resources;
- Effectiveness of herbicides on noxious weed, desirable vegetation and sensitive plants;
- Effectiveness of biological control agents;
- Effectiveness of cultural weed management activities;
- Effectiveness of herbicides on surface water quality; and
- Implementation of environmental protection measures.

Comparison of Weed Management Methods

Table 1-1. Compares the relative limitations, management effectiveness, and approximate costs of the weed management methods used in the analysis.

Methods	Limitations	Management Effectiveness ¹	Approximate Cost/Acre
CULTURAL			
Seeding	Environmental limitations; cannot be conducted on steep, remote, rocky sites; causes ground disturbance which may increase likelihood of re-invasion; most effective after weed populations have been reduced by other control actions.	Not able to estimate	\$100 to \$300 Average \$250
Grazing Animals	Treatment must occur during proper phenological stage; herding required; sometimes nonselective; can reduce forage available for big game; predator predation problems; disease transfer to bighorn sheep	Low cost/low effectiveness	\$50
MECHANICAL			
Mowing	Limited to smooth gentle slope; treatment timing critical; impact on non-target vegetation	Low cost / low effectiveness	\$200
Hand pulling/ Grubbing	Labor intensive; not effective on deep-rooted or rhizomatous perennial; causes ground disturbance which may increase susceptibility of site; effective on single plants or small low-density infestations.	High cost/ low effectiveness	\$400
BIOLOGICAL			
Parasites, Predators and Pathogens	Does not achieve eradication; effective only on one species, only a few weeds with available agent; most agents not effective by themselves need multiple agents	Moderate cost/ moderate effectiveness	\$150
HERBICIDES			
Ground Application	Not cost effective on slopes greater than 40 percent; must have accessible sites; potential impacts to non-target vegetation; application timing limited based on plant phenology and weather conditions.	Low cost/ moderate to high effectiveness	\$30 –Vehicle. \$125 –Backpack, \$50 – ATV, \$65 – Horse Average \$100
Aerial Applications	Potential impacts to non-target resources; application timing limited based on plant phenology and weather conditions.	Low cost/ moderate to high effectiveness	\$40
WEED PREVENTION			
All Methods	Not effective on existing infestations; ineffective if not enforced	Not measurable	

Notes: ¹Percent of target species killed in a treatment area: High = 75 to 100 percent; Moderate = 46 to 75 percent; Low = 25 to 45 percent; Very Low = 0 to 24 percent.

Not measurable – means the cost/effectiveness is not measurable or quantifiable.

PURPOSE OF AND NEED FOR ACTION

Invasive weeds are threatening or dominating areas of the Forest with negative impacts on native plant communities, wildlife habitat, soil and watershed resources, recreation, and aesthetic values. A shift from native vegetation to invasive weeds decreases wildlife forage, reduces species diversity, and increases soil erosion due to a decrease in surface cover. For these reasons it is imperative to aggressively manage weeds across the Forest.

The purpose and need of the project is to prevent and reduce loss of native plant communities associated with the spread of weeds. Specifically, the purposes of this project are to treat weeds within the Gallatin National Forest, and to reduce the impact of weeds on other resources.

PROPOSED ACTION

The Forest is proposing to broaden the 1987 Environmental Analysis for control of weeds to:

1. Permit the use of different types of herbicides;
2. Treat 13,260 acres with a combination of treatment methods such as herbicides, biological control agents, grazing, mechanical and cultural (the actual amount of annual treatment will depend on available funding and monitoring results);
3. Adopt adaptive management tools for assessing new treatments and new sites;
4. Broaden control methods to include the use of aerial application (on 255 acres).

Alternative 1 further describes specific treatment sites for the proposed action, size of treatment, targeted species, and treatment methods in Chapter 2.

Authorizing Acts

Direction and authority for invasive weed management is provided in the National Forest Management Act (PL94-588), Federal Land Policy and Management Act (PL 94-579), Carlson-Foley Act (PL-583), Federal Noxious Weed Control Act (PL-629), and the Montana Weed Management Plan (2001).

General land management and environmental analysis direction is provided by the National Forest Management Act, National Environmental Policy Act, and Federal Land Policy and Management Act. The Carlson-Foley Act allows states to control weeds on federal land provided that: 1) the control program is approved by the federal agency administering the land, 2) control methods are acceptable to the federal agency, and 3) similar procedures are followed as applied to private land. The Carlson-Foley Act authorizes federal agencies to reimburse states for weed control expenses on federal land. The Federal Noxious Weed Act defined noxious weeds and authorized cooperative weed control agreements between federal agencies and other agencies, organizations, or individual.

In Montana, the Montana County Noxious Weed Management Act (MCA 7-22-2101) states that it is unlawful for any person to allow noxious weeds to propagate or go to seed on their land unless they have an approved weed management plan. This act directs counties to develop weed control plans and implement weed control efforts.

The US Forest Service strategy for noxious and non-native invasive plant management (USFS, 1998B) provides the Forest Service with a “roadmap into the future for preventing and controlling

the spread of noxious weeds and non-native invasive weed plants.” Executive Order 13112 directs all federal agencies to conduct activities that reduce invasive populations.

Permits Required

Prior to implementation of aerial application of herbicides, A Montana Pollutant Discharge and Elimination System permit may be required. Consultations with the Montana Department of Environmental Quality and US Environmental Protection Agency will determine whether a permit is needed at that time.

SCOPE OF THE ANALYSIS

The scope of this analysis is limited to the effects of weeds, and weed control treatments (as proposed in Alternative 1) on different resources within the Gallatin National Forest boundary.

Impacts

Regulations contained in 40 CFR 1508.25(c) require analysis of direct, indirect, and cumulative impacts. Direct effects are caused by the action and occur at the same time and place as the Proposed Action. Indirect effects are caused by the action and occur later in time or farther removed in distance, but are still reasonably foreseeable. Cumulative impacts are those impacts on the environment that result from incremental impact of the action where added to other past, present, and reasonably foreseeable future action.

Alternatives

In determining the scope of analysis, the agency must consider three types of alternatives (40 CFR 1508.25[b]): no action alternative, other reasonable courses of action, and mitigation measures. Chapter 2 presents a range of alternatives for site-specific treatment of invasive weeds. Alternatives that have a reasonable likelihood of partial success are discussed in detail. Mitigation measures for each alternative have been developed by the Forest and included as Environmental Protection Measures. Impacts of the no-action alternative, which would maintain the current program projects on the forest, are also considered.

Connected, Cumulative And Similar Actions

Regulations in Code of Federal Regulations (CFR) Title 40 1508.25 address the scope of analysis and elements to be considered in a proposed action. The regulations recognize that separate activities can combine and interact to create impacts that may be significantly beyond the effects of individual actions. These actions are considered cumulative, and their additive effects must be addressed in the analysis.

Federal regulations also require a combined analysis of connected actions. Connected actions are those that are closely related and 1) automatically trigger other actions, 2) could not or would not proceed unless other actions are taken previously or simultaneously, and 3) are interdependent parts of a larger action and depend on the larger action for their justification. The effects of connected actions should be analyzed together.

Similar actions are those that share a common timing or geography and therefore can be evaluated together.

SCOPE OF THE DECISION TO BE MADE

Geographic Scope

The geographic scope of this analysis is confined to the treatment areas that would occur within the Gallatin National Forest boundary. For each resource issue an analysis area was determined that could be used to adequately measure cumulative effects of the proposed alternatives. Unless otherwise stated, the cumulative effects area is the same as the project area.

Temporal Scope

The timeframe for project implementation is 5 to 15 years. Direct, indirect, and cumulative effects, if any, would occur during that period. For cumulative effects analysis, an additional 10 years past the final implementation year is included in the analysis. In some cases, longer-term effects are also discussed.

Decision Framework

Based on the environmental analysis in the EIS and consideration of public comments, the Forest Supervisor of the Gallatin Forest is responsible for making the decision concerning this proposal. Given the purpose and need, the deciding official reviews the alternatives, and the environmental consequences in order to make the following decisions:

- Whether to expand current efforts to control invasive weeds;
- What treatment methods would be used;
- What herbicides would be used;
- What mitigation and monitoring measures would be required; and whether to include an adaptive approach to address future spread of invasive weeds.

The EIS is a project level analysis. The scope of the project is confined to issues and potential environmental consequences relevant to the decision. This analysis does not attempt to re-evaluate or alter decisions made at higher levels. The decision is subjected to and would implement direction from higher levels.

National, regional, and Forest Plan rules, policies, and direction require consideration of effects of all projects on weed spread and prescribe mitigation measures where practical to limit those effects. Reconsideration of other existing project level decisions or programmatically prescribing mitigation measures or standards for future Forest management activities (such as travel management, timber harvest, and grazing management) are beyond the scope of this document. Cumulative effects of the Project are addressed where appropriate in Chapter 4, combined with effects of other Forest activities.

Decisions that will not be made based on this analysis are briefly discussed below:

- Changes in land use and Forest Management objectives;
- Changes in the level of wildland suppression, strategies and tactics, and decisions on whether or not to control wildfire;
- Changes in travel, road use and access;

- Road analysis or road management decisions. These decisions will be addressed by the Gallatin Travel Management Plan, which is being revised in a separate.
- Prevention measures that minimize establishment and spread of noxious weeds are already a part of Forest Service policy and recent decisions, and therefore will not be repeated in this analysis. The Gallatin National Forest fully utilizes prevention, education, and non-chemical activities to combat weeds on the forest. Herbicide, cultural, mechanical, and biological methods as addressed in this analysis would be used in conjunction with these other activities where necessary or appropriate. The following outlines recent prevention and education decisions, policy, and measures for the weed control program occurring within the analysis area.
- - (1) Forest Service Policy (FSM2080 R1 Supplement) provides Best Management Practices for weed control. They specify incorporation of weed prevention and control through project layout, design, and alternative evaluation and project decisions to reduce potential sites for weed establishment.
 - (2) Coordination of weed prevention and control efforts continues at the local, county, state, regional, and national levels.
 - (3) The Weed Seed Free Feed and Straw program is a Forest and Region-wide requirement.
 - (4) The Off Highway Vehicle (OHV) amendment for Region One was implemented in January 2001. Off road or trail use by OHV is restricted and will reduce an important vector of weed spread. The first year focused on public education of riders in the field. In 2002 the enforcement phase of the amendment resulted in more enforcement, resulting in citations and warnings.
 - (5) Timber sales and other activities utilizing mechanical equipment off roads require that off-road equipment be washed prior to entering sites on the Gallatin National Forest.
 - (6) Each Ranger District Office provides a wide array of information on noxious weed identification, prevention, and control. In addition, most trailheads are posted with information about weed identification and the requirement to use only certified noxious weed seed-free feed for livestock.
 - (7) Field employees will continue to be trained in identification of invasive weeds.

CHAPTER 2 ALTERNATIVES CONSIDERED

SUBSTANTIVE CHANGES BETWEEN DRAFT AND FINAL EIS

- 1) Table 2-4 “Access” was removed as a trade name for picloram, because it is not registered for use in Montana.
- 2) Added a column in the Environmental Protection Measure Table 2-11 to address the goal and effectiveness for each of the mitigation measures.
- 3) Removed redundant mitigation measures, or statements that only described the alternative and were not truly mitigations measures.
- 4) Modified some mitigation measures to incorporated suggestions received by the public.
- 5) Modified some mitigation measures to clarify or better define the activity.

INTRODUCTION

Chapter 2 provides information on how the public was involved in providing comments on this Project, how the alternatives were developed, and a description of how issues and alternatives were addressed in this document. This is followed with a description of the four alternatives that are studied throughout the document, a description of adaptive management, a brief economic comparison of the alternatives, and a list of mitigation measures. A summary comparison and maps of the four alternatives can be found at the end of the chapter.

PUBLIC INVOLVEMENT IN THE DEVELOPEMTN OF THE DRAFT EIS

A public scoping letter was sent to more than sixty interested citizens or agencies on December 18, 2002 asking for comments on the Gallatin National Forest invasive weed control proposal. A Notice of Intent to prepare an EIS on this proposal was published in the Federal Register on January 17, 2003. Publication of the Notice of Intent initiated a public scoping period that ended February 28, 2003. A Legal Notice was also published in the Bozeman Chronicle on January 12, 2003. In total, written comments were received from EPA and the Ecology Center, during the scoping period.

Comments received during scoping were evaluated to determine potential issues, and then the identified issues were categorized according to relevance, to the purpose and need. The categories included: significant issues; concerns; and issues beyond the scope of the purpose and need for this project (see project file for content analysis on scoping letters). Also, included in the content analysis are those suggestions for mitigation measures, monitoring recommendations, and alternatives. Significant issues were used to develop a range of alternatives to the proposed action. Concerns were used to help define the scope of analysis. Issues that were considered outside the scope of the EIS are described in this chapter, along with alternatives that were dismissed from detailed analysis. Mitigation measures and monitoring that were identified from scoping are listed near the end of this chapter.

ALTERNATIVE DEVELOPMENT PROCESS

Comments from the public and from the Gallatin National Forest resource specialists were used to determine issues of concern that could result from implementing the proposed action. The following issues were considered to be significant because there is uncertainty regarding the

effects of the proposed action. The best way to analyze the issues, are through the development of alternatives, which display the effects and trade-off between different alternative actions. The effects are measured by an “Issue Indicator,” and are summarized in the “Summary Comparison of Alternatives” Table 2-13 at the end of the chapter, and also discussed in Chapter 4.

The issues that drove the development of different alternatives include the concern of potential impacts of herbicide on human health, the potential effects of herbicides on wildlife and aquatic resources, and the potential effects of aerial application. In response to these issues four alternatives were developed: Alternative 1 - Proposed Action Alternative (included the use of both ground and aerial application of herbicide); Alternative 2 - No Herbicide Alternative; Alternative 3 - No Action (no change from current management decision covered under the 1987 Gallatin Noxious Weeds EIS and the 1992 East Dam Spotted Knapweed EA); and Alternative 4 - No Aerial Application Alternative.

ISSUES USED TO EVALUATE ALTERNATIVES

Key Issue 1: Potential effects of herbicides on Human Health-

A letter received from The Ecology Center was concerned with potential impacts on human health from the use of herbicides to control weed infestation. More specifically they were concerned about chronic toxicity, effects on endocrine disruption, and the lack of available data regarding synergistic and low-dosage effects. Also, they wanted to know how people who are sensitive to herbicides would be protected.

Potential effects on human health from herbicides use have been addressed and considered by the EPA (Environmental Protection Agency), as well as by the Forest Service. A list of documents assessing risk to human health is contained in the Human Health section of Chapter 4.

Issue Indicators:

- Potential for exposure in excess of safe reference dose.

Key Issue 2: Potential Effects Of Aerial Application of Herbicides-

The Ecology Center expressed concern about herbicide drifting from treatment areas into riparian areas, streams, and other lands with unintended consequences. The specific concern was that aerial applied herbicides could not be effectively controlled. Aerial application has a greater risk for drift and collateral damage to non-target species than does ground application.

Issue Indicator:

- Potential for spray drift.

Key Issue 3: Potential Effects of Herbicides on Aquatic Resources-

Both the Ecology Center and the Environmental Protection Agency expressed concern about the effects of herbicides on water quality and aquatic organisms (fisheries, insects and amphibians).

Issue Indicator:

- Impacts that exceed regulatory compliance thresholds;
- Potential impact of herbicides to non-target resources.

Key Issue 4: Potential Effects of Herbicides on Wildlife-

The Ecology Center expressed concern about the effects of herbicides on wildlife, and the risk of bio-accumulation of herbicides within the environment.

Issue Indicator:

- Impacts that exceed regulatory compliance thresholds;
- Potential impact of herbicides to non-target resources.

ISSUES AND ALTERNATIVES NOT STUDIED IN DETAIL

A few issues that were raised during the scoping period but were not analyzed in detail because: 1) there are no direct or indirect effects from the proposed action; 2) the issue is outside the scope of decision; or 3) past research and analysis show no significant effects for similar actions.

Several alternatives for the proposed project were considered but eliminated from detailed analysis. Reasons for their dismissal include not meeting project purposes and needs; not meeting CEQ (NEPA) guidelines of being reasonable, feasible, and viable; not differing substantially from other alternatives being analyzed in detail; being beyond the scope of the EIS; and/or not complying with current laws, regulations, policies, and Forest Plan direction.

Prohibit all activities that spread weeds. An alternative that alters or eliminates activities that provides vectors for weed infestation and spread, was identified by the public during scoping for consideration as an alternative to be analyzed in the EIS. The intent of the alternative is to address and take action on human activities that promote the spread of weeds, specifically, close roads, alter or eliminate authorized livestock grazing permits, existing timber, mining and recreational Off-Highway Vehicle (OHV) activities. These human uses and activities are authorized through previous decisions made in the Record of Decision for the Gallatin National Forest Plan, which incorporates requirements of several public land laws and regulations authorizing multiple uses on National Forest Systems lands. Taking action on activities, authorized under existing public laws, regulations, permits, and the Gallatin Forest Plan, which may contribute to the spread of weeds, is beyond the scope of this EIS. All existing activities are periodically re-authorized or terminated, and will be evaluated for risk to weed spread at that time; if necessary, will require additional mitigation measures to address this concern.

No Weed Treatment. An alternative that discontinues the current weed management program was considered but eliminated from detailed analysis because it does not meet the project's purpose and need, does not comply with the Forest Service's Integrated Pest Management program, is inconsistent with Forest Service policy that noxious weeds and their adverse effects

be managed on National Forests, and violates federal and state laws and executive orders. It also would be irresponsible of the Forest Service to ignore weeds on the Gallatin National Forest when their presence may impact weed control on adjacent private and public lands.

Use herbicide only after other treatment methods failed. Other alternatives also eliminated from detailed analysis included mechanical, vegetative, biological, and combinations of treatments followed by herbicides application if these treatments are unsuccessful. This alternative was eliminated because there is concern that if the non-herbicidal treatments fails and some time passes before this failure is determined, the subsequent weed infestation may have expanded substantially beyond the original acreage, thus further impacting forest resources. The need for increased follow-up herbicide treatments would then have greater potential impacts than the original action. Such an occurrence would not be consistent with meeting project purposes and needs.

ISSUES AND ALTERNATIVES CONSIDERED IN DETAIL

In addition to the key issues identified earlier other concerns were expressed and mitigation measures were developed that reduces their significance. These concerns analyzed in Chapter 4, include the following:

- Effects of weeds and weed treatment on native vegetation, and sensitive plants;
- Effects of herbicide use on soils and groundwater quality;
- Effects of weed treatment on wilderness, wilderness study areas, inventoried roadless areas, wild and scenic rivers, and research natural areas; and
- Effects on recreation users.

ALTERNATIVES CONSIDERED IN DETAIL

Alternative 1 – Proposed Action

The Gallatin National Forest proposed weed control on 13,260 acres (10,600 acres noxious weeds, 1,995 acres invasive plants, and 665 acres tall larkspur control). Actual treatment would provide for:

- 5,179 acres ground herbicide application;
- 255 acres aerial herbicide application;
- 4985 acres biological control (herbicide treatment would be used along the perimeter and small patches to contain the weeds);
- 41 acres pulling (herbicides may be used to reduce plant density to low levels, then pull isolated plants);
- 2135 acres cultural (herbicides or grazing may be used to reduce plant density then plant more desirable vegetation);
- 665 acres of larkspur control through herbicide, fertilizing, mineral supplement, sheep grazing, and supplementing native biological control agents.

Implementation would occur over a 5 to 15 year period. Every acre would not be treated every year. Acres treated would depend on available funding and on a priority rating system described in Table 2-1. Most areas would be treated repeatedly for 5 to 8 years to ensure effective control. Monitoring would be used to determine effectiveness and to identify areas that would need to be re-treatment or if treatment areas could be reduced based on effectiveness of previous treatments.

Table 2-2 has a current list of invasive plants that would be treated. Under Alternatives 1, 2 and 4 the list would be updated as new plants are recognized as a threat to the ecosystem. Alternative 3 is limited to the plants listed in the 1987 Gallatin Forest Noxious Weeds Control EIS, and the 1992 East Dam Spotted Knapweed Infestation EA (i.e., spotted knapweed and leafy spurge). Tall larkspur control would occur separately on a case-by-case basis between the allotment permittee and the responsible District Range Management Specialist.

Table 2-1. Gallatin National Forest Weed Treatment Priority Rating System.

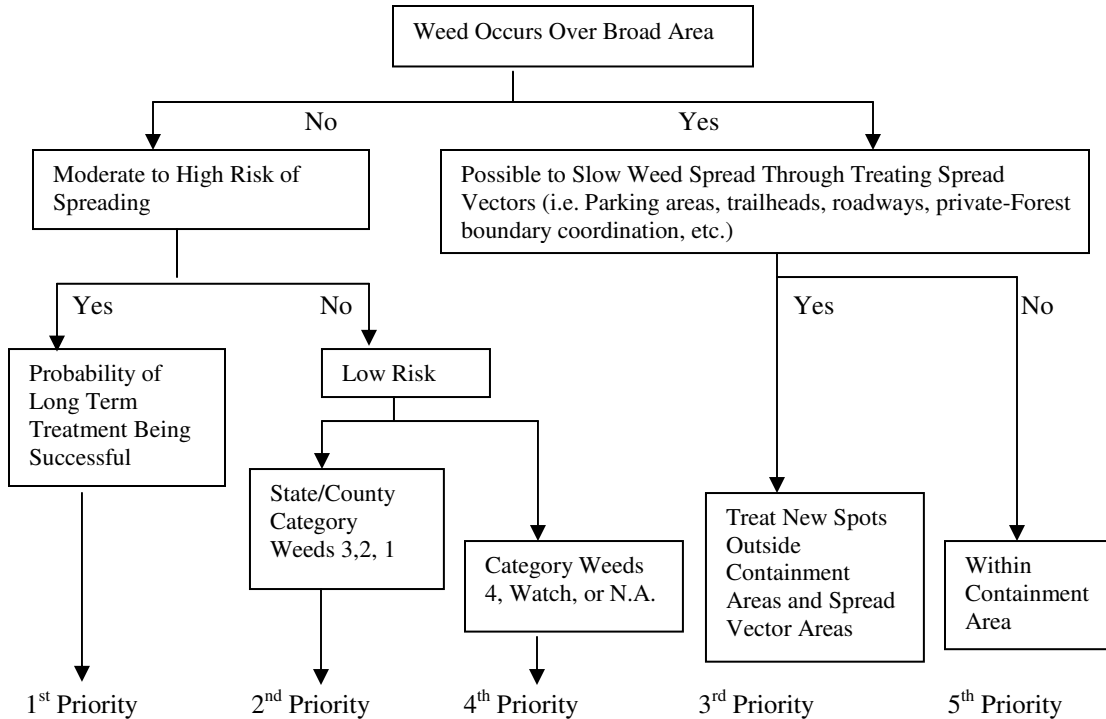


Table 2-2. Invasive Plant Species List as of 2004. This list will change as new plants are determined to be a threat to the ecosystem.

Montana State Noxious Weed List -2003		County Noxious Weeds (combines Carbon, Gallatin, Madison, Meagher, Park, and Sweet Grass Counties) and additional invasive plants for the Gallatin National Forest	
Common Name	Scientific Name	Common Name	Scientific Name
Category 1*			
Canada thistle	<i>Cirsium arvense</i>	common burdock	<i>Arctium minus</i>
common tansy	<i>Tanacetum vulgare</i>	common cocklebur	<i>Xanthium strumarium</i>
Dalmatian toadflax	<i>Linaria dalmatica</i>	black henbane	<i>Hyoscyamus niger</i>
diffuse knapweed	<i>Centaurea diffusa</i>	field scabious	<i>Knautia arvensis</i>
field bindweed	<i>Convolvulus arvensis</i>	meadow knapweed	<i>Centaurea pratensis</i>
hounds-tongue	<i>Cynoglossum officinale</i>	mullien	<i>Verbascum thapsus</i>
leafy spurge*	<i>Euphorbia esula</i>	musk thistle	<i>Carduus nutans</i>
ox-eye daisy	<i>Chrysanthemum leucanthemum</i> or <i>Leucanthemum vulgare</i>	poison hemlock	<i>Conium vulgare</i>

Montana State Noxious Weed List -2003		County Noxious Weeds (combines Carbon, Gallatin, Madison, Meagher, Park, and Sweet Grass Counties) and additional invasive plants for the Gallatin National Forest	
St Johnswort (goatweed) Spotted knapweed ⁺	<i>Hypericum perforatum</i> <i>Centaurea maculosa</i> or <i>C. biebersteinii</i>	absinth wormwood	<i>Artemisia absinthium</i>
sulfur cinquefoil Russian knapweed	<i>Potentilla recta</i> <i>Acroptilon repens</i> or <i>Centaurea repens</i>	bull thistle cheat grass	<i>Cirsium vulgare</i> <i>Bromus tectorum</i>
yellow toadflax (butter and eggs) white top (hoary cress)	<i>Linaria vulgaris</i> <i>Cardaria draba</i>	golden chamomile	<i>Anthemis tinctoria</i>
Category 2 *		perennial sowthistle plumeless thistle	<i>Sonchus arvensis</i> <i>Carus acanthoides</i>
dyer's woad meadow hawkweed complex orange hawkweed perennial pepperweed purple loosestrife	<i>Isatis tinctoria</i> <i>Hieracium pratense</i> , <i>H. floribu</i> <i>Hieracium aurantiacum</i> <i>Lepidium latifolium</i> <i>Lythrum salicaria</i> or <i>L. virgatum</i>	scentless chamomile white bryony tall larkspur	<i>Anthemis arvensis</i> <i>Bryonia albas</i> <i>Delphinium occidentale</i>
tall buttercup tamarisk tansy ragwort	<i>Ranunculus acris</i> <i>Tamarix spp</i> <i>Senecio jacobaea</i>		
Category 3*			
common crupina Eurasian milfoil yellow flag iris yellow starthistle rush skeletonweed	<i>Crupina vulgaris</i> <i>Myiophyllum sibiricum</i> <i>Iris pseudacorus</i> <i>Centaurea solstitialis</i> <i>Chondrilla juncea</i>		

*Categories of weeds are based upon their distribution across the State. Category 1 weeds are currently established and generally widespread in many counties of the State. Category 2 weeds recently introduced or rapidly spreading from current infestation sites. Category 3 weeds are those not detected or found only in small, scattered, localized infestations.

⁺Only plants treated in Alternative 3, the 1987 Gallatin Noxious Weed Control EIS and Record of Decision emphasized only these two species. The 1992 East Dam Spotted Knapweed Infestation EA only addressed spotted knapweed.

A summary of the different treatment types for each alternative is provided in Table 2-3. Maps are included at the end of this chapter.

Table 2-3. Treatment Acres (gross area) for all Alternatives.**

Alt.	Biological control*	Cultural*	Mechanical*	Herbicide	Aerial	Tall Larkspur	No Treatment
1	4985	2,135	41	5,179	255	665	0
2	7,622	2,017	130	0	0	665***	2,826
3	535	0 ⁺	281 ⁺	346	0	0	11,538
4	5,086	2,135	41	5,179	0	665	153

** Some acres are counted more than once because more than one species is present on the same site and each species may have unique treatment strategy.

* For all alternatives except Alternative 2, herbicides would be used in conjunction with biological, culture and mechanical control methods.

⁺ In the 1987 Noxious Weed EIS cultural treatments were grouped with mechanical treatments, as they are here.

*** No herbicides or fertilizers would be allowed but Silent Herder® mineral and native biological control supplementation would be permitted.

Under Alternatives 1, 2 and 4, new weed infestations could be treated provided that the steps identified in the Adaptive Management section are followed. All infestations would use the priority decision process outlined in Table 2-1 to determine the type of treatment (e.g. high priority areas would receive treatments with a high level of effectiveness, while low priority treatments might use biological control agents that may have a lower level of effectiveness) on each weed infestation. Likewise, all infestations would use Table 2-6 to determine the appropriate treatment for new weed sites. If the weeds are in the Wilderness, then Wilderness Minimum Tool Guidelines found in Appendix C would be used.

One feature of Alternatives 1 and 4 is the flexibility to use updated agents as they are registered and approved by the EPA. All herbicides would be applied according to label specification; or when additional mitigation is required by Forest Service policy as described in this chapter. Impacts on soil and water would be mitigated to meet Montana Water Activities and Pesticide Application Requirements, Northern Region Soil and Water Standards, and Gallatin Forest Plan Standards. Table 2-4 lists some of the herbicides addressed in this document.

Table 2-4. EPA Registered Herbicides Available for Control under Alternatives 1 and 4. Alternative 3 Would Use Only 2,4-D and Picloram.

Common Name	Partial List of Trade Names	Target Weed Species (general)
2,4-D*	Hi-Dep®, Weedar 64®, Weed RHAP®, Amine 4®, Aqua-Kleen	thistles, sulfur cinquefoil, dyers woad, knapweeds, purple loosestrife, tall buttercup, whitetop knapweeds
Chlorsulfuron	Telar®	dyer's woad, thistles, common tansy, houndstongue, whitetop, tall buttercup
clopyralid	Stringer®, Curtail®, Transline®, Redeem®	thistles, yellow starthistle, hawkweeds, knapweeds, rush skeletonweed, oxeye daisy
dicamba	Banvel®, Clarity®, others	houndstongue, yellow starthistle, common crupina, hawkweed, oxeye daisy, tall buttercup, blueweed, leafy spurge, tansy ragwort, knapweeds,
glyphosate	Roundup®, Rodeo®, Accord®, Glyphomate®	purple loosestrife, field bindweed, yellow starthistle, thistles, cheatgrass, common crupina, toadflax,
Hexazinone	Velpar®, Pronone 10G®	cheatgrass, oxeye daisy, yellow starthistle, thistles
Imazapyr	Arsenal®, Chopper®	dyers woad, field bindweed
Methsulfuron methyl	Escort, Ally	houndstongue, thistle, sulfur cinquefoil, common crupina, dyers woad, purple loosestrife, common tansy, whitetop, blueweed
Picloram*	Tordon®, Grazon®, Pathway®	thistles, yellow starthistle, common crupina, hawkweeds, knapweeds, rush skeleton weed, common tansy, toadflax, leafy spurge
Imazapic	Plateau®	cheatgrass, leafy spurge, toadflax
Sulfometuron methyl	Oust®	cheatgrass, whitetop, oxeye daisy, tansy ragwort, musk thistle
Triclopyr	Garlon®, Redeem®, Remedy®	hawkweed, sulfur cinquefoil, purple loosestrife, knapweed, oxeye daisy, thistle

Herbicides Treatments –

Herbicide selection would be based on environmental conditions such as groundwater depth, soil type, non-target vegetation, and management objectives. Table 2-5 displays examples of herbicides proposed for use and a range of application rates. Herbicide selection considers the following criteria:

- Herbicide label considerations;
- Herbicide effectiveness on target weed species;

- Proximity to water or other sensitive resources;
- Soil characteristics;
- Potential unintended impacts to non-target species such as conifers or shrubs;
- Application method (aerial, ground, or wick applicator);
- Other weed species present at the site, and effectiveness of herbicides on those species (for example spotted knapweed infestations with inclusions of toadflax);
- Adjacent treatments (total quantity of herbicide used within a 6th order hydrologic unit – as outlined in Appendix D);
- Timing of treatments (spring/fall); and
- Priority weed – new invaders vs. existing.

Table 2-5. Herbicide Application Rates and Timing.

Weed Species	Plant biology	Herbicide	Rate	Application Timing
Spotted knapweed Diffuse knapweed Yellow starthistle	Tap root	Tordon®	1 pint/ac	Active growth
		Curtail®	2 quarts/ac	Bolt to early bud; fall
		Transline®	2/3 pint/ac	
		2,4-D	1 quart/ac	Rosette to bolt
Sulfur cinquefoil	Tap rooted	Tordon®	1 pint/ac	Active growth
		2,4-D	1 quart/ac	Rosette to bolt
St. Johnswort	Perennial/Deep-root Rhizominous	Tordon®	1 pint/ac	Pre-bloom
		2,4-D	1 quart/ac	Seedling/pre-bloom
Canada thistle	Perennial/Deep-root Rhizominous	Tordon®	1 pint/ac	Late bolt pre-bud
		Curtail®	2 quarts/ac	Bolt - early bud
		Tarnsline®	2/3 pint/ac	Bolt to pre-bud
		2,4-D	1 quart/ac	Bolt
Musk thistle	Tap rooted	Tordon®	1 pint/ac	Rosette to bolt. Fall rosette
		Curtail®	2 quarts/ac	
		Tarnsline®	2/3 pint/ac	
		2,4-D	1 quart/ac	Rosette to bolt
Leafy spurge	Perennial/Deep-root Rhizominous	Tordon®	1 quart/ac	Full flower/fall
		Plateau®	8-12 oz/ac	Fall prior to frost
		2,4-D	1 quart/ac	Full flower
Dalmatian toadflax/yellow Toadflax	Perennial/Deep-root Rhizominous	Tordon®	1 to 2 pint/ac	Flower / fall
		Plateau®	8/10 oz/ac	Fall prior to frost
		Telar	1.5 oz/ac	Spring/fall
		2,4-D	1 to 2quarts/ac	Flower
Houndstonge	Perennial/tap root	Escort®	0.25-0.5 oz/ac	Rosette to bolt
		Telar®	1 oz/ac	Fall
		2,4-D	1 quart/ac	Rosette
Common tansy	Perennial/ Rhizominous	Escort®	0.3-1.0 oz/ac	Full flower/fall
		2,4-D	1 quart/ac	Full flower
Oxeye daisy	Perennial/Shallow – rooted / Rhizominous	Tordon®	1 pint/ac	Late bud/early bloom
		Escort®	0.05 oz/ac	
		2,4-D	1 quart/ac	
Russian knapweed	Perennial/Deep-root Rhizominous	Tordon®	1 pint/ac	Fall, early bud
		Curtail®	2 quarts/ac	Early bud
		Transline®	1 pint/ac	Early bud
		2,4-D	1 quart/ac	Early bud

Weed Species	Plant biology	Herbicide	Rate	Application Timing
Hawkweeds	Perennial/Rhizominous	Curtain®	2 quarts/ac	Rosette to bolt
Tansy ragweed	Perennial/fibrous root	Transline®	1 pint/ac	Rosette to bud; fall
Whitetop	Perennial/ Rhizominous	Escort®	03.-0.5 oz/ac	Rosette to pre-bud
		2,4-D	1 quart/ac	Rosette
Cheatgrass	Annual/fibrous root	Glyphosate	2-4 oz/ac	Early –pre-root development
Tall buttercup	Fibrous/Tap rooted	2,4-D	2 quarts/ac	Rosette to bolt
		Clarity	1 quart/ac	
Tall larkspur	Perennial/Tap Rooted	Tordon	1 quart/ac	Rosette to bolt
		Escort	.8-1.6 oz./ac	

Note: these are the most commonly used herbicides and rates are examples. In all cases, application rates would be those indicated on herbicide labels or less. On going testing may result in new instructions on rate and target species.

Herbicides, like biological control agents, go through an extensive screening and testing process before they are registered and approved for use, by the U.S. EPA. Initial pesticide registrations with the EPA typically require a minimum of 120 tests, take seven to ten years to complete, and cost between \$30 and \$50 million. Herbicide labels have the force of law and include safe handling practices, application rates, and practices to avoid undesirable impacts to humans and the environment.

Chemical treatments would include both ground and aerial herbicide applications, in compliance with the mitigation measures listed in this document. Chemical applications would take place at the appropriate time of year for targeted weed species and incorporate environmental considerations such as proximity to raptor nests or other resources of concern. Equipment for spraying includes the use of helicopters, trucks, ATVs, horses, backpack sprayers, and other hand held application equipment. Herbicides proposed for use include picloram, 2,4-D, clopyralid, dicamba, glyphosate, imazapyr, imazapic, hexazinone, chlorsulfuron, imazapic, metsulfuron methyl, sulfometuron methyl, and triclopyr. Following the Adaptive Management Strategy, other herbicides permitted by the EPA and registered for use by the Montana Department of Agriculture may be used when they become available, if the herbicide is water soluble and less environmentally persistent than picloram. This would occur after interdisciplinary review and line officer approval.

Surfactant adjuvant would be used in certain situations to increase efficacy, primarily on target species with a waxy cuticle (especially toadflax), or when temperature and humidity are not optimal (but still within label and more locally-prescribed limits) yet other conditions, such as plant growth stage, are ideal. Surfactants may be used during period of drought. Surfactants proposed for use would follow the same mitigation measures as picloram. Only those labeled for use in and around water would be used within 50 feet of water, or the edge of sub-irrigated land, whichever distance is greater, or on high run-off areas. Some surfactants are labeled for use in and around water including Activate Plus®, LI-700®, Preference®, R-11®, Widespread® and X-77®.

Areas with aerial applications would also include ground applications, to treat buffer areas and skipped areas. These areas are estimated at 5 to 10 percent of the aerial treatment acres. Based on monitoring, follow-up aerial and ground treatments are expected to occur on third and fifth years after initial treatment, as portions of the dormant seed or root system propagate. Based on previous experience with weed treatments, it is likely that the treatment areas would then enter “maintenance mode” where spot treatments of infestations would continue to occur until weeds are eradicated. Aerial application would not be in designated wilderness areas, research natural areas, or near sensitive area (such as near water or sensitive plants). Sites identified for aerial

treatment are either not accessible by roads (previous roads have been decommissioned) or have steep slopes which make the walking difficult.

Improper aerial application would not be allowed. All herbicide applicators would follow label instructions. A field inspector would be on-site during all aerial applications to monitor drift and compliance with label specification. Label information is available in the Project File and at <http://npic.orst.edu/tech.htm>, an Environmental Health Reference and Resource Materials website.

Ground applied herbicide treatments would occur in areas where there is good access, a manageable size of infestation, and available funding.

Biological Control Treatments –

Existing and newly approved biological controls would be introduced where appropriate. Some of the biological control agents in use are: thistle seed head beetles (*Ceutorhynchus litura*), knapweed seed head gall flies (*Urophora affinis*, *U. quadrifasciata*, and *Larinus minutus*), knapweed root feeding insect (*Agapeta zoegana*, and *Cyphocleonus achates*); leafy spurge flea beetles (*Aphona czwalilnae* and *A. lacertoa*); toadflax root boring beetles (*Mecinus janthinus*); and toadflax seed head beetles (*Gymnetron linariae* and *Brachyperolus pulicarius*) and a defoliating moth (*Calophasia lunula*). As of yet, only leafy spurge has a biological control agent that can substantially reduce plant density in a wide variety of sites. Sites with both large number of acres (more than 25 to 50 acres) and with weed species that have an effective agent would be managed with biological control. Since biological control agents are usually very slow to establish and would never eradicate its host, these sites would need to be contained with the use of herbicides.

Cultural Treatments –

Cultural treatments, such as selective grazing or reseeding, would occur on sites where the native vegetation lends itself to this type of treatment. Herbicides may be used to reduce the density of weeds prior or along with reseeding. Weed managers identified four areas were as being appropriate for cultural treatment:

- 1.) Durham meadow (T6S, R5E, Sec 12) in the Gallatin Canyon would see a change in grazing (from horses to high intensity short duration cattle grazing), followed with herbicide treatments, fertilization and re-seed to native grass (till and drill-seed into old fields);
- 2.) Gardiner valley (numerous locations) cheat grass and crested wheatgrass would be treated with herbicide and then planted with native grasses (till and drill-seed into old fields);
- 3.) Re-vegetate (plant with native grasses, shrubs and cottonwoods) an abandon gravel pit (T12S, R5E, Sec 17) after herbicide treatment; and
- 4.) Plant native grass and forbs after spraying orange hawkweed at Lonesomehurst summer-homes (T13S, R4E, Sec 33) near West Yellowstone.

Most of the other weed sites currently have an adequate source of native plants and do not require additional seeding with native species.

Mechanical Treatments -

Mechanical treatments, such as hand pulling, would occur on particularly sensitive areas, or areas of small infestations. Hand pulling is minimally effective on plants that spread via roots because the soil needs to be excavated repeatedly to remove all root fragments. Sites less than 0.1 acre with non-rhizomatous species and low weed density would be hand pulled. On some sites herbicides would be used in conjunction with pulling to help reduce plant density so that pulling is cost efficient.

Alternative 2 – No Herbicide

This alternative was requested by the public and describes a weed control program that does not use herbicides. Under Alternative 2 the following activities would occur: 130 acres of mechanical treatments (hand pulling); 2,017 acres cultural treatments (grazing and seeding with native plants); 7,622 acres with biological control agents; and 665 acres tall larkspur controlled with Silent Herder ® mineral and biological control agents. This alternative would also result in 2,826 acres not being treated for the following reasons: (1) currently no approved biological control agent; (2) weed patch is too large and can not be hand pulled because of lack of resources; and/or (3) the plant spreads via roots and extensive soil disturbance is not acceptable.

The effectiveness of these treatments is diminished because weed density would not be controlled with herbicides. Mechanical treatments would only occur in areas with low weed density (a few weeds per acres) for maximum cost effectiveness. Cultural treatments, such as seeding native plants without removing the weeds would cause a decrease in seedling survival due to plant competition. Biological control agents that are currently available would only reduce the plant density of a few weed species (most agents have not been effect as of yet) and would not prevent the weeds from spreading into new areas.

Alternative 3 – No Action, No Change from Current Weed Treatment

This alternative is the same as current management practices covered by previous NEPA decisions. No additional herbicide treatment would occur outside of those areas identified in the 1987 Gallatin National Forest Noxious Weeds Control EIS and the 1992 East Dam Spotted Knapweed Infestation EA. Alternative 3 would only treat spotted knapweed and leafy spurge on 346 acres with herbicides (only 2,4-D and picloram), treat 281 acres using mechanical and cultural treatments (the 1987 Noxious Weeds EIS combined these activities), and treat 535 acres with biological control agents. This Alternative would not treat 11,433 acres because they were not covered in previous environmental analysis.

Alternative 4 - No Aerial Treatment

This alternative is the same as Alternative 1 except that the aerial treatment sites would not be treated. Alternative 4 would treat 5086 acres with biological control (herbicides would also be used to contain the weeds), 2,135 acres using cultural treatments (grazing and seeding, herbicides would also be used to improve the effectiveness of the treatment), 5,179 acres using herbicide treatment, and 41 acres using mechanical treatment (herbicide may be used to decrease plant density prior to pulling). This alternative would not treat 153 acres because biological control insects are not available for the weeds present on the site, and access is too difficult for ground application of herbicide.

ADAPTIVE MANAGEMENT APPROACH

The following adaptive management strategy applies to Alternatives 1, 2 and 4, and is made up of two principle components:

1. To quickly and effectively treat newly discovered weed infestations, a decision tree based on site characteristics, weed species, and location would be used to select treatment methods (see Table 2-6).

Using an adaptive management approach would allow for treatment of new sites or new species without a lengthy delay while still addressing other resource concerns. Although treatments of noxious weeds are expected to be effective in reducing existing weed infestations, all infestations cannot be treated immediately due to budgetary and logistical constraints. Existing infestations will expand before they can be treated, and new areas will be identified. Since every acre of the Gallatin National Forest has not been inventoried for weeds many existing sites have yet to be identified. Also, new invasive weed species may be added to the invasive weed list and they will be incorporated into this analysis.

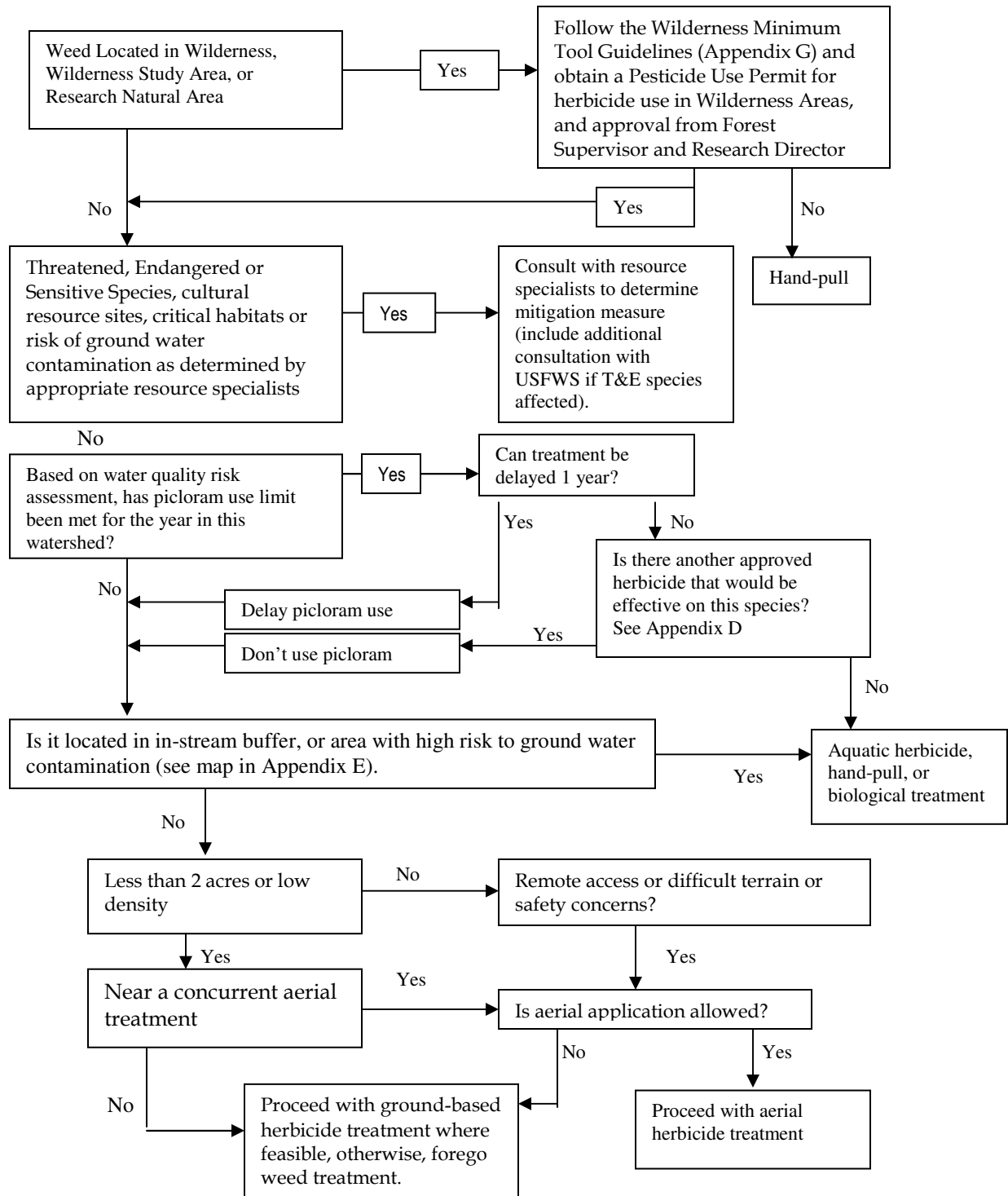
For analysis purposes, the EIS included a possible 25 percent increase in acres that may need treatment within the next 15 years (approximate life span for this EIS). For example, this means that Alternative 1 can treat up to 16,575 acres and still be covered under the analysis completed for this EIS. All new sites will need to be mapped and inventoried, and will need to follow the Decision Tree shown in Table 2-6 (next page).

- The decision (if and how) to treat newly discovered infestations would be driven by the Decision Tree for New Weed Locations as shown in Table 2-6;
- New invaders, should be given high priority for eradication, if feasible;
- New infestations may be treated with herbicide as long as the acres treated remain within the limits described above and adhere to all mitigation measures in this document; and
- Use appropriate methods and environmental protection measures described above.

2. To improve effectiveness and reduce impacts, new technologies, biological controls, or herbicides would be evaluated for use.

New technology, biological controls, herbicide formulations, and supplemental labels are likely to be developed within the next 15 years. These new treatments would be considered when there are indications that they would be more weed-specific than methods analyzed here, less toxic to non-target vegetation, less toxic to people, or less persistent and less mobile in the soil. Newly registered, water-soluble herbicides that display toxicity, leaching, and persistence characteristics less than or equal to picloram may be used. The Adaptive Management Strategy would allow incorporation of these new treatment methods:

- The decision by the line officer to use a new treatment method would be driven by an interdisciplinary review to confirm that the new treatment method is within the scope of the analysis in this EIS, and complies with a site characteristic evaluation (Table 2-6);
- New herbicides or formulations registered and approved by the US Environmental Protection Agency, which would be applied according to label specifications;
- New biological control agents approved by Animal Plant Health Inspection Service; and
- New mechanical or cultural methods of treatments as developed. These methods would be reviewed before use to determine impacts to other resources.

Table 2-6: Decision Tree for New Weed Locations.

ECONOMIC COMPARISON

This decision is about how to, not whether to, manage weeds on the Gallatin National Forest. This section provides the decision maker with comparative information on the relative costs per acre of the alternatives. The figures are taken from expenditures supplied by District weed coordinators. Since there is a lot of variability on how to calculate the per acre costs, the figures presented in the table are intended for relative comparison only:

Table 2-7. Estimated Cost Comparison.

Treatment	Direct Cost per Acre
Manual (Hand Pulling, Digging, etc.)	\$400
Ground Applied Herbicide	\$100
Aerial Applied Herbicide	\$40
Biological Control	\$150
Cultural (Grazing, Burning, Planting, etc.)	\$250

Hand pulling is the only manual control practical on many parts of the forest. Four people can pull an acre of weeds in one day and the Forest Service commonly assigns this work to seasonal employees at the GS 3, 4 and 5 wage levels. A total cost per acre of \$400 dollars is representative of the Forest's experienced costs on many of the more lightly infested sites.

Ground application commonly involves spraying an herbicide from a vehicle, usually a pick-up truck or an ATV. Experienced costs for ground application are approximately \$80 per acre to apply Tordon 22-K®, the herbicide most commonly used on the Forest for spotted knapweed. Backpack sprayers cost a minimum of \$200 per acre. This system is used less frequently than trucks or ATV's, and the production rate (acres treated per hour) is less because applicators have to walk between weeds, often on steep slopes. Difficult access increases the costs of both systems and access is frequently the limiting factor determining whether a site can be treated from a vehicle or on foot. For this comparison, a value of \$100 per acre represents the Forest's experienced costs.

Aerial application costs include both fixed wing and helicopters. This analysis uses a value of \$40 per acre since the areas to be treated tend to be small and few areas have been identified as suitable for aerial treatment.

Biological control agents in general have not been in place long enough to show results on an area basis. The Gallatin averages about \$750 per site or \$150 per acre to collect and release insects, and then monitor for establishment and effectiveness.

Cultural work includes the use of fire, grazing, mowing, seeding and other activities that aid in achieving weed defense. A value of \$250 per acre will be used in this analysis.

The following table displays the suitable treatments acres, generated by GIS analysis of vegetative data, by treatment method and Alternative:

Table 2-8. Summary of Annual Direct Weed Control Acres by Method. (Since the proposed larkspur treatment is a combination of ground applied herbicide, biological control and cultural control, these acres were not incorporated into the economic analysis).

Alternative	Manual	Ground Applied	Aerial Application	Biological Control	Cultural	Total Annual Treatments	Percent of GNF 1,800,000 ac)	Percent of GNF Weed Base (12,595 ac)
Alternative 1	41	5179	255	4985	2135	12595	0.7	100.0
Alternative 2	130	0	0	7622	2017	9769	0.5	77.5
Alternative 3	281	346	0	535	0	1162	0.06	9.2
Alternative 4	41	5179	0	5086	2135	12441	0.7	98.7

The following table displays the relative costs per acre, by Alternative:

Table 2-9. Relative Cost per Acre by Alternative.

Treatment	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Manual	\$16,400	\$52,000	\$112,400	\$16,400
Ground Applied	\$517,900	\$0	\$34,600	\$517,900
Aerial Application	\$10,200	\$0	\$0	\$0
Biologic Control	\$747,750	\$1,143,300	\$80,250	\$762,900
Cultural	\$533,750	\$504,250	\$0	\$533,750
Total	\$1,826,000	\$1,699,550	\$227,250	\$1,830,950
Relative Cost per Acre	\$145	\$174	\$196	\$147

Average appropriations for weed control are about \$225,000, annually. Expenditures are increased by various grants from partnership projects and Knutson-Vandenberg Act (KV) funds. KV dollars come from forest project funds and fluctuate with the level of activity on each District. All totaled (includes grants, special deposits, and appropriations), the average expenditure, forest-wide, per year, is approximately \$300,000.

All of the Alternatives show (Table 2-9) a total cost greater than the Forest is budgeted to accomplish on an annual basis. To give a more fiscally realistic portrayal of what the Forest weeds program could be expected to accomplish, the acreage figures in Table 2-10 were revised to (1) limit total annual costs to approximate historic budget amounts and (2) reflect the choices that have to be made when too few dollars are available to fully satisfy the objectives. The following table displays the acres by Alternative and treatment method that could be treated, assuming continuing budget support at historic levels:

Table 2-10. Summary of Annual Direct Noxious Weed Control Acres by Method (Budget Driven).

Alternative	Manual	Ground Applied	Aerial Application	Biologic Control	Cultural	Total Annual Treatments	Total Cost	Percent of GNF Weed Base (12,600 ac)
Alternative 1	1.0	2956.0	0.0	25.0	1.0	2983.0	\$300,000	23.7
Alternative 2	5.0	0.0	0.0	1985.0	1.0	1991.0	\$300,000	15.8
Alternative 3	281.0	346.0	0.0	535.0	0.0	1162.0	\$227,250	7.0
Alternative 4	1.0	2956.0	0.0	25.0	1.0	2983.0	\$300,000	23.7

The distribution of acres by treatment method and Alternative was guided by the following assumptions:

1. Table 2-10 reflects the best mix of treatment types given at this time. The Ranger Districts will update their weed priorities each year and adjust treatment priorities accordingly to maximize long-term effectiveness.
2. Aerial treatment is not considered a priority for the \$300,000 currently being budgeted, because these areas are low priority based on Table 2-1. The use of aerial application methods could very well be utilized under Alternative 1, should specific earmarked funding become available and/or issues associated with long-term effectiveness be resolved.
3. Providing for at least some early detection and mechanical pulling of small infestations remains a high priority under every alternative.
4. Cultural treatment types: grazing, burning, seeding, etc while not currently given many acres will increase as technology and native seed sources improves. Emphasis is currently directed towards those wildfire areas having a potential weed problem following a high intensity, high severity burn.
5. Current biological control agents on the Gallatin National Forest have had limited success in limiting weed spread to date. More emphasis will be given to these agents as their effectiveness and spread improves.
6. Alternative 3 – Current Management does not meet the budget ceiling. This is because the acres that can be treated reaches the legal constraint imposed by the governing environmental document (Forest Weeds EIS) before it reaches the fiscal limitation. The reported 281 acres of manual treatment includes a combination of hand pulling, digging, spot spraying, etc.

FEATURES COMMON TO ALL ACTION ALTERNATIVES

Best Management Practices for weed prevention and weed management would be included and followed (see Appendix A).

Establishing native species would be the long-term goal. On some sites, establishing a non-native stand of competitive grasses may be necessary in reducing the cheatgrass competitiveness before replacing with the more desired native species. Re-vegetation would only be used on those sites most prone to noxious weed invasion or erosion.

The Administration Travel Policy would be enforced. The policy conforms to the letter written by former Regional Forester Dale Bosworth in the Off-highway Vehicle FEIS for Montana, North Dakota, Appendix D (US BLM, 2001), regarding administrative off-road travel. The Gallatin National Forest policy states: motorized access on National Forest roads, trails, and areas closed to the public will be authorized when it is determined that such motorized use results in efficiencies and cost savings, and resource concerns are considered. Examples of types of appropriate motorized access include, but are not limited to, noxious weed spraying, fuel reduction projects, transport of fish and game species, timber management activities, resource monitoring, and administration of permits.

MONITORING

A strong monitoring program will be incorporated as part of the adaptive management approach to controlling weeds. Monitoring is the collection of data to determine the effectiveness of management actions in meeting prescribed objectives. Monitoring will focus on the: 1) density and rate of spread, and the effect these aggressive plants have on natural resources; 2) effects of herbicides on noxious weeds; 3) establishment and effectiveness of biological control agents; and 4) presence of herbicide in surface or ground water in high risk areas (accidental spills, aerial application, or areas with westslope cutthroat trout and sizable acres of weed treatment adjacent to water).

The monitoring program includes annual survey and mapping of weed populations. The maps and associated data are kept in GIS (Geographic Information System) and are consistent with the national Forest Service standards. Also, long-term growth rate plots containing yellow toadflax are established for the purpose of measuring rate of weed spread and change in plant composition over time. In addition, long-term herbicide test plots and long term biological control plots are established for the purpose of tracking the effectiveness of control.

Monitoring of aerial applications of herbicides and drift detection will include the following activities. The first aerial herbicide application of each season adjacent to sensitive resources (streams, lakes, wetlands, sensitive plants) will be monitored to determine the amount and distribution of spray drift. Spray detection cards will be placed along the perimeter of the treatment area and inside the buffer around sensitive areas. The cards will be visual examined immediately after spraying and photographed. A written summary of the drift pattern as interpreted from the detection cards and the photos will be used to document the result. If necessary, aerial application methodology will be modified (buffer size, droplet size, different weather parameters) to reduce the amount of drift.

For water quality monitoring, the Forest hydrologist or fish biologist will review the program of work and select sensitive water resources areas to monitor. Water samples will be collected immediately after spraying whenever there is reason to suspect that herbicides may have entered the stream during the spraying operation (such as herbicides detected on drift cards, or if a spill occurred). Laboratory analysis, by an independent lab, will test the water samples for herbicides. Water samples will also be collected after the first substantial rain to detect herbicides that could possibly enter surface water through leaching or runoff. Detection of any herbicide will trigger an immediate verification sampling. The use of herbicides in excess of limits defined by Montana Department of Environmental Quality (Montana Numeric Water Quality Standards, Circular WQB-7, see Appendix D for a summary table of limits set for herbicides address in this EIS) will be discontinued. Monitoring will continue (sampling intensity will be adjusted for individual site characteristics) until herbicides are no longer detected.

ENVIRONMENTAL PROTECTION MEASURES

Table 2-11 lists the environmental protection measures, the objective and effectiveness, and the applicable alternative(s). The following definitions were used for rating purposes.

High effectiveness: This mitigation measure is very effective (estimated to be at least 90 percent effective). Determination of effectiveness is based on literature; professional judgment from previous experience; or logical deduction.

Moderate: Mitigation measure is reasonably effect (estimated between 40 to 89 percent effective). Determination of effectiveness is based on literature; professional judgment from previous experience; or logical deduction. Monitor the mitigation measures effectiveness.

Low: Mitigation measure is somewhat effective (estimated at less than 40 percent).

Determination of effectiveness is unavailable or professional judgment indicates success is uncertain. Monitor the mitigation measures effectiveness.

Unknown: Effectiveness is unknown or unverified; there is little or no documentation, or applied logic is uncertain. Monitor the mitigation measures effectiveness.

Table 2-11. Environmental Protection Measures.

Protection Measure	Objective, Effectiveness, and Basis for Rating	Applied to Alternatives (s)
Aerial Application		
(1.) On each side of streams and wetlands, a 300-foot buffer will be established where aerial applications will not be allowed.	Prevent high concentration of drift from reaching wetlands; High effectiveness (USFS. 2001b. page I-8)	1
(2.) Within 300-foot aerial spray buffers, spot ground-application of herbicides may occur. Herbicide selection will be based on product label restrictions and site characteristics (such as soil type, distance to water, and weed species present). Less persistent herbicides will be used within 50 feet of streams or wetlands, and will also be based on herbicide label restrictions.	Treat weeds in buffer area while protecting resources; High effectiveness (USFS. 2001b. page I-8)	1
(3.) Aerial spray units will be ground-verified, flagged, and marked using GPS prior to spraying to ensure only appropriate portions of the unit are aerielly treated. A GPS system will be used in the spray helicopter and each treatment unit mapped before the flight to ensure that only areas marked for treatment are treated. Prior to treatment, the pilot and project manager will fly the treatment area to confirm locations.	Ensure accurate location of treatment; High effectiveness (Kulla, A. 2003. pages 11-13)	1
(4.) No aerial spraying will be allowed within Zones I and II (800 meters) of an active bald eagle nest, from February 1 to August 15.	Minimize impact to nesting eagles; High effectiveness (MT Bald Eagle. 1994. page 24)	1
(5.) No aerial spraying will be allowed within 400 meters of an active goshawk nest from April 1-August 15.	Minimize impact to nest; High effectiveness; (Reynald. 1992. page 13)	1
(6.) No aerial spraying will be allowed within 1 mile of an active peregrine falcon nest from April 1 to August 15.	Minimize impact to nesting peregrine; Highly effective (US Fish and Wildlife. 1984. page 34)	1
(7.) Only 8 hours of aerial spraying will be allowed in grizzly bear core habitat within a given Bear Management Subunit each year. Coordinated with other administrative uses to prevent recurring helicopter flight within secure habitat.	Retain function of secure habitat; High effectiveness (IGBC. 2003. page 46)	1

Protection Measure	Objective, Effectiveness, and Basis for Rating	Applied to Alternatives (s)
(8.) Aerial applications will be excluded from Research Natural Areas, Special Interest Areas, designated Wilderness, and near campgrounds or residential areas.	Avoid conflict; High effectiveness (Logical - avoids area)	1
(9.) Signing and on-site layout will be preformed one to two weeks prior to actual aerial treatment. Temporary area and road/trail closure will ensure public safety during aerial treatment.	Provide public notification and safety; High effectiveness (Logical – limits exposure to spray)	1
(10.) To reduce risk of acute effects on aquatic species, aerial spray operations will be closely monitored. Field inspectors will provide on-site monitoring for drift and label compliance. Inspectors will be trained and wearing personal protective equipment.	Ensure implementation of protective measures; High effectiveness (USFS. 2001b. page I-8)	1
(11.) Communications will be maintained between the helicopter and project leader during spraying operations. Ground observers will maintain communication with the project leader. Observers will be located at various locations adjacent to the treatment area, to monitor wind direction and speed, as well as to visually monitor drift and deposition of herbicide.	Ensure implementation of protective measures; Moderate to High effectiveness (Logical – communication improves compliance)	1
(12.) Spray cards will be placed out to 350 feet perpendicular to perennial creeks (if close by) to monitor herbicide presence.	Document herbicide disposition; High effectiveness (Kulla, A. 2003. page 10)	1
Drift Reduction		
(13.) Drift control agents may be used in aerial spraying during low humidity to reduce drift into non-target areas. Products that reduce volatility, have been shown to keep droplet sizes larger, and are appropriate adjuvant for the herbicide (as specified by labeling of both the herbicide and the drift agent, in consultation with the herbicide manufacturer) will be used. Use appropriate nozzle, spray pressure, nozzle orientation to reduce drift.	Control drift; Moderate to High effectiveness (EIS pages 4-72 to 4-73); Monitor with drift cards	1
(14.) Aerial application of herbicides will occur when wind speeds are less than 6 mph and blowing away from sensitive areas, but not during weather inversions.	Protect sensitive area; High to Moderate effectiveness (Logical – limits drift); Monitor with drift cards	1
(15.) Weather conditions will be monitored on-site (temperature, humidity, wind speed and direction), and spot forecasts will be reviewed for adverse weather conditions.	Control drift; Moderate to High effectiveness (Logical – limits drift); Monitor with drift cards	1
Herbicide Use		
(16.) Operators should calibrate spray equipment at regular intervals (approximately after every 80 to 160 hours of use) to ensure proper rates of herbicide applications.	Control Application Rates; Moderate effectiveness (Logical –check equipment); Monitor –equipment for wear	1, 3, 4
(17.) Herbicides will be used in accordance with label instructions and restrictions. Herbicides will not be applied to open water. In areas at risk to groundwater contamination use herbicides with low leachability or hand pull them (see EIS, Appendix E). Maximum amount of herbicide that could be applied in a watershed is listed in Appendix D. Application will be done or supervised by licensed applicators.	Ensure responsible application of herbicide; Moderate effectiveness (EIS pages 4-19, 4-22, & 4-23); Monitor –Daily Pesticide Application Record or similar database.	1, 3, 4
(18.) Procedures for mixing, loading, and disposal of pesticides and a spill plan will be followed. All herbicide storage, mixing,	Ensure responsible application of herbicide;	1, 3, 4

Protection Measure	Objective, Effectiveness, and Basis for Rating	Applied to Alternatives (s)
and post-application equipment cleaning is completed in such a manner as to prevent the potential contamination of any perennial or intermittent waterway, unprotected ephemeral waterway or wetland. These procedures are outlined in Appendix B. Herbicide applicators shall carry spill containment equipment, be familiar with and carry an Herbicide Emergency Spill Plan.	High effectiveness (Professional experience)	
(19.) Treatment sites will be evaluated for sensitive plants habitat suitability and suitable habitats will be surveyed as necessary before treatment. If sensitive plant surveys find invasive plants in the area, a weed control plan will be developed to help protect the sensitive plant. Provide the weed crew with maps of all known sensitive plants so that these sites can be identified and protected. Train the weed crew to identify sensitive plants so that new sites can be identified and protected. Broadcast spraying is not allowed within 100 feet of sensitive plants. Weeds within 50 feet of sensitive plants shall be treated with one of the following methods (a) Hand pulling if the resultant ground disturbance will not harm the sensitive plant. (b) Use a herbicides that do not leach into the soil (e.g., glyphosate). (c) Use herbicides when the sensitive plant is senescent; or by protecting the sensitive plant from herbicide drift by placing a physical barrier (e.g., a plastic bag) over the plant; or by using a wick applicator (wiping herbicide only on the weeds).	Avoid impact to sensitive plants; Moderate effectiveness (EIS, page 4-14) Monitor - audit treatments next to sensitive plants for impacts to sensitive plants	1, 4
(20.) In public recreation areas (such as campgrounds, and trailheads) post treated area until the area is safe to re-enter.	Inform public and reduce exposure; High effectiveness (Logical – prevent exposure)	1, 4
Surfactants		
(21.) Surfactants are proposed for use with the same mitigation as picloram (see mitigation number 32). Only those labeled for use in and around water will be used within 50 feet of water, or the edge of subirrigated land, whichever distance is greater, or on high run-off areas. Some surfactants are labeled for use in and around water such as: Activate Plus ®, LI-700 ®, Preference ®, R-11 ®, Widespread® and X-77®.	Protect Aquatic Resources; High effectiveness (EIS, page 4-23).	1, 4
Dyes		
(22.) Water-soluble colorants, such as Hi-Light® blue dye, will be used in some situations to enable applicators and inspectors to better see where herbicides has been applied.	Safe handling of herbicide; High effectiveness (Logical – visible)	1, 3, 4
Biological Controls		
(23.) Biological agents will not be released until screened for host specificity and approved by the USDA Animal Plant Health Inspection Service.	Minimize injury to non-target species; Highly effective (Logical – tested prior to approval)	1, 3, 4
Cultural Treatments		
(24.) Mitigation measures that pertain to grazing with sheep and goats are addressed in the Wildlife section below.	See wildlife section	1, 4
(25.) The timing of herbicide treatment will avoid conflict with grazing livestock as required by the herbicide label	Prevent livestock from ingesting herbicide; High effectiveness (required by herbicide label)	1, 4

Protection Measure	Objective, Effectiveness, and Basis for Rating	Applied to Alternatives (s)
Adjacent Land		
(26.) In cooperation with federal, state, county agencies and private landowners, weeds on non-Forest Service land may be treated when adjacent to the Gallatin National Forest boundary. Decisions regarding the treatment methods will be negotiated between the Forest Service and the other owner/agency.	Prevent weeds from spreading onto FS land; Moderate effectiveness (Professional experience); Monitor results in weeds database	1, 4
Research Natural Areas/Wilderness Areas		
(27.) If any treatment with herbicide is planned within a Research Natural Area (RNA) or a Special Interest Area (SIA) boundaries, then concurrence must be obtained through the Research Station Director and Forest Supervisor. This includes all future treatments of newly identified infestations.	Avoid conflict with protected area; High effectiveness (EIS, page 4-59)	1, 4
(28.) With the exception of roads and trails within Research Natural Areas (RNAs) or Special Interest Areas (SIAs), motorized vehicles will not be used for herbicide treatments in designated Wilderness, RNAs and SIAs.	Avoid conflict with protected area; High effectiveness (EIS, page 4-59)	1, 2, 4
(29.) Wilderness area management will take precedence over Research Natural Areas (RNA) or Special Interest Areas (SIA) direction when proposed weed control activities are identified for an RNA or SIA within designated wilderness boundaries.	Avoid conflict with protected area; High effectiveness (EIS, page 4-59)	1, 2, 4
Historical Resources		
(30.) All historical sites will be avoided in mechanical treatments. Significant sites that could be damaged by multiple off-road travel or equipment will be mapped and provided to weed treatment coordinators in order to avoid any damages.	Protect Cultural Resource sites; High effectiveness (Logical – avoids impact to area)	1, 2, 4
Aquatic		
(31.) Herbicide will not be used to control weeds within a 100-foot radius of any potable water spring development on the Forest. Do not use herbicides 1/2 mile (100 feet each side) upstream from municipal water divergent point.	Protect aquatic resources and ground water; High effectiveness (EIS, page 4-23)	1, 4
(32.) Picloram will not be used within 50 feet of water bodies, or the edge of subirrigated land, whichever is greater. In watersheds where picloram delivery modeling indicated possible concerns (see Table 2-12) use one or more of the following strategies: • Treat some infestations with another appropriate herbicide (see Appendix D and Appendix E), • Postpone treatment of some infestations for at least 10 to 12 months; and /or • Use biological control as appropriate.	Protect aquatic resources and ground water; High effectiveness (EIS, page 4-23).	1, 4
(33.) INFISH standard FA-4 prohibits storage of fuels and other toxicants within Riparian Habitat Conservation Areas (RHCAs) and refueling within these areas unless there is no other alternative. Category 1 – Fish bearing streams: RHCAs consist of the stream and the area on either side of the stream extending from the edges of the active channel to the top of the inner gorge, or to the outer edges of the 100 year floodplain, or to the outer edges of the riparian vegetation, or 300 feet slope distance (600 feet, including both sides of the stream channel), whichever is greatest. Category 2 – Permanently flowing non-fish bearing streams: RHCAs consist of the stream and the area on either side of the	Protect aquatic resources; High efficiency (EIS, page 4-23)	1, 4

Protection Measure	Objective, Effectiveness, and Basis for Rating	Applied to Alternatives (s)
stream extending from the edges of the active channel to the top of the inner gorge, or to the outer edges of the 100 year floodplain, or to the outer edges of the riparian vegetation, or 150 feet slope distance (300 feet, including both sides of the stream channel), whichever is greatest. Category 3 - Ponds, lakes, reservoirs and wetlands greater than 1 acre: RHCAs consist of the body of water or wetland and the area to the outer edges of the riparian vegetation, or to the extent of the seasonally saturated soil, to the extent of moderately and highly unstable areas, or 150 feet slope distance from the edge of the maximum pool elevation of constructed ponds and reservoirs or from the edge of the wetland, pond or lake, whichever is greatest. Category 4 – Seasonally flowing or intermittent streams, wetlands less than 1 acre, landslides, and landslide-prone areas: This category includes features with high variability in size and site-specific characteristics. At a minimum the interim RHCAs must include: a. the extent of landslides and landslide-prone areas; b. the intermittent stream channel and the top of the inner gorge; c. the intermittent stream channel or wetland and outer edges of the riparian vegetation d. the area from the edges of the stream channel, wetland, landslide, or landslide prone area to a distance of 100 feet slope distance.		
(34.) No ester formulations of herbicides will be used. Fish toxicity is the concern.	Protect aquatic resources; High efficiency (EIS, page 4-23)	1, 3, 4
(35.) Herbicides sprayed within 50 feet of water, or the edge of sub-irrigated land (whichever is greater) will be approved for this use as stated on the herbicide label. Herbicide application within this zone will occur when winds are less than 10 mph and blowing away from these areas. Apply spray pointed away from the water, not towards the water.	Protect aquatic resources and ground water; High efficiency (EIS, page 4-23).	1, 4
(36.) Western Toads and Leopard Frogs (or any species listed as threatened or sensitive) - When ground application of herbicide is necessary within 50 feet of a water body; surveys of the treatment area will be required. If adult northern leopard frogs or western toads, are identified, the extent of distribution within the proposed treatment area will be marked on the ground and reported to the district amphibian specialist (fisheries or wildlife biologist) and weed coordinator within two days. If treatment is not possible without directly spraying individuals then hand pulling or wick application will be employed. If tadpoles or metamorphs of either species are identified, the location will be reported to the district amphibian specialist (fisheries or wildlife biologist) and weed coordinator within two days, and application of herbicides will be delayed until metamorphs disperse.	Protect aquatic resources and ground water; High efficiency (EIS, page 4-26), avoids exposure	1, 4
Wildlife		
(37.) No human activities associated with weed control will be allowed within zone I (<400 meters) of an active bald eagle nest from February 1-August 15, except within 20' of roads that are open for public motorized use.	Minimize impact to nesting eagles; High effectiveness (MT Bald Eagle Working Group. 1994. page 24)	1, 2, 3, 4

Protection Measure	Objective, Effectiveness, and Basis for Rating	Applied to Alternatives (s)
(38.) Sheep and Goat Grazing – Sheep and goat grazing for weed control purposes will not be used on Gallatin National Forest lands within the Grizzly Bear Recovery Zone (Primary Conservation Area). Outside of the Primary Conservation Area a herder and guard dogs will be present to monitor sheep and goats used for weed control purposes at all times. The herder will be required to notify the local District Ranger within 24 hours of any loss of sheep or goats being used for weed control purposes on the Gallatin National Forest. Sheep and goats being used for weed control purposes will be removed from the Gallatin National Forest within 24 hours of any grizzly bear or wolf depredations. The herder will be required to comply with the Gallatin National Forest food storage order so that human and livestock/pet foods, refuse, and other attractants are made unavailable to bears. The carcasses of sheep or goats that died while being used for weed control will be removed from the Gallatin National Forest within 24 hours to avoid habituation of grizzly bears or wolves to livestock as carrion. Sheep and goats used for weed control will be contained each night within the perimeter of an electric fence. Herders of sheep and goats used for weed control purposes will be required to receive training from the U.S. Fish & Wildlife Service or other authorized organization in the use of hazing techniques to prevent depredations by wolves. Herders will be required to implement those techniques when wolves are known to be in proximity to domestic sheep or goats being used for weed control.	Minimize mortality to bears and wolves from sheep depredation; High effectiveness (Meet and exceed Conservation Strategy and Gallatin Forest Plan)	
(39.) Proposals for goat or sheep grazing for weed control purposes will be coordinated with the appropriate MT FWP wildlife biologist to determine if bighorn sheep may occur in the area. At least 9 miles of separation will be maintained between bighorn sheep and domestic sheep or goats being used for weed control purposes.	Prevent transmitting disease to bighorn sheep; High Effectiveness (Aune. 2004)	1, 2, 4
(40.) Herbicides will only be applied using concentrations and techniques that will minimize mortality of native trees and shrubs to protect habitat for bald eagles, lynx, and other species.	Protect wildlife habitat; High effectiveness (Logical –no injury to trees/shrubs)	1, 4
(41.) District/Forest wildlife biologists will review and coordinate weed management projects with the District/Forest weed coordinators to identify current raptor nesting areas, grizzly bear core habitat, wolf territories, or other critical wildlife areas that may be affected by weed control activities, to ensure the mitigation measures described in this report are implemented properly.	Ensure weed staff have current wildlife information; Moderate Effectiveness (Professional experience); Monitor – document meeting	1, 2, 4

Table 2-12. Picloram Treatment Acres Thresholds in Sensitive Watersheds.

District	HUC Name	HUC Number	Restriction (Annual Application)
Hegben Lake	Upper Madison	100200070202	Do not exceed 90 lbs Active Ingredient
Hegben Lake	SF Madison	100200070203	Do not exceed 29 lbs Active Ingredient
Hegben Lake	Denny	100200070205	Do not exceed 81 lbs Active Ingredient
Hegben Lake	Duck Red Canyon	100200070304	Do not exceed 46 lbs Active Ingredient
Hegben Lake	Hegben Lake	10020007050	Do not exceed 69 lbs Active Ingredient
Hegben Lake	Lower Beaver	100200070603	Do not exceed 36 lbs Active Ingredient
Hegben Lake	Sheep	100200070801	Do not exceed 15 lbs Active Ingredient.
Bozeman	Moose Tamphery	100200080602	Do not exceed 22 lbs Active Ingredient
Bozeman	Logger	10020008060	Do not exceed 22 lbs Active Ingredient
Bozeman	Bozeman	100200080803	Do not exceed 62 lbs Active Ingredient
Bozeman	Beasley M	100200080805	Do not exceed 30 lbs Active Ingredient
Bozeman	SF Sixteenmile	100301010302	Do not exceed 55 lbs Active Ingredient
Gardiner	Sphinx Slip and Slide	100700020108	Do not exceed 57 lbs Active Ingredient
Gardiner	Eagle Reese	100700010902	Do not exceed 56 lbs Active Ingredient
Livingston	Deep	100700020108	Do not exceed 36 lbs Active Ingredient
Livingston	Donahue Daily	100700020304a	Do not exceed 32 lbs Active Ingredient
Livingston	Lower Mill	100700020305a	Do not exceed 46 lbs Active Ingredient

For a complete list of watersheds for each herbicide see Appendix D.

ENVIRONMENTALLY PREFERRED AND AGENCY PREFERRED ALTERNATIVE

Alternative 1 is both the environmentally and the agency preferred alternative because it best protects native species and habitat diversity, while minimizing impacts other resource value with the use of mitigation measures.

SUMMARY COMPARISON OF ALTERNATIVES

With each alternative action, there is a trade-off between beneficial and adverse impacts. This section focuses on issues identified during the scoping process as described earlier in this Chapter. Important components of these issues are impacts to human health, non-target plants, animals, fish, soils, and water. These tradeoffs are analyzed in Chapter 4 and then summarized in Table 2-13. Impacts are based upon the application of appropriate mitigation discussed here.

Table 2-13. Summary of Trade-Offs and Potential Impacts Between Alternatives.

Issue or Concern	Potential Impacts			
	Alt. 1- Proposed Action	Alt. 2 – No Herbicides	Alt. 3- No Action	Alt. 4 – No Aerial
Impacts of weeds: - Loss of native plant community; - Loss of sensitive plant populations; - Human Health (e.g. allergies, asthma)	- Maximizes protection of native plants -Low risk, effective mitigation - Decrease weed impact	- High loss of native plants -High risk (weeds out compete rare plants) - Increased allergies	- High loss of native plants -High risk (weeds out compete rare plants) - Increased allergies	- Some loss of native plants, remote areas. -Low risk, effective mitigation - Decrease weed impact
Impacts of using herbicides: - Human health; - Fish and animals; - Non-target plants; - Water quality	-Low risk, effective mitigation -Low risk, effective mitigation -Low risk, effective mitigation -Low risk, effective mitigation	- No risk - No risk - No risk - No risk	-Low risk, effective mitigation -Low risk, effective mitigation -Moderate risk – picloram injury -Low risk, effective mitigation	-Low risk, effective mitigation -Low risk, effective mitigation -Low risk – effective mitigation -Low risk, effective mitigation
Additional risks of aerial spraying: - Human health; - Fish and animals; - Non-target plants.	-Low risk, effective mitigation -Low risk, effective mitigation -Low risk, effective mitigation	N/A – no aerial herbicide application	N/A – no aerial herbicide application	N/A – no aerial herbicide application
Effectiveness of control actions: - Limit spread, or eliminate existing infestations - Percent area treated based on current budget.	Very Effective 23.7 %	Not Effective 15.8 %	Effective on limited area 7.0 %	Very Effective, except remote areas. 23.7 %
Constraints to users of National Forest	Temporary closure during treatment, warning signs posted when treating developed recreation areas.	No additional constraints required.	No treatment within developed recreation areas	Warning signs posted when treating developed recreation areas
Wilderness Character: - Natural Integrity - Solitude and Remoteness	-Maximizes natural integrity -Minor short-term effects when recreational users encounter weed control crews.	- Some loss of natural integrity with increasing weeds. -Short-term effects, hand control crews spend more time treating weeds, increased chances for encounters with humans.	- Some loss of natural integrity with increasing weeds. -Minor short-term effects when recreational users encounter weed control crews.	-Improves natural integrity on areas accessible by ground crews. -Minor short-term effects when recreational users encounter weed control crews.

CHAPTER 3 AFFECTED ENVIRONMENT

SUBSTANTIVE CHANGES BETWEEN DRAFT AND FINAL EIS

Revised sensitive plant species to reflect recent changes in the list (the following three species were removed from the Gallatin's list *Castilleja gracillima*, *Carex livida*, and *Salix wolfii* var. *wolfii*, and *Mimulus nanus* was added)

Revised the sensitive species list to reflect that Goshawk was de-listed, however, it is still considered as a Management Indicator Species on the Gallatin Forest. Comments regarding the Goshawk are still relevant so will remain unchanged in the EIS.

Change chronic toxicity Table 3-22 to reflect concerns addressed by the public that the previous table failed to portray effects clearly.

INTRODUCTION

This chapter describes existing conditions for resource areas (water quality, fisheries, amphibians, soils, wildlife, vegetation, human health, recreation and wilderness) within the National Forest that may be affected by the proposed action. For each resource area, there will be a description of the relevant regulatory requirements, the analysis area, the method used in the analysis, and the affected environment. More detailed information on each resource can be found in the resource specialist's reports in the project file.

FOREST PLAN MANAGEMENT DIRECTION

Management direction for the Gallatin National Forest is found in the 1987 Gallatin National Forest Plan. The following summary highlights the management direction relevant to this proposal. Goals and standards found in the Forest Plan relevant to the proposed action include:

- Manage National Forest resources to prevent or reduce serious long lasting hazards from pest organisms utilizing principles of integrated pest management (Gallatin Forest Plan, Forest-wide Goal, page II-1).
- Noxious weeds along roads and trails will be treated page (Gallatin Forest Plan, Forest-wide Standard, page II-27).
- Implement an integrated weed control program in cooperation with the state of Montana and County Weed boards to confine present infestations and prevent establishing new areas of noxious weed. Noxious weeds are listed in the Montana Weed Law and designated by County Weed Boards. Integrated Pest Management, which uses chemical, biological, and mechanical methods, will be the principal control method. Spot herbicide treatment of identified weeds will be emphasized. Biological control methods will be considered as they become available. Funding for weed control on disturbed sites will be provided by the resource that causes the disturbance (Gallatin Forest Plan, Forest-wide Standard, page II-28).

Management area goals, objectives and standards relevant to the proposed action:

Management area descriptions are found in Chapter 3 of the Gallatin Forest Plan. These descriptions provide specific goals and management direction to achieve the Forest-wide goals and standards found in Chapter 2 of the Forest Plan. Proposed actions will occur on

nearly all management area allocations identified in the Forest Plan. None of the management areas restrict the control of noxious weeds. Some management areas, however, restrict motorized access. The Forest Service may use motorized vehicles to apply weed control in closed areas when necessary, by obtaining variance. Steps will be taken to minimize tracks, by staying on established tracks. Weed control methods will comply with motorized restrictions in wilderness areas and Research Natural Areas.

AGENCY POLICY AND DIRECTION

Important policy and direction relevant to weed control is given in the Chief's Natural Resource Agenda (1998), the Northern Region Overview, and the Forest Service Manual.

1988 Natural Resource Agenda. In March of 1998, Forest Service Chief Mike Dombeck presented the Agency's emphasis in management direction for the 21st century. In this Agenda was a strong emphasis on conserving and restoring degraded ecosystems, including actions to "attain desirable plant communities", and "prevent exotic organisms from entering or spreading in the United States."

Forest Service Manual 2259.03. "Forest office shall cooperate fully with State, County and Federal officials in implementing 36 CFR 222.8 and sections 1 and 2 of PL 90-583 (see below). Within budgetary constraints, the Forest Service shall control to the extent practical, noxious farm weeds on all National Forest System lands."

LAWS AND REGULATIONS

The following laws and regulations give both broad and specific authority and direction for control of noxious weeds on National Forest system lands:

Executive Order 13112. Invasive Species, February 3, 1999. This order directs Federal Agencies whose actions may affect the status of invasive species to (i) prevent the introduction of invasive species (ii) detect and respond rapidly to, and control, populations of such species in a cost-effective and environmentally sound manner, as appropriations allow.

36 CFR Sub A, Sec 222.8. "... The chief, of the Forest Service, will cooperate with County or other local weed control Districts in analyzing noxious farm weed problems and developing control programs in areas which the National Forest and National Grasslands are a part."

Federal Noxious Weed Act of 1974 (sec 9) authorized the Secretary to cooperate with other Federal and State agencies or political subdivisions thereof, and individuals in carrying out measures to eradicate, suppress, control or prevent the spread of noxious weeds.

Public Law 90-583 (Carlson-Foley Act, October 17, 1968). Authorized and directs heads of Federal Departments and Agencies to permit control of noxious plants by State and local governments on a reimbursement basis in connection with similar and acceptable weed control programs being carried out on adjacent non-Federal land.

Public Law 94-579 (The Federal Land Policy and Management Act of 1976). This act provides authority to control weeds on rangelands as part of a rangeland improvement program.

Public Law 94-588 (The National Forest Management Act of 1976). This act provides authority for removal of deleterious plant growth and undergrowth and provides for expenditures of funds to serve as a catalyst to encourage better management of private forests and rangelands.

The State of Montana County Noxious Weed Management Act provides for designation of noxious weeds within the State and directs control efforts. Provisions are made for registration of pesticides, licensing of distributors and applicators, and enforcement of State statutes. An enforcement responsibility for the control of noxious weeds within Montana is delegated to County Commissioners through Weed Management District Boards.

ENVIRONMENTAL JUSTICE

Executive Order 12898, issued in 1994 ordered Federal agencies to identify and address any adverse human health and environmental effects of agency programs that disproportionately impact minority and low-income populations. At this time, no minority or low-income communities have been identified in southwest Montana.

NATIVE AMERICAN TREATY RIGHTS

While the alternatives may have differing impacts on wildlife and fish, as described in Chapter 4, none of the alternatives would alter opportunities for subsistence hunting, fishing, and plant gathering by Native American tribes. Tribes holding treaty rights on the Gallatin National Forest were contacted during this EIS process and they did not express a concern regarding this project.

VEGETATION

Regulatory Framework -Vegetation

The previous section (Agency Policy and Direction; and Law and Regulations) discussed the regulations that pertain to weeds.

Forest Service Manual 2670.22 Sensitive species, provides the following direction for sensitive plants:

- Develop and implement management practices to ensure that species do not become threatened or endangered because of Forest Service actions.
- Maintain viable populations of all native and desired nonnative wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands.
- Develop and implement management objectives for populations and/or habitat of sensitive species.

Affected Area – Vegetation

The analysis area for vegetation includes all vegetation communities in proximity to proposed treatment areas. These plant communities have the potential to be directly or indirectly impacted by weeds and proposed treatment methods.

Analysis Method - Vegetation

Information used came from data on file at the Gallatin National Forest, literature review, and personal communications with resource specialists with knowledge of vegetation, weed control, and herbicide effects. Acreage values were derived utilizing GIS.

The following technique was used to evaluate the different alternatives and their impacts on sensitive plants. First, all known sensitive plants and invasive plant locations have been mapped. Sites having both types of plants within 500 feet were identified as high-risk areas. The 500 feet distance intended to include sites that may become infested with weeds in the near future. Next, each alternative was evaluated for effectiveness of treatment based on the following criteria: will the site be treated under this alternative; will the treatment stop the spread of weeds into the area with sensitive plants; and will the treatment have a detrimental impact on the sensitive plants.

Affected Environment - Vegetation

Components of the affected vegetation are the weed species themselves, and the native plants communities. The vegetation information is presented in three sub-sections:

- Weed Species (Invasive and Noxious)
- Native Plant Communities
- Rare Native Plant Species

Twenty-seven plant species are currently listed as noxious weeds in Montana State, classified as one of the following three categories: 3 (New Invader); 2 (Rapid Spreading); or 1 (Wide Spread). At least one of the five counties (Madison, Gallatin, Park, Sweet Grass, or Carbon) within the Forest identified twelve additional species as category 4 (county level) noxious weeds. The Gallatin Forest has also identified an additional 10 species of concern. Of the total combined lists of 49 species, 28 have actually been located and mapped on the Forest. Tables 3-1 and 3-2 display the acreage for each of these weed species. Canada thistle, spotted knapweed, hounds tongue, and musk thistle are the predominant noxious weed species, comprising 59 percent or 7,748 net acres. Cheatgrass, the predominant invasive species mapped, involves 17 percent or 2,202 of the total mapped acres.

A majority of these sites have a high component of cheatgrass. Macrobiotic crusts once occupied much of the inter-space between perennial shrubs and grasses. Excessive soil disturbing activities, such as trampling by ungulates, over the past 100 years combined with the introduction of highly invasive plants has slowly converted the inter-space to thick sagebrush-cheatgrass communities. Cheatgrass is exceptionally competitive which makes it difficult for indigenous perennials to pioneer into the cheatgrass environment. Many of the cheatgrass communities throughout the country, especially the drier sites, are slowly changing to more perennial European type weeds that have the ability to expand in size exponentially each year. The Gallatin National Forest could experience a massive invasion of knapweed, leafy spurge, Dalmatian toadflax, and/or yellow toadflax in the very near future. As tougher deep tap rooted perennial plants become established, the expense for grassland rehabilitation increases significantly. Attempts to replace cheatgrass with perennial grasses have been difficult, especially where grazing continues to occur. The best success of out-competing cheatgrass has involved the seeding of crested and Siberian wheatgrasses (Personal communication, S. McDonald at Circle S Seed, and P. Hoppe at Gardiner Ranger District). This requires seeding shallow rooted species such as sandbergs bluegrass, Sherman big bluegrass, or covar sheep fescue in addition to the crested and Siberian wheatgrasses. The perennial plant cover in a stand of cheatgrass is generally less than five

percent. A successful weed treatment seeding would occur if the perennial species establish a groundcover of 15 to 25 percent.

The remaining 23 weed species, of varying densities, grow on the remaining 24 percent or 3,148 mapped acres. Some sites having multiple weed species so the actual infested acreage is slightly overestimated and may include some private land in-holdings.

Table 3-1. Category 3, 2, and 1 Weed Acreage on the Gallatin National Forest (infested acres not gross).

	District/Forest Acres						Treatment Priority:
	D-1	D-2	D-3	D-6	D-7	Total	
Category 3 (New Invader):							
Yellow Starthistle						0	1
Common Crupina						0	1
Rush Skeletonweed						0	1
Yellow Flag Iris						0	1
Eurasian Watermilfoil						0	1
Sub Total	0	0	0	0	0	0	
Category 2 (Rapid Spreading):							
Dyers Woad					0.1	0.1	1
Purple Loosestrife						0	1
Tansy Ragwort						0	1
Meadow Hawkweed Complex				0.3		0.3	1
Orange Hawkweed					1.6	1.6	1
Tall Buttercup						0	1
Tamarisk						0	1
Perennial Pepperweed						0	1
Sub Total	0	0	0	0.3	1.7	2	
Category 1 (Wide Spread):							
Canada Thistle	211	730	145	852	164	2102	3,5
Field Bindweed		0.4			0.7	1.1	2
Whiteweed or Hoary Cress		3		7	0.1	10.1	1
Leafy Spurge	173	68		98	2.3	341.3	1,3,5
Russian Knapweed		0.1			0.2	0.3	1
Spotted Knapweed	21	185	230	485	820	1741	1,3,5
Diffuse Knapweed					0.9	0.9	1
Dalmatian Toadflax	2	5	445	0.01	0.4	452.41	1,3,5
St. Johnswort (Goatweed)		1		12	0.5	13.5	1
Sulfur (erect) Cinquefoil	9	0.2		37	3.3	49.5	1
Common Tansy		15		87	1.3	103.3	2
Oxeye Daisy	124	5		161	35	325	1,3,5
Houndstongue	196	489	382	1160	94	2321	1,3,5
Yellow Toadflax	3	15		15	748	781	1,3,5
Sub Total	736	1501.7	1202	2899.01	1122.7	7461.41	
Total	736	1501.7	1202	2899.31	1124.4	7463.41	

Table 3-2. Category 4 Noxious Weed, Watch Species, and Invasive Species Acreage on the Gallatin National Forest.

	Weeds on National Forest by County											Forest Treatment Priority
	Sweet Grass		Meagher		Park		Gallatin		Madison		Total Acres	
	Key	Acres	Key ⁺	Acres	Key	Acres	Key	Acres	Key	Acres		
Meadow Knapweed	W	0	C-3	0	N.A.	0	C-4	0.3	N.A.	0	0.3	1
Musk Thistle	C-4	148	C-1	6.7	C-4	431	C-4	928	C-4	70.5	1584.2	1,3,5
Poison Hemlock	N.A.	0	C-2	0	C-4	0	C-4	9	N.A.	1.3	10.3	1,3,5
Common Burdock	N.A.	0	C-1	0	C-4	0.1	N.A.	0.1	C-4	0	0.2	2,4
Common Mullein	N.A.	68	C-1	0	C-4	22	N.A.	69	C-4	43	202	2,4
Common Cocklebur	N.A.	0	W	0	C-4	0	N.A.	0	N.A.	0	0	2,4
Bull Thistle	C-4	0	W	0	W	79	N.A.	0.1	N.A.	4.5	83.6	2,4
Black Henbane	N.A.	0	C-1	0	W	3	W	0	C-4	0	3	2,4
Common Teasel	N.A.	0	W	0	N.A.	0	N.A.	0	C-4	0	0	2,4
Field Scabious	W	0	C-2	0	N.A.	0	W	3.4	C-4	1.6	5	1
Catch Weed Bedstraw	N.A.	0	W	0	W	0	W	0	N.A.	0	0	2
Meadow Sage (Salvia)	N.A.	0	W	0	N.A.	0	W	0	N.A.	0	0	4
Cheat Grass	N.A.	145	N.A.	0	N.A.	2057	N.A.	0	N.A.	0	2202	4
Golden Chamomile	N.A.	0	W	0	W	0	N.A.	0	N.A.	3	3	2,4
Plumeless Thistle	N.A.	0	N.A.	0	W	0.1	N.A.	0	N.A.	0.7	0.8	2,4
Woodland Sage	W	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	0	2,4
Hoary Allyssum	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.	1500	1500	3,5
Perrenial Sowthistle	N.A.	0	C-1	0	N.A.	0	N.A.	0	N.A.	0	0	2
Absinth Wormwood	N.A.	0	C-2	0	N.A.	0	N.A.	0	N.A.	0	0	2
Scentless Chamomile	N.A	0	N.A	0	N.A	0	N.A	0	N.A	40.5	40.5	2
White Bryony	N.A	0	N.A	0	N.A	0	N.A	0	N.A	0	0	2
C-4 Total		148		6		453		937		115	1660	
W Total		0		0		3		3		40	47	
N.A. Total		213		0		2136		69		1509	3927	
Grand Total		361		6		2592		1009		1665	5634	

Key

C-4 = Category 4, New Invader

C-3 = Category 3, New Invader

C-2 = Category 2, Rapid Spreading

C-1 = Category 1, Wide Spread

W = Watch List

N.A. = Not A Concern

+ (Meagher County breaks C-4 further, ie. C--3, C-2, or C-1):

Figure 2-1, located in Chapter 2, depicts weed treatment priorities commonly utilized on the Gallatin National Forest due to a shortage of funding and effectiveness potential. Priority is generally given to those new populations of aggressive invader species where long-term management can be successful. An example would be a new site consisting of 5 plants of yellow star thistle that have not been allowed to produce viable seed yet. On larger, well established infestations, such as 20 acres of leafy spurge, where long term effectiveness is questionable, containment strategies play a much more important role. Even then control emphasis is provided along the spread vector areas such as trailheads, roadways, and parking areas. Tables 3-1 and 3-2 denote the combination of treatment priorities each weed species may need. Table 3-5 denotes the potential spread of some of the more concern weeds.

Biological control is becoming more important where actual eradication or control is not likely. Our best defense has been one of attacking weeds from every angle possible. Table 3-3 depicts the various biological control agents that have been released on the Gallatin Forest to date. While some agents have reduced weed densities by as much as 30 to 40 percent, none have eliminated a weed completely. Some agents require a number of years to become established and have a significant effect on weed populations. Efforts to establish insectaries will continue as the biological control program develops more options.

Table 3-3. Biological control agents released on the Gallatin Forest.

Weed	Biological Control Agent	Number of Release Sites by Ranger District				
		Big Timber	Livingston	Gardner	Bozeman	Hebgen
Canada Thistle	<i>Ceutorhynchus litura</i>				1	1
	<i>Cassida rubiginosa</i>					
	<i>Urophora cardui</i>		1			
Leafy Spurge	<i>Aphthona flava</i>		1			
	<i>Aphthona nigriscutis</i>	14	2		23	
	<i>Aphthona lacertosa</i>	20	2		15	2
	<i>Aphthona czwalinae</i>	17	2		15	2
	<i>Aphthona cyparissiae</i>	4				
	<i>Oberea erythrocephala</i>					
	<i>Spurgia esulae</i>					
St. Johnswort	<i>Chrysolina quadrigemina</i>					
	<i>Aplocera plagiata</i>					
Knapweed	<i>Larinus obtusus</i>					
	<i>Cyphocleonus achates</i>					4
	<i>Larinus minutus</i>					1
	<i>Agapeta zoegana</i>				2	1
	<i>Sclerotinia</i> (fungus)					1
Yellow and	<i>Mecinus janthinus</i>			2		6
Dalmatian	<i>Brachypterolus pulicarius</i>					
Toadflax	<i>Gymnetron antirrhini</i>					

Weed	Biological Control Agent	Number of Release Sites by Ranger District				
		Big Timber	Livingston	Gardner	Bozeman	Hebgen
	Scientific Name					
	<i>Calophasia lunula</i>			2		
Poison Hemlock	<i>Agonopterix alstroemeriana</i>					
Musk Thistle	<i>Trichosirocalus horridus</i>					
	<i>Cassida rubiginosa</i>					

Native Plant Communities:

The 1.8 million acres of Gallatin National Forest land supports a very diverse mixture of plant communities. Vegetation runs from open, dry grasslands and sagebrush/grass in the valley bottoms, to dense lodgepole, subalpine fir and Douglas fir forest in the mid elevations. Subalpine/alpine grasslands, tundra and rock barrens dominate the high elevations. Wetlands and riparian areas are scattered throughout the Forest. Table 3-4 show a breakdown of existing habitat types for the forest and the amount of weeds present. Based on the data available 27.8 percent or roughly 500,000 acres is naturally susceptible or at high risk to weed invasion.

Table 3-4. Weed Occurrence by Habitat Type on the Gallatin National Forest.

Primary Habitat Type Code	Total Acres on Forest	Percent of Forest	Number of Instances Associated with Weed Polygons	Average Acres	Total Acres	Percentage of Total
UNCLASSIFIED	23,006	1.1	40	0.49	19.42	0.00
ABLA-PIAL/VASC	34,426	1.6	22	1.59	35.01	0.00
ABLA/CARU	33,735	1.6	18	0.80	14.35	0.00
ABLA/GATR, VAGL	75,360	3.5	77	2.36	181.57	0.01
ABLA/LIBO	67,894	3.2	146	1.06	155.44	0.01
ABLA/VAGL	15,202	0.7	259	1.39	358.93	0.03
ABLA/VAGL, ARCO	18,160	0.8	16	0.78	12.54	0.00
ABLA/VAGL, PICEA/GATR	15,994	0.7	257	1.71	439.36	0.03
ABLA/VAGL, LIBO	564,340	26.3	31	0.83	25.76	0.00
ABLA/VASC	14,414	0.7	823	1.41	1159.74	0.09
ABLA/VASC, LIBO	17,425	0.8	9	0.32	2.85	0.00
ABLA/VASC, ABLA/VAGL	309,745	14.4	20	1.95	39.09	0.00
ARAR/FEID, ARTR/FEID	6,719	0.3	73	6.08	443.92	0.03
ARTR/AGSP	7,420	0.3	415	4.47	1853.56	0.14
ARTR/FEID	79,544	3.7	1403	2.85	3995.95	0.30
DECA/CAREX	16,077	0.7	190	2.51	475.95	0.04
FEID-AGSP	33,644	1.6	1338	4.37	2204.40	0.17
FEID/AGCA	109,767	5.1	15	1.46	21.85	0.00
FEID/DECA	434,875	20.3	131	3.57	467.55	0.04

Primary Habitat Type Code	Total Acres on Forest	Percent of Forest	Number of Instances Associated with Weed Polygons	Average Acres	Total Acres	Percentage of Total
PICO/PUTR	6,736	0.3	245	2.74	672.04	0.05
PSME/FEID	25,254	1.2	226	1.02	231.61	0.02
PSME/PHMA	93,285	4.3	46	2.12	97.68	0.01
PSME/SYAL	49,645	2.3	253	1.47	372.60	0.03

Some plant species can be considered an undesirable even though they are native to the area. Tall larkspur, especially where conditions support it becoming a major component of the landscape, can be poisonous to cattle. Management of these sites often occurs where significant poisoning occurs. Sheep grazing, fertilizing, and grazing avoidance during the early summer months, and herbicides have all proven effective.

Since the late 1800's exotic plant species have been spreading across the Pacific Northwest. It's clear when studying distribution records of exotic plant species over time that the plants are increasing and expanding their range once they are established (Rice 1999). Based on these historic trends, we expect that these patterns of expansion will continue due to transport of seeds from increasing intercontinental travel and trade, and through continued disturbance on all lands (through agricultural, residential, recreational, and commercial developments). Nationally, Forest Service lands have an estimated six to seven million acres that are infested with noxious or invader weeds. This figure is increasing at an exponential rate of 8-12 percent per year. For example, 10 acres of spotted knapweed left unmanaged today in a disturbed environment has the potential of increasing to 1,000 acres in ten years. Risk assessments are complete for 12 weeds occurring on the Forest using the assessment protocols developed by Maria Mantas for the state of Montana (http://www.fs.fed.us/r1/cohesive_strategy/datafr.htm). Table 3-5 quantifies the acreage at risk of invasion if the current weed populations are allowed to grow unchecked. Many of the associated sites are already infested with early pioneering plant species making them prime candidates for weed spread.

Table 3-5. Acres on the Gallatin at Risk to Invasive Weeds, without Disturbance.

	High Risk	Moderate Risk	Low Risk	Unknown Risk	No Risk
Whitetop	31,886	0	126,336	1,270,140	673,131
Spotted knapweed	428,804	0	360,308	0	1,312,382
Canada thistle	7,497	0	498,894	0	1,595,102
Hounds tongue	0	0	213,170		1,495,818
Leafy spurge	429,136	0	71,439	0	1,600,919
Orange hawkweed	169,769	125,605	59,864	81,025	1,665,228
St. Johnswort	219,881	1,597	414,509	53,146	1,394,362
Dyers woad	396,536	9,238	0	56,430	1,639,289
Field scabious	146,713	27	0	1,528,257	426,497
Dalmatian toadflax	404,669	0	71,782	17,867	1,607,174
Yellow toadflax	112,879	429	395,781	70,417	1,521,987
Sulfur cinquefoil	310,999	31	424,351	22,776	1,343,336

Ground disturbing catastrophic events, such as a wild fire, create an environment most prone to the spread of noxious weeds. Weeds typically establish most quickly on previously forested areas having burnt under high intensity and high severity conditions. Prior to the fires of 2000, shading by conifers inhibited noxious weeds from spreading into areas with unburned overstories. With the overstory forest canopy having been lost very little understory vegetation exists to compete with weeds. Post-fire monitoring suggests that there may be an increase in the number of weeds, especially spotted knapweed and Dalmatian toadflax following the fires. The Douglas-fir habitats in the Fridley Burn area of the Livingston Ranger District and the Purdy Burn of the Bozeman District are probably most prone to long-term invasion

The threat of the weeds occurring on the Gallatin National Forest developing a resistance to the herbicides has not been documented to date. However, the likelihood of this happening does exist. One of the best ways of preventing herbicide resistant weeds from occurring is to rotate the herbicides used on each site from one year to the next. As an adaptive management approach, herbicide rotation will be considered where resource management objectives can still be met. Rotating herbicides by chemical family and preferably by mode of action would minimize the potential development of herbicide resistant weeds. Table 3-6 depicts the modes of action and family name for some of the more commonly used rangeland herbicides.

Table 3-6. Commonly Used Herbicides.

Mode of Action	Chemical Family	Common Name	Trade Name	Weed Spectrum	Soil Residual
EPSP synthesis inhibitor (Blocks protein synthesis)	Glyphosate	Glyphosate-ipa	Roundup, Rodeo, Accord, Glyphomate	Non-selective	No
ALS inhibitors (Blocks protein synthesis)	Imidazolinones	Imazapic	Plateau	selective	Yes
		Imazapyr	Arsenal	Non-selective	Yes
	Sulfonylureas	Chlorsulfuron	Glean, Telar	Broadleaf species	Yes
		Metsulfuron	Ally, Escort	Broadleaf species	Yes
		Sulfometuron	Oust	Broadleaf species (Mustards)	Yes
Synthetic auxins (Growth regulator)	Phenoxy acetic acids	2,4-D	2,4-D, Curtail*, Aqua-Keen	Broadleaf species	No
	Benzoic acid	Dicamba	Banvel, Clarity	Broadleaf species	Yes
	Pyridines	Clopyralid	Transline, Redeem*, Curtail*	Compositae, Polygonaceae, Fabaceae, Solanaceae	Yes
		Picloram	Tordon 22K	Broadleaf species	Yes
		Triclopyr	Garlon, Redeem* (Garlon 4)	Trees and Brush	No

* Curtail and Redeem are a mix of Clopyralid and Triclopyr.

Additional herbicide support may be found in the Nature Conservancy guide:

<http://tncweeds.ucdavis.edu/handbook.html>

Rare Native Plant Species:

Habitat for 21 sensitive plants may exist on the Gallatin National Forest. Most of the listed sensitive plant species are located in alpine, subalpine or moist areas. Of the 21 species, four species have been located on the National Forest: large-leaved balsamroot (*Balsamorhiza macrophylla*); slender paintbrush (*Castilleja gracillima*); discoid goldenweed (*Haplopappus macronema* var. *macronema*); and Wolf's willow (*Salix wolfii* var. *wolfii*). It is possible that Jove's buttercup (*Ranunculus jovis*) is present but not detected in the surveys due to the plant physiology at the time of year when the surveys were conducted (Jove's buttercup completes its life cycle in early summer and surveys often occur in mid summer). Currently there are 45 known sites that contain sensitive plants, six of these sites also contain invasive plants. For these sites both the weeds and the method of controlling the weeds can impact the sensitive plants.

Plants listed as sensitive by the Gallatin National Forest are described in Table 3-7 (Lesica and Shelly 1991, pages 12-13, 16-17, 21, 23, 26, 29, 34, 36-37, 39, 47, 49-51, 53, 56, and 58).

Table 3-7. Description of sensitive plant habitat.

Species	Habitat	Habitat Present
<i>Adoxa moschatellina</i> Musk-root	Grows in moist, mossy areas often in rock crevices and boulder slopes that may provide protection from human activities from 4,400-5,400 feet.	Yes
<i>Aquilegia brevistyla</i> Small-flowered Columbine	Found in meadows, open woods and rock crevices with limestone soils from 5,000-6,000 feet.	Yes
<i>Balsamorhiza macrophylla</i> Large-leaved Balsamroot	Grows on open hills at 7,000-8,500 feet. Associated with bunch grasses. Generally flowers and seeds late June through early August. Two sites have been located on the forest.	Yes
<i>Carex livida</i> * Pale sedge	In Montana, grows in sphagnum bogs and fens from 4,000-6,000 feet.	Yes
<i>Castilleja gracillima</i> * Slender Paintbrush	Located in wet meadows and along stream banks and other riparian areas from 6,700-7,000 feet. Flowers late June through late August. Numerous sites located on the Forest.	Yes
<i>Cypripedium calceolus</i> var. <i>parviflorum</i> Small Yellow lady's-slipper	Occurs in damp woods, bogs, mossy seeps and moist forest-meadow ecotones from 3,000-6200 feet.	Yes
<i>Drosera anglica</i> English Sundew	Found in sphagnum bogs at mid-elevations in the mountains.	Yes
<i>Eleocharis rostellata</i> Spike Rush	Grows in bogs.	Yes
<i>Epipactis gigantea</i> Giant Helleborine	In Montana, occurs only around thermal springs, perennial springs with year-round water flow, bogs and fens, and seeps from 2,000-5,750 feet.	Yes
<i>Eriophorum gracile</i> Cotton Grass	Occurs in bogs at lower elevations.	Yes
<i>Gentianopsis simplex</i> Hiker's Gentian	Found growing in mountain bogs, meadows and seepage areas from 4,400-8,400 feet. Flowers in July and August.	Yes
<i>Goodyera repens</i> Northern Rattlesnake-plantain	Grows in cool north aspects characterized by spruce/twinflower or subalpine-fir/twinflower habitat types. Flowers in August.	Yes

Species	Habitat	Habitat Present
<i>Haplopappus macronema</i> var. <i>macronema</i> Discoid Goldenweed	Generally found growing at or above timberline (usually above 7,640 feet) in rocky, open or sparsely wooded slopes and often in talus slopes. Flowers in late July and August. Two sites have been located on the forest.	Yes
<i>Juncus hallii</i> Hall's Rush	Associated with montane to subalpine meadows, moist to dry meadows and slopes between 6,900-8,400 feet. Flowers in July and August.	Yes
<i>Mimulus nanus</i> ** Pink monkey flower	Obsidian Sand bluffs. Flowers July, August (if moisture present)	Yes
<i>Polygonum douglasii</i> var. <i>austiniae</i> Austin's knotweed	Grows on open, gravelly, often shale-derived soil with eroding slopes and banks from 5,800-6,600 feet.	Yes
<i>Ranunculus jovis</i> Jove's buttercup	Occurs on sagebrush slopes and open areas in spruce/fir parklands from 7,500-9,500 feet. Flowers and seeds generally set in May or June.	Yes
<i>Salix barrattiana</i> Barratt's willow	Found growing in cold, moist soils near or above treeline (6,800-10,500 feet) especially in alpine areas. Fruits in late July or August.	Yes
<i>Salix wolfii</i> var. <i>wolfii</i> * Wolf's willow	Grows along streambanks and in wet meadows generally from 8200-9000 feet. Numerous sites located on the Forest.	Yes
<i>Shoshonea pulvinata</i> Shoshonea	Grows on open, windswept limestone substrates (in thin, rocky soils) along ridges and canyon rims from 6,800-9,000 feet. Blooms in late June through July.	Yes
<i>Thalictrum alpinum</i> Alpine Meadowrue	Occurs in montane and subalpine habitat on hummocky ground where shrubs are present. Moist, alkaline meadows from 6,500-7,000 feet. Generally flowers and sets seeds in May and June.	Yes
<i>Veratrum californicum</i> California false-helleborine	Found growing in wet meadows and along stream banks in montane and subalpine habitat; 5,000-8,500 feet. Flowers in July and August.	Yes

*Species recently removed from the Gallatin's sensitive plant list

**Species recently added to the Gallatin's sensitive plant list

Below is a description of the six sites that contain both sensitive plants and invasive plants. Two sites involve *Salix wolfii* (a willow species): one site has an adjacent patch of spotted knapweed; and the other site has Canada thistle. Another site has both *Balsamorhiza macrophylla* and Canada thistle. On this site *Balsamorhiza* (which has a root tuber) and Canada thistle (which spreads by both wind disseminated seeds and rhizomes) may have a considerable amount of competition between the two species. On two other sites, one has *Haplopappus macronema* and the other *Castilleja gracillima*, both are at risk of being invaded by yellow toadflax, spotted knapweed, and scentless chamomile. In numerous locations throughout the Hebgen Basin yellow toadflax has formed dense patches to the point of excluding native plants. Finally, the last site has *Castilleja gracillima* and houndstongue. Since *Castilleja gracillima* is rhizomatous, and houndstongue has a taproot, and both plants have similar size; it is reasonable to assume that the *Castilleja* will compete well with the houndstongue, and is not at risk.

In addition, the Horse Butte area and Hebgen Dam areas have *Mimulus nanus* and possibly *Mimulus brevipetalus*. Both species were recently added to the Montana State list, and only *Mimulus nanus* is believed to occur on the Gallatin Forest <<http://nhp.nris.state.mt.us/plants/index.html>>. The Horse Butte site does not have weeds adjacent to the rare plants, but the Hebgen Dam site does have knapweed in close proximity.

SOILS AND GROUND WATER

Regulatory Framework - Soils

The National Forest Management Act requires that lands be managed to ensure the maintenance of long-term soil productivity, soil hydrologic function, and ecosystem health. Soil resource management will be consistent with these goals.

The Forest Service Manual (FSM) 2550 – Soil management has a goal to optimize sustained yield of goods and services without impairing the productivity of the land, and it is the policy of the Forest Service to manage land in a manner that will improve soil productivity.

Other laws and guidance include the Soil Conservation and Domestic Allotment Act (16 USC 590) that states soil erosion is a menace to national welfare. This Act provides for the prevention of erosion on lands owned or controlled by the United States through a variety of means including the establishment of vegetative cover. In addition, Congress declares that unsatisfactory conditions on public lands present a high risk of soil loss, subsequent loss of productivity, and unacceptable levels of siltation that can be mediated by increasing rangeland management (43 CFR §1901).

Affected Area – Soils and Ground Water

Affected areas for the impact analysis of proposed actions on soil quality are weed-infested sites currently under consideration for spray with herbicides. Noxious weeds currently occur on approximately 12,600 acres on the Gallatin National Forest. (Map and data tables are located in the project file, Gallatin Forest Weeds Inventory.)

Noxious weeds occur on most combinations of landforms, geology, and soil in the foothills to midmontane elevation zones. Often, darker colored soils having relatively high organic matter levels occur in conjunction with weeds. These soils are generally associated with lower elevation vegetation types having a grass or shrub component. (Davis and Shovic, 1984.)

Analysis Method - Soils and Ground Water

Impacts on soil quality resulting from weed infestation and weed control measures were incorporated by reference from other recent weed EIS (as discussed below). To assess impacts to ground water quality, the RAVE (Relative Aquifer Vulnerability Evaluation) model use used (developed by Montana State University Extension Service, 1990). GIS (Geographic Information System) incorporate the RAVE model, herbicide soil mobility rate, the Gallatin National Forest soil surveys, distance to water, and topographic position. The GIS maps allowed for a landscape analysis so that areas with low to unacceptable risk of groundwater contamination could be identified. See Appendix E for more details of this analysis process and landscape level maps.

Several major factors in a particular area determine the relative vulnerability of ground water to pesticide contamination. Nine of these factors were incorporated into the RAVE score card and are defined below and in Appendix E. Values for these factors were developed on a landscape basis, as defined below. Pesticide leaching potential is based on the soil persistence and herbicide mobility. For this planning effort, a highly leachable herbicide was modeled. This was done to give a “worst case” scenario.

The herbicide picloram (Tordon®) is considered a highly leachable chemical (Montana State University, Extension Service. 1990), (Kamrin, 1997, pages 8, 506-510). It is quite soluble in water, and it is poorly bound to soils. It is also moderately persistent (average of 90 days ½ life.) Degradation by microorganisms is mainly aerobic. Volatilization is low and photochemical degradation occurs only at the soil surface. For these reasons, picloram is used as an index in this evaluation. Because of its moderate ½ life, and high leachability it is not considered a candidate for long-term buildup in soils. However, traces of it can remain in the soil for up to eleven years, so it is important to carefully consider application rates (Rew, Lisa, PhD, Montana State University, personal communication 2003).

Factor definitions used in the RAVE score card system.

Irrigation Practice: A rating based on whether a field is flood, sprinkler or non-irrigated.

Depth to Ground Water: The distance, in vertical feet, below the soil surface to the water table.

Distance to Surface Water: The distance, in feet, from the application site to the nearest flowing or stationary surface water.

Percent Organic Matter: The relative amount of decayed plant residue in the soil (most Montana soils are < 3 percent).

Pesticide Application Frequency: The number of times the particular pesticide is applied during one growing season.

Pesticide Application Method: A rating based on whether the pesticide is applied above or below ground.

Pesticide Leachability: A relative ranking of the potential for a pesticide to move downward in soil and ultimately contaminate ground water based upon the persistence, adsorptive potential and solubility of the pesticide.

Topographic Position: Physical surroundings of the field to which the pesticide application is to be made. Flood plain = within a river or lake valley, Alluvial Bench = lands immediately above a river or lake valley, Foot Hills = rolling up-lands near mountains, Upland Plains = high plains not immediately affected by open water or mountains.

All spatial layers were co-located in a geo-database. Ratings for the factors listed above were assigned to soil survey map units. These were spatially joined to the buffered stream and lake layers to rate depth to ground water. All rankings were totaled and classed in ACCESS as described below for risk categories. The resulting layer was limited to the Gallatin National Forest boundary. This was joined to a sixth level Hydrologic Unit Code (HUC6) watershed layer and the layer showing existing weed infestations for the Forest. The resulting tables were queried to provide risk classification summaries by watershed and presence of weeds. All spatial data and analytical procedures are on file at the Gallatin National Forest.

The RAVE score card rates aquifer vulnerability on a scale of 30 to 100 for individual application sites and pesticides. Higher values indicate high vulnerability of ground water to contamination by the pesticide used in the evaluation. Those values greater than or equal to 65 indicate a potential for ground water contamination. In such instances alternative pesticides should be sought which have a lower leaching potential. Scores of 80 or greater indicate that pesticide applications should not be made at this location unless an alternative product greatly reduces the score. Scores between 45 and 64 indicate a moderate to low potential for ground water contamination and scores less than 45 indicate a low potential for ground water contamination by the pesticide in question. Even in such cases, careful use of pesticides and following label instructions is imperative to protect ground water (Table 3-8 describes risk classes).

Table 3-8. Risk classes for herbicide/groundwater aquifer contamination.

RAVE Rating Score	Risk Class
< 45	Low
45-64	Low to moderate
65-79	High
80-100	Unacceptable

Affected Environment – Soils and Ground Water

Because of the relatively low proportion of weeds on the Gallatin Forest, there has not been a large soil effect from their incursion. Of 1.75 million acres, less than 12,600 acres have weed infestations. However, it is important to keep these values low to prevent soil degradation and erosion.

Other recent EIS documents (USFS, 2003. Helena National Forest DEIS and USFS, 2002. Beaverhead-Deerlodge National Forest EIS) have addressed the effects of weeds on soil organic matter, soil water interactions, soil evaporation rates, soil erosion, soil biota, and soil nutrients. The amount of impact is proportional to the amount of weeds. These documents also addressed the effects of herbicide on soil productivity. The Beaverhead-Deerlodge Noxious Weeds EIS stated that adverse effects of soil quality or productivity could not be detected (USFS 2002, page 3-43). They cited annual or semi-annual herbicide treated knapweed infested areas have lower knapweed cover and higher native grass cover than observed untreated knapweed stands. This agreed with studies elsewhere (Stalling, 1999). Since these documents did not find a measurable effect on projects that involved more acres (Helena National Forest proposed treatment on 23,000 acres, and the Beaverhead-Deerlodge National Forest proposed treatment on 16,000 acres) it is logical to assume that there will be no measurable effect with this proposed project. Consequently, the effects of weeds and herbicides on soil productivity will not be repeated in this document, rather they will be incorporated by reference (see soil analysis in project file).

Herbicide Degradation in the Environmental

Pesticide applicators of today are faced with growing concern over the potential for pesticide contamination of ground water. Over 50 percent of all Montanan's and 95 percent of the agricultural community consume ground water as their source of drinking water. Protecting this fragile resource from pesticide contamination is imperative, because some pesticides may be harmful to humans at very low concentrations and clean-up of ground water is extremely difficult. Pesticide residues in ground water may also adversely affect sensitive crops and wildlife (Montana State University, Extension Service, 1990).

There are several ways for herbicides to damage resources. These include buildup in the soil, contamination of groundwater through infiltration, and surface runoff to streams. This analysis deals only with groundwater contamination and buildup. Other models are used to predict surface water contamination by runoff (see the following the water quality section).

Caution must be taken to avoid long-term buildup of herbicides in soils. Not only could they approach toxic levels, they may become more susceptible to movement and contamination as concentrations increase. Several processes affect persistence in soils (Vighi and Funari, 1995, pages 78-79). These include transport (volatilization, leaching, runoff, and erosion), adsorption and partition (immobilization by soil components), transformation (degradation by biological, photochemical, or other chemical processes), and plant processes (uptake, metabolism,

immobilization.) Herbicides vary in their persistence, but generally have short “half-lives” (that period of time to degrade ½ of a given addition in or near the surface of the soil.) This measure is a result of those processes described above with the exception of removal.

WATER QUALITY, FISHERIES, and AMPHIBIANS

Regulatory Framework – Water Quality, Fisheries, and Amphibians

Clean Water Act and Montana Water Quality Act

Most of the Gallatin National Forest is classified at B-1 by the Montana Department of Environmental Quality (ARM 16.20.604). The associated beneficial uses of B-1 water are drinking, culinary and food processing purposes and conventional treatment: bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, furbearers, and other wildlife; and agricultural and industrial water supply (ARM 17.30.607 & 623). Wilderness areas are classified as A-1, as are municipal watersheds noted in the previous section.

Applicable standards for Montana's B-1 streams and rivers include maximum allowable increase in naturally occurring turbidity is five nephelometric turbidity units (NTU); and no increases are allowed above naturally occurring concentrations of sediment, settleable solids, oil, or floating solids, which will or are likely to create a nuisance or render the water harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife (ARM 17.30.623).

In Montana, numeric water quality standards as specified in Circular Water Quality Bulletin WQB-7, Montana Numeric Water Quality Standards (MDEQ 2002) for human health water quality standards and herbicides that could be use in the Forest are listed in Table 3-9. No aquatic life standards have been established for these herbicides.

Table 3-9. Montana Water Quality Human Health Standards for Herbicides (micrograms/liter).

Herbicide	Category	Human health standard (micrograms/liter)	
		Groundwater	Surfacewater
clorpyralid	toxin	3,500	3,500
dicamba	toxin	210	210
2,4-D	toxin	70	70
imazapyr	carcinogen	21,000	21,000
methsulfuron methyl	toxin	1,750	1,750
chlorsulfuron	toxin	1,750	1,750
clopyralid	toxin	3,500	3,500
sulfometuron methyl	toxin	1,750	1,750
picloram	toxin	500	500

Section 303(d) of the federal Clean Water Act directs states to list water quality impaired streams and develop "total maximum daily loads" (TMDLs) for the affected stream segment. The 2002 Montana DEQ 303(d) list includes 11 stream segments on the Gallatin National Forest including the Gallatin River, Squaw Creek, Taylor Fork, Cache Creek, East Boulder River, Mill Creek, Watkins Creek, Fisher Creek, and the Clarks Fork of the Yellowstone. Primary causes listed for

stream impairment include flow alteration, siltation, land development, roads, and other habitat alterations. None of the Gallatin National Forest 303(d) listed sites had herbicides as a cause for impairment. A list, map, and impairment specifics as well as a description of the Montana DEQ 303(d) process is located at http://nris.state.mt.us/wis/environet/2002_303dhome.html.

Presidential Executive Order 12962

Presidential Executive Order 12962, signed June 7, 1995, furthered the purpose of the Fish and Wildlife Act of 1956, the National Environmental Policy Act of 1969, and the Fish and Wildlife Coordination Act, seeking to conserve, restore, and enhance aquatic systems to provide for increased recreational fishing opportunities nationwide. This order directs Federal agencies to “improve the quantity, function, sustainable productivity, and distribution of aquatic resources for increased recreational fishing opportunity by evaluating the effects of Federally funded, permitted, or authorized actions on aquatic systems and recreational fisheries and document those effects relative to the purpose of this order.”

Land-use Strategy for Implementation of the 1999 Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout in Montana

The Memorandum of Understanding and Conservation Agreement (MOUCA) for Westslope Cutthroat Trout in Montana includes as objectives 1) protecting all pure and slightly introgressed (90 percent or greater purity) westslope cutthroat trout populations; and, 2) ensuring the long-term persistence of westslope cutthroat within their native range. The Land-use Strategy for Implementation of the 1999 Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout in Montana (Strategy) for the MOUCA, adopted by the Forest Service and Bureau of Land Management in 2002, further defines how the MOUCA will be implemented by federal land management agencies. For new activities, the Strategy stipulates that the Forest Service will 1) provide watersheds supporting conservation populations of westslope cutthroat trout with the level of protection necessary to ensure their long-term persistence; 2) defer any new federal land management action if it cannot be modified to prevent unacceptable aquatic/riparian habitat degradation; and 3) maintain westslope cutthroat trout habitat at 90 percent of optimum habitat conditions. When this 90 percent of optimum condition criteria is not met, only activities resulting in habitat improvement are to be considered. The Strategy also states that Forest Service Biological Evaluations (FSM 2670) prepared for new activities should, in most cases, conclude that there will be a beneficial effect or no effect to the westslope cutthroat trout population or its habitat. The Gallatin National Forest has adopted the Strategy for its Yellowstone cutthroat trout populations as well.

Sensitive Species

Sensitive species are those animal species identified by a Regional Forester for which population viability is a concern as evidenced by a significant current or predicted downward trend in population numbers, density, or in habitat capability that will reduce a species' existing distribution (FSM 2670.5.19). There are ten species listed as sensitive for the Northern Region.

Protection of sensitive species and their habitats is a response to the mandate of the National Forest Management Act (NFMA) to maintain viable populations of all native and desired non-native vertebrate species (36 CFR 219.19). The sensitive species program is intended to be proactive by identifying potentially vulnerable species and taking positive action to prevent declines that will result in listing under the Endangered Species Act.

As part of the National Environmental Policy Act (NEPA) decision-making process, proposed Forest Service programs or activities are to be reviewed to determine how an action will affect any sensitive species (FSM 2670.32). The goal of the analysis should be to avoid or minimize impacts to sensitive species. If impacts cannot be avoided, the degree of potential adverse effects on the population or its habitat within the project area, and on the species as a whole needs to be assessed.

Forest Plan

Goals of the Gallatin National Forest Plan as they relate to fisheries include: 1) "Maintain and enhance fish habitat to provide for an increased fish population." and, 2) "Meet or exceed State of Montana Water Quality standards"(USFS, 1987, page II-5). The Gallatin National Forest Plan Management Area (MA7) management goal is to "manage the riparian resource to protect the soil, water, vegetation, fish and wildlife dependent upon it"(USFS, 1987, page III-19). Gallatin National Forest Plan implementation guidelines further define how fish habitat will be maintained and enhanced through the development of a stream classification system, which corresponds to the sensitivity and importance of streams relative to their aquatic communities and environments. The intent of this classification system is to provide specific management objectives, along with a description of optimal habitat attributes that would be associated with the habitat objectives (Table 3-10).

Table 3-10. Optimal habitat attributes, from Gallatin National Forest Plan implementation guidelines, for streams within the analysis area (May 1996). “% fines” means the amount of fine sediments (<6.3 mm) deposited as a percentage of overall substrate composition

Stream Class	Class Description	Analysis area streams	Management objective	% fines	Annual/Cumulative percent > natural
A	Streams with Sensitive <i>Spp</i> or Blue Ribbon Fisheries	All	90% (of pristine)	<25	30%/300%
B	Streams of regional or local importance as a fishery	None in the project area	75% (of pristine)	<30	50%/500%
C	Streams that support fish but have limited recreational value	None in the project area	60% (of pristine)	<35	60%/600%
D	Streams that do not support fish	None in the project area	Maintain water quality and channel integrity	NA	100%/1000%

The Gallatin National Forest Plan Management Area 7 management goal is to “manage the riparian resource to protect the soil, water, vegetation, fish and wildlife dependent upon it”(USFS, 1987, page III-19). Specific Management Area direction for livestock management requires that “livestock concentrations will be kept at a level compatible with riparian zone-dependent resource needs through development of pasture systems and associated improvements”(USFS, 1987, page III-20).

The Gallatin Forest Plan does not provide specific water resource direction for weed or herbicide treatments but references the "Watershed Management Guidelines for the Gallatin National Forest" (Glasser, 1987) which has several pesticide and chemical requirements including:

8.1 The Forest will use an interdisciplinary team approach in evaluating the practicality for pesticide/chemical application.

- 8.2 Apply Pesticide/Chemical according to label and EPA registration directions.
- 8.3 Provide feedback on effectiveness of pesticide placement near surface waters or other non-target areas.
- 8.4 Develop pesticide/chemical accidental spill contingency plans.
- 8.5 Leave a protection zone around stream, lakes, and wet areas or riparian areas to prevent pesticides falling directly into surface waters.

Affected Area – Water Quality, Fisheries, and Amphibians

Spatial Bounds: Aquatic environments, within the forested ecosystem, are heavily influenced by the physical and biological processes (Vannote et al. 1980). For this reason the analysis area, for both fish and amphibians, will encompass all watersheds within the project area boundary. These include all of the watersheds on the Gallatin National Forest (Table 3-11).

Table 3-11. Summary of Road density, Stream Buffers, Road Stream Intersections, and sensitive species known (bold type) or likely present (normal type) by HUC5. Species abbreviations are YCT, Yellowstone cutthroat; WCT, westslope cutthroat; NLF, northern leopard frog; WT, western toad. YCT and WCT designations indicate >90% genetic purity. Confirmed presence does not indicate uniform distribution in a drainage; for example, most cutthroat populations are fragmented and restricted to drainage headwaters.

HUC5 name	HUC number	acres	miles of road	miles of road per sq mile	acres of buffered stream	miles of road in stream buffer	Sensitive Species Present in Drainage
American Fork	10040201060	9816	3.57	0.23	1136	0.98	None known
Bangtail	10070003040	11566	99.03	5.48	1010	7.99	WT, YCT
Bear	10070001110	49348	161.43	2.09	4289	13.79	YCT
Bear-Wilson	10020008070	35078	268.85	4.91	2800	20.06	WT, WCT, NLF
Beaver-Cabin	10020007060	58040	27.26	0.30	5326	2.96	WCT, WT
Big Timber	10070002070	33872	47.99	0.91	3876	9.12	YCT
Big-Rock	10070002020	101210	231.65	1.46	8924	31.11	YCT
Boulder	10070002080	189255	89.96	0.30	14825	19.89	YCT, WT
Bozeman-Bear	10020008080	34925	131.58	2.41	2571	14.04	WT, NLF
Brckett	10070003030	20313	140.26	4.42	2500	25.78	YCT, WT
Bridger	10070002130	12547	27.30	1.39	1239	10.74	WT
Broadwater-Lake	10070006080	74945	32.79	0.28	5098	2.57	WT
Buck	10020008040	35755	208.41	3.73	3164	20.85	WCT, WT
Buffalo	10070001090	93642	0.00	0.00	6746	0.00	WT
Cascade	10020008060	37810	20.33	0.34	4137	5.67	WT
Cherry	10020007160	17591	11.23	0.41	1457	0.37	WCT*, WT
Cottonwood	10020008110	15403	3.28	0.14	1728	0.94	YCT, WT
Deer	10070002110	47334	49.42	0.67	4302	10.35	YCT
Flathead	10070003010	26136	140.29	3.44	2106	16.29	YCT
Hebgen Lake	10020007050	100031	426.25	2.73	9057	22.68	WCT, WT

HUC5 name	HUC number	acres	miles of road	miles of road per sq mile	acres of buffered stream	miles of road in stream buffer	Sensitive Species Present in Drainage
Hellroaring	10070001100	86337	0.00	0.00	5183	0.00	WT
Hyalite	10020008090	32671	158.65	3.11	3527	21.36	WCT, WT
Jackson	10020008080	20423	169.82	5.32	2122	18.45	WT
Mill	10070002030	97062	110.91	0.73	7911	19.86	YCT, WT
Mission	10070002050	15098	10.53	0.45	1210	2.74	YCT
Pass-Reese	10020008100	21122	30.05	0.91	1957	3.90	WT
Porcupine	10020008040	60675	18.21	0.19	6321	8.23	WT
Rock	10070003040	32510	42.21	0.83	3326	5.73	YCT
Sage-Tepee	10020008010	55360	18.42	0.21	4651	4.88	WT
Sheep-Mile	10020007080	15710	15.83	0.64	1337	1.95	None Known
Shields	10070003020	55106	330.58	3.84	6028	50.27	YCT, WT
Sixmile	10070002020	40886	40.84	0.64	2938	8.99	YCT
Sixteenmile	10030101030	27156	117.50	2.77	2629	18.63	WCT
Slushman	10020008080	9123	57.74	4.05	1133	9.18	WT
Soda Butte	10070001090	10140	56.73	3.58	564	3.29	YCT, WT

*Introduction planned in 2005 or 2006

Temporal Bounds: Because stream fish habitats may continue to be impacted by anthropogenic activities for many decades after the initial disturbance, temporal cumulative effects for fish and fish habitat will span the breadth of known human activity in the project area. Therefore, the temporal bounds for fish and fish habitat is from 1880 to five years after project implementation (year 2009).

Amphibian habitats may also be negatively impacted long after certain types of anthropogenic actions (Maxell, 2000). Therefore, the cumulative effects will be examined for the period for which literature suggests habitat may continue to be impacted: 50 years in the past (1953) and 5 years into the future (2009).

Activities considered in the cumulative effects analysis include those directly modifying fish and amphibian habitat as well as those indirectly modifying sediment delivery and routing, and modifying hydrologic regimes. These activities include past road construction and stabilization, vegetation management, grazing, recreation, trail maintenance, and past wildfires (Table 3-12).

Table 3-12. Common Gallatin National Forest land management activities and associated levels of impacts.

ACTIVITY	TYPICAL HABITAT ALTERATION OR IMPACT ON AQUATIC SPECIES	CURRENT DEGREE OF IMPACT
Livestock grazing	Bank alteration, stream channel over-widening, sediment introduction	Low to high
Timber harvesting	Sediment introduction, reduction of woody debris recruitment potential, modified water temperature regimes	Low to high
Road building	Sediment introduction, migration barriers	Moderate to high
Recreation (non-fishing)	Sediment introduction, habitat modification	Low
Recreational fishing	Hooking and handling mortality; harvest	Low to high

ACTIVITY	TYPICAL HABITAT ALTERATION OR IMPACT ON AQUATIC SPECIES	CURRENT DEGREE OF IMPACT
Water withdrawal	Reduction of instream flows	Low to moderate
Dams	Altered water temperatures, fish migration barriers, altered sediment transportation, altered aquatic communities, altered flow regimes	Moderate to high
Lake fish stocking	Competition/hybridization between introduced species and native species	High
Noxious weed management	Chemical poisoning of aquatic organisms	Low

Affected Method – Water Quality, Fisheries, and Amphibians

The methodology of analysis used for this EIS is based on the Beaverhead-Deerlodge National Forest Noxious Weed Control Program Final EIS (2002) Section 4.4.1. Water and fish resources were evaluated together because of related impacts from herbicide application for the control of noxious weeds on the Gallatin National Forest. Active ingredients in herbicides proposed for use, and analyzed, include 2,4-D, chlorsulfuron, clopyralid, dicamba, glyphosphate, hexazinone, imazapyr, metsulfuron methyl, picloram, imazapic, sulfometuron methyl, and triclopyr. Impacts on aquatic organisms, including fish, amphibians, and their habitat, including Management Indicator Species and sensitive species, were analyzed by considering:

- Research results and other literature on individual herbicide characteristics and toxicities for different aquatic species;
- Studies evaluating potential for herbicide entry into surface and groundwater, via different routes (leaching, overland flow, direct application, and drift);
- Results of recent analyses conducted by other National Forests in Region 1;
- Specific mitigations comprising part of each alternative for this EIS;
- Scope of the proposed treatments;
- Treatment methods proposed within alternatives;
- Proximity of proposed treatments to water bodies supporting westslope and Yellowstone cutthroat trout and other sensitive species.

The Beaverhead-Deerlodge National Forest Noxious Weed Control Program Final EIS (2002) Section 4.4.1, pages 4-13 through 4-16 evaluated herbicide characteristics and toxicities and concluded that picloram tends to be more toxic to aquatic organisms than any of the other herbicides. With this in mind, picloram is used as a surrogate for all herbicides to assess risks to aquatic species in this analysis. For this analysis, selection of a “safe” concentration level for fish follows recommendations presented in the Fisheries and Herbicides Work Group Findings and Recommendations, Draft Version 3c (March 19, 2003). The “safe” concentration level chosen is synonymous with a “maximum allowable toxicant concentration” or MATC equaling 0.075ppm. This value was derived, by taking 1/20 of 1.5 ppm (the 96 hour LC-50 for cutthroat trout).

Method of risk assessment for the amount of picloram which could be applied in Alternative 1 are the same as in the Beaverhead-Deerlodge National Forest Noxious Weed Control Program Final EIS (2002) Section 4.4.1, pages 4-17 steps 1-5. Rather than use storm events the Gallatin National Forest analysis was based on flow duration curves developed from daily discharge data of US Geologic Service gauging records of six gauges on or near the Gallatin National Forest. The drainage areas varied from 48-98 mile² and a period of record from 11 to 100 years. A Q95 (95 percent of the time flows are greater than) regression for the six gauges was used to determine the Q95 low flow for each HUC 6 (sixth order hydrologic unit code). The equation is $Q95 \text{ discharge} = 0.2143x^{0.893}$ ($R^2 = 0.7149$) where x is the watershed size in square miles. Minimum

capacity for dilution (C), maximum probable concentration, and maximum pounds of herbicide per application were then calculated for each HUC6.

Affected Environment – Water Quality, Fisheries, and Amphibians

Water quality in the Gallatin National Forest is unique in that headwaters of most of the streams occur in Gallatin National Forest wilderness areas, other unroaded areas, or in Yellowstone National Park. Water quality is generally excellent but is influenced by multiple use activities on Gallatin National Forest and private lands. The Gallatin National Forest contains about 1,000 miles of fishable perennial streams, several of which are of national scenic, historic, and recreational significance. The headwaters of the Madison, Gallatin, Yellowstone, and Boulder Rivers occur on or just upstream of the Forest in Yellowstone National Park. These "blue ribbon" rivers and tributaries have generally excellent water quality and provide an important source of aesthetics, recreation, wetland and riparian habitat, and water supply for a variety of downstream beneficial uses (domestic, irrigation, municipal, and agricultural). The Gallatin National Forest provides approximately two million acre-feet of water per year to the Missouri River system.

Average precipitation on the Forest varies from 15 to 65 inches a year with about 50 percent as snow in lower elevations and 75 percent at higher elevations. June receives the largest amount of moisture. Average snowfall varies from about 60 inches in the Deer Creek area and Paradise Valley to about 400 inches in the Beartooth Range. Precipitation intensity is relatively moderate. The two year-six hour precipitation varies from 0.7 to 1.5 inches (Miller et al. 1973). Winters are long and cold and snow usually remains at the higher elevations for eight to nine months. Snowdrifts can persist in some high elevation cirques and passes throughout the year. Summertime temperatures remain in the 70's and 80's with occasional 90 degree temperatures.

For most of the Gallatin National Forest, private agriculture (primarily ranching) or rural home sites are adjacent to the Forest with more extensive irrigation agriculture land use further downstream. With the exception of the West Yellowstone and Gardiner, which directly abut the Gallatin National Forest, concentrated urban areas are about ten miles from the Gallatin National Forest including Bozeman, Livingston, and Big Timber. Downstream beneficial uses of the Gallatin National Forest include fish and aquatic life, recreation, irrigation, stock use, public water supply, private water supply, and wildlife. Hyalite Creek and Bozeman Creek are designated as municipal watersheds for the city of Bozeman and have substantial water diversions and a water treatment facility near the Gallatin National Forest boundary. Several ditch associations have diversions on the Gallatin National Forest and distribute water over large areas with ditch systems. The Madison, Gallatin, Yellowstone, and Boulder Rivers provide increasing amounts of recreation for floating including drift boats, rafts, canoes, and kayaks. The watersheds (HUC5s) with the greatest number of miles in the stream buffer and number of road stream intersections are also those with the greatest number of road miles (Table 3-11). These include Bear-Wilson, Big-Bear, Brackett, Buck, Hegben Lake, Hyalite, Jackson, Mill, Shields, South Plateau, Squaw, Taylor Fork, Trail, and West Fork Gallatin.

A major beneficial use in, and downstream of, the Gallatin National Forest is salmonid habitat. The Gallatin National Forest encompasses many of the headwater tributaries of the Madison, Gallatin, and Yellowstone Rivers, which are Blue Ribbon trout fisheries. Several significant tributaries such as Squaw Creek, Swan Creek, Hyalite Creek, Mill Creek, South Rock Creek, Bear Creek, Shields River, and Big Timber Creek provide fish habitat that supports the nationally renowned trout fisheries.

Sensitive fish and amphibian species historically present in the project area were westslope cutthroat trout (*Oncorhynchus clarki lewisi*), Yellowstone cutthroat trout (*O. clarki bouvieri*), Arctic grayling (*Thymallus arcticus*), northern leopard frog (*Rana pipiens*), and boreal toad (*Bufo boreas*). Currently, Arctic grayling are not known to exist on the Gallatin National Forest and their status off the Forest is also uncertain. The distribution of Yellowstone and westslope cutthroat in Gallatin National Forest watersheds is restricted from its historic range, with westslope cutthroat currently occupying 33 miles of stream and Yellowstone cutthroat about 700 miles. Amphibian distribution is likely also truncated, although distribution data are limited (Atkinson and Peterson 2000, Maxell 2000). The current distribution of both sensitive fish and amphibian species, by watershed, is displayed in Table 3-11 above. All wild trout are Management Indicator Species (MIS) for project area streams; MIS occurring in the project area include brook (*Salvelinus fontinalis*), rainbow (*O. mykiss*), Yellowstone cutthroat, westslope cutthroat and brown trout (*Salmo trutta*).

Wetlands are lands in transition between terrestrial and aquatic systems where the water table is at or near the surface of the land and often covered by shallow water. In order to be considered jurisdictional wetlands, the wetland must be saturated and at least part of a year have un-drained hydric soils, and support predominantly hydrophytic vegetation. Wetlands are extremely valuable to recreational users, esthetic quality, and wildlife habitats, and serve important functions such as sediment filtration, flow moderation, nutrient and other pollutant attenuation. They also act as sources of organic energy for adjacent aquatic habitats. The Gallatin National Forest is heavily dissected and well drained, and has limited areas of wetlands. The most frequent type of wetlands on the Forest include lacustrine wetlands along lake and pond shorelines, palustrine wetlands of wet meadows and forested wet areas, and riverine wetlands along perennial stream channels and springs.

In general, the Gallatin National Forest has limited wetlands in upper and mid slope positions where some slump related palustrine wetlands, and narrow riverine wetlands occur. The majority of Forest wetlands are located on low slope positions, mostly in the stream and buffer areas listed in Table 3-11.

The Gallatin National Forest has two large reservoirs (Hegben Lake and Hyalite Reservoir), several small reservoir/stock ponds, and multiple water diversions. Canals and pipeline distribution systems are fairly limited as most of the steam diversions occur below the Forest boundary. Large water diversion systems and associated pipeline or ditches on the Forest include the Mill Creek NRCS 566 ditch, Pine Creek diversions, Cottonwood Creek flume and diversions, Sheep and Mile Creek diversions, and Hyalite and Bozeman Creek diversion structures and pipelines for the City of Bozeman water system.

The Gallatin National Forest has two roaded municipal watersheds, Hyalite Creek and Bozeman Creek, which are the main source of municipal water for the City of Bozeman. The City Water Treatment Plant is located below the Forest boundary, near Bozeman Creek with treatment supply consisting of about 2/3 Bozeman Creek water and 1/3 Hyalite Creek water. The Montana DEQ has designated Bozeman Creek as an A-Closed watershed and Hyalite Creek as A-1 (Montana Water Quality Standards, ARM 17.30.610) which are very restrictive designations to protect water quality. As for Bozeman Creek, the A-Closed designation does not allow for motorized public use and no livestock grazing is permitted. Hyalite Creek is very heavily used for developed and dispersed recreation with constrained motorized recreation activities.

WILDLIFE

Regulatory Framework – Wildlife

Regulations on wildlife resources are outlined in 36 CFR 219.12 and 219.27. These regulations state that management indicator species (MIS) will be identified by each national forest in order to adequately maintain distributed habitat for these species and to evaluate the impacts of management activities on these species. Forest Service Manual 2670.31 (6) directs “identify and prescribe measures to prevent adverse modification or destruction of critical habitat and other habitats essential for the conservation of endangered, threatened, and proposed species.”

Forest Service Manual 2670 at 2670.22 – Sensitive Species, provides the following direction for sensitive wildlife:

- Develop and implement management practices to ensure that species do not become threatened or endangered because of Forest Service actions;
- Maintain viable populations of all native and desired nonnative wildlife, fish, and plant species in habitats distributed throughout their geographic range on national forest system lands;
- Develop and implement management objectives for populations and/or habitat of sensitive species.

The Endangered Species Act requires the conservation of threatened and endangered species, and prohibits carrying out or authorizing any action that may jeopardize a listed species or its critical habitat.

The National Forest Management Act provides for balanced consideration of all resources. It requires the Forest Service to plan for diversity of plant and animal communities. Under its regulations, the Forest Service is to maintain viable populations of existing and desired species, and to maintain and improve habitat of management indicator species.

The Gallatin National Forest Plan provides standards and guidelines for management of wildlife species and habitats on the Forest. The Forest Plan also identifies Management Indicator Species.

Affected Area - Wildlife

The analysis area for wildlife includes species-specific habitats in proximity to proposed treatment areas. These habitats have the potential to be directly or indirectly impacted by herbicide application and disturbances associated with the proposed weed treatment methods.

Analysis Method - Wildlife

Published reports in scientific journals were reviewed along with file data from the Gallatin National Forest, unpublished reports, and personal communications. A detailed discussion of the effects on wildlife of each herbicide proposed is included in the project file.

Information on ecology, distribution, and habitat affinities for sensitive species was also obtained from Montana Natural Heritage Database <http://nris.state.mt.us/animal/index.html>.

Species known to occur on the Forest and species with the potential to occur are identified and discussed. Potential impacts were assessed based on animal habitat affinities and probability that a given habitat would be treated with herbicide to control noxious weed communities.

Affected Environment - Wildlife

The wildlife issue is ground into four main categories: Threatened and Endangered Species; Sensitive Species; Management Indicator Species; Migratory Birds and Biodiversity; and Herbicide Toxicity to Terrestrial Mammals and Birds.

Threatened And Endangered Species

Grizzly Bear

The grizzly bear was once found throughout much of the lower 48 states west of the Mississippi River. Currently, their distribution is restricted to five discrete populations: the Greater Yellowstone Ecosystem in portions of Montana, Wyoming, and Idaho; the Northern Continental Divide Ecosystem in Montana; the Cabinet-Yaak area in Montana and Idaho; the Selkirk Mountains in Idaho and Washington; and the North Cascades in Washington (Servheen, 1993, pages 11-13). The Gallatin National Forest provides important habitat for grizzly bears in the Yellowstone Ecosystem. The Greater Yellowstone Ecosystem grizzly bear population has increased in size and distribution over the past decade, and has now met all recovery criteria (IGBC, 2003, page 16). They have expanded their range on the Forest over the past several decades, and most areas of the Forest located south of interstate highway I-90 are currently occupied habitat (Schwartz *et al.*, 2002, page 209).

Grizzly bears are large omnivores that typically utilize a wide variety of foods. Vegetation such as roots, tubers, bulbs, berries, nuts, and green herbaceous plants are seasonally important to grizzly bears. Additionally, high calorie animal food sources such as ungulates, ground squirrels, carrion, fish, and insects are highly valuable to them when they can be obtained (Servheen, 1993, page 7). To utilize such a wide variety of foods, bears use a wide variety of vegetation types spread out over large distances. These vegetation types include lower elevation sagebrush/grasslands or Douglas-fir stands as well as higher-elevation whitebark pine, lodgepole pine, and Engelmann spruce/subalpine fir.

Because maintaining secure areas with low levels of human disturbance is a key component of grizzly bear habitat management, Amendment 19 to the Gallatin Forest Plan adopted guidance from the Interagency Grizzly Bear Committee Taskforce Report – Grizzly Bear/Motorized Access Management (IGBC, 1998) as standards for road density and motorized access within the recovery zone. These standards require that there be no decrease in core areas within each Bear Management Subunit. Core areas are at least 0.3 miles from any open road or trail, where no motorized or high-intensity non-motorized use is allowed during the non-denning period. The Final Conservation Strategy for the Grizzly Bear in the Yellowstone Area provides additional direction for access management, and specifies that reoccurring low-level helicopter flights should not be allowed within 500 meters of core habitat (IGBC, 2003, page 41).

The use of sheep or goat grazing as a weed management tool has the potential to cause conflicts with grizzly bears. Grizzly bear depredations on domestic sheep and goat grazing allotments have long been a source of conflict between humans and bears. The Gallatin Forest Plan (USFS, 1986, pages G-15, G-16) and Final Conservation Strategy for the Grizzly Bear in the Yellowstone Area (IGBC, 2003, page 43) both contain standards addressing this fact. The applicable Forest

Plan standards are: 1) the District Ranger will specify in the annual permittee plan of use appropriate measures for removal or destruction of livestock carcasses to avoid habituation of grizzlies to livestock as food; 2) in the event livestock are preyed upon, the following procedures will be used...remove livestock from allotment. The standards from the Conservation Strategy are: 1) no new active commercial livestock grazing allotments will be created inside the primary recovery area; and 2) there will be no increases in permitted sheep animal months inside the primary recovery area from the identified 1998 baseline.

Gray Wolf

Wolves were reintroduced to the Yellowstone area in 1995. The Forest Service is a full partner in implementing the conservation measures outlined in the Federal Register final rule, November 22, 1994. Wolves reintroduced to Yellowstone National Park (YNP) and the Greater Yellowstone Area (GYA), have been designated as a non-essential experimental population in accordance with Section 10 of the Endangered Species Act. The gray wolf historically occupied the Gallatin National Forest, and the Forest is within the Greater Yellowstone Gray Wolf Recovery Area. As of January 2002, there were an estimated 271 wolves in this area (USFWS *et al.*, 2003, page 1). There are approximately 14 packs whose territories are entirely or partially within the Forest, but only 1-2 packs are known to den on the Forest (J. Fontaine, U.S. Fish & Wildlife Service, personnel communication on 04/28/03).

In the Yellowstone area, wolves feed on elk, deer, moose, bison, and other ungulates, but elk are their primary prey (USFWS *et al.*, 2003, page 12-13). Wolves have also preyed on livestock (USFWS *et al.*, 2003, page 17). Wolves follow big game movements and may concentrate on elk winter ranges or elk calving areas (USDI 1993, pages 6-27 to 6-28). Pups are whelped in a den during the spring (Mech, 1970, page 123), and moved to a rendezvous site several months later when they are able to leave the den until they are mobile enough to travel with the pack (Mech, 1970, page 146-148).

Wolf territories are variable and may range from 60 to 900 square miles in size. Wolf packs recently reintroduced into YNP initially ranged over an area of 650 square miles (Fritts *et al.* 1997, pages 22-23). Wolves may occupy a variety of habitats including grasslands, sagebrush steppes, coniferous and mixed forests, and alpine areas. Wolf distribution and habitat use is more closely tied to availability of food (especially ungulate prey) and denning areas than to vegetation cover type. Because of this, there would be overlap between wolf habitat and areas infested with weeds.

Canada Lynx

Optimal lynx habitat can generally be described as a mosaic of early-successional forest stands for foraging and late-successional forests with deadfall for security cover and denning habitat (Ruggiero *et al.*, 1994, page 86). Lynx inhabit the mid to high elevations where snow excludes most other predators during winter. Denning habitat occurs most often in subalpine fir forests where there is a high amount of down material (Ruggiero *et al.*, 1994, page 89). Snowshoe hares are the primary prey for lynx. Primary forest types that support snowshoe hare are subalpine fir, Engelmann spruce, Douglas-fir and lodgepole pine. The key component of snowshoe hare habitat is dense understory vegetation. In winter, lynx forage for hares in vegetation that provides a high density of young conifer stems or branches that protrude above the snow (Ruediger *et al.*, 2000, page 1-4 and 1-7). Snowshoe hares appear to avoid clear-cuts and very young stands (Ruediger *et al.*, 2000, page 1-7).

Lynx habitat and weed infestations generally do not overlap, because lynx are typically found in dense forested stands in which weeds are not able to compete with native vegetation. Although approximately 9 percent (or 1,000 acres) of known weeds infestations on the Forest are in subalpine fir habitat types, these are generally found in clearcuts that have not yet regenerated enough for weeds to be shaded out, and are unsuitable lynx habitat. Weed treatments in these areas would be designed to minimize mortality of regenerating trees and shrubs. Orange hawkweed can invade closed-canopy forests that may be suitable lynx habitat, and is currently known to occur on one 20-acre site on the Forest. Because its distribution is so limited, treatments of orange hawkweed are not expected to occur within the next 10-15 years on a scale that could affect lynx or their habitat. Therefore, lynx will not be discussed further in this report.

Bald Eagle

The Forest provides yearlong habitat for bald eagles. In Montana, bald eagle nest sites are generally distributed around the periphery of lakes and reservoirs greater than 80 acres (32.4 ha) as well as in forested corridors within one mile (1.6 km) of major rivers (MT Bald Eagle Working Group, 1994, page 2). There are currently six known active nest sites on the Forest, all of which are in the Hebgen and Earthquake Lake area near West Yellowstone. Three of these nests are located in a relatively small area on Horse Butte along Hebgen Lake. In Montana, an annual breeding cycle from initiation of courtship and nest building through fledging of young occurs approximately from February 1-August 15 (MT Bald Eagle Working Group, 1994, page 22). Once fledged, young are dependent on adults for six to ten weeks (MT Bald Eagle Working Group, 1994, page 3).

Adults may migrate or remain within their ecosystems during the winter. Wintering bald eagles occupy areas near unfrozen portions of lakes and free flowing rivers, or upland areas where ungulate carrion and lagomorphs are available (MT Bald Eagle Working Group, 1994, page 4). Bald eagles primarily winter in open water areas of Hebgen and Earthquake Lakes, and along the Madison, Gallatin, and Yellowstone Rivers.

An available prey base may be the most important factor determining the nesting habitat suitability, the nesting density and the productivity (MT Bald Eagle Working Group, 1994, page 2) of bald eagles. Bald eagles are opportunist feeders and will prey on fishes, waterfowl, lagomorphs, and some ground dwelling mammals, as well as ungulate carrion. In the Hebgen Lake area, fish made up the majority of prey items observed obtained by breeding pairs (Stangl, 1994, page 73). Ungulate carrion and waterfowl may also have been seasonal food sources (Stangl, 1994, page 74).

Bald eagles may be affected by a variety of human activities (MT Bald Eagle Working Group, 1994, page 4). Responses of eagles may range from abandonment of nest sites to temporary temporal and spatial avoidance of human activities. Responses may also vary depending on type, intensity, duration, timing, predictability and location of human activities. Individual pairs may respond differently to human disturbances because some birds are more tolerant than others (MT Bald Eagle Working Group, 1994, page 4). Generally, eagles are most sensitive to human activities during nest building, egg-laying, and incubation from February 1-May 30 (MT Bald Eagle Working Group, 1994, page 22). Human activities during this time may cause nest abandonment and reproductive failure. Once young have hatched, a breeding pair is less likely to abandon the nest. However, eagles may leave the nest due to prolonged disturbances, exposing young to predation and adverse weather conditions (MT Bald Eagle Working Group, 1994, page 22). Weed treatment activities have the potential to cause disturbance to nesting bald eagles if they occurred within nesting territories.

The Gallatin Forest Plan (USFS, page II-19) specifies that management direction for bald eagles would be provided by the Greater Yellowstone Bald Eagle Management Plan (Greater Yellowstone Bald Eagle Working Group 1996). This document provides guidelines for managing human activities around bald eagle nest sites (Greater Yellowstone Bald Eagle Working Group, 1996, pages 24-25). It recommends that human activities should not exceed minimal levels (no human activity except for existing agricultural uses, nesting surveys, or river boat traffic during less than 70 percent of daylight hours) within the occupied nesting area or zone I (less than 400 meter from a nest) of eagle nests from February 1-August 15. Within the primary use area or zone II (less than 800 meter from a nest), no more than light human activity levels (day use and low impact activities at low densities and frequencies) should be allowed during the same time period. Moderate activity (low impact activities at any intensities) would be allowed within the home range or zone III (<4 km of a nest).

Sensitive Wildlife Species

Sensitive species are those animal species identified by the Regional Forester for which population viability is a concern as evidenced by a significant downward trend in population numbers, density, or in habitat capability that will reduce a species' existing distribution (FSM 2670.5.19). There are eight terrestrial wildlife species listed as sensitive for the Northern Region National Forests including the Gallatin, and which are discussed in this section. Sensitive fish and amphibians are addressed in the Fisheries/Amphibians section. Sensitive plants are addressed in the Vegetation section.

Protection of sensitive species and their habitats is a response to the mandate of the National Forest Management Act (NFMA) to maintain viable populations of all native and desired non-native vertebrate species (36 CFR 219.19). The sensitive species program is intended to be proactive by identifying potentially vulnerable species and taking positive action to prevent declines that will result in listing under the Endangered Species Act.

As part of the National Environmental Policy Act (NEPA) decision-making process, proposed Forest Service programs or activities are to be reviewed to determine how an action will affect sensitive species (FSM 2670.32). The goal of the analysis should be to avoid or minimize impacts to sensitive species. If impacts cannot be avoided, the degree of potential adverse effects on the population or its habitat within the project area and on the species as a whole needs to be assessed.

Peregrine falcons

Peregrines occupy a variety of habitat but are typically found near water because of the abundance of prey associated with such sites. Nests are generally located below 8500 feet in elevation, less than 3,000 feet from water or a wetland, on a greater than 150 percent slope, and on a cliff ledge that is 3,000 feet in length and greater than 4,000 feet in height. Prey consists almost entirely of birds, which are usually taken on the wing. Surveys of potential peregrine falcon nesting habitat are completed on the Forest each year to monitor known nest sites and document new breeding pairs. There are 11 known active or historic eyries on the Forest with five located on the Bozeman District, three on the Hebgen Lake District, two on the Big Timber District, and one on the Livingston District.

It appears that peregrine falcons are sensitive to human activities, especially those occurring above the nest site. They are more tolerant of activities that occur below the nest site if there is

pronounced relief from the valley floor to the nest site (U.S. Fish and Wildlife Service, 1984, pages 9-10). Human disturbance at the nest may lead to abandonment and interference with care of the chicks. Guidelines for minimizing disturbance to nesting peregrine falcons are to restrict human activities and disturbances in excess of what historically occurred during the nesting season within one mile of nest cliffs (U.S. Fish and Wildlife Service, 1984, page 34). The use of pesticides that persist in the environment and magnify through the food chain also presents a risk to peregrines (U.S. Fish and Wildlife Service, 1984, pages 9-10). Because peregrines may forage in a variety of habitats, some areas used by these birds for foraging may be at risk of weed infestation while others would not be. Peregrine eyries may be located near weed infestations.

Northern goshawk

On October 2004, the goshawk was removed from the sensitive species list; however, it is a Management Indicator Species for the Gallatin Forest and it still needs to be analyzed. For the sack of efficiency, the analysis for the goshawk will remain the same in the final EIS as in the draft.

The goshawk is a large forest-dwelling hawk. Their prey may include grouse, smaller birds such as jays and woodpeckers, snowshoe hares, and squirrels (Reynolds *et al.*, 1992, page 4). Reynolds *et al.* (1992, page 3) identified the three components of a goshawk nesting home range as being the nest area, post-fledging family area (PFA), and foraging area. Nest areas are composed of older-aged forests with a closed canopy and larger diameter trees located on northern aspects with gentle to moderately steep slopes below 7500 feet in elevation (Reynolds *et al.*, 1992, page 22). PFA's contain a large percentage of mature forest habitat. Closed crowns forming a matrix enable young fledged birds to branch from one tree to the next and move throughout the forest canopy. Foraging areas are increasingly larger and more diverse than either the habitat maintained for nesting or the PFA. A diverse complex of vegetation within the foraging area supports a varied and abundant prey-base. Foraging habitat in Montana includes forest edges, open meadows, and moderate to densely forested stands (Hayward *et al.*, 1990, page 21). Goshawks are known to occur on the Forest and suitable goshawk habitat is found on all districts, but the number of nesting goshawks is unknown. Goshawk foraging areas may include areas at risk of weed infestations, but nesting and PFA's would generally not because canopy closure would be too great. A possible exception is orange hawkweed sites, which currently are known to occur on only one 20-acre site on the Forest.

Flammulated owl

The flammulated owl is a small, secretive owl that is known to occur over a wide geographic area in interior mid-elevation montane forests from British Columbia to south of the Mexican border (Hayward and Verner, 1994, page 17). It is an obligate secondary cavity nester that breeds in open ponderosa pine, Douglas fir, or mixed species forests. They are nocturnal hunters that feed mostly on arthropod prey (Hayward and Verner, 1994, page 27). The flammulated owl tends to avoid both arid and cold areas, and upper-elevation forests. Due to its secretive nature and a lack of targeted survey efforts, population trends for flammulated owls are uncertain although they now appear to be more common than was once thought (Hayward and Verner, 1994, page 18). On the Gallatin National Forest, flammulated owls are known to occur only on the Big Timber Ranger District within ponderosa pine/Douglas fir forest, although there has been little effort to survey specifically for this species. Habitat is limited on the Forest because ponderosa pine stands are rare and many Douglas fir stands have lost their historically open-canopy structure as a result of fire suppression. Other forest types found on the Gallatin such as lodgepole pine,

Engelmann spruce/subalpine fir, and whitebark pine, are unsuitable habitat for flammulated owls. Flammulated owl foraging habitat would likely include areas at risk of weed infestation.

Wolverines

Wolverines are the largest member of the weasel family. Although few studies have been conducted on them, they appear to utilize a wide variety of food sources including carrion, rodents, berries, insects, and birds (Reel *et al.*, 1989, page 32; Ruggiero *et al.* 1994, page 111-113). In the western United States they occupy a variety of mostly remote montane habitats throughout the year including alpine areas, boulder and talus fields, mature and intermediate forests adjacent to natural openings, big game winter ranges, and riparian areas (Reel *et al.*, 1989, page 32; Ruggiero *et al.* 1994, pages 100-115). Extensive travel by wolverines is not unusual and home ranges are typically very large (Ruggiero *et al.*, 1994, page 117). Although wolverine populations have increased in western Montana since the 1920's, they occur at low densities even where habitat is optimal (Ruggiero *et al.*, 1994, page 103). Suitable habitat for wolverines on the Forest is found in the Beartooth, Absaroka, Bridger, Crazy, Gallatin, Madison, and Henry's Lake Mountain Ranges. Wolverines are known to occur on the Forest as they are legally trapped on occasion and observations of wolverines or their tracks are regularly reported, but their distribution and abundance remains unclear. Most wolverine habitat would be at low risk of weed infestation, with the exception of big-game winter ranges.

Western (Townsend's) big-eared bat

The distribution of the western (Townsend's) big-eared bat is strongly correlated with the availability of caves or abandoned mine shafts where they winter in communal roosts and where females roost with their young. If suitable roosting areas are available, they occur within a wide variety of habitats from arid pine forests to high-elevation mixed coniferous forests (Reel *et al.*, 1989, page 38). Foraging habitat includes riparian areas, forest edge, and diverse forest stands. They are insectivorous and feed primarily on moths. The disruption of roosting habitat can cause permanent abandonment of roost sites (Reel *et al.*, 1989, page 39). Although there is suitable habitat for this species on the Forest, there are no known hibernacula or roost sites and their distribution and abundance is poorly understood. Western big-eared bat foraging habitat could include areas at risk of weed infestation.

Black-backed woodpecker

Black-backed woodpecker inhabits mature to over-mature coniferous forests across North America. It is rare throughout its range, but may be locally common in response to a temporary abundance of food. Black-backed woodpeckers respond opportunistically to insect outbreaks and seem to prefer recently burned stands, where it forages on insects. Populations of the black-backed woodpecker tend to be irruptive in nature and correspond with the sporadic abundance of bark beetles, its preferred prey. The woodpecker shows a preference for mature pine stands at elevations at or below 6,000 feet (Cherry, 1997). Black-backed woodpeckers will use higher elevation areas once a fire or other disturbance occurs which brings in snags and insects (Cherry, 1997). Burned areas inhabited by this species may be at high risk for weed infestation. However, they are dependant on forest structure rather than ground vegetation, and would not be affected by project activities. Therefore, they will not be discussed further in this document.

Trumpeter swan

The trumpeter swan is the largest of North American waterfowl. Their populations have increased dramatically since the early 1900's, when over-exploitation had reduced their numbers to a few birds in Yellowstone National Park and the adjacent Red Rock Lakes area. They nest in wetland habitat including secluded shallow marshes, lakes, and rivers, and often return to the same nest sites each year (Reel *et al.*, 1989, page 26). Large numbers of trumpeters winter in the Greater Yellowstone area where open water and aquatic vegetation are available. On the Gallatin National Forest, Hebgen Lake provides spring and winter habitat for the trumpeter swan. Historic nest sites were located in the Taylor Fork drainage and along the Gallatin River, but swans have not been observed to nest in either area in recent years. Due to spatial separation of preferred habitats and areas at risk of weed infestation, trumpeter swans would not be affected by this project and will not be discussed further in this document.

Western harlequin duck

Western harlequin duck population winters along the north Pacific Coast, and migrates inland to breed east to the Rocky Mountains. They occupy fast, swift moving mountain streams during the breeding season. Females usually return to the same breeding sites each year (Reel *et al.*, 1989, page 34). Despite survey efforts on the Forest, the harlequin duck is known to nest only on the Big Timber District. Harlequin drakes have been observed on the Madison River on the Hebgen Lake District in early spring (Marion Cherry, Forest Biologist, Gallatin N.F.), and it is suspected that this area is used as a temporary stopover point during spring migration. There is little overlap between harlequin duck habitat and areas at risk of weed infestation. Therefore, they would not be affected by this project and will not be discussed further in this document.

Management Indicator Species (MIS)

Management Indicator Species (MIS) are species whose habitat is most likely to be affected by forest management activities and serve as indicators of change for threatened or endangered species, big game species, or certain habitat types (USFS, 1987, page II-18). There are five terrestrial MIS for the Gallatin National Forest, several of which are discussed elsewhere in this document. Grizzly bears and bald eagles are indicators for threatened and endangered species, and were discussed under the Threatened, Endangered, and Proposed Species section. The goshawk is a Northern Region sensitive species as well as an indicator for old growth dependent species on dry Douglas fir sites, and was discussed under the Sensitive Species section.

Elk are indicators for big game species. Elk are a highly adaptable species that annually use a wide variety of habitats including open sagebrush and grasslands as well as all forest types. Nearly the entire Forest provides habitat for elk during some time of the year. Elk generally summer on National Forest lands in the higher elevation mountain ranges and migrate to winter ranges on National Forest, state, Bureau of Land Management, and private lands in lower elevation valleys. They are capable of grazing or browsing a wide range of plants during different seasons, but in Montana grasses or forbs are a critical dietary component for much of the year (Nelson and Leege, 1982, page 344-354). Noxious weeds are typically not eaten by elk at all, or are of very low palatability. Important winter ranges for elk normally occur in grassland or sagebrush habitats that are at high risk for weed infestation. Infestations of weeds such as spotted knapweed can lead to 60-90 percent decreases in forage production on winter ranges (Rice *et al.*, 1997, page 628), which would potentially decrease the number of ungulates that winter ranges can support (Trammel and Butler, 1995, page 814). Elk populations on the Forest are currently at or above objectives set by the Montana Department of Fish, Wildlife, and Parks (MDFWP) with

the exception of the Upper Gallatin herd, which has been below the objective for several years (Cherry, 2002).

Pine martens, also known as American martens, typically utilize late-successional mesic conifer stands (Ruggiero *et al.*, 1994, page 7), although in southwest Montana they also use other coniferous habitats such as lodgepole pine and are not restricted to old growth forest stands (Coffin, 1994, page 73). Although their distribution is broad in western North America, ranging from northern New Mexico to arctic Alaska, they are only associated with montane coniferous forests in the Rocky Mountains (Ruggiero *et al.*, 1994, p.7). They prefer stands with complex structures near the ground (Ruggiero *et al.*, 1994, page 7) including dense herbaceous growth and deadfall (Kujala, 1993, page 28). They may utilize talus areas above treeline, but are normally not found in open rangelands below the lower elevational limit of trees (Ruggiero *et al.*, 1994, page 7). For this reason, there is little overlap between pine marten habitat and areas at risk of weed infestation. The exception is orange hawkweed, which can invade closed-canopy forests and is currently known to occur on one 20-acre site on the Forest. Because its distribution is so limited, treatments of orange hawkweed are not expected to occur within the next 10-15 years on a scale that could affect martens or their habitat. Therefore, martens will not be discussed further in this report.

Migratory Birds and Biodiversity

An executive order signed by President Clinton on January 10, 2001 requires the Forest Service and other federal agencies to evaluate the effects of agency actions on migratory birds. Additionally, migratory birds have a variety of life history strategies that tie in a wide variety of other plant and animal species. Therefore, they were used to assess biodiversity for this analysis. Numerous species of migratory birds seasonally inhabit a variety of habitats across the Forest. The Draft Montana Bird Conservation Plan (Casey, 2000) identified priority bird species for conservation within various habitat types. Birds were ranked according to priority for conservation. Level I birds were those with declining population trends and thought to require conservation action; level II birds were those with lesser threat or stable populations but as a minimum require more monitoring; and level III were those that were of local concern but not in imminent risk. Nine species occurring during the breeding season on the Forest in grassland or sagebrush steppe habitats that are most susceptible to weed invasion were listed as level I-III conservation priority (Table 3-13). Numerous other species of birds occur in these habitats as well.

Table 3-13. Priority birds species for conservation occurring on habitats most at risk for weed infestations on the Gallatin National Forest, from the Draft Montana Bird Conservation Plan (Casey, 2000, pages 33-81)

Habitat Type	Species	Priority Rank
Grasslands	Sprague's Pipit	I
	Ferruginous Hawk	II
	Long-billed Curlew	II
	Northern Harrier	III
	Short-eared Owl	III
	Bobolink	III

Habitat Type	Species	Priority Rank
Sagebrush Shrubsteppe	Loggerhead Shrike	II
	Brewer's Sparrow	II
	Lark Sparrow	III

The ecology of the species listed in Table 3-13 is representative of many migratory birds found in grassland and sagebrush habitats. All of the species listed in Table 3-13 nest on the ground or in low shrubs or trees, and are dependent on native vegetation to provide adequate nesting cover. These species also depend upon native vegetation to provide forage plants or cover for prey. Ferruginous hawks, northern harriers, and short-eared owls eat mainly mice, voles, and a variety of other small mammals, birds, and reptiles (Degraff, 1991, pages 76, 90, 203). Loggerhead shrikes prey on a variety of insects, mammals, birds, and reptiles (Degraff, 1991, page 373). Brewer's sparrows, bobolinks, lark sparrows, and sprague's pipits forage on insects and plant seeds (Degraff, 1991, pages 466, 470, 496). Noxious weeds were listed as a threat for species inhabiting both grasslands and sagebrush shrubsteppe habitats (Casey, 2000, pages 37, 67).

Herbicide Toxicity to Terrestrial Mammals and Birds

Exposure of terrestrial animals to herbicides may result from several actions including direct spray application, ingestion of plants or other items that have been sprayed, grooming, and indirect contact with vegetation that has been sprayed or inhalation of spray (Durkin, 2001, page 4-13). Wildlife may spend long periods in contact with contaminated vegetation (Durkin, 2001, page 4-16), or ingest contaminated vegetation or prey (Durkin, 2001, page 4-17).

Pesticides have been identified as a major cause of mortality for numerous species. Organophosphorus and carbamate insecticides are currently the chemicals most commonly associated with mass mortality of wildlife, especially migratory birds (Vyas, 1999). The herbicides proposed for use on the Gallatin National Forest (Table 3-14) are made up of different chemical compounds (phenosyaliphatic acids, triazoles, bensoics, and phosphonomethyl). The effects of many herbicides on mammalian and avian wildlife have not been studied in detail, although most herbicides have been tested on laboratory animals (especially rats, mice, rabbits, and dogs). Findings are then extrapolated to wildlife (USFS, 1992, page III-F-1), which means that conclusions regarding the effects of these chemicals on wildlife are somewhat uncertain. However, risk levels for herbicide use are calculated in a very conservative manner and worst-case exposure scenarios have been studied for most herbicides. Lethal Dose 50 (LD50) values are used as a measure of toxicity and are defined as the quantity of chemical per unit body weight that would cause lethal effects in 50 percent of a study population with a single dose. Reported LD50 values for herbicides were sometimes highly variable (Table 3-14), reflecting differences among studies such as use of different species or exposure techniques, varying sample sizes, etc. Despite this variability in LD50's, data is sufficient to determine that the herbicides proposed for use under the Proposed Action are generally of low toxicity to mammalian and avian wildlife (Table 3-14). Exposure to extremely high levels of most herbicides through direct ingestion or spraying during laboratory studies often lead to death or a variety of sub-lethal toxic effects including damage/irritation to the nervous system, kidneys, eyes, skin; inhibition of reproduction; and other problems. However, the doses required to produce such effects were much higher than those wildlife would encounter from application of herbicides in the field even under worst-case scenarios.

In addition to the active ingredients in chemicals used for weed control, commercial herbicide formulations contain various inert ingredients. These ingredients have been placed in four categories by the Environmental Protection Agency according to their toxicity (Moore, 1987). The categories are: 1) inerts of toxicological concern; 2) potentially toxic inerts/high priority for testing; 3) inerts of unknown toxicity; and 4) inerts of minimal concern. The majority of inerts are currently in category 3, indicating that there is a large degree of uncertainty regarding the effects of inert ingredients. Also largely unknown are the possible synergistic effects of various inert ingredients and pesticides.

The long-term fate of herbicides in the environment is also a concern. Bioaccumulation is the process by which chemicals enter the food chain from the environment, whereas bio-magnification is the increase in concentration of these chemicals from one link in the food chain to the next. The combined effects of these processes means that small concentrations of chemicals can lead to toxic effects, especially for organisms high in the food chain. However, for bio-magnification to occur, the chemical must be long-lived, mobile, and fat-soluble. If a chemical is not long-lived, it will break down before entering the food chain. If it's not mobile, such as when it's bonded to soil, it is unlikely to be taken up by an organism. If it is water-soluble, rather than fat-soluble, it will be excreted by the organism. The herbicides proposed for use in this project (Table 3 - 14) appear to be rapidly excreted (USFS, 1992;1998a, page 3-7; 1999, page 3-5; 2001, page 3-6) and do not accumulate in tissues, although data was often limited. Because of this, these herbicides present a low risk for bio-magnification.

Table 3-14. Toxicity of herbicides proposed for use on the Gallatin National Forest.

Chemical name (common brand names)	Mammalian toxicity (LD50 in mg/kg body weight)	Avian Toxicity (LD50 in mg/kg body weight)	Risk Assessment
2,4-D (amine form) (Hi-Dep, Weedar 64, Weed RHAP A- 4D, Weed RHAP A)	¹ moderate (639 >5,000) ² low /moderate (100- 1800)	¹ low/moderate (472- >2,000) ² low/moderate (300-5,000)	Good data for mammals and birds; birds somewhat less sensitive than mammals; exposure not expected to cause observable adverse signs of toxicity but may lead to eye or skin irritation; exposure at higher than expected levels also affects kidneys, nervous system, and thyroid and may lead to vomiting, diarrhea, and muscle twitches.
Chlorsulfuron (Telar)	¹ nearly nontoxic (<5,000) ³ very slightly toxic (5,545)	¹ nearly nontoxic (<5,000) ³ very slightly toxic (>5,000)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; potential for adverse effects to mammals and birds appears to be remote.
Clopyralid (Stinger, Reclaim, Transline)	¹ low (none given) ² low (>3,000-5,000)	¹ low (none given) ² low (1,465)	Well studied in experimental mammals but not birds or other wildlife; potential for adverse effects to mammals and birds appears to be remote, given available data.
Dicamba (Banvel, Banex, Trooper)	¹ slightly toxic (566- 3,000) ² low (600->3,000)	¹ nearly nontoxic (673- 2,000) ² low (none given)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; toxic

Chemical name (common brand names)	Mammalian toxicity (LD50 in mg/kg body weight)	Avian Toxicity (LD50 in mg/kg body weight)	Risk Assessment
			effects unlikely for application rates at or above those normally used.
Glyphosate (Roundup, Rodeo, Accord)	¹ nearly nontoxic (none given) ² low (1,500->5,000)	¹ nearly nontoxic (3,850) ² low (1,500->5,000)	Good data on mammalian and avian wildlife; toxic effects very unlikely even at highest allowable application rates.
Hexazinone (Velpar, Velpar ULW, Velpar L, Pronone 10G)	¹ nearly nontoxic (none given) ² low (none given)	¹ nearly nontoxic (3,850) ² low (2,258)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; available data indicate it is unlikely to cause adverse effects to terrestrial species; ingestion of crystals by birds immediately after application may cause reproductive effects or overt signs of toxicity.
Imazapyr (Arsenal, Chopper, Contain)	¹ nearly nontoxic (4,800-5,000) ² low (none given)	¹ nearly nontoxic (<2,150) ² low (none given)	Most data are from experimental animals, there is some uncertainty about extrapolating conclusions to wildlife; little data on toxic levels; sufficient data are available to conclude that adverse effects to terrestrial species are unlikely under typical or worst-case cases of exposure.
Metsulfuron methyl (Escort, Ally)	¹ nearly nontoxic (none given) ² low (>2,000)	¹ nearly nontoxic (<2,150) ² low (>2,000)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; sufficient data are available to conclude that adverse effects to terrestrial species are unlikely under typical or worst-case cases of exposure; may cause weight loss at sub-lethal doses.
Picloram (Tordon, Grazon, Access, Pathway)	¹ low (<950-8,200) ² low (3,000-5,000)	¹ nearly nontoxic (<2,000) ² low (>2,000)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; adverse effects to mammals or birds are unlikely under typical or worst-case cases of exposure.
Imazapic	² low (none given)	² low (none given)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; larger mammals affected more than smaller, however adverse effects to mammals or birds are unlikely under typical or worst-case cases of exposure.
Sulfometuron	¹ low (<5,000 ppm)	¹ low (<5,620 ppm)	Very limited data on birds;

Chemical name (common brand names)	Mammalian toxicity (LD50 in mg/kg body weight)	Avian Toxicity (LD50 in mg/kg body weight)	Risk Assessment
glyph (Oust)	² low (none given)	² low (none given)	observable effects to most mammals & birds not expected; possible reproductive effects to some species although evidence is not conclusive.
Triclopyr (Garlon, Grazon)	¹ slightly toxic (310-713) ² low (none given)	¹ very low (1,698) ² low (none given)	Good data for birds and mammals; application rates at or above those normally used not expected to affect terrestrial animals.

Data are from ¹*Pesticide Fact Sheets* (PFS), Information Ventures, Inc. (<http://infoventures.com/e-hth/pesticides>), ²*Human Health and Ecological Risk Assessments* (ERA), Syracuse Environmental Research Associates, Inc. (<http://www.fs.fed.us/foresthealth/pesticide/risk.htm>), ³Risk Assessment for Herbicide Use in Forest Service Regions 1, 2, 3, 4 and 10 on Bonneville Power Administration Sites, LABAT-ANDERSON, Inc. 1992.

WILDERNESS AND INVENTORIED ROADLESS AREAS

Wilderness Areas are areas of Federally owned land that have been designated by Congress as Wilderness, in accordance with the Wilderness Act of 1964. These areas are protected and managed so as to preserve their natural conditions which (1) generally appear to have been affected primarily by forces of nature with the imprint of man's activity substantially unnoticeable; (2) have outstanding opportunities for solitude or a primitive and confined type of recreation; (3) have at least 5,000 acres or is of sufficient size to make practical their preservation, enjoyment, and use in an unimpaired condition; and (4) may contain features of scientific, educational, scenic, or historical value as well as ecologic and geologic interest. A Wilderness Study analysis is conducted on candidate areas to determine an area's appropriateness, cost, and benefits for addition to the National Wilderness Preservation System.

Inventoried Roadless Areas (IRAs) are areas identified in a set of inventoried roadless area maps, contained in Forest Service Roadless Area Conservation, Final Environmental Impact Statement, Volume 2 dated November 2000, which are held at the national headquarters office of the Forest Service or any subsequent update or revision of those maps.

Regulatory Framework – Wilderness and Inventoried Roadless Areas:

Designated Wilderness is mandated to be administered so that its community of life is untrammelled by man, its primeval character retained and naturally functioning ecosystems preserved (PL 88-577).

Wilderness areas are managed as directed by the Wilderness Act of 1964. Management actions within Wilderness focus on maintaining naturally functioning ecosystems, providing access through appropriate means (typically trails) and managing some pre-existing uses like grazing allotments and outfitter operations. Examples of management activities include trail construction and maintenance, fire suppression or management of naturally ignited fires, removal of existing structures, and noxious weed treatment.

Forest Service Manual (FSM) 2323.26b allows plant control for "noxious farm weeds by grubbing or with chemicals when they threaten lands outside Wilderness or when they are

spreading within the Wilderness, provided that it is possible to effect control without causing serious adverse impacts on Wilderness values. FSM 2109.14 (13.4) requires Regional Forester approval of pesticide use in designated Wilderness Areas.

Congress gives no specific direction as to management of noxious weeds in the Montana Wilderness Study Area. It simply states that agencies are directed to manage these areas to “maintain their presently existing Wilderness character and potential for inclusion in the National Wilderness Preservation System”. This implies that the natural integrity of ecosystems as they existed in 1977 should be preserved, as well as opportunities for solitude, a sense of remoteness, and a natural appearing environment.

Generic direction for Wilderness Management is found in the Gallatin Forest Plan, page III-10. Specific direction for the Lee Metcalf and Absaroka Beartooth are found in Appendices F1 and F2. Specifically direction relating to management of noxious weeds states:

Absaroka Beartooth

- All feed packed into the Wilderness will either be certified weed free or processed feed.
- Visitors will be encouraged to remove burrs and weed seeds from stock prior to entering the Wilderness. This will be accomplished through brochures and at trailheads.
- Develop a program of noxious weed control.

Lee Metcalf

- Non-native plants, especially those which may significantly alter natural plant succession, will be controlled as needed, by means that have the least impact on the Wilderness resource. Chemical weed control projects will not commence before a plan for weed control is reviewed by the public. Any use of chemicals must be approved by the appropriate agency officer.
- Use of certified weed free feed will be required by 1988.
- Monitoring of vegetation condition will be conducted.

Inventoried Roadless Lands: There is currently no specific congressional oversight of inventoried roadless lands. Weed treatments on inventoried roadless lands would not need special approval simply because of the area’s roadless status.

Affected Area – Wilderness and Inventoried Roadless Areas

The analysis area for wilderness and inventoried roadless areas is the extent of the individual wilderness area and/or roadless area.

Analysis Method – Wilderness and Inventoried Roadless Areas

Geographic Information System (GSI) spatial data was used to determine the location of Wilderness Areas, Wilderness Study Areas and IRAs relative to the proposed activities in the action alternatives. Existing condition was determined through mapping of known weed infestations from the GIS weed database. Potential types of treatments within these areas were estimated.

Management activities (proposed, and past, present and reasonably foreseeable) were evaluated for their potential effects on the Wilderness attributes listed in the Forest Service Northern Region “Our Approach to Effects Analysis” for assessing the impacts on Wilderness and roadless characteristics. This method will be used for designated Wilderness, Wilderness Study Areas, and Inventoried Roadless Areas. The attributes include: natural integrity, apparent naturalness, remoteness and solitude, management, and boundaries. Natural integrity is the extent to which long-term ecological processes are intact and operating. Apparent naturalness is a measure of how natural the environment appears. Impacts to natural integrity and apparent naturalness are measured by the presence and magnitude of human induced change to an area. Solitude is a personal subjective value defined as isolation from the sights, sounds and presence of others, and the developments of man. Management and boundaries will not be affected by proposed activities and will not be discussed further.

Affected Environment – Wilderness and Inventoried Roadless Area

The Gallatin National Forest is largely comprised of designated Wilderness, Wilderness Study Areas (WSA), or IRAs. Of the Forest’s approximately 1,808,259 acres of public land, over 75 percent of the Forest is within designated Wilderness, WSA, or Inventoried Roadless Areas. See Table 3-15 for the breakdown of acres.

Table 3-15. Summary of area of land in Wilderness and Roadless Designation.

Total Forest Acres	Absaroka Beartooth Wilderness	Lee Metcalf Wilderness	Hyalite Porcupine Buffalo Wilderness Study Area	Inventoried Roadless (excluding the WSA)
1,808,259	575,771	140,594	155,000	519,000

Absaroka Beartooth Wilderness: Congress designated the Absaroka-Beartooth (AB) Wilderness Area in 1978. It encompasses a total of 943,626 acres. Montana contains 920,343 acres, divided between the Gallatin and Custer National Forest’s. The Wyoming portion contains 23,283 acres (located on the Shoshone NF).

The Crow Indians called themselves Apsaalooke, hence the name of the mountain range that, along with Beartooth, characterizes this Wilderness. Active glaciers, sweeping tundra plateaus, deep canyons, sparkling streams, and hundreds of alpine lakes combine to make this one of the most outstanding Wilderness areas in America.

The Absarokas, unlike Beartooth, have ample vegetative cover, including dense forests and broad mountain meadows crossed by meandering streams. Bighorn sheep and mountain goats roam about the mostly rugged country, along with elk, deer, moose, marmots, coyotes, black bears, wolves and members of a substantial grizzly population. The harsher Beartooths accommodate far fewer animals. Trout reside in many of the lakes and streams in both ranges.

The history of domestic livestock grazing in the Absaroka-Beartooth has played a role in noxious weed distribution throughout this area. At one time, over 300,000 domestic sheep were grazed in the area. There are currently three active allotments in the Absaroka-Beartooth: one sheep, one cattle, and one horse.

Prevention and education has long been an important tactic in preventing the spread of noxious weeds in the Absaroka-Beartooth. Since 1977, all commercial outfitters have been required to use only certified weed free feeds. Since the mid 1990's all users were required to use certified weed free feeds. Educating the public about the weed issue, and vulnerability of weeds in the Absaroka-Beartooth has been a priority for over a decade.

Wilderness managers have been inventorying and monitoring weed populations in the Absaroka-Beartooth for over 20 years. Hand control operations, grubbing, pulling have been used throughout the Wilderness and limited chemical and biological controls have been applied in specific locations (e.g. East Dam Ck. Spotted Knapweed Control Project). Chemical control of weeds has been implemented only through site-specific NEPA (National Environmental Policy Act) decisions in the Absaroka-Beartooth. The following table represents the weed inventory (Gallatin portion only) in the Absaroka-Beartooth at the end of 2002.

Table 3-16. Summary of mapped weed population in the Absaroka-Beartooth.

Plant Name	Polygons Mapped	Acres
Bull Thistle	3	2
Canada Thistle	169	689
Cheat Grass	10	96
Common Tansy	8	0.50
Dalmatian Toadflax	26	4
Houndstongue	118	274
Mullein	1	2
Musk Thistle	27	140
Oxeye Daisy	10	2
Spotted Knapweed	47	43
Sulfur Cinquefoil	1	0.10
Yellow Toadflax	2	0.10

Certainly other infestations of weeds exist in the Absaroka-Beartooth, but this table represents a fairly extensive inventory. Most of the infestations are proximate to trails, disturbed areas, grazing allotments or burned areas.

There are many aggressive weed infestations peripheral to the Absaroka-Beartooth. Notably – there is a significant Oxeye Daisy infestation in the main Boulder drainage, and Dalmatian toadflax in the Gardiner Basin. Spotted knapweed is well established in large populations on the periphery of the Absaroka-Beartooth in the Custer National Forest. These aggressive weeds have the potential to infect the Wilderness, and destroy naturally functioning ecosystems.

Lee Metcalf Wilderness: Congress designated the Lee Metcalf (LM) Wilderness Area in 1983 including a total of 254,288 acres. All of the Wilderness is within the state of Montana on the Gallatin and Beaverhead Deerlodge (B-D) National Forests, and the Bureau of Land Management (BLM) lands.

This Wilderness consists of four separate units in the Madison Range of Montana, ranging from a huddle of high peaks rising above 10,000 feet and exquisite subalpine meadows, to the arid river Bear Trap Canyon managed by the BLM. The BLM manages all 6,000 acres of the Bear Trap Canyon Unit, a stretch of wild canyon country along the Madison River. This was the BLM's first designated Wilderness. The BLM is actively monitoring and treating weeds in the Bear Trap.

(USDI, ND). The Bear Trap Wilderness Weed Management Plan utilized an integrated management approach to weed control, using all appropriate methods or combination of methods of weed control (chemical, biological, cultural and educational methods).

The Monument Mountain Unit lies on the northwest boundary of Yellowstone National Park, an isolated piece of territory rarely visited but rich in wildlife, including a large population of grizzly bears. All 30,000-plus acres lie within Gallatin National Forest.

The 78,000-acre Spanish Peaks Unit encompasses steeply rugged, glaciated peaks rising more than 11,000 feet above scenic cirques and gemlike lakes. This heavily used area, popular with local and regional visitors, hosts a well-developed trail system.

At about 141,000 acres, the Taylor-Hilgard Unit is the largest wilderness unit. It runs along the crest of the Madison Range, with several peaks exceeding 11,000 feet above the Hilgard Basin, with its meadows and lakes surrounded by snowcapped summits.

There has been a long history of domestic livestock grazing in the Lee Metcalf – including sheep, cattle and horses. Currently there is only one active allotment in the Lee Metcalf – the Sage Creek horse allotment located in the Monument Mountain Unit.

For the last ten years, wilderness rangers have been sporadically monitoring weed infestations in the Lee Metcalf (Gallatin portion). The Madison Ranger District and BLM have active weed monitoring programs. Both the Beaverhead-Deerlodge National Forest and the BLM have aggressively been treating weeds within the Wilderness for several years using all methods of control from grubbing/pulling, chemical applications to biological controls. See the BLM's Bear Trap Weed Management Plan (USDI, ND) for further information. Weed infestations in the Gallatin portion of the Lee Metcalf are believed to be light (inconclusive information, since we lack exhaustive weed monitoring data in the Lee Metcalf), while the Beartrap is heavily infested.

Table 3-17. Summary of mapped weed population in the Lee Metcalf.

Plant Name	Polygons Mapped	Acres
Houndstongue	1	5
*Poorly Inventoried		

Populations of Canada thistle and other weeds likely exist within the Gallatin portion of the Lee Metcalf. However, weed inventories of the area limited. General observations suggest that most of the serious weed threats occur just outside of the Wilderness at trailheads and on surrounding National Forest. Species present in the nearby Beartrap unit of the Lee Metcalf include: Canada thistle, leafy spurge, spotted knapweed, sulfur cinquefoil, houndstongue, musk thistle, common mullein, and black henbane.

Hyalite Porcupine Buffalo Horn (HPBH) Wilderness Study Area: The Montana Wilderness Study Act of 1977 (P.L. 95-150) created eight Wilderness Study Areas in Montana, of which the Hyalite Porcupine Buffalo Horn was one. This study area is located in the roadless core of the Gallatin Range, running north to Hyalite Canyon, and south to the Yellowstone National Park boundary. In the early 1980's the Forest Service studied the areas' suitability for inclusion in the Wilderness preservation system, and did not recommend that it be designated Wilderness at that time. Checkerboard ownership was largely responsible for the conclusion that the area was

unsuitable for future Wilderness designation. Since then, nearly 37,000 acres of private land have been acquired within the Hyalite Porcupine Buffalo Horn boundary.

Weed monitoring has been infrequent and recent in the Hyalite Porcupine Buffalo Horn. The following table represents current data (most of the monitoring has occurred on the Livingston Ranger District – eastern portion of the study area):

Table 3-18. Summary of mapped weed population in the Hyalite Porcupine Buffalo Horn Wilderness Study Area.

Plant Name	Polygons Mapped	Acres
Canada Thistle	10	34
Houndstongue	13	14
Mullein	3	4
Musk Thistle	5	0.5
Oxeye Daisy	1	0.10
Pennycress	1	0.10
Spotted Knapweed	1	0.10
White Top, Hoary Cress	1	0.10
Yellow Toadflax	1	0.10

Inventoried Roadless Lands: Approximately 674,000 acres of inventoried roadless in 12 separate areas are located on the Gallatin National Forest. The inventory was displayed in the Gallatin Forest Plan EIS, Appendix C (USDA, 1987). In the late 1990's the Clinton Administration completed a nationwide study of "roadless" lands on public land, and maps of record included in the final rule (USDA, 2001). The final rule acknowledges that this inventory may not be perfectly accurate, and likely included lands that no longer retained their roadless characteristics. Inventoried roadless lands are found in all the mountain ranges on the Gallatin National Forest, and are currently allocated a wide variety of Forest Plan Management Area designations from the most protective (MA 4 – recommended Wilderness) to allocations focusing on timber or range management. A wide variety of land uses occur within these areas, from range allotments and minor mineral developments to dispersed recreation use of trails and trail-less areas.

The following table summarizes weed inventory data collected at the end of 2002 for inventoried roadless lands on the Forest:

Table 3-19. Summary of mapped weed population in the Inventoried Roadless Area.

Plant Name	Polygons Mapped	Acres
(Diffuse) White Knapweed	6	1
Bull Thistle	28	22
Canada Thistle	163	221
Cheat Grass	63	895
Common Tansy	20	1
Dalmatian Toadflax	33	1091
Golden Chamomile	4	2
Houndstongue	169	305
Leafy Spurge	34	95

Plant Name	Polygons Mapped	Acres
Mullein	1	0.10
Musk Thistle	48	49
Oxeye Daisy	27	13
Poison Hemlock	2	0.10
Spotted Knapweed	158	105
St. John's Wort	6	10
Sulfur Cinquefoil	2	0.10
White Top, Hoary Cress	2	0.10
Yellow Toadflax	16	69
Field Scabious	2	0.10

WILD AND SCENIC RIVERS

Regulatory Framework – Wild and Scenic Rivers

The Wild and Scenic Rivers Act (16 US1271) and Interagency Guidelines provided in the Wild and Scenic Rivers Reference Guide (USDA and others, 1995) provide the general direction for management of these rivers. Additional goals, guidelines, and standards are found in the Gallatin Forest Plan as amended by amendment #12. The Gallatin Forest Plan provides a goal to “Manage the eligible Wild and Scenic Rivers to protect their outstandingly remarkable values.” A standard states: “Management activities will comply with the standards for Wild and Scenic Rivers from Chapter 8 of the Forest Service handbook 1909.12.”

Analysis Area – Wild and Scenic River

The analysis area for Wild and Scenic Rivers are those streams and adjacent lands within the Gallatin National Forest that are currently listed for protection under the Wild and Scenic Rivers Act.

Analysis Method – Wild and Scenic Rivers

The source of information for the Affected Environment was the Forest Plan and its associated EIS. The analysis is based on the potential for the proposed weed treatment activities to impact the values inherent to rivers or streams on the Gallatin National Forest that are potentially eligible for protection under the Wild and Scenic Rivers Act.

Affected Environment - – Wild and Scenic Rivers:

Portions of four streams were identified as “eligible” for Wild and Scenic River designation during the Gallatin Forest Plan (USDA, 1987). Those included the Madison, Gallatin, Yellowstone and Boulder Rivers. One additional segment was added to that list in a Forest Plan Amendment (#12) in 1993- the Clarks Fork of the Yellowstone. See the Forest Plan – Appendix J for a complete description of the eligible segments of these streams. Congress has not designated these river segments, as “Wild and Scenic,” to date.

The Wild and Scenic Rivers Act was enacted to preserve in a free-flowing condition rivers that possessed outstanding scenic, recreational, geologic, fish and wildlife, historic cultural or other similar values. Congress declared that it was important to manage certain rivers in their free

flowing condition, and to manage them and their immediate environment to protect those qualities for the benefit and enjoyment of present and future generations. The presences of weeds along the river corridor can detract from the aesthetic and recreational opportunities. The eligible river segments are assigned a potential classification of wild, scenic, or recreational.

Characteristics of these classifications are:

- Wild River areas -free of impoundments, generally accessible only by trail, shorelines primitive and the water unpolluted;
- Scenic River areas - free of impoundments, shorelines largely undeveloped but accessible in places by road;
- Recreational River areas –readily accessible by roads, some development and may have impoundment or diversion.

Madison River – approximately eight miles of this river located within the Gallatin National Forest is considered eligible. Outstandingly remarkable values identified included the geologic features associated with the earthquake of 1959, a blue ribbon trout fishery, nesting bald eagles and osprey, and outstanding recreation opportunities. It is considered eligible under a “recreation” classification.

Gallatin River – approximately 39 miles of the river is located within Gallatin National Forest boundaries. The outstandingly remarkable values identified included scenery, blue ribbon trout fishery, and recreation. It is considered eligible under a “recreation” classification.

Yellowstone River – approximately 16 miles of the Yellowstone River are located within the Gallatin National Forest boundary. The outstandingly remarkable values identified for the Yellowstone included its recreation and scenic qualities. An important trout fishery was also noted. It is considered eligible under a “recreation” classification.

Boulder River – approximately 28 miles of this river are within the Gallatin National Forest boundaries. Outstandingly remarkable values identified included the unique geologic features of the Natural Bridge, recreational, and scenic values. It is considered eligible under a “recreation” classification.

Clarks Fork of the Yellowstone - approximately 1.8 miles of this stream fall within the Gallatin National Forest boundary. Outstandingly remarkable values identified included the unique geologic features of the Beartooth Plateau, and high recreation values. This addition was made partially because a lower section of this river in Wyoming was classified as designated a Wild and Scenic River in the late 1980’s.

RESEARCH NATURAL AREAS

Regulatory Framework – Research Natural Areas

Research Natural Areas (RNAs) and Special Interest Areas (SIAs) are managed to maintain the undisturbed conditions and natural processes that characterize these areas. At the time the Gallatin Forest Plan was signed, there were no areas formally designated as RNAs or SIAs although nine areas were identified for designation based on their representative and/or unique natural and ecological features. The Forest Plan was amended in 1997, formally designating seven RNAs and one SIA on the Gallatin National Forest. They include the East Fork Mill Creek RNA, Passage Creek RNA, and Sliding Mountain RNA on Livingston Ranger District; the Palace

Butte and Wheeler Ridge RNA on Bozeman Ranger District; and the Black Butte RNA, Obsidian Sands RNA and Black Sands Springs SIA on Hebgen Lake Ranger District.

The Code of Federal Regulations (CFR) provides management direction as follows “Forest Planning shall provide for the establishment of RNAs” (36 CFR 219.25) and “[RNAs] will be retained in a virgin or unmodified condition except where measures are required to maintain a plant community which the area is intended to represent” (36 CFR 251.23). The Forest Service Manual (FSM) also provides guiding management direction for RNAs (FSM 4063) and SIAs (FSM 2372). In addition, the individual establishment records for each area serves as Forest Plan direction (as amended).

Applicable to invasive species management, FSM 4063.3.8, 9 directs activities to comply with the following standards: “8) *Where pest management activities are prescribed, they shall be as specific as possible against target organisms and induce minimal impact to other components of the ecosystem, and* 9) *If practicable, remove exotic plant or animal life.*” Further, FSM 4063.32 directs that “*If exotic plants or animals have been introduced into an established RNA, the Station Director and the Regional Forester shall exercise control measures that are in keeping with established management principles and standards to eradicate them, when practical.*”

Lastly, FSM 4063.34 [in part] “*Use only tried and reliable vegetation management techniques and then apply them only where the vegetative type would be lost without management. The criterion here is that management practices must provide a closer approximation of the naturally occurring vegetation and the natural processes governing the vegetation than would be possible without management. Unless the manager is certain that the management practice will meet this criterion, do nothing.*” Responsibility for management of RNAs is shared between the National Forest System and the Forest Service Rocky Mountain Research Station. The Regional Forester, with concurrence of the Research Station Director, has the authority to establish RNAs and approve research and monitoring activities. FSM 4063.34 continues, “*The Station Director, with the concurrence of the Forest Supervisor, may authorize management practices that are necessary for noxious weed control or to preserve the vegetation for which the research natural area was created. These practices may include grazing, control of excessive animal populations, or prescribed burning.*”

While the list of practices does not mention herbicides, chemical control methods may be used in RNAs as long as it meets the vegetation management criterion, according to Regional RNA Coordinator, Steve Shelly. Concurrence of the Research Station Director and the Forest Supervisor is required for management actions, including proposed control methods that would involve herbicide use in established RNAs (Shelly, personal communication).

The Decision Notice establishing the RNAs selected an alternative that included this direction: “*Procedures permitted for control of noxious weeds and use of herbicides are described in FSM 4063. Generally, the broad application of herbicides within RNA/ SIA would not be allowed. Actions would be taken to prevent introduction of noxious weeds to RNAs and SIAs.*” In addition, no motorized access is permitted (with few exceptions) in RNAs and only limited motorized access is permitted in Black Sands SIA.

The establishment records for all of the RNAs and SIAs also state “*Pest management and noxious weed control will be as specific as possible against target organisms and induce minimal impact to other components of the area... If invasive exotics are discovered within the RNA, measures will be taken to control or eradicate these populations.*” Relative to some RNAs within

designated wilderness areas is the direction that “*Management of the RNA will be compatible with and consistent with Wilderness management direction.*”

Analysis area – Research Natural Areas

The analysis areas for RNAs and SIA are the RNAs and SIA themselves. The focus of the analysis will be those RNAs or SIA that currently have some level of weed infestation as identified in the Affected Environment Section.

Analysis Method – Research Natural Areas

Information for the Affected Environment came from the Establishment Records for the individual RNAs and SIA, which were completed in 1997, and current GIS and weed inventory data. The analysis is based on the effect the proposed activities in each alternative would have on the establishing criteria for each RNA and SIA, and potential for affecting ecological integrity.

RECREATION

Regulatory Framework – Recreation

The goal of the Gallatin National Forest Plan (1997) relative to recreation is to provide a broad spectrum of recreation opportunities in a variety of Forest settings. The Forest Service Manual, FSM 2300, describes the Forest Service Authority, Objectives, Policy, and Responsibility for recreation management. Pertinent Federal Laws are the Forest Rangeland Renewable Resources Planning Act of 1974, as amended by the National Forest Management Act, and the Wilderness Act of 1964.

Analysis Area - Recreation

The analysis area for recreation analysis is confined to all developed and non-developed recreation sites on the Gallatin National Forest.

Analysis Method - Recreation

The source of information for the Affected Environment was the Forest Plan and its associated EIS. The analysis is based on the potential for proliferation of invasive weeds if left untreated, and proposed weed treatment activities to impact recreational opportunities on the Gallatin National Forest.

Affected Environment - Recreation

Invasive weeds can affect the recreation experience. Invading weeds such as spotted knapweed, thistles, toadflax, leafy spurge, houndstongue, and oxeye daisy detract from the desirability of using recreation sites and enjoyment of the forest environment. These species diminish the usefulness of sites because the stiff plant stalks, thorns, or toxic sap can discourage or prevent walking, sitting, or setting up a camp. Invasive weeds also detract from the recreation experiences by reducing the variety and abundance of native flora to observe or study and reducing forage availability for wildlife and recreational livestock.

Weeds are frequently spread through recreational activities, particularly along roads, trails, campgrounds, and dispersed recreation sites. The Gallatin National Forest provides a variety of

recreational experiences including camping, hiking, hunting, fishing, mountain biking, snow mobiling, horseback riding, skiing, and driving for pleasure. Passenger vehicle roads provide primary transportation routes into and through out the Forest. While these roads provide access for a variety of purposes (commercial, residential, administrative), the primary public benefit may be for recreational purposes. Controlling weeds along roads and recreational sites will reduce the tendency for recreational activities to spread weeds into adjacent areas.

The issue of effects of herbicides on human health is treated separately in this analysis. Please refer to the human health issue in Chapters 3 and 4 for more information.

HUMAN HEALTH

Regulatory Framework - Human Health

Safety standards for herbicides use are set by the Environmental Protection Agency, Occupational Health and Safety Administration, Code of Federal Regulations (40 CFR part 170), and individual states. In addition, several sections of the Forest Service Manual (FSM, 1994) provide guidance to the safe handling and application of herbicides. These include:

- Preparation of a safety plan for all pesticide use projects (FSM 2150);
- Consultation of pesticide handling requirements set forth in the Forest Service Health and Safety Code Handbook (FSM 6709.11) and (FSM 2156);
- Pesticide-Use Management and Coordination Handbook that requires the Forest to review pesticide use proposals in terms of human health (FSM2109.13.2);
- Recommendation to complete risk assessments prior to pesticide use to ensure public safety (FSM 2109.14);
- Completion of project work plans prior to implementation, including a description of personal protective clothing and equipment required (FSM 2109.14.3);
- Safety planning the requires development of a safety plan to protect the public and employees from unsafe work conditions when pesticides are involved (FSM 2109.16, FSM 2153.3);
- Safety and Health Hazard Analysis that requires completion of a Job Hazard Analysis (FS-67007-7) to determine hazards on the project and identify ways to eliminate them (FSM 2109.16.2, FSM 6700, FSH 6709.11).

Finally, FSM 2109.16.3 states the requirement for, and defines Pesticide Risk Assessment as “Another method of helping to ensure safety in pesticide use is to conduct risk assessments. Analyses estimate the possible pesticide dose to workers and the public who may be affected by a pesticide application; and the potential effects on fish, wildlife, and other non-target organisms. These estimated doses are then compared with levels of no observed effects based on tests of laboratory animals.”

These analyses are usually incorporated into the decision making documents prepared in compliance with the National Environmental Policy Act (FSM 1950). A pesticide risk assessment does not, in itself, ensure safety in pesticide use. The analysis must be tied to an action plan that provides mitigation measures to avoid potential risks identified by the risk assessment.

Affected Area - Human Health

The analysis area is confined to the Gallatin National Forest boundary. Effects are related both to the impacts of weeds on humans and the impacts of weed control. For weeds, concerns are related to the impacts from exposure to pollens and plant chemical. For weed control, concerns are related to the exposure to toxicant found in the herbicides used in ground and aerial applications.

Analysis Method - Human Health

The effects analysis compares the application rates, location and timing, and mitigation measures specified in Chapter 2 with scientific literature on toxicity and risks. The review of the effects of herbicide application in this document includes possible pesticide doses workers and the public may receive, and are compared to levels of no observed effects.

Affected Environment- Human Health

The Forest Service contracted with Information Ventures, Inc. and Syracuse Environmental Research Association, Inc. (SERA) to summarize ecological and toxological data and human health effects based on Environmental Protection Agency (EPA) studies. Toxicity information for herbicides was reviewed to determine the levels of these chemicals that would be harmful to human health. Potential exposures and doses are estimated for workers and the general public. Toxic effect levels are compared to predicted dose levels to determine the possibility of human impact.

Considerable data from tests on laboratory animals is available for the herbicides proposed for use with this project. All herbicides proposed for use on the Gallatin National Forest are EPA approved and have a recent risk assessment completed by SERA as posted on the internet. <http://www.fs.fed.us/foresthealth/pesticide/risk.shtml>

All herbicides proposed for use have been subjected to long-term feeding studies that test for general systemic effects such as kidney and liver damage. In addition, tests of effects on reproductive systems, mutagenicity (birth defects), and carcinogenicity (cancer) have been conducted.

Pesticides are not risk-free. The reason EPA allows the use of products with the potential to cause toxicity is that, “when used according to label instructions” the risks of the pesticide are outweighed by the benefits. Reading and following instructions on labels is the best way to insure personal safety. Toxicity tests required by EPA for pesticide registration include “Acute” (short term) or “Chronic” (longer Term) exposures.

Acute toxicity can be a function of the amount of toxicant received, the route of administration, and the type of animal tested. Acute reactions tested include: oral dermal and inhalation toxicity, acute delayed neurotoxicity, eye and dermal irritation, and dermal allergic sensitization. Tables 3-20 and 3-21 display acute toxicity categories for the proposed herbicides.

Chronic toxicity results from prolonged, repeated or continuous exposure to a chemical, typically at levels lower than necessary to cause acute toxicity. It often demonstrates a delayed response. Public concerns toward herbicides generally focus on potential chronic toxicity. Sublethal poisoning or exposure may be expressed by any of the following: skin/eye irritation; nervous system disorders; reproduction system disorders; damage to other organ systems (liver, kidney, lungs, etc.); birth defects; mutations; and cancer.

The EPA evaluates all of the disorders listed above, including carcinogenicity, teratology (birth defects), reproductive and mutagenicity effects to animals during the herbicide registration process. The study data is used to make inferences relative to human health. Table 3-22 compares chronic effects between various herbicides as summarized by Information Ventures Inc.

<http://infoventures.com/e-hlth/>, EXTOTOXNET for Oregon State University <http://extotoxnet.orst.edu/>, and by SERA <http://www.fs.fed.us/foresthealth/pesticide/risk.shtml>.

None of the herbicides being considered in this analysis have been shown to cause chronic toxicity when doses are below the safe exposure levels. To determine the safe exposure level (Reference Dose, RfD), toxicity studies expose different animals to range of herbicide concentrations, making note of the dose response level and then dividing by a factor of 100, to account for uncertainty.

It is important to note that there is much uncertainty and controversy regarding chronic toxicity. For example, the risk analysis completed by EPA makes four primary assumptions: that a carcinogenic substance in animals will have similar potency in humans; that there is a linear relations between dose and carcinogenic response; that the slope of the dose response relationship at low doses can be derived from data at high doses; and it treats all carcinogens, regardless of the mechanism of action, in the same manner

<http://phys4.harvard.edu/~wilson/cancer&chemicals/ccar.html>> While these assumptions may be valid, they are not proven, and they show some of the complexity associated with risk analysis for chronic toxicity.

Concerns have been expressed by the public, as to the potential for adverse health effects, from contacting or consuming treated vegetation, water, or animals. Harmful effects from this type of exposure are low for most of the herbicides being proposed for this project. “The exposure levels a person could receive from these sources, as a result of routine operations are below levels shown to cause harmful effects in laboratory studies” (Information Ventures, 1995). Exceptions are 2,4-D, Hexazinone, Sulfometuron Methyl, and Glyphosate.

Hexazinone: “To prevent residues of hexazinone in meat or milk, do not graze domestic animals on treated areas within 30 days after treatment.”

2,4-D: “To keep residues of 2,4-D out of meat or milk, do not graze dairy cattle on treated areas for seven days after application. Do not cut hay for 30 days and do not slaughter meat animals for three days. Contact with dried residues on vegetation is not expected to be hazardous.”

Sulfometuron Methyl: No reports of acute poisoning in humans have been found. No reports of chronic poisoning in humans have been found.

Glyphosate: Most incidents reported in humans have involved skin or eye irritation in workers after exposure during mixing, loading or application of glyphosate formulations. Nausea and dizziness have also been reported after exposure. Swallowing the Roundup® formulation caused mouth and throat irritation, pain in the abdomen, vomiting, low blood pressure, reduced urine output, and in some cases death. These effects have only occurred when the concentrate was accidentally or intentionally swallowed, not as a result of the proper use of Roundup®. The amount swallowed averaged about 100 milliliters (about half a cup). There are no reported cases of long-term health effects in humans due to glyphosate or its formulations. Glyphosate is sold over the counter at retail stores and would be used on the Forest in limited applications such as aquatic approved formulation near water.

Table 3-20. Toxicity Categories for Various Types of Harmful, Acute Reactions.

Toxicity Category	Signal Word	Oral (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	Eye Irritation	Skin Irritation
I	DANGER Poison	0-50	0-200	0-0.2	Corrosive: corneal opacity not reversible within 7 days.	Corrosive
II	WARNING	>50-500	>200-2000	>0.2-2.0	Corneal opacity reversible within 7 days; irritation persisting for 7 days	Sever irritation at 72 hours
III	CAUTION	>500-5000	>2000-20,000	>2.0-20	No Corneal opacity; irritation reversible within 7 days	Moderate irritation at 72 hours
IV	NONE	>5000	>20,000	>20	No Irritation	Mild irritation at 72 hours

Table 3-21. Human Hazards Based on Acute Toxicity Categories. (Information Ventures Inc., Pesticide Fact Sheet and EXTNET, Pesticide Information Profiles, Oregon State University)

Herbicide	Acute Oral Toxicity	Acute Dermal Toxicity	Acute Inhalation	Primary Eye Irritation	Primary Skin Irritation
Picloram	Caution	Caution	None	Caution	None
Metsulfuron Methyl	None	Caution	Caution	Warning	Caution
Hexazinone	Caution	None	None	Danger-Poison	None
Clopyralid Methyl	Caution	Caution	Caution	Warning	None
Chlorsulfuron	None	Caution	Caution	Caution	None
Triclopyr	Caution	Caution	Caution	Caution/Danger	Caution
Imazapyr	None	Caution	Caution	Caution	Caution
2,4-D Amine	Caution	Caution	Caution	Danger-Poison	Caution
Dicamba	Caution	None	None	Danger-Poison	None
Glyphosate	None	None	Caution	Warning	None
Sulfometuron Methyl	Caution	Caution	Caution	None	None

Table 3-22. Chronic Toxicity: Brief summary of EPA chronic toxicity studies used in evaluating herbicides for registration as cited in Information Ventures, Inc. 1998. <http://infoventures.com>

Herbicide Active Ingredient	Potential Chronic Effects			
	Carcinogenic	Teratogenic	Reproductive	Mutagenic
Picloram ¹ Chronic RfD* (Reference Dose) 0.2 mg/kg/day	Not determined at this time. EPA will re-evaluate mouse and rat study.	EPA will re-evaluate rat and rabbit study.	Rat study with no adverse effects with doses up to 150 mg/kg/day. EPA requiring additional study.	Negative in two tests.
Metsulfuron Methyl ² Chronic RfD 0.25 mg/kg/day	Study with mice and rats found no cancer up to 5,000 ppm for 18 months and 2 yrs.	Pregnant rat study no evidence of birth defects at doses up to 1,000 mg/kg/day; and rabbits 700 mg/kg/day.	Two-generations of rats, 5,000 ppm (highest dose tested), no effects observed	Negative on four tests, positive on one test.
Hexazinone ³ Chronic RfD	Study with rats found no tumors up to 125	Pregnant rat study no evidence of birth	Three-generations of rat study found no	Three of four tests were negative. EPA

Herbicide Active Ingredient	Potential Chronic Effects			
	Carcinogenic	Teratogenic	Reproductive	Mutagenic
0.05 mg/kg/day	mg/kg (highest dose tested). EPA will re-evaluate mouse study.	defects at doses up to 100 mg/kg/day; higher doses did have effects. EPA concludes not teratogen.	evidence of reproductive effects, except decreased weight of pups at highest dose (125 mg/kg). EPA requested further information.	concluded not a mutagen.
Clopyralid Methyl ⁴ Chronic RfD 0.15 mg/kg/day	Two year study with mice (2000 mg/kg or rate (1,500 mg/kg) no evidence of tumors	Rate or rabbits at 250 mg/kg no evidence of developmental toxicity	Two-generations of rats, 1500 mg/kg, no effects observed	No evidence found in five studies.
Chlorosulfuron ⁵ Chronic RfD 0.02 mg/kg/day	Mice and rats fed up to 5,000 ppm per day for 2 years showed no signs of carcinogenicity	Pregnant rats (2,500ppm per day) and rabbits (75 mg/kg/day) no evidence of birth defects.	Three-generations of rat study, found a slight decrease in fertility at highest doses (2,500 ppm), no decrease with doses up to 500 ppm	In three tests, no genetic damage
Triclopyr ⁶ Chronic RfD 0.05 mg/kg/day	Rats fed 30 mg/kg/day for two years no evidence of carcinogenicity. EPA "not classifiable" because of increase tumors in mice and rats ¹²	Rats (doses up to 200 mg/kg/day) and rabbits (up to 100 mg/kg/day) no evidence of birth defects. Rat at 200 mg/kg dose level with signs of mild toxicity of fetus/	Three generation rats no adverse effects on fertility or reproduction at doses up to 30 mg/kg/day.	Negative in several tests, but weakly positive in a test in rats.
Imazapyr ⁷ Chronic RfD 2.5 mg/kg/day	Not determined at this time.	Pregnant rats (1,000ppm per day) and rabbits (400 mg/kg/day) no evidence of birth defects.	Not determined at this time.	Negative in tests for genetic damage
2,4-D Amine ⁸ Chronic RfD 0.01 mg/kg/day	Two year mice and rats study was not tumor causing, toxic effects in animal's kidneys present at low doses. Additional tests are underway.	Pregnant rats at highest dose tested (75 mg/kg/day), fetuses showed delayed bone formation. Other studies show toxic effects to fetuses but not birth defects. EPA requires additional tests	Two generation rats study no adverse effects on fertility and reproduction at doses up to 80 mg/kg/day. A reduction in rat pup weight was seen when parents exposed to as little as 20 mg/kg/day.	EPA requires additional studies.
Dicamba ⁹ Chronic RfD 0.045 mg/kg/day	Dogs (up to 50 mmp, 2 yrs study), mice (up to 10,000 ppm for 14 to 19 mnths), and rats (500 ppm, 2 yrs) no evidence of tumors.	Pregnant rats and rabbits indicated no evidence of birth defects	Three-generations of rat study, no adverse effects on fertility or reproduction with doses up to 25 mg/kg/day	Negative in tests for genetic damage
Glyphosate ¹⁰ Chronic RfD 2 mg/kg/day	EPA classified as Evidence of non-carcinogenicity for humans	Pregnant rats (up to 3,500 mg/kg/day) and rabbits (up to 350 mg/kg/day) indicated no	Three-generations of rat study, no adverse effects on fertility or reproduction with doses up to 30	Negative in tests for genetic damage

Herbicide Active Ingredient	Potential Chronic Effects			
	Carcinogenic	Teratogenic	Reproductive	Mutagenic
		evidence of birth defects	mg/kg/day	
Sulfometuron Methyl ¹¹ Chronic RfD 0.02 mg/kg/day	No carcinogenic effects in 2 year rat or 1 year dog study.	Rats fed 250 mg/kg/day or rabbits fed 300 mg/kg/day, no evidence of causing birth defect.	Two-generation rats fed 250 mg/kg/day ate less, gained less weight, and produced litters with fewer pups; no effects when fed 25 mg/kg/day	No evidence of mutagenic activity when tested with standard assays.

¹ <http://infoventures.com/e-hlth/pesticide/picloram.html>

² <http://infoventures.com/e-hlth/pesticide/metsulf.html>

³ <http://infoventures.com/e-hlth/pesticide/hexazino.html>

⁴ <http://infoventures.com/e-hlth/pesticide/choyrali.html>

⁵ <http://infoventures.com/e-hlth/pesticide/chlorsul.html>

⁶ <http://infoventures.com/e-hlth/pesticide/triclopy.html>

⁷ <http://infoventures.com/e-hlth/pesticide/imazapyr.html>

⁸ <http://infoventures.com/e-hlth/pesticide/24d.html>

⁹ <http://infoventures.com/e-hlth/pesticide/dicamba.html>

¹⁰ <http://infoventures.com/e-hlth/pesticide/glyphos.html>

¹¹ <http://infoventures.com/e-hlth/pesticide/sulfomet.html>

¹² <http://www.epa.gov/REDs/factsheets/2710fact.pdf>

*Reference dose as cited in USFS Risk Assessments (USFS, 1996b-d; USFS, 1997a-b; USFS, 1998a-b; USFS, 1999a-c; USFS, 2000b; USFS, 2001a; USFS, 2003a-c; USFS, 2004a-f).

Herbicide Drift

Spray drift is the direct movement of herbicide from the target to areas where herbicide application was not intended. Movement of spray droplets or herbicide vapor causes herbicide drift. Several factors affect spray drift and are defined below, the results of which are summarized in Table 3-23. Incorporating these factors into the project design will reduce the risk of drift.

Spray Particle Size – Spray drift can be reduced by increasing droplet size, since large droplets move less than small droplets in wind. Reducing spray pressure, increasing nozzle orifice size, special drift reducing nozzles, additives that increase spray viscosity, and rearward nozzle orientation, all can increase droplet size.

Method of Application – Herbicide spray drift is generally greater from aerial application than from ground application. Low-pressure ground sprayers generally produce larger spray droplets, which are released from the nozzle closer to the target than with aerial sprayers.

Distance Between Nozzle and Target – Less distance between the droplet release point (the boom arm) and the target reduces spray drift. The spray travels a shorter distance with less opportunity for drift.

Herbicide Volatility – All herbicides can drift as spray droplets, but some are sufficiently volatile to cause plant injury from drift of fumes.

Relative Humidity and Temperature – Low relative humidity and/or high temperature cause more rapid evaporation of spray droplets between the nozzle and target than high relative humidity.

and/or low temperature. Evaporation reduces droplet size, which in turn increase the potential drift of the spray droplets.

Wind Direction – Herbicides should only be applied when the wind is blowing away from non-target plants.

Wind Velocity – The amount of herbicide lost from the target area and the distance the herbicide moves will increase as wind velocity increase, so greater wind velocity will generally cause more drift.

Air Stability – Horizontal air movement is generally recognized as an important factor affecting drift, but vertically air movement is often overlooked. Vertical stable air (temperature inversion) occurs when air near the soil surface is cooler or similar in temperature to higher air. Small spray droplets can be suspended in stable air, move laterally in a light wind and impact plants downwind.

Spray Pressure – Spray pressure influences the size of droplets formed from the spray solution.

Nozzle Spray Angle – Spray angle is the angle formed between the edges of the spray pattern from a single nozzle. Nozzles with wider spray angles produce smaller spray droplets than those with narrower spray angle at the same delivery rate.

Nozzle Type – Nozzle types vary in droplet sizes produced at various spray pressures and gallons per minute output.

Air Movement around Aircraft – Vortices are irregular drifts of air around the fixed wing of airplanes or the rotary blades of helicopters. The fixed wing or rotor tips produces an updraft, while the body of the aircraft produces a downdraft. Vortices affect the deliver of spray particles accordingly.

Table 3-23. Effects of Drift Factors on Herbicide Drift.

Factor of Drift	More Drift	Less Drift
Spray particle size	Smaller	Larger
Release height	Higher	Lower
Wind Speed	Higher	Lower
Spray pressure	Higher	Lower
Nozzle size	Smaller	Larger
Nozzle orientation	Forward	Backward
Nozzle location	>3/4 wingspan	<3/4 wingspan
Air temperature	Higher	Lower
Relative humidity	Lower	Higher
Nozzle type	Small droplets	Large droplets
Air stability	Stable	Unstable
Herbicide volatility	Volatile	Non-volatile

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

SUBSTANTIVE CHANGES BETWEEN DRAFT AND FINAL EIS

Revised the sensitive plant list to reflect recent changes (removal of *Castilleja gracilima*, *Carex livida*, and *Salix wolfii* var. *wolfii*; and addition of *Mimulus nanus*).

Revised the sensitive species list to reflect that Goshawk was de-listed, however, it is still considered as a Management Indicator Species on the Gallatin Forest. Consequently, comments regarding the Goshawk are still relevant so will remain unchanged in the EIS.

Corrected the number of acres on page 4-74 to read, “255 acres with aerial spray, and up to 5179 acres with ground applied herbicides.”

Revised Table 4-16 Comparison of Herbicide Toxicity to include the most current risk assessments data.

INTRODUCTION

This chapter discloses the direct, indirect and cumulative effects of the alternatives described in Chapter 2. The affected environment and methodology for analysis was addressed in Chapter 3.

DIRECT AND INDIRECT EFFECTS

Direct effects are caused by an action and occur at the same time and place. Indirect effects are caused by an action and occur later in time or farther removed in distance, but are still reasonably foreseeable.

Direct and indirect effects analysis for each alternative and each resource area are based on the description of the alternatives provided in Chapter 2, including the mitigation measures described under each alternative and under Features Common to All Alternatives section.

Also, every resource assumed that all acres indicated in Chapter 2 would be treated in each of the alternatives. Due to the way the inventory and mapping was done, treatment acres may be less than those indicated. This is mostly caused by areas of light or no weed infestation being included within a weed location “polygon” in the mapped database. The minimum size of a weed polygon is 0.01 acres, where the actual size might be one plant or a small patch.

SHORT TERM USE VS. LONG TERM PRODUCTIVITY

Unless otherwise specified, short-term effects are those that occur within three years after treatment. Long-term effects are those that occur in three to five years after last treatment.

IRREVERSIBLE / IRRETRIEVABLE

National Environmental Policy Act requires identification of irreversible and irretrievable commitment of resources. These effects are identified in resource areas where they may occur including soils, vegetation, and wilderness and Inventoried Roadless Areas.

ENVIRONMENTAL JUSTICE

No minority or low-income communities would be disproportionately impacted by any of the alternatives. Implementing any alternative would not alter opportunities for subsistence hunting by Native American tribes.

ENERGY REQUIREMENT

None of the alternatives being considered for this project have unusual energy requirements.

ADVERSE EFFECTS THAT CANNOT BE AVOIDED

There are no adverse effects associated with this project identified in the analysis that cannot be avoided. Environmental protection measures listed in Chapter 2, page 2-17, will be implemented and will mitigate any adverse effects from weed control.

CUMULATIVE EFFECTS

Cumulative impacts are impacts on the environment that result from the incremental impact of actions when added to other past, present, and reasonably foreseeable future actions. For each resource, an analysis area was identified and used to adequately measure cumulative effects of the proposed alternative. Unless otherwise stated, the cumulative effects area, or the geographic scope, is the treatment area. For temporal scope, the timeframe for project implementation is 15 years and an additional five years past the final implementation year is considered.

Past present and reasonable foreseeable activities

Weed control efforts including aerial and ground application of herbicides will continue on privately-owned and public lands with and adjacent to the Gallatin National Forest. Government agencies such as the National Park Service, Bureau of Land Management, Bonneville Power Administration, Beaverhead-Deerlodge National Forest, Lewis & Clark National Forest, Custer National Forest, Targhee National Forest, Montana Fish Wildlife and Park, Montana State University, Montana Highway Transportation Department, Montana State Public Lands, City of Bozeman, Gallatin County, Park County, Madison County, Sweet Grass County, Carbon County and Meagher County all use herbicides to control weeds adjacent to the Gallatin National Forest. Activities that alter vegetation and may potentially act as a weed vector such as wildfires, timber harvesting, fuel reduction, livestock grazing, and recreational uses (hunting, hiking, motorized recreation, etc.) will continue to dominate the landscape. The Forest Service has developed prevention and mitigation measures that minimized the impacts of these activities on weed spread (FSM 2080). The Best Management Practices for Weed Control is listed in Appendix A.

VEGETATION

This section is divided into three main categories (weed species, native plant and rare plants) and will evaluate the effects of the four alternatives along with the cumulative effects.

Weed Species, Direct and Indirect Effects - Alternative 1 (Proposed Action)

Under this alternative various pest management practices such as pulling, biological control, and herbicide treatment would be used in combination to control, contain and/or eradicate populations of weed species. Aerial application of herbicides is also provided, thus, larger or remote infestations can be treated in a safe, efficient, and economical manner. The most effective means for control and/or eradication would be chosen depending on the likelihood of long-term effectiveness or resource values at risk. Table 2-1 would generally guide actual treatment priority with emphasis generally being given to new invaders and species having the greatest risk of spread. For example, the Gardner Ranger District may collect enough funds to treat all of the priority 1, 2, and 3 sites but only a small portion of the priority 4 and 5 sites. At the same time, special funding may also become available that provides for treating a priority 5 site, knowing the control may be only temporary. An example might involve improving the winter range in an effort to pull wintering big game away from private lands.

This alternative provides for treatment of roughly 2,983 acres with a budget of \$300,000 annually. Table 4-1 identifies the additional acreage that could be treated given additional funding. This alternative provides for the maximum treatment of 23.7 to 96.2 percent of the current weed base. A majority of the current weed sites are less than one tenth acre in size and still very manageable. In other words, treating the small satellite populations and keeping those priority weeds in “check” will limit spread into new areas. Aerial application of herbicides would occur on 255 acres or 2 percent of the current weed base. The Ranger Districts would reassess priorities from year to year with the intent of focusing efforts on those weeds most threatening resource values.

Table 4-1. Alternative 1 - Acres of Weed Treatment Based on Funding, Gallatin National Forest.

Ground Applied Herbicide	Aerial Application	Manual Hand Pulling	Biological Control	Cultural	Total Annual Treatments	Percent GNF Weed Base (12,600 ac)
2956	0.0	1	25	1.0	2983	23.7
5179	255	41	4985	2135	12595	96.2

Ground application of herbicides would be used on some 2,956 acres of weeds as the least cost effective means of control. Efforts to utilize the most selective herbicide would also be entertained.

This alternative provides for the use of a wide variety of herbicides that have a wide range of plant selectivity. Glyphosate is the least selective, affecting most plant species. Clopyralid is the most selective herbicide, affecting only plants in the sunflower (Compositae), buckwheat (Polygonaceae), nightshade (Solanaceae), and pea (Fabaceae) families. Sixteen of the thirty existing Gallatin Forest weed species are in these families. The other herbicides fall between these two in their selectivity. Most affect all broad leaf plants but do not harm grass and grass-like species. All of the Gallatin National Forest weed species are broad-leaved species, except cheatgrass. Conifers have variable response to herbicides, but many are negatively affected by most herbicides. Application rate and extent of coverage, either spot or broadcast, can affect what plant species are impacted by the herbicides. Many of the species can be protected through following label application limits. The timing of application and rotation of herbicides may also be important in limiting impacts to non-target native vegetation. This alternative provides for two additional herbicide families to choose from that would not be used in Alternative 3. Rotating between three family groups of herbicides that are selective in nature will significantly limit

potential damage to non-target native plants. Impacts to native plant communities and rare plant species can be greatly reduced while still controlling the weeds on the site.

Aerial application will greatly increase the efficacy of the weed control program on the larger, more remote sites. Weed densities can be greatly reduced through broad scale treatments. Ground crews will have more time to focus on the smaller, scattered infestation, prior to the weeds increasing to the point where control efforts become overwhelming. Aerial treatment is a valuable tool in areas where weeds become established on the steeper slopes or where terrain is a safety concern.

Manual control of areas ranging from 1 to 41 acres is anticipated each year on sites that have very few plants, and/or where the plants have already established viable seed before herbicide treatment occurs. Manual methods are very labor intensive and generally effective only on weed species that do not have extensive root systems. For treatment to be effective the site needs to be checked multiple times during the growing season to prevent weeds from going to seed. The site must also be treated yearly until the weeds are eradicated. This method is primarily used where a few plants exist, and in sensitive areas such as adjacent to open water or high water table sites. It is also used where threatened, endangered or sensitive plants species are present and other control methods would harm the rare species.

The biological control program on the Gallatin National Forest would be expanded to include new sites, when necessary, as a secondary form of control. The effectiveness of other control measures would limit the need for focusing much attention on the use of biological control agents. Coordination with Animal Plant Health Inspection Service (APHIS) and other affiliations to release and monitor current and new control agents would occur. Use of biological control agents would be focused on Table 2-1, priority 5 sites. The nature of biological control agents is to reduce density and seed production of the target weed, not necessarily to contain or eradicate the species. Multiple biological control agents that work on different parts of the plant tend to be more successful than relying on a single agent. Two weed species, leafy spurge and musk thistle, do have biological control agents that are showing promising results in reducing plant density and coverage.

Cultural control of at least one acre per year would also be encouraged. Efforts to convert cheatgrass communities to native bunchgrass communities would be given priority before the sites are converted to more aggressive perennial weed sites. Efforts to convert exotic plant communities back to native ecosystems would also be encouraged as native seed sources become readily available. Removing unwanted weeds would involve herbicidal control, possibly seedbed preparation, and seeding. The best seeding success involves drill planting and irrigating at least until vegetative stand establishment occurs.

Weed Species, Direct and Indirect Effects - Alternative 2 (No Herbicide)

This alternative does not rely on herbicides for controlling weed infestations. Manual, mechanical and biological control methods would be used to control weeds on the Gallatin National Forest. This alternative provides for the treatment of approximately 1,991 acres each year with a budget of \$300,000. Table 4-2 identifies 15.8 to 74.6 percent of the current weed base being available for treatment. Manual methods of control are very labor intensive and generally effective only on weed species that do not have extensive root systems. Biological control agents would be the primary method used and this tool has had very limited effect on controlling the density of most weed species. At the present time, the Forest has found leafy spurge flea beetle effective in reducing the spurge density on some dry sites. Other biological control agents released on the Forest have not made a noticeable change in weed density. In the

future as biological control agents become more abundant and other insects become available, then this may become a more effective tool.

Table 4-2. Alternative 2 - Acres of Weed Treatment Based on Funding, Gallatin National Forest.

Ground Applied Herbicide	Aerial Application	Manual Hand Pulling	Biological Control	Cultural	Total Annual Treatments	Percent GNF Weed Base (12,600 ac)
0.0	0.0	5	1985	1.0	1991	15.8
0	0	130	7622	2017	9769	74.6

Pulling can be effective on new infestations or very small sites with a low plant density. For treatment to be effective the site needs to be checked multiple times during the growing season to prevent the weeds from going to seed. The site must also be treated yearly until the weed is eradicated. Pulling would kill the individual plants that are removed so long as the entire root is taken. Pulling is not affective on species with extensive root systems, like those of leafy spurge or Canada thistle.

Mowing or use of a weed whacker can be used to prevent weed species from going to seed. This is a very long-term control method. If you can keep the weed from producing seed eventually the individual plants may die out. Again this is only for species that reproduce primarily by seed. Weeds with extensive root systems would not be affected. In fact many such species are stimulated to increase their root systems when their tops are cut. Control by mowing is similar to pulling; the site must be retreated multiple times during the growing season to prevent the plant from producing any seeds. The site also must be treated each year or the benefits of the previous years treatment is lost.

Manual methods can be affective in localized sites. However, even with the relatively small amount of weed infestations on the Gallatin National Forest it is impossible to make any meaningful control effort by the use of manual methods.

A variety of biological control agents are present on the Gallatin National Forest. Coordination with Animal Plant Health Inspection Service (APHIS) to release and monitor current and new control agents will continue. Use of biological control is the primary focus for weed control under this alternative. Biological control agents would be placed on some 1,985 to 7,622 acres each year with the intent of giving the agents every possible opportunity to do some good. The nature of biological control agents is to reduce the density and seed production of the target weed, not to contain or eradicate the species. At this time most biological agents have not shown significant effects on the majority of weed species. Two weed species, leafy spurge and musk thistle, do have biological agents that are showing promising results in reducing plant density and coverage. Currently no biological control agent has shown an ability to control or reduce the spread of any Gallatin National Forest weed species.

This alternative provides for 1,991 acres of treatment, the least of any alternative considered. Biological control agents could be released on all weed infestations, but until such time as they become effective at reducing the density and spread of these weeds no effective control is expected. The risk of weeds taking over a majority of the sites depicted in Table 3-5 becomes more probable.

The threat of herbicides impacting native plant communities is far exceeded by weeds displacing plants under this alternative.

Weed Species, Direct and Indirect Effects - Alternative 3 (No Change from Current Management)

This alternative would treat up to 1,162 acres currently approved for treatment with a budget of \$300,000 annually. The primary differences between this alternative and Alternative 1 is that herbicide treatments would be restricted to ground based application, and would only use picloram and 2,4-D herbicides on pre-approved sites. This alternative provides treatment for 8.9 percent of the current weed base. Rapid spread of weeds on those sites not previously approved for treatment would occur.

Table 4-3. Alternative 3 - Acres of Weed Treatment Based on Funding, Gallatin National Forest.

Ground Applied Herbicide	Aerial Application	Manual Hand Pulling	Biological Control	Cultural	Total Annual Treatments	Percent GNF Weed Base (12,600 ac)
346	0	281	535	0	1162	8.9

Cultural treatments would not be provided for, most likely resulting in cheatgrass sites becoming infested with perennial weeds.

Weed Species, Direct and Indirect Effects - Alternative 4 (No Aerial Application)

Direct and indirect effects of this alternative are similar to Alternative 1. The primary difference is all herbicide treatments would be restricted to ground based application. This alternative provides for treatment of 2,983 acres with a budget of \$300,000 annually. Table 4-4 identifies the additional acreage that would be treated given additional funding. This alternative provides treatment for 23.7 to 95 percent of the current weed base. No aerial application of herbicides would be allowed. Biological control agents would be the primary control option in this alternative. The direct and indirect effects described in Alternative 2 would be the same for these sites.

Table 4-4. Alternative 4 - Acres of Weed Treatment Based on Funding, Gallatin National Forest.

Ground Applied Herbicide	Aerial Application	Manual Hand Pulling	Biological Control	Cultural	Total Annual Treatments	Percent GNF Weed Base (12,600 ac)
2956	0.0	1	25	1.0	2983	23.7
5179	0	41	5086	2135	12441	95.0

Weed Species, Cumulative Effects

Invasive weeds are an ongoing battle, especially where eradication isn't likely. The odds of having an effective eradication program improve drastically with treating weeds before they become established through seed reserves and/or extensive root networks. The adaptive management approach as designed in Alternatives 1 and 4 best provides for early detection and eradication. Biological control is a slow and long-term process, especially in Alternative 2 where it is the primary form of control. While biological control agents haven't successfully eradicated any one species on the Gallatin Forest they have softened the impacts significantly for some species such as Canada thistle.

Alternatives 1 and 4 would add to efforts ongoing by adjacent counties and ownerships to control weeds surrounding the Gallatin National Forest. Other landowners, including private and corporate owners, State, and others would benefit from reduced weed populations on the Gallatin Forest. Actions under these alternatives would allow the Gallatin Forest to work closer with surrounding landowners, counties, and other land management agencies to be more effective at controlling and containing weed infestations.

Under Alternatives 2 and 3, since the effectiveness of the weed control will be reduced, adjacent land owners will see an increase in weeds spreading from the Forest lands onto their lands over time.

Native Plant Communities, Direct and Indirect Effects - Alternative 1 (Proposed Action)

There is little doubt that measures taken to control weeds will kill some non-target, native plant species. It is important to note that although most weed control activities may kill some individual native plants, the action would be intended to prevent the far greater loss of species diversity resulting from further uncontrolled weed infestations. Impacts to plant communities are reduced when control actions are taken at an early stage of invasion. Impacts on plant communities increase as weed infestations expand in size and density. The increased impacts come not just from the weeds but also from the control measures. When treatments must be broadcast across an entire area and not specifically focused on the target plant, control measures have a greater potential for negative impacts. This is true for manual, biological, and herbicide treatment methods.

Pulling target weeds has little effect on native vegetation. This is due primarily to the very limited area that can be affectively treated by this method and the fact that you are pulling just the target plant. Pulling may affect adjacent plant species due to soil disturbance when removing the entire root system. Significant soil disturbance is rare and generally only seen where weed densities are very high. Mowing may reduce the vigor and reproductive ability of native plant species, which are mixed in with target weeds. As the goal of mowing is to prevent weed species from producing viable seed, timing of the treatment can be used to reduce the impacts to native species. For either of these methods the extent of their use is very limited and the proportion of native plant populations affected would be very small.

Biological control agents are rigorously selected and screened to prevent impacts to non-target species. Not all native species are tested for each new agent. A few biological control agents released prior to the current, more stringent screening protocols, have been found to feed on native plant species. Their impacts have not fully been evaluated. In general, biological control agents are useful in native plant communities because they avoid other non-target vegetation. The Gallatin National Forest will rely on the updated screening process being followed for biological control agents. None-the-less, because of the remote possibility of effects to native plant species from biological control agents, the Forest will review decisions to release new agents on the Forest.

Use of herbicides has the highest potential to impact native plant communities. Herbicide use will kill non-target plants. The degree of mortality of native species depends on the herbicide used, and the application method, and rate and frequency. As discussed earlier the herbicides to be used range in their effects on plant species. Clopyralid is the most selective and glyphosate is a non-selective herbicide that will kill most plant species including grasses.

Of the proposed application methods, aerial application is most likely to affect non-target native plants. This is because this method indiscriminately applies herbicide to all plants in the

treatment area. Also, drift can affect plants outside the treatment area. However, precautions would be taken to minimize drift. Spot applications with backpack sprayers, truck mounted sprayers or wick applicators focus the herbicide on the target weeds with limited treatment to adjacent non-target vegetation. These methods would affect native species the least.

Under this alternative, Integrated Pest Management strategy methods that would be most effective on controlling invaders, while minimizing impacts on native species would be used. This approach would help decrease the effects of herbicide use. In addition, as only a small portion of the overall infested areas would be treated, the impacts to common native plants are insignificant as they relate to species abundance, distribution, and population viability on the Gallatin National Forest. Relative speaking, this alternative has the best odds of keeping those potential areas identified in at high risk from becoming weed infested.

This alternative will, in the short term, affect more native plants due to the broadcast application of herbicides by aerial application than the other alternatives. In the long term this alternative will protect more native plants and plant communities because of the same actions. Being able to treat a large number of infested acres will greatly improve the probability of controlling many of the weed species currently found on the Forest.

Native Plant Communities, Direct and Indirect Effects - Alternative 2 (No Herbicide)

The negative affects of exotic species introduction have been well documented. A review of the many effects that invasive species impose on native plant and animal communities can be found in Sheley and Petroff (1999). In brief, exotic plant species can decrease plant diversity, structure and function in native plant communities by out competing native species for available resources. Exotics have also been known to displace rare plant species (Thompson *et al.*, 1987; Lesica and Shelly, 1996). Some invaders release secondary compounds or allelopathogens that can affect the establishment of native plant species. In addition, some believe that there are situations where the invasion of exotic species is second only to habitat destruction as the most important threat to biodiversity.

These changes in native species composition and structure can have severe impacts on wildlife populations by altering forage availability, reducing cover and eliminating breeding sites. These effects may be felt from invertebrates and soil microbes to the largest ungulate, which depend on native plants for forage.

Invasive weeds can decrease organic matter content and nutrient availability in soils and can increase soil erosion and infiltration. Some species can even increase the salinity of the soil.

Plant communities altered by invasion will not respond to historical disturbance regimes such as fire, insect and pathogens and wind and storm events as they once did. As noted earlier, we conducted a risk assessment on the Gallatin National Forest, which showed the vulnerability of lands subject to invasion of weeds. The analysis shows 27.8 percent or 500,000 acres of the Forest at high risk to weed infestations (see the project file, vegetation section). This is a significant portion of the land base. Furthermore, this acreage is not distributed evenly among the vegetation types. The higher elevation moist forest types are the least vulnerable to invasion, yet every acre of the low elevation non-forested communities is at risk. Although there is less acres of non-forest communities than forested, they comprise some of the more unique, species rich communities next to riparian and wetlands on the Gallatin National Forest. Once converted, these habitats may never be restored to their original condition.

This is not to say that the forest types would not be at significant risk as well. Early successional stages of forest community, those that are most vulnerable to invasion, could be altered to where

early forest succession could be impacted. Tree seedlings may have difficulty becoming established, which in turn may alter the future composition and vegetative structure of the forest. These changes in early and mid-seral vegetative structure also affects the frequency and intensity of nature disturbance processes, such as fire and insect infestations.

With Alternative 2 there will be an increase of weed spread, and the consequences described above will occur on the lands identified at risk for the Gallatin National Forest.

Native Plant Communities, Direct and Indirect Effects - Alternative 3 (No Change from Current Management)

Direct and indirect effects of this alternative are similar to Alternative 1 for the 1,162 acres previously approved for treatment. The primary difference is all herbicide treatments would be restricted to ground based application. No aerial application of herbicide would be allowed. In addition, the only herbicides that would be available for use would be picloram, and 2,4-D. Restricting the use of herbicides would eliminate the option of rotating herbicides due to one of the two options being non-selective. This alternative would impact fewer native plant species or communities by the application of herbicides. This is because aerial herbicide application would not be allowed. The number of acres that can be treated by ground-based application is limited in extent, due to terrain, personnel, and time constraints. Impacts to native plant communities will come more from the continued spread of weed species than the loss of non-target plants to herbicides. Relatively speaking, this alternative protects the native plant communities better than Alternative 2 but not as good as Alternatives 1 and 4.

Native Plant Communities, Direct and Indirect Effects - Alternative 4 (No Aerial Application)

Direct and indirect effects of this alternative are similar to Alternative 1. The difference being some of the higher valued lands treated in Alternative 1 with aerial herbicide application would now be treated with biological controls only. Thus, these sites become established with weeds quicker and provide a larger seed source for other sites. Further effects to those areas not permitted aerial treatment will be comparable with those in Alternative 2.

Native Plant Communities, Cumulative Effects,

In addition to the native species that would possibly be killed under Alternatives 1 and 4, other ongoing actions such as timber harvest, grazing, recreational use, mining and harvest of alternative forest products would also kill native plants. Although non-target plants will be affected from the use of herbicides, there is far greater potential loss of these native species and their habitats if nothing is done

With Alternatives 2 and 3 the trend of increasing infestations on the Gallatin National Forest lands are likely to also occur on adjacent private lands used for agriculture, lawns, grazed, pastured and developed commercially. These alternatives would compound this problem by making greater acreage on public land available for invasion. Although most infestations do not originate on the Gallatin National Forest, there are cases where invasions originate on Forest lands and could potentially move out to invade private lands. In many cases, if the Forest Service fails to actively treat weeds then adjacent landowners will do the same.

Rare Plants, Direct and Indirect Effects Common to all Alternatives

On October 28, 2004 the list of sensitive plant species was revised, three species that occur on the Gallatin Forest were removed from the list (*Castilleja gracilima*, *Carex livida*, and *Salix wolfii*

var. wolfii) and one added (*Mimulus nanus*). The effects analysis still contains the discussion regarding *Castilleja gracilima* and *Salix wolfii*, because it displays generalized concepts regpossible effects and concerns regarding weed management and sensitive plants. As for *Mimulus nanus*, the draft EIS disclosed the effects for this plant, so no substantive changes occurred between the draft EIS and final EIS.

Currently there are six sites that have invasive weeds immediately adjacent to rare plants. The amount of impact that the weeds will have on the rare plants will depend on plants physical characteristics. For example, *Salix wolfii* is a shrub that forms a dense canopy that will grow taller and thicker than the weeds. In this situation, the weeds will not detrimentally impact the willow, because most weeds will not survey in dense shade.

On a different site that has both *Balsamorhiza* (which has a root tuber) and Canada thistle (which spreads by both wind disseminated seeds and rhizomes) there may be a considerable amount of competition between the two species. Canada thistle has the ability to spread quickly and for thick patches that can exclude native plants. Since *Balsamorhiza macrophylla* is known to occur on only two sites on the Forest, effort should be made to prevent Canada thistle from out-competing the *Balsamorhiza*. Treating the weeds by using the mitigation measures listed above will protect the sensitive plant from both the Canada thistle and herbicide treatment. Also, to help protect the *Balsamorhiza macrophylla* on this site, periodically inspect the area for the presence of invasive weeds. Treatment efforts are more effective and less disruptive when only treating a few weeds. If Canada thistle or other invasive weeds become well established, then the treatment will be detrimental to the *Balsamorhiza macrophylla*. Do not treat the weeds if the treatment will negatively impact the rare plant.

There are two sites one with *Haplopappus macronema* and the other with *Castilleja gracillima* that are at risk of being invaded by yellow toadflax, spotted knapweed, and scentless chamomile. In numerous locations throughout the Hebgen Basin yellow toadflax has formed dense patches to the point of excluding native plants. Since these invasive plant species are very aggressive it is reasonable to conclude that these sensitive plants might be out-competed by invasive plants. Sites with native plants need to be protected from invasive plants by treating the weeds and preventing further spread of weeds (use Best Management Practices, FS Manual 2080). The mitigation measures listed above will protect the sensitive plants from herbicide or hand grubbing treatments.

The last site has *Castilleja gracillima* and houndstounge. Since *Castilleja gracillima* is rhizomatous, and houndstounge has a taproot, and both plants have similar size; it is reasonable to assume that the *Castilleja* will compete well with the houndstounge and is not at risk. Also, houndstounge can be controlled by cutting-off the flower stock when working within 50 feet of the sensitive plant. Consequently, at this site, neither the invasive plant nor the treatment will impact the sensitive plant.

In addition, the Horse Butte area and the Hebgen Dam have *Mimulus nanus* and possibly *Mimulus breviflorus*. *Mimuls nanus* was added to the sensitive plant list in October 2004, between the draft and final EIS. Weeds are not immediately adjacent to *Mimuls nanus* at the Horse Butte site so will not be impacted by weed treatments. At Hebgen Dam, the spotted knapweed will be pulled to minimizaed impact. Although *Mimulus breviflorus* is not likely to occur on the Gallatin National Forest, it is listed as a sensitive plant in Montana according to the Montana Heritage Program (<http://nhp.nris.state.mt.us/plants/index.html>). To minimize impact on sensitive plants use the following mitigation measure.

Mitigation Common to all Alternatives

The following mitigation measures will further reduce the risk of damage to sensitive plants:

- Use the control method with the least impact on the rare plants (for example, pull the weeds if the roots of the rare plant will not be detrimentally affected by the soil disturbance);
- Do not broadcast spray (including aerial treatment) herbicide within 100 feet of a sensitive plant;
- When applying herbicides within fifty feet of a sensitive plant, use a herbicide that does not leach in the soil (for example glyphosate) and protect the sensitive plant from herbicide drift (for example cover plant with plastic when spraying herbicide or use a wick applicator).

Rare Plants, Direct and Indirect Effects - Alternatives 1 and 4

Since the effects of Alternatives 1 and 4 are the same with respect to sensitive plants, these two alternatives will be addressed together. The risk with these alternatives is that herbicides will accidentally be sprayed on sensitive plants. However, with the following mitigation measures this risk is very low.

- Complete a sensitive plant survey prior to treating sites.
- Provide the weed crew with maps of all known sensitive plants so that these sites can be identified and protected.
- Train the weed crew to identify sensitive plants so that new sites can be identified and protected.
- If sensitive plant surveys find invasive plants in the area, a weed control plan will be developed to help protect the sensitive plant.
- Implement the Noxious Weeds Best Management Practices (FS Manual 208) to help prevent the spread of invasive plants.
- When using herbicide treatments within 100 feet of sensitive plant (including aerial spray), do not broadcast spray.
- When treating weeds within 50 feet of sensitive plants: pull the weeds if the soil disturbance will not harm the sensitive plant; use herbicides that do not leach in the soil (glyphosate); applying herbicide when the sensitive plant is senescent, or protect the sensitive plant from herbicide drift by placing a physical barrier (such as a plastic bag) over the sensitive plant, or use a wick application to apply the herbicide directly on the weed so mist is not created.

Adaptive Management for Treating New Sensitive Plant Sites

Over time new sensitive plant sites will be discovered and new plants will be added to the sensitive plant list. The following section will explain how each alternative will treat new sites.

In the No Change from Current Management Alternative 3, new weed sites will not be treated and sensitive plants will not be treated because they are not covered in the 1987 EIS.

In the No Herbicide Alternative 2, new sites and new sensitive plants will be treated if the treatment will not have a detrimental impact on the sensitive plant. Treatment will not include herbicides, and only use pulling provided that the ground disturbance will not impact the sensitive

plant. In situations where the weeds spread by roots these sites will not be treated so the weeds will not be controlled.

For Alternatives 1 and 4, consider the following variables when developing a control strategy: 1) Look at the life cycle of the weeds and the rare plants to determine if the weeds will have an adverse impact on the rare plants. For example, a rare plant that is a tall shrub may not be threatened by low growing weeds that are biennial, but could be threatened by a vine that grows over the tops of other plants; 2) Consider the life cycle of both the weeds and rare plants when developing a control strategy to ensure that an effective control method is being used and is not detrimental to the rare plants. For example, a rare plant that is a shallow rooted annual may be impacted by the ground disturbance from pulling of weeds. A better control method in this case might include the clipping of the seed heads of the invasive weeds to keep new weeds from establishing. In some situations the weeds will spread via roots and will out compete the rare plants overtime. Clipping the seed head of weeds that have rhizomatous root systems will not prevent the weeds from displacing the rare plants, and the use of herbicides may be the most effective control method; 3). If herbicides are used in the vicinity of rare plants adhere to the following mitigation measures: do not broadcast spray (including aerial treatment) herbicide within 100 feet of a sensitive plant; when selectively applying herbicides within fifty feet of a sensitive plant, use a herbicide that does not leach in the soil (for example glyphosate) and protect the sensitive plant from herbicide drift (for example cover plant with plastic when spraying herbicide or use a wick applicator). Regardless of the control method that is selected, if the control method is believed to have a detrimental impact on the rare plants, then it will not be used.

Rare Plants, Direct and Indirect Effects - Alternative 2 (No Herbicides)

With this alternative the known sensitive plant sites can be protected from invasive plants provided that the invasive plant can be pulled or has an effective biocontrol agent. Unfortunately, not all of the invasive plants that are present on the six known sites (the sites with sensitive plants) can be effectively pulled (for example, weeds that are rhizomatous such as with Canada thistle and yellow toadflax) and none of these weed species currently have effective biocontrol agents. On these sites the invasive plants will continue to spread. Due to limited funding, hand grubbing can only be implemented on a limited number of acres. Also, grubbing plants that spread via roots requires excavating the soil, which is detrimental to the sensitive plant. Due to the limited methods of control, this alternative will offer very little protection to the known sensitive plant sites from invasion from exotic plants. Only two of the six sites (Red Canyon and Dudely Creek areas) will be protected from invasive species; the other sites will not be protected.

Rare Plants, Direct and Indirect Effects - Alternative 3 (No Change from Current Management)

With this alternative none of the known sensitive plant sites will be protected from invasive plants because these sites were not identified in the 1987 EIS for treatment. Currently the Gallatin Forest has six sites that have invasive plants near sensitive plants. The invasive plants would not be treated and would continue to compete with the sensitive plants for sunlight, soil nutrients and water.

Rare Plants, Cumulative Effects

Spatial Boundary: The boundary for this analysis is limited to the Gallatin National Forest and some of the adjacent lands (private and federal). The boundary follows topographic features (such

as streams, and ridges), and roads (see the map in project file, rare plants section). These features are physical barriers that allow for more effective weed control.

Temporal Boundary: Includes all known sensitive plant locations that have been identified within the last 10 ten years and all reasonably foreseeable activities that may impact these locations over the next five years.

The following activities are within the spatial and temporal boundaries, and are included in the cumulative effects analysis: weed control effort on land adjacent to the Gallatin National Forest; and other activities on the Gallatin National Forest that contribute to the spread of weeds near sensitive plant locations (such as timber harvest, prescribed and natural fires, recreation sites, and grazing).

First, if adjacent landowners do not control their weeds there is a risk that the weeds will spread to the National Forest and impact sensitive plants. Since Alternatives 1 and 4 are more efficient in controlling the spread of invasive plants, these alternatives would be able to respond to this type of situation with a more effective weed control program. Alternatives 2 and 3 would not be able to stop the spread invasive plants, because the tools are less effective (biological control agents are only effective on a few plants and pulling rhizomatous plants is detrimental to sensitive plants) or the location was not included in the 1987 environmental analysis so would not be treated (i.e., the No Action Alternative 3). If the weeds are being controlled on adjacent lands there is slight risk that the herbicides will impact the sensitive plants on the Gallatin National Forest. Most of the rare plants are more than 50 feet from the boundary and the herbicide is not likely to move this distance (either by drifting or by leaching) at concentrations that are lethal to the sensitive plants.

Second, other activities such as timber harvest, prescribed fires, recreation sites, and grazing may impact the spread of invasive plants and inadvertently impact sensitive plants. Prior to implementing all activities a sensitive plant survey and a weed risk assessment would be completed. The activities would be modified to mitigate the impact to the sensitive plants or the risk of spreading weeds. Also, the Best Management Practices for Noxious Weeds (FS Manual 2080) list activities that will be incorporated into the management of these activities to help prevent the spread of weeds. Since Alternatives 1 and 4 are more efficient in controlling the spread of invasive plants, these alternatives would be better able to control the spread of weeds. Alternatives 2 and 3 would not be able to stop the spread of invasive plants, because the tools are less effective (biological control agents are only effective on a few plants and pulling rhizomatous plants is detrimental to sensitive plants) or the location was not included in the 1987 environmental analysis (the No Action Alternative 3) so it would not be treated.

Biological Evaluation Determinations

Table 4-5 provides the determination of effects to sensitive plant species listed for the Gallatin National Forest that may occur in the analysis area. All alternatives have the risk of impacting an individual patch of rare plants (either from the weeds out-competing the rare plant or from accidental herbicide damage). At the same time, none of the alternatives will contribute towards federal listing because the plants are located in a number of different sites and the probability of impacting all sites is very unlikely. Determinations are based on the following:

NI	No impact
MIH	May impact individuals or habitat but will not likely contribute to a trend towards listing or loss of viability to the population or species

WIFV Will impact individuals or habitat with a consequence that the action may contribute to a trend towards federal listing or cause a loss of viability to the population or species*

BI Beneficial impact

Table 4-5. Determinations of effects of Alternative 1, 2, 3 and 4 to sensitive plant species. This table was revised to reflect the October 2004 changes to the sensitive plant species list.

Alternatives/Species	1 Proposal	2 No Herb.	3 No Action	4 No Aerial	Statement of Rationale
Musk-Root <i>Adoxa moschatellina</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Small-flowered Columbine <i>Aquilegia brevistyla</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Large-leaved Balsamorhiza <i>Balsamorhiza macrophylla</i>	MIH	MIH	MIH	MIH	Suitable habitat present. Populations observed and effects were mitigated.
Small Yellow Lady's Slipper <i>Cypripedium parviflorum</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
English Sundew <i>Drosera anglica</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Spike Rush <i>Eleocharis rostellata</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Giant Helleborine <i>Epipactis gigantea</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Cotton Grass <i>Eriophorum gracile</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Hiker's Gentian <i>Gentianopsis simplex</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
N. Rattlesnake Plantain <i>Goodyera repens</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Discoid Goldenweed <i>Haplopappus macronema</i> var <i>macronema</i>	MIH	MIH	MIH	MIH	Suitable habitat present. Populations observed and effects were mitigated.
Hall's Rush <i>Juncus hallii</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Pink Monkey Flower <i>Mimulus nanus</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Austin's Knotweed <i>Polygonum douglasii</i> spp. <i>austiniae</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Jove's Buttercup <i>Ranunculus jovis</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Barratt's Willow <i>Salix barrattiana</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Shoshonea <i>Shoshonea pulvinata</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Alpine Meadowrue <i>Thalictrum alpinum</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.
Calif. False-helleborine <i>Veratrum californicum</i>	MIH	MIH	MIH	MIH	Suitable habitat may be present. Habitat will not be affected by action alternatives.

Irreversible and Irretrievable Commitment of Resources to Vegetation

Implementation of Alternatives 1 or 4 with appropriate mitigation measures and site rehabilitation would result in no irreversible or irretrievable loss of native plant communities. Currently, native plant communities are more at risk from invasion and displacement by invasive weed populations. Implementing Alternatives 2 or 3 could result in irretrievable impacts to native plant communities on some areas if noxious weeds spread from untreated areas and dominate large areas that cannot be treated under existing policies and methods of weed control. With Alternatives 2 or 3 weeds would continue to proliferate and control measures would not be sufficient to prevent continued expansion of weeds and associated losses in native plant communities.

Consistency with Forest Plan and other Laws, Regulations and Policies to Vegetation

All alternatives would be consistent with direction in the Forest Plan and other laws regarding weed control.

SOILS AND GROUND WATER

Direct and Indirect Effects to Soils and Ground Water

Herbicides vary in their persistence in the environment and in their ability to move through the soil, and can pose an unintentional threat to groundwater quality. This analysis incorporates a hazard rating system known as Relative Aquifer Vulnerability Evaluation (RAVE) and GIS data (soil types, proximity to water, location of weeds) to determine area at risk. See the Soil and Ground Water section in Chapter 3 for a more detailed discussion on the methodology used to analyze this issue. The results from the analysis are presented below.

Table 4-6 shows RAVE risk classes for the entire Forest, and Table 4-7 proportions classes by Ranger District. Figure 1 (in Appendix E) shows areas at risk for the entire Gallatin Forest. Table 4-8 depicts areas of existing weeds (from the Gallatin National Forest Invasive Species Inventory) intersected with the “High” risk areas from the RAVE model. Table 4-9 shows total “High” risk by watershed and total area of existing weeds intersected with those “High” areas. Highlighted watersheds are those having greater than 640 acres of “High” areas. Watersheds with an asterisk (*) have more than 20 acres of existing weeds within those “High” areas. Figure 2 (also in Appendix E) shows risk areas and “High” risk weed infestations displayed by watershed.

Table 4-6. RAVE Risk Classes for the Entire Forest.

RAVE Score Class	Acres
Low to Moderate	1,994,893
High	105,353
Total	2,100,246

Table 4-7. RAVE Risk Classes by Ranger District.

DISTRICT	RAVE Score Class	Acres
Big Timber RD	Low to Moderate	378,334

DISTRICT	RAVE Score Class	Acres
Bozeman RD	High	7,868
	Low to Moderate	538,327
	High	17,065
Gardiner RD	Low to Moderate	351,429
	High	64,016
Hebgen Lake RD	Low to Moderate	324,604
	High	13,143
Livingston RD	Low to Moderate	402,185
	High	3,261
Total		2,100,232

Table 4-8. Percentage of Existing Weed Area by Risk Class for the Forest.

RAVE Score Class	Acres	Percentage of Total Existing Weed Area
Low to Moderate	4,555	92
High	394	8
Total	4,949	100

Table 4-9. High RAVE Risk Class by HUC6 Watershed (Acres in Risk Class and Acres of Risk Class In Weed Areas) If the HUC is not listed then no acres of “High” Rave Class existed

HUC6	HUC6 Name	Acres rated as “HIGH” RAVE Class	Acres rated “HIGH” in existing weed areas	High Risk Areas (gt 640 acres of “High” RAVE risk)	High Weed Occurrence in High Risk Area (gt than 20 acres)
100700060101	Broadwater Fisher	16,769		x	
100700060104	Russell	16,184		x	
100700060105	Beartooth	13,564		x	
100700010705	Upper Slough	5,128		x	
100200071601	Cherry	2,987		x	
100700020801	Rainbow	2,677	0	x	
100200070205 *	Denny	2,674	25	x	x
100700060103	Clarks Fork	2,496		x	
100200070306	Tepee	2,133		x	
100700010706	Lower Slough	1,851		x	
100200071401	Bear Trap	1,786		x	
100200080104	Bacon Rind	1,438		x	
100700010806	Crevice	1,331		x	
100700010702	Soda Butte	1,185		x	
100200080504	Twin	1,180	0	x	
100700010805	Lower Hellroaring	1,114		x	
100200070505	Hebgan Lake	1,076	19	x	
100700020804	Upsidedown Bridge	1,053	8	x	
100700030201	Shields Headwaters	899		x	
100700060107	Beartooth Lake	867		x	

HUC6	HUC6 Name	Acres rated as "HIGH" RAVE Class	Acres rated "HIGH" in existing weed areas	High Risk Areas (gt 640 acres of "High" RAVE risk)	High Weed Occurrence in High Risk Area (gt than 20 acres)
100700010708	Buffalo	862		x	
100700020809	Upper East Boulder	858	2	x	
100200080604	Squaw	842	8	x	
100200080502	NF Spanish	807		x	
100700020808	Middle Boulder	782	2	x	
100200080107 *	Upper Taylor	752	25	x	x
100200080901	Hyalite	712	11	x	
100200070603	Lower Beaver	661	6	x	
100700020905	Lower West Boulder	658	1	x	
100700010802	Upper Hellroaring	648		x	
100200070304	Duck Red Canyon	642	14	x	
100200070202	Upper Madison	620	10		
100200070204 *	S. Fk. Madison	619	29		x
100700020102	Mulherin	544			
100200081102	Boswick M Cottonwood	529			
100700030202	Smith	496	1		
100200080406	Dudley Levinski	495			
100200070305	Greyling	479	11		
100700021101	Upper Lower Deer	444			
100200080605	Cascade	436	5		
100200080103	Headwaters Gallatin	427			
100200080108	Wapiti	423	3		
100200080703	S Cottonwood	412			
100700020101	Cinnebar	405	0		
100200080302	Middle FK West Gallatin	398			
100700010803	Middle Hellroaring	352			
100200080803	Bozeman	346	18		
100700030301	Brackett	335	1		
100200070601	Upper Beaver	335	3		
100200080601	Portal	319	4		
100700020105	Upper Tom Miner	317	8		
100700020305a *	Lower Mill	305	29		x
100700020301b	Rock	295			
100700020301a	Upper Mill	294			
100200080501	SF Spanish	272	4		
100700020904 *	Middle West Boulder	256	52		x
100200081003	Reese	252			
100200080407	Deer Asbestos	236	0		
100700020302b	Passage	226			
100700010804	Horse	216			

HUC6	HUC6 Name	Acres rated as “HIGH” RAVE Class	Acres rated “HIGH” in existing weed areas	High Risk Areas (gt 640 acres of “High” RAVE risk)	High Weed Occurrence in High Risk Area (gt than 20 acres)
100200080405	Porcupine	204	0		
100200080303	West FK West Gallatin	195			
100200080603	Swan	194	2		
100200080602 *	Moose Tamphry	194	60		x
100200080106	Sage	180			
100200080404	Beaver	179	0		
100200080804	Bridger Canyon	177			
100700020803	Meatrack	172	15		
100402010601	American Fork	169			
100700030101	Fairy Carrol	165	1		
100700020810	Lower East Boulder	163			
100200081004	Quagle	162			
100200080802	Bear Canyon	137			
100301010302	S FK Sixteen mile	123	0		
100200080606	Hellroaring	116			
100200080801	Jackson Meadow	116	0		
100700020712	Swamp	114			
100200080402	Elkhorn	113			
100700030402	Cottonwood	108			
100700020302a	Upper Big	107			
100200081002	Pass Mill	105	0		
100200070203	Dry Canyon	105	1		
100700021202	Lower Sweetgrass	104			
100700020303a	Lower Big	101	1		
100700021302	West Bridger	96			
100200080701	Yankee Wilson	90			
100700030408	Willow	75	11		
100700030403	Rock	74			
100700020714	Big Timber	73			
100700020304a	Donahue Daily	62	0		
100200080401	Buffalo Horn	60			
100700020406	Suce Strickland	58	0		
100700020713	M FK Big Timber	57			
100700030406	Bangtail	57			
100700020306	Emigrant	53			
100200070602	Cabin	52			
100200080505	Wilson Draw	51			
100700020807	Shorty	49	0		
100200080702	Big Bear	44			
100700020711	Little Timber	43			

HUC6	HUC6 Name	Acres rated as “HIGH” RAVE Class	Acres rated “HIGH” in existing weed areas	High Risk Areas (gt 640 acres of “High” RAVE risk)	High Weed Occurrence in High Risk Area (gt than 20 acres)
100700021001	Otter	37			
100700020402	Trail	36			
100200080403	Buck	35			
100700020108	Sphinx Slip and Slide	35	0		
100700020906	Boulder	35	0		
100700020307	Fridley	31			
100700030104	Lower Flathead	29			
100700020309	Pole Conlin	28			
100700020305b	Sixmile	25			
100700030405	Canyon	25			
100200081103	Sypes	23			
100700020106	Horse	21			
100700020903	Blacktail	19			
100700020403	Pine West	13	2		
100700020303b	West Fork Mill	13			
100700020505	Mission	13			
100700020308	Eightmile	12			
100700030204	Porcupine1	8			
100700030102	Upper Flathead	6			
100700030205	Elk	4			
100700021201	Upper Sweetgrass	3			
100700020811	Lower Boulder	2			
Total		102,649	392		

Though all the factors discussed above influence rating scores, it appears that depth to groundwater and pesticide leachability account for most of the “High” ratings. Though this model is designed for a programmatic planning level, and is not appropriate for on-site design, the data depicted in Figure 1 (in Appendix E) is accurate enough to use on a district level if mapped at that scale. This analysis also provides useful “red flag” indicators for applications specialists when in areas designated “High” risk.

For the case using a highly-leachable herbicide, almost all of the Gallatin Forest falls in the “low to moderate” risk class. Only five percent falls in the “High” class (Table 4-6.) This indicates that as far as groundwater contamination is concerned, careful use of herbicides on most lands on the Forest is likely a reasonable activity. There are “hot spots” in each Ranger District where special mitigation measures should be considered (Figure 1 in Appendix E). The Gardiner District has the most area in this class (Table 4-7), primarily due to the high elevation area near Cooke City.

In any of these areas, use of an alternate herbicide with a low leaching index should reduce risk to reasonable levels. High-risk areas average a score of 75. Selecting an alternative herbicide with a low leachability (in Appendix E) giving a rating factor value of 5 rather than 20. This lowers the average score to 60, well within the “Low to Moderate” risk class (Table 3-8.)

Figure 2 (in Appendix E) shows there are some watersheds that should be reviewed for risks of groundwater contamination, based on the potential for contamination through existing weed infestations and potential future contamination if weeds are found in or migrate to those areas. These watersheds are listed in Table 4-9. The watersheds having existing weed infestations in “High” risk areas should have special mitigation measures designed into all current treatment plans.

Although only a small portion of weeds fall into the “High” risk areas (Table 4-8), there are some areas of specific concern. Watersheds having both a significant area in “High” risk and a significant area of weeds in those “High” risk areas should use herbicides that have low leaching potential. Watersheds of “Low to Moderate” risk can be evaluated at a less intense level. In terms of long term planning, watersheds having few weeds, but some potential for contamination should include prevention and weed surveys at a higher level than other watersheds to prevent the establishment of weeds into those areas. For example, the Cooke City area (Figure 2 in Appendix E) has few weeds at present. However because of shallow groundwater and abundant surface water, the area should be specified for special mitigation measures (e.g. using herbicides of low leachability) as well as increased preventative measures such as travel restrictions or washing guidelines for vehicles.

Generalizing from the above discussion, it appears that under Alternatives 1 and 4 the Gallatin Forest has a low to moderate potential for groundwater contamination from foliar-applied herbicides. The areas of higher risk probably can be mitigated with herbicide selection to minimize that contamination potential.

A positive effect of Alternatives 1 and 4 is that weed incidence on the Forest will be reduced. The removal of exotic species is generally beneficial for the soil-part of the ecosystem and there should be beneficial effects here.

Alternatives 2 and 3 will not use herbicides in areas at risk to ground water contamination so there is no associated risk. However, the weeds will continue to spread under these alternatives and this will eventually lead to a reduction in soil productivity as has been documented in the Beaverhead-Deerlodge Noxious Weed Control EIS and in the Helena National Forest Weed EIS (USFA, 2002; USFS, 2003).

Cumulative Effects to Soils and Ground Water

Other foreseeable actions include treatment of weeds by other agencies or by private landowners within these areas at risk to ground water contamination. Although directions on herbicide labels prohibit applying herbicide in areas at risk to ground water contamination, people have not always followed these directions and there is always the risk of an accidental spill in an area with a high water table. However, with this analysis the areas at risk are easily discernable and herbicides that leach rapidly into the soil and aquifer will not be used in these areas. Given the mitigation measures there is a very low risk of ground water contamination from multiple applications of herbicides (either from multiple application within a HUC or over many years of continuous treatments).

Irreversible and Irretrievable commitment of Resources - to Soils and Ground Water

No irreversible or irretrievable commitment of soil or ground water resources is expected to result from any of the alternatives. Mitigation measures are in effect to control long-term impacts from

herbicide treatments: consequently, Alternatives 1 and 4 will not impact these resources. Alternatives 2 and 3 will not effectively control the spread of weeds so there will be an irreversible loss of soil productivity.

Consistency with Forest Plan and other Laws, Regulations and Policies to Soils

As each alternative provides some measure of weed control, they are consistent with the Forest Plan standard, which states that management activities would be planned to sustain site productivity. They are consistent with the Soil Conservation and Domestic Allotment Act (16 USC 590), as they limit decreases in soil productivity and suppress sedimentation. These alternatives are also consistent with 43 CFR § 1901 and MCA 76-13-101 which authorize land supervisors to manage vegetation in a way that reduces soil erosion. Additionally, preventing weed propagation is consistent with the Montana County Noxious Weed Management Act.

WATER QUALITY, FISHERIES, AND AMPHIBIANS

Direct and Indirect Effects - Alternative 1 (Proposed Action), Water Quality, Fisheries, And Amphibians

Results from the analysis (as described in Chapter 3) indicate treatments proposed for weeds within 17 of the 108 , 6th code HUCs (Hydrologic Unit Codes) across the Forest, show some risk for exceeding “safe” concentrations in surface waters (Table 4 -10).

Table 4-10. Gallatin National Forest watersheds (6th code HUCs) that show some risk for exceeding ‘safe’ concentrations of picloram.

District	HUC Name	HUC Number	Restriction
Hegben Lake	Upper Madison	100200070202	Do not exceed 90 lbs Active Ingredient
Hegben Lake	SF Madison	100200070203	Do not exceed 29 lbs Active Ingredient
Hegben Lake	Denny	100200070205	Do not exceed 81 lbs Active Ingredient
Hegben Lake	Duck Red Canyon	100200070304	Do not exceed 46 lbs Active Ingredient
Hegben Lake	Hegben Lake	10020007050	Do not exceed 69 lbs Active Ingredient
Hegben Lake	Lower Beaver	100200070603	Do not exceed 36 lbs Active Ingredient
Hegben Lake	Sheep	100200070801	Do not exceed 15 lbs Active Ingredient.
Bozeman	Moose Tamphery	100200080602	Do not exceed 22 lbs Active Ingredient
Bozeman	Logger	10020008060	Do not exceed 22 lbs Active Ingredient
Bozeman	Bozeman	100200080803	Do not exceed 62 lbs Active Ingredient
Bozeman	Beasley M	100200080805	Do not exceed 30 lbs Active Ingredient
Bozeman	SF Sixteenmile	100301010302	Do not exceed 55 lbs Active Ingredient
Gardiner	Sphinx Slip and Slide	100700020108	Do not exceed 57 lbs Active Ingredient
Gardiner	Eagle Reese	100700010902	Do not exceed 56 lbs Active Ingredient
Livingston	Deep	100700020108	Do not exceed 36 lbs Active Ingredient
Livingston	Donahue Daily	100700020304a	Do not exceed 32 lbs Active Ingredient
Livingston	Lower Mill	100700020305a	Do not exceed 46 lbs Active Ingredient

Direct Effects: Potential direct effects to aquatic organisms from noxious weed management are largely associated with the herbicide application on and around streams, lakes or other water bodies. Contamination can occur through direct herbicide contact with surface water (by either inadvertent application or accidental spill), or by herbicides leaching through the soils into groundwater. It may also occur when herbicides are applied intentionally or accidentally to ditches, irrigation channels, or are carried away in runoff to surface waters. Each route of entry results in varied magnitude and duration of contamination. Aerial spraying near aquatic zones has the most potential to expose aquatic organisms to contaminants, either through direct application or drift. Herbicides from ground-based equipment may also enter streams directly or through drift. However, the risk of contamination is reduced because application occurs more slowly and applicators are able to immediately recognize problems and adjust application techniques.

Introduction via overland flow is a consideration for some herbicides. Risks vary with the persistence of active ingredients, soil composition and characteristics, and the intensity and timing of precipitation events after herbicide application. Overland flow occurs infrequently on most well vegetated forests and rangelands because soil infiltration capacity is usually greater than precipitation. However, denuded and compacted soil typically provides increased potential for surface runoff. Mobilization in ephemeral stream channels is also a possible mechanism for herbicide entry to streams. Ephemeral stream channels may be difficult to see from the air and may be sprayed inadvertently. Ground application provides greater opportunity for identifying and avoiding these areas. Leaching through the soil profile can occur, but generally poses the least risk to aquatic environments. While there are exceptions, most herbicides disappear quickly from both the ground surface and soil. Reduced potential for leaching is largely facilitated by plant uptake of the herbicide, natural decomposition and volatilization of active ingredients, and/or adsorption of the herbicide by soil particles. Most groundwater contamination by herbicides results from point sources, such as spills, leaks, storage and handling facilities, improperly discarded containers, or rinsing equipment in loading and handling areas. Point sources are discrete, identifiable locations that discharge relatively high local concentrations of herbicides. Such problems can be avoided through proper calibration and rinsing and cleaning equipment.

Of the herbicides proposed for Gallatin National Forest use, picloram has the greatest potential to impact aquatic fauna. It persists longer than other chemicals considered, is slightly to moderately toxic to aquatic organisms, and is currently being used to control weeds on the Gallatin National Forest. Using the analysis procedures outlined above, extreme concentrations of picloram would never occur during Gallatin National Forest weed spraying activities, unless a spill occurred directly into a stream. However, proposed treatments may still result in small amounts of herbicide entering water. The analysis indicates herbicide applications in all but a few 6th code HUCs on the Forest should remain well below “safe” concentrations and pose little risk to fisheries (Table 4-10). This assumes that project implementation and mitigation measures described in the EIS are followed.

By following restrictions noted above (Table 4-10), instream concentrations should remain below 0.12 ppm and negative impacts to sensitive or Management Indicator Species aquatic species should not occur, since mitigation measures defined in Chapter 2 provide significant protection and all standardized values used in the model were extremely conservative.

The likelihood that an isolated, intense storm would occur right after extensive herbicide application and center itself on the treated area is very low. Observation of weather forecasts is required prior to aerial application. Using weather forecasts to guide herbicide application should

effectively reduce the concentrations delivered to streams by another 10 to 50 percent, provided forecasts are relatively accurate for at least 2 or 3 days. Based on results from Watson, Rice and Monnig (1989), photo-decay of picloram ranged from 22 to 44 percent within seven days. The following rationale further supports the likelihood that impacts to aquatic species within those HUCs will be avoided.

- 1) Most range and forest lands represent infiltration dominant sites rather than overland runoff sites. The model was standardized to say that 50 percent of every treated weed site is runoff dominant.
- 2) A six percent delivery of herbicide during overland runoff events represents the upper end of rates documented in the literature.
- 3) A 300-foot buffer maintained for aerial spraying will serve to intercept water and provide an additional infiltration area should precipitation events occur.
- 4) Stream flows increase as they travel down drainage, decreasing concentrations and further detoxifying chemicals.
- 5) Unlike the 96-hour acute toxicity LC-50 tests in the lab, organisms in the field would only be exposure to herbicides for a brief time.
- 6) The “safety threshold” used in this analysis is the most conservative threshold recommended.
- 7) Aerial treatment will not occur within 300 feet of a stream, lake or water body, which supports westslope cutthroat, Yellowstone trout, or other species of special consideration.
- 8) The analysis is extremely conservative and does not take into account the capability of aquatic organisms to move out of contaminated stream reaches.
- 9) None of the 17 HUCs showing some risk for exceeding “safe” concentrations in surface waters are proposed for aerial treatment.

Limiting the amount of picloram that can be applied within the 17 HUCs would ensure that instream concentrations remain below the 0.12 ppm and effects on organisms in the water would be discountable. However, ground application of picloram near water bodies will be restricted to 50 feet from the water’s edge, or the edge of subirrigated land, whichever distance is greater, or on high run-off areas (Chapter 2-Environmental Protection Measures). Within this buffer zone, only those chemicals with short persistence and classified as slightly toxic or practically non-toxic ($LC_{50} > 10$ mg/l) will be used. Examples include aquatic approved glyphosphate, 2,4-D, and triclopyr. Rodeo® is a preparation of glyphosate specifically formulated for applications directly into water. Some formulations of 2,4-D (Weedar 64®) can be used in close proximity to water and have the advantage of being selective for broadleaf plants. Triclopyr is “practically non-toxic” to fish (USDOE, 2000).

Information is limited on the types of surfactants used and the toxicity of surfactants. Surfactants are proposed for use with the same mitigation measures as picloram. Only those labeled for use in and around water would be used within 50 feet of water, or the edge of subirrigated land, whichever distance is greater, or on high run-off areas. Some surfactants are labeled for use in and around water including: Activate Plus®, LI-700®, Preference®, R-11®, Widespread®, and X-77®.

The non-herbicide treatments proposed under this alternative would have negligible effects on water resources. Mechanical treatments could result in localized soil disturbance but an increase in sediment to streams would likely be undetectable for several reasons. Disturbed areas would be quite localized and would be reseeded with desirable species after treatment, reducing erosion as roots become established. Project related soil disturbance would be minimal and localized. Cultural treatments (seeding, transplanting, and fertilizing) would not affect fisheries or water

quality. Fertilizers would be applied according to Forest Service and manufacturer guidelines. Runoff nutrient concentrations would not be large enough to measurably enrich streams, as is the case with current Gallatin National Forest road construction projects. Seeding and transplanting would involve limited soil disturbance. Release of biological control agents would have no direct effect on fisheries or surface water quality. These agents would not compete with aquatic insect species since their food base is very specific, nor would they provide more than an incidental food source for fish.

In summary, direct impacts of herbicides, surfactants and non-herbicide treatments, as mitigated, are expected to be negligible. Therefore, habitat quantity and quality will not be impacted, nor will fish or amphibian populations.

Indirect effects can result from alterations in the composition of vegetative ground cover through proliferation or reduction of noxious weeds. On sloped terrain, the possibility of surface runoff and sediment introduction into streams and other water bodies increases as weeds replace bunchgrasses and other vegetation. If sediment introduction is excessive, fish habitat and amphibian habitat could become degraded (Platts, 1991; Maxell, 2000). Instream cover for fish might also change, based on alterations in riparian vegetation along stream margins. Additional effects to fish could include short-term changes in food supply, should aquatic invertebrates be susceptible to low concentrations of herbicides.

Control of noxious weeds using methods described for this alternative would benefit both fish and amphibian habitat conditions by retaining native vegetation both in riparian and upslope areas. The mitigation measures and herbicide limits described above greatly reduce the likelihood that herbicide application will have any negative impacts.

Direct and Indirect Effects - Alternative 2 (No Herbicide), Water Quality, Fisheries, And Amphibians

The water and fisheries effects of the no herbicide alternative are negligible since treatments on Gallatin National Forest land would be entirely bio-control, cultural, or mechanical.

Direct and Indirect Effects - Alternative 3 (No Change from Current Management), Water Quality, Fisheries, And Amphibians

This alternative would involve only about ten percent of the herbicide use in analyzed in Alternative 1 so risks to water quality and fish are reduced from those described for Alternative 1. This alternative involves less bio-control and no cultural control. Mechanical treatment is much larger (450 acres) than any other alternative so potential for soil erosion and sedimentation is greater than the other alternatives but still quite limited.

Direct and Indirect Effects - Alternative 4 (No Aerial Application), Water Quality, Fisheries, And Amphibians

Alternative 4 is similar to Alternative 1 for bio-control, mechanical, and herbicide treatments. No aerial herbicide treatments would be applied, slightly reducing the risk of accidental herbicide contamination of surface water as compared to Alternative 1. The effects and mitigation measures for ground treatment in Alternative 1 also apply for Alternative 4. Therefore, impacts to fish, amphibians and their habitats are effectively the same for this alternative as for Alternative 1.

Cumulative Effects to Water Quality, Fisheries, And Amphibians

Weed treatments with herbicides will also occur within some of the HUC6 watersheds by county weed control districts treating weeds along roads, adjacent private landowners, and other Forest Service projects. The Forest Service projects are directly regulated by the mitigation measures in this EIS. The Forest Service has no direct jurisdiction over weed control methods by the counties or private landowners but their weed herbicide control activities are required to follow EPA label requirements. Assuming county and private landowner weed control activities follow requirements, no measurable direct/indirect effects should occur on water quality and fisheries. However, if county and private landowners violate EPA label requirements or have herbicide spills in or near stream, lakes, or wetlands then adverse impacts to the aquatic systems could occur.

As proposed, Alternatives 1, 3 and 4 are not expected to cumulatively interact with past, current, and reasonably foreseeable actions to negatively impact sensitive amphibian populations. Alternatives 1, 3 and 4 are also not expected to have negative cumulative impacts on Management Indicator Species or sensitive fish populations. Alternative 2 (No Action) will maintain existing cumulative effects to amphibians, Management Indicator Species, and sensitive fish populations.

Biological Evaluation Determination

Fish Species

Westslope cutthroat trout and fluvial Arctic grayling are Forest Service Northern Region sensitive fish species that historically inhabited the upper Missouri River drainage (Benke, 1992; Vincent, 1962). Thus, the Gallatin River and Madison River drainages are classified as historical habitat for these two species. As noted in Table 3-10, some portions of the project area contain westslope cutthroat trout. There is no documented presence of Arctic grayling within the analysis area. An attempt has been made by Montana Fish Wildlife Projects to reintroduce fluvial Arctic Grayling into the upper Gallatin River over the past several years. The success of this effort is not known. The Yellowstone cutthroat trout is a Forest Service Northern Region sensitive fish species that historically inhabited the upper Yellowstone River drainage (Varley and Gresswell, 1988). Yellowstone cutthroat remain widely distributed in the drainage, but populations are fragmented and, in many cases, reduced to headwater streams.

The proposed action, as mitigated, is expected to pose little risk to fish populations and their habitat. Therefore, this action may impact individual Arctic grayling and westslope cutthroat trout, but will not impact populations of these species.

Amphibian Species

The northern leopard frog and the western toad are on the sensitive amphibian species list for the Northern Region of the Forest Service. The northern leopard frog is widely distributed at lower elevations but is rare on the Gallatin National Forest. Western toads are locally present across the project area.

Northern leopard frogs breed from mid-March to early June (Maxell, 2000). Mating occurs when males congregate in shallow water and begin calling during the day (Maxell, 2000). Eggs are laid at the water surface in large, globular masses of 150 to 500 (Maxell, 2000). Frogs disperse into marsh and forest habitats, but are not usually far from open water (Maxell 2000).

Western toads inhabit all types of aquatic habitats ranging from sea level to 12,000 in elevation (Maxell, 2000). They breed in lakes, ponds, and slow streams, preferring shallow areas with mud bottoms (Maxell, 2000). Western toads breed from May to July, laying long, clear double-strings of eggs (Maxell, 2000). Tadpoles metamorphose in 40 to 70 days (Maxell, 2000). Because of their narrow environmental tolerance (10-25 C throughout the year), adults must utilize thermally buffered microhabitats during the day, and can be found under logs or in rodent burrows (Maxell, 2000). Adults are active at night and can be found foraging for insects in warm, low-lying areas (Maxell, 2000).

The proposed action, as mitigated, is expected to pose little risk to amphibian populations and their habitat. Therefore, this action may impact individual boreal toads or northern leopard frogs, but will not impact populations of these species.

Table 4 –11. Biological Evaluation Determination for Sensitive Species.

Species	Determination	Comments
Westslope cutthroat	MIIH	Based on the slight risk of a spill.
Yellowstone cutthroat	MIIH	Based on the slight risk of a spill.
Arctic grayling	MIIH	Based on the slight risk of a spill.
Northern leopard frog	MIIH	Based on the slight risk of a spill.
Western toad	MIIH	Based on the slight risk of a spill.

MIIH – May Impact Individuals, but will not lead toward listing or loss of viability to the species.

Monitoring Requirements

Monitoring for aerial application will consist of detection cards as described in Chapter 2 (Environmental Protection Measures).

A field inspector will be present during all aerial application to monitor drift using 12” x 12” Spray detection cards placed in buffer areas along any stream or lake comprising a sport fishery, or waters important for Threatened, Endangered or Sensitive (TES) aquatic species. Cards will be placed prior to herbicide application and will be sufficient in number and distribution to adequately determine when drift of herbicide into the buffer area exceeds acceptable levels.

Consistency with Forest Plan and other Laws, Regulations and Policies to Water Quality, Fisheries, And Amphibians

All alternatives would meet all water quality standards and maintain beneficial uses of surface water and groundwater resources, assuming implementation of environmental protection measures and other mitigation measures occurs as necessary.

WILDLIFE -

Direct and Indirect Effects to Wildlife

There is a concern that weed treatments may impact wildlife by herbicide toxicity, by habitat modification, and by displacement during treatment. For analysis purpose the wildlife species will be divided into four groups for each alternative: Threatened and Endangered Species; Sensitive Species; Management Indicator Species; and Migratory Bird Species. Mitigation measures will be outlined prior to the effects analysis of each alternative.

Mitigation Common to all Alternatives

No human activities associated with weed control would be allowed within zone I (within 400 meters) of an active bald eagle nest from February 1-August 15, except within 20 feet of roads that are open for public motorized use.

Herbicides would only be applied at concentrations that would avoid tree mortality to protect potential nesting habitat for bald eagles and other species.

Sheep and Goat Grazing: A herder and guard dogs would be present to monitor sheep and goats used for weed control purposes at all times. The herder would be required to notify the local District Ranger and remove the live stock within 24 hours of any loss of sheep or goats being used for weed control purposes on the Gallatin National Forest. The herder would be required to comply with the Gallatin National Forest food storage order so that human and livestock/pet foods, refuse, and other attractants were made unavailable to bears. The carcasses of sheep or goats that died while being used for weed control would be removed from the Gallatin National Forest within 24 hours to avoid habituation of grizzly bears or wolves to livestock as carrion. Sheep and goats used for weed control would be contained each night within the perimeter of an electric fence. Herders of sheep and goats used for weed control purposed would be required to receive training from the U.S. Fish & Wildlife Service or other authorized organization in the use of hazing techniques to prevent depredations by wolves. Herders would be required to implement those techniques when wolves are known to be in proximity to domestic sheep or goats being used for weed control.

To prevent disease transmission between domestic sheep or goats and bighorn sheep, all proposals for goat or sheep grazing for weed control purposes would be coordinated with the appropriate Montana Fish, Wildlife and Parks biologist to determine if bighorn sheep may occur in the area. At least nine miles of separation would be maintained between bighorn sheep and domestic sheep or goats being used for weed control purposes.

To prevent conflict with grizzly bears, no grazing of sheep or goats will be allowed in the recovery area.

District/Forest wildlife biologists would review and coordinate weed management projects with the District/Forest weed coordinators to identify raptor nesting areas, grizzly bear core habitat, wolf territories, or other critical wildlife areas that may be affected by weed control activities, to ensure the mitigation measures described in this report are implemented properly.

Additional Mitigation for Alternative 1

No aerial herbicide spraying would be allowed within zones I or II (within 800 meters) of an active bald eagle nest from February 1-August 15.

No aerial spraying within 1 mile of an active peregrine falcon nest from April 1-August 15.

No aerial application would be allowed within 400 meters of an active goshawk nest from April 1-August 15.

Only eight hours of aerial spraying would be allowed in grizzly bear core habitat within a given Bear Management Subunit each year.

Direct and Indirect Effects – Grizzly Bear***Grizzly Bear - Herbicide Toxicity, Alternative 1 (Proposed Action), Direct and Indirect Effects***

This alternative proposes more acres of herbicide treatment than all other alternatives. Grizzly bears would be likely to occasionally contact herbicides by ingesting plants that had been sprayed and by dermal absorption following contact with sprayed plants. There is also a very small chance that grizzly bears could be directly sprayed with herbicide during aerial application. However, the toxicity of herbicides proposed for use is low, as are the chances of grizzly bears receiving doses great enough to cause toxic effects. However, this must be qualified by the fact that there is uncertainty regarding the toxicity of some herbicides and inert ingredients.

Grizzly Bear - Habitat Modification, Alternative 1 (Proposed Action), Direct and Indirect Effects

Compared to the No Change from Current Action - Alternative 3, more vegetation would be treated with herbicides. Therefore, there would be a larger short-term loss of forage resulting from mortality of non-target plants in treatment areas. However, native vegetation would begin to recover and provide forage within two to three years of herbicide treatment (Rice et al. 1997, page 631). Long-term impacts to grizzly bear spring foraging opportunities as weeds out-compete native vegetation would be lower than under the Alternative 3 (No Change from Current Action), because the acreage of untreated weed infestations would be smaller.

Grazing by goats and sheep in grizzly bear habitat to favor the growth of native plants would be used under this alternative. Grizzly bears could be attracted to and prey upon these animals. This could result in the conditioning of grizzly bears to livestock as food, and lead to conflicts with livestock on adjacent grazing allotments resulting in management removals of grizzly bears. However, goats and sheep would be used in localized areas. Bands of sheep and goats would be much smaller than those typically associated with commercial livestock grazing. Additionally, mitigation measures would be applied to lessen the chances of depredation conflicts developing. Herders and guard dogs would be used to monitor herds, and would immediately report any depredations. Electric fencing would be used to contain sheep and goats at night. Camps would be subject to the food storage order and herders required to dispose of any sheep or goat carcasses to prevent attracting bears. Sheep and goats would be removed from the Forest if grizzly bear depredations were to occur. Application of the above mitigation measures would ensure compliance with applicable Gallatin Forest Plan grizzly bear standards (USDA Forest Service, pages G-15, G-16). Use of goats and sheep for weed control under this alternative would also be in compliance with standards from the Final Conservation Strategy for Grizzly Bears in the Yellowstone Area (IGBC 2003, page 43) because grazing would be temporary and occur outside of any existing allotment, no new allotment would be created, and no animal months would be allocated.

Grizzly Bear - Disturbance And Displacement, Alternative 1 (Proposed Action), Direct and Indirect Effects

The potential for disturbance or displacement of grizzly bears would be similar to that under Alternative 4 (No Aerial Application), except that there would be an additional chance of displacing bears with aerial spraying. No aerial spraying is currently proposed within grizzly bear core habitat, although the need for this activity may arise in the future. Aerial spraying of a weed patch would occur once per year, and would be completed in several hours or less. Mitigation measures would be applied to allow only 8 hours of aerial spraying within core habitat

per Bear Management Sub-unit per year in order to limit disturbance within this important habitat. This would be consistent with core habitat management direction from Forest Plan Amendment 19 and the Conservation Strategy, because there would be no reduction in core habitat and there would be no reoccurring low-level helicopter flights over core habitat.

Grizzly Bear - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 2 (No Herbicides), Direct and Indirect Effects

There would be no toxic effects to grizzly bears under this alternative because no herbicides would be used.

Under this alternative there would be no short-term loss of grizzly bear forage resulting from non-target plants killed by herbicides, because no herbicides would be used. Instead, the long-term availability of native forage plants would be reduced as they are out-competed by weeds. The effects of sheep and goat grazing for weed management on grizzly bears would be similar under all alternatives. Their effects are described in detail under Alternative 1.

Disturbance and displacement of grizzly bears under this alternative would be minimal. Mechanical and herbicide treatments require the most human activity and have the most potential to cause disturbance. No herbicide treatment and very limited amounts of mechanical treatment would be used under this alternative.

Grizzly Bear - Herbicide toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 3 (No Change from Current Management), Direct and Indirect Effects

Grizzly bears would be likely to occasionally contact herbicides by ingesting plants that had been sprayed and by dermal absorption following contact with sprayed plants. The toxicity of herbicides proposed for use is low, along with the chances of grizzly bears receiving doses great enough to cause toxic effects. However, this must be qualified by the fact that there is uncertainty regarding the toxicity of some herbicides and inert ingredients.

Under this alternative, grizzly bear habitat would be treated with herbicides each year. These areas would have reduced foraging capacity for grizzly bears because non-target plants would be killed by broad-spectrum herbicides until native vegetation began recovering within 2-3 years of herbicide treatment (Rice et al. 1997, page 631). Weed infestations are most likely to occur in association with roads or other human developments, while grizzly bears tend to avoid those same disturbances (IGBC 1998). Despite this potential spatial separation, it is highly likely that grizzly bears use areas with weed infestations to some degree. However, many weed infestations would not be treated, and they would continue to spread and displace native forage plants (especially in lower-elevation sagebrush/grassland habitat types). Grizzly bears forage in these areas primarily during spring or early summer when green plants are emerging but higher-elevation habitats are still snow-covered (Servheen 1993, page 7). The long-term availability of spring forage for grizzly bears would be somewhat reduced by the continued spread of weeds. Other important grizzly bear habitats including avalanche chutes, high elevation meadows, and whitebark pine stands that would be largely unaffected since they are at low risk for weed infestations. The effects of sheep and goat grazing for weed management on grizzly bears would be similar under all alternatives. Their effects are described in detail under Alternative 1.

It is likely that grizzly bears would occasionally be displaced as a result of weed treatment activities. However, activities such as herbicide spraying and grubbing would be of short

duration in any given spot, so any displacement would be localized and last only a few days. Bears could resume use of treated areas shortly thereafter.

Grizzly Bear -Herbicide Toxicity, Habitat Modification, Disturbance and Displacement, Alternative 4 (No Aerial Application), Direct and Indirect Effects

The chances of grizzly bears contacting herbicides would be slightly smaller than under Alternative 1 (the proposed action), due to the lack of aerial spraying. Otherwise, the effects of this alternative would be similar to those described under Alternative 1.

The impacts would be very similar to those described under Alternative 1, except for a small long-term reduction in potential spring foraging areas due to the lack of aerial spraying. The effects of sheep and goat grazing for weed management on grizzly bears would be similar under all alternatives. Their effects are described in detail under Alternative 1.

The chances of disturbance and displacement of grizzly bears would be very similar to those described under Alternative 1 (the proposed action). The main difference is that there would be no aerial spraying, so disturbance and displacement of bears would be somewhat less likely to occur than in Alternative 1.

Cumulative Effects – Grizzly Bear

Grizzly Bear – Alternative 1 – Cumulative Effects

Cumulative effects to grizzly bears resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because the herbicides proposed for use are rapidly excreted and do not bio-accumulate. Weed control activities would not alter access values and impacts to grizzly bear core habitat from aerial spraying would be mitigated, therefore any disturbance to grizzly bears resulting from this alternative would not contribute to cumulative effects on grizzly bears. This alternative would have a greater probability of containing the spread of weeds than the others and would have the least cumulative effects on grizzly bear foraging opportunities.

Grizzly bear – Alternative 2 – Cumulative Effects

No herbicides would be used, so there would be no cumulative toxic effects. Weed control activities would not impact core areas or alter other access values, so any disturbance to grizzly bears resulting from this alternative would have discountable cumulative effects. This alternative would have a lower probability of containing the spread of weeds than all others and would do the least to preserve grizzly bear foraging opportunities. It would therefore have more cumulative effects than other alternatives.

Grizzly bear – Alternative 3 – Cumulative Effects

Cumulative effects to grizzly bears were analyzed for the 16 Bear Management Subunits on the Gallatin National Forest (Boulder Slough #1&2; Crandall/Sunlight #1 &2; Hellroaring/Bear #1&2; Gallatin #1,2, &3; Hilgard #1&2; Lamar #1; Madison #1&2; Henry's Lake #2; and Plateau #1), because Bear Management Subunits are approximately the average size of a female grizzly bear's home range and contain all necessary seasonal habitat components. The temporal bounds for the analysis were the past 10 years and 15 years into the future, because weed infestations

have changed rapidly and it is difficult to predict how their spread beyond that timeframe would affect grizzly bear habitat.

Weed control with herbicides is an activity that has been occurring for years in the analysis area, and undoubtedly will continue for many years into the future. Private landowners, county governments, and other state and federal agencies all use herbicides to control weeds. However, this use has been compatible with grizzly bear recovery and is expected to continue to be so. The herbicides proposed for use are water-soluble and do not bio-magnify, so cumulative toxic effects to grizzly bears resulting from these processes would not occur.

A large variety of human activities occur in the analysis area, many of which may disturb or displace grizzly bears. Grizzly bear access management in the recovery zone is designed to balance these effects by providing core habitat characterized by a low level of human activity that could cause disturbance to bears. The analysis area was 3,319 mi², and approximately 2,648 mi² or 80% of this was secure habitat (IGBC 2003, page 151). The amount of secure habitat in these Bear Management Subunits was deemed adequate, because at least that much was present in 1998 when the grizzly bear population achieved recovery goals (IGBS 2003, page 145). The exceptions were the Henry's Lake #2, Gallatin #3, and Madison #2 Bear Management Subunits that were identified as having potential for improvement (IGBC 2003, pages 43-44). Aerial spraying in core habitat could temporarily displace grizzly bears from localized areas. However, cumulative effects resulting from such actions would be discountable, due to their short duration and localized nature. Adjacent areas of core habitat would continue to be managed to provide secure grizzly bear habitat.

Threats to several major grizzly bear food sources in the analysis area have been documented. The long-term persistence of whitebark pine trees, whose nuts provide a critical seasonal food source for grizzly bears (Mattson et al. 1990, page 1622), is threatened by blister rust, mountain pine beetle attack, and climate change (Tomback et al. 2001, page 9). Increased development of private lands may decrease habitat availability for ungulate populations, which are more important to bears in the Yellowstone area than to other grizzly populations (IGBC 2003, page 46).

Bears may be forced to rely more on herbaceous vegetation if these food sources decline in the future. Weeds have not been implicated as a major threat to grizzly bear forage, but the potential does exist for this to become more of an issue in the future if weeds spread into core habitat and other areas with low access densities that are preferred grizzly bear habitat. Although there is uncertainty regarding the ultimate impacts of weeds on grizzly bear foraging opportunities in the analysis area over the long-term, it is likely that over the next 15 years weeds would not have a major impact due to the broad diets of bears and the current low amount of weed infestation in the most important bear habitats. Forest Service projects such as timber sales and prescribed fires, road maintenance, recreational activities and vehicle use, special use permits (both recreation events and non-recreation), livestock grazing, and summer home residence may contribute to the spread of weeds. Recently adopted Best Management Practices (Forest Service Manual 2080) for preventing weed spread are incorporated as mitigation measures in project plans, which would help limit weed spread from Forest Service actions. Therefore, even though this alternative would be insufficient to contain the spread of most weed infestations, cumulative impacts to grizzly bear foraging opportunities would be low.

Grizzly bear - Alternative 4 - Cumulative Effects

Cumulative effects to grizzly bears resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because the herbicides proposed for use are rapidly excreted and do not bio-accumulate. Weed control activities would not impact core areas or alter other access values, so any disturbance to grizzly bears resulting from this alternative would have discountable cumulative effects. This alternative would be more likely to contain the spread of weeds than the No Action Alternative, and would have lower cumulative effects on grizzly bears.

Direct and Indirect Effects – Gray Wolf***Gray Wolf - Herbicide Toxicity, Alternative 1 (Proposed Action), Direct and Indirect Effects***

Wolves would be likely to occasionally contact herbicides by dermal absorption following contact with sprayed plants. There is also a very small chance that they could be directly sprayed with herbicide during aerial application. However, the toxicity of herbicides proposed for use is low (Table 3-14). Although there is uncertainty involved with the toxicity of some herbicides and inert ingredients, the chances of wolves receiving doses great enough to cause toxic effects are very low.

Gray Wolf - Habitat Modification, Alternative 1 (Proposed Action), Direct and Indirect Effects

Under this alternative, fewer acres of weed infestations would go untreated compared to all other alternatives. Elk populations, which are the primary prey for wolves, are not currently limited by weed infestations so short-term effects on wolves would be similar to the Alternative 3 (No Change from Current Action). The long term effects of weed infestations on elk populations are uncertain, but this alternative would do the most to maintain forage for the prey populations that wolves are dependent on.

As with grizzly bears, the use of sheep and goats for weed management could lead to possible conflicts with wolves. Wolf depredation can be a problem when commercial sheep grazing operations are located in proximity to areas occupied by wolves (USFWS 1987, page 71). This could lead to conditioning of wolves to livestock as food, and lead to conflicts with livestock on adjacent grazing allotments resulting in management removals of grizzly bears. However, the grazing use proposed in this alternative differs from typical commercial grazing operations in several key ways that would reduce the likelihood of this occurring.

Goats and sheep would be used in localized areas. Bands of sheep and goats would be much smaller than those typically associated with commercial livestock grazing. Additionally, mitigation measures would be applied to lessen the chances of depredation conflicts developing. Herders and guard dogs would be used to monitor herds, and would immediately report any losses of their stock. Herders would be required to immediately dispose of any sheep or goat carcasses to prevent attracting wolves, receive training from the U.S. Fish and Wildlife Service or other authorized organization in the use of hazing techniques to prevent depredations by wolves, and to implement those techniques when wolves are known to be in proximity to domestic sheep or goats being used for weed control. Electric fencing would be used to contain sheep and goats at night. Sheep and goats would be removed from the Forest if wolf depredations were to occur. Despite such precautions, wolves have preyed upon domestic sheep being used for weed control in the Yellowstone area (Bangs 2003, page 2) with resulting management removal of a wolf, and there is potential for this to occur on the Forest when goats or sheep are used.

Gray Wolf - Disturbance And Displacement, Alternative 1 (Proposed Action), Direct and Indirect Effects

Wolves could be displaced by activities such as ground-based herbicide spraying. However, activities would be of relatively short duration during daylight hours, so disturbance or displacement would be very temporary and affect only localized areas. Aerial spraying would be more likely to disturb or displace wolves than ground spraying, but the additive disturbance of this treatment on wolves would be discountable due to the short duration and localized nature of aerial spraying. Weed treatment activities would not disturb wolf denning activities because dens are typically located in inaccessible areas where weed control would be unlikely to occur (J. Fontaine, U.S. Fish & Wildlife Service, personnel communication on 04/28/03).

Gray Wolf - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 2 (No Herbicides), Direct and Indirect Effects

There would be no toxic effects to gray wolves under this alternative because no herbicides would be used.

The effects of sheep and goat grazing for weed management on wolves would be similar under all alternatives. Their effects are described in detail under Alternative 1.

Long-term negative impacts to elk forage and ultimately the prey base for wolves would be uncertain, but potentially greater for this alternative than all others because the treatments proposed would be the least likely to contain the spread of weeds.

Although weed management activities would vary among alternatives, they would have similar displacement and disturbance effects on wolves. These effects are described in detail in Alternative 1, and are expected to be discountable due to their short duration and localized nature.

Gray Wolf - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 3 (No Change from Current Management), Direct and Indirect Effects

Wolves would occasionally come into contact with herbicides through dermal absorption following contact with treated vegetation. Due to the low toxicity of herbicides proposed for use and the low doses expected with dermal absorption, toxic effects to wolves would be extremely unlikely even with the uncertainty involved regarding the toxicity of some herbicides and inert ingredients.

The acreage of weed treatment would be insufficient to contain the spread of weeds. Elk winter ranges are generally in low-to-mid elevation rangelands that have a high risk for infestation by weeds. Degradation of elk winter ranges on the Forest due to weed infestation would likely lead to lower populations of prey for wolves. The effects of sheep and goat grazing for weed management on wolves would be similar under all alternatives. Their effects are described in detail under Alternative 1.

Although weed management activities would vary among alternatives, they would have similar displacement and disturbance effects on wolves. These effects are described in detail in Alternative 1, and are expected to be discountable due to their short duration and localized nature.

Gray Wolf - Herbicide Toxicity, Habitat Modification, Disturbance and Displacement, Alternative 4 (No Aerial Application), Direct and Indirect Effects

The chances of wolves contacting herbicides would be slightly smaller than under Alternative 1, due to the lack of aerial spraying. Otherwise, the effects of this alternative would be similar to those described under Alternative 1.

The treatment proposed under this alternative would lead to long-term improved elk winter range conditions when compared to the Alternative 3 (No Action), but potentially less favorable than those expected under Alternative 1 (the proposed action). In the foreseeable future, the treatments proposed under this alternative would be likely to maintain prey populations at levels sufficient to support wolves. The effects of sheep and goat grazing for weed management on wolves would be similar under all alternatives. Their effects are described in detail under Alternative 1.

Although weed management activities would vary among alternatives, they would have similar displacement and disturbance effects on wolves. These effects are described in detail in Alternative 1, and are expected to be discountable due to their short duration and localized nature.

Cumulative Effects – Gray Wolf***Gray Wolf – Alternative 1 – Cumulative Effects***

Cumulative effects to wolves resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because of the low potential for herbicides proposed for use to bio-magnify. Weed control activities would not impact dens, and any disturbance to wolves resulting from this alternative would have discountable cumulative effects. This alternative would have the greatest probability of containing the spread of weeds, and would do the most to preserve elk populations that provide the forage base for wolves. It would have the least cumulative effects on wolves.

Gray Wolf – Alternative 2 – Cumulative Effects

No herbicides would be used, so there would be no cumulative toxic effects. The potential for disturbance and displacement would be lowest under this alternative, and would have discountable cumulative effects. This alternative would be more likely to contribute to cumulative effects on wolves than Alternative 3 (No Action), because it would be less likely to contain the spread of weeds in elk habitat over the next 15 years and lower elk populations could result.

Gray Wolf – Alternative 3 – Cumulative Effects

Cumulative effects to gray wolves were analyzed for the Madison, Gallatin, Bridger, Emigrant, Absaroka, and Crazy Elk Management Units (EMU's), which contain all seasonal ranges for elk on the Gallatin National Forest. EMU's were delineated in the Statewide Elk Management Plan for Montana as a collection of hunting districts that share similar ecological conditions and encompass the yearlong range of major elk populations (Youmans 1992, page 3). They were used because elk populations are the primary factor determining wolf distribution on the Forest. The temporal bounds for the analysis were the past 10 years and 15 years into the future. Because weed infestations have changed rapidly and it is difficult to predict how they will spread beyond that timeframe, it will also be difficult to predict how weeds would affect wolves and their prey.

Weed control with herbicides is an activity that has been occurring for years in the analysis area, and undoubtedly will continue for many years into the future. Private landowners, county governments, and other state and federal agencies all use herbicides to control weeds. However, this use has been compatible with wolf recovery and is expected to continue to be so in the future. The herbicides proposed for use are water-soluble and do not bio-magnify, so cumulative toxic effects to wolves under this alternative would not occur.

A large variety of human activities occur in the analysis area. Isolated cases of disturbance to wolf dens from human activity have occurred in the past (Smith 1998, page 5), but have not affected wolf recovery. Disturbance or displacement of wolves under this alternative would be infrequent and have discountable cumulative effects to wolves.

Elk populations, which provide the bulk of the forage base for wolves in the analysis area, are generally robust. Private land development is probably the main threat to elk populations, but public land winter range is also available. The quality of public lands winter ranges may become more important in the future, as private lands winter ranges are lost to development. The continued spread of weeds on elk winter ranges could decrease forage availability and ultimately elk populations within the next 15 years. This alternative could contribute to cumulative effects on wolves because it may not be sufficient to contain the spread of weeds in important elk habitat, and lower elk populations could result.

Other Forest Service projects such as timber sales and prescribed fires, road maintenance, recreational activities and vehicle use, special use permits (both recreation events and non-recreation), livestock grazing, and summer home residence may contribute to the spread of weeds in winter range areas. Recently adopted Best Management Practices (Forest Service Manual 2080) for preventing weed spread are incorporated as mitigation measures in project plans, which would help limit weed spread from Forest Service actions.

Gray Wolf - Alternative 4 - Cumulative Effects

The herbicides proposed for use are water-soluble and do not bio-accumulate, so cumulative toxic effects to wolves resulting from bio-accumulation would not occur. The potential for disturbance and displacement of wolves would be greater than under Alternative 3 (No Action), but would still have discountable cumulative effects. This alternative would contribute less to cumulative impacts on wolves than Alternative 3 (No Action) because treatments would be more likely to contain the spread of weeds in elk habitat and higher elk populations could result.

Direct and Indirect Effects – Bald Eagle

Bald Eagle - Herbicide Toxicity, Alternative 1 (Proposed Action), Direct and Indirect Effects

Bald eagles would be most likely to contact herbicides around Hebgen Lake. This is especially true for Horse Butte, where there are numerous weed infestations and three nesting pairs of bald eagles. Eagles may occasionally perch on the ground in treated areas, and could absorb small amounts of herbicide through contact with sprayed vegetation. No aerial spraying would be allowed within 800 meters of an active bald eagle nest, which would prevent the direct spraying of adult birds or chicks on their nests. The chances of bald eagles being directly sprayed would otherwise be very remote. The amount of herbicide absorbed would be very low, and toxic effects would be unlikely due to the low toxicity of herbicides proposed for use. However, this must be qualified by the fact that there is uncertainty regarding the toxicity of some herbicides and inert

ingredients. The herbicides proposed for use do not appear to bio-accumulate or bio-magnify, so the probability of toxic effects to eagles resulting from them eating contaminated prey would also be very low.

Bald Eagle - Habitat Modification, Alternative 1 (Proposed Action), Direct and Indirect Effects

Weed infestations and treatments proposed under this alternative would have little effect upon bald eagle habitat. Weeds have not affected aquatic systems supporting fish populations on Hebgen and Earthquake Lakes that in turn provide the majority of forage for breeding bald eagles on the Forest. Fish populations in major water bodies such as Hebgen and Earthquake Lakes that are the most important to bald eagles would not be affected by herbicide use because mitigation measures would be applied to protect aquatic species (see Fisheries/Amphibians specialist's report) and the large volume of water in these lakes would dilute any herbicides that entered the system to non-toxic levels.

Bald Eagle - Disturbance And Displacement, Alternative 1 (Proposed Action), Direct and Indirect Effects

Because of the high potential for disturbance to nesting eagles from aerial spraying, mitigation measures would be applied preventing aerial spraying within zones I or II (less than 800 meters) of bald eagle nests. Ground-based human activities associated with the project would not be allowed within zone I (less than 400 meters) of an active nest, except along roadways open to public motorized use (such as the Horse Butte Road #610) where disturbance already occurs. These measures would be in compliance with recommendations for bald eagle nesting territory management (Greater Yellowstone Bald Eagle Working Group 1996, pages 24-25) and would effectively prevent disturbance of nesting eagles. Project activities could otherwise lead to the occasional disturbance and displacement of foraging eagles, but these effects would normally be discountable due to the localized nature of treatments and the availability of alternative foraging locations.

Bald Eagle - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 2 (No Herbicides), Direct and Indirect Effects

There would be no toxic effects to bald eagles under this alternative because no herbicides would be used.

Impacts to bald eagle habitat would be very similar under all alternatives. The effects are described in detail under Alternative 1. The only difference is that elk populations could be lower under this alternative, possibly leading to reduced availability of carrion for eagles.

The potential for disturbance or displacement of foraging bald eagles would be very low because biocontrol would be the treatment method affecting the most acres. Little human activity is associated with biocontrol. Mechanical and herbicide treatments require the most human activity and have the most potential to cause disturbance. No herbicide treatment and very limited amounts of mechanical treatment would be used under this alternative.

Bald Eagle - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 3(No Change from Current Management), Direct and Indirect Effects

The effects of this alternative would be similar to those described in Alternative 1, except that there would be a lower chance of bald eagles contacting herbicides due to the lower number of acres proposed for treatment.

Impacts to bald eagle habitat would be very similar under all alternatives. The effects are described in detail under Alternative 1. The difference is that elk populations could be lower under this alternative, possibly leading to reduced availability of carrion for eagles.

The potential for disturbance and displacement of bald eagles would be lower than under Alternative 1, because no aerial spraying would occur and fewer acres would be treated using ground-based activities. Bald eagles could be still disturbed or displaced by weed control activities, especially by ground-based herbicide spraying around nests in the Horse Butte area. The same mitigation measures would apply to ground-based weed management activities to prevent disturbance of nesting eagles.

Bald Eagle – Herbicide Toxicity, Habitat Modification, Disturbance and Displacement – Alternative 4 (No Aerial Application), Direct and Indirect Effects

The effects of this alternative would be similar to those described in Alternative 1, except that there would be a slightly lower chance of bald eagles contacting herbicides due to the lower number of acres proposed for treatment.

The effects of this alternative would be similar to those described in Alternative 1, except that there would be a slightly lower chance of bald eagles contacting herbicides due to the lower number of acres proposed for treatment.

The potential for disturbance and displacement of bald eagles would be lower than under Alternative 1, because no aerial spraying would occur. Bald eagles could be still disturbed or displaced by weed control activities, especially by ground-based herbicide spraying around nests in the Horse Butte area. The same mitigation measures would apply to ground-based weed management activities to prevent disturbance of nesting eagles.

Cumulative Effects – Bald Eagle

Bald Eagle – Alternative 1 – Cumulative Effects

Cumulative effects to eagles resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because the herbicides proposed for use are rapidly excreted and do not bio-accumulate. Cumulative impacts of disturbance to foraging eagles resulting from this alternative would be slightly greater than under the No Action Alternative. However, these effects would be very slight due to the short duration and localized nature of the proposed treatments. As for the No Action Alternative, there would be no cumulative effects to bald eagle forage or their habitat.

Bald Eagle – Alternative 2 – Cumulative Effects

No herbicides would be used, so there would be no cumulative toxic effects. The potential for disturbance and displacement of eagles would be minimal under this alternative, and would have

discountable cumulative effects because alternate foraging areas would still be available. This alternative would have no direct or indirect effect upon the forage base for eagles or their habitat, and would not have any cumulative effect.

Bald Eagle – Alternative 3 – Cumulative Effects

The analysis area for bald eagles was the area inhabited by the Greater Yellowstone bald eagle population as described in the Greater Yellowstone Bald Eagle Management Plan (Greater Yellowstone Bald Eagle Working Group 1996, page 2). The temporal bounds for the analysis were the past 10 years and 15 years into the future, because weed infestations have changed rapidly and it is difficult to predict how they spread beyond that timeframe would affect eagles.

Weed control with herbicides is an activity that has been occurring for years in the analysis area, and undoubtedly will continue for many years into the future. Private landowners, county governments, and other state and federal agencies all use herbicides to control weeds. Other pesticides including organophosphates and carbamates are also in use and have caused bald eagle mortalities in the analysis area (Greater Yellowstone Bald Eagle Working Group 1996, page 15). However, the herbicides proposed for use are water-soluble and do not bio-magnify. Therefore, no toxic cumulative effects to bald eagles are expected under this alternative.

A large variety of human activities occur in the analysis area. The human population in the analysis area is growing rapidly. The potential for disturbance and displacement of eagles has therefore also increased. Although private land eagle habitat may be affected more, recreational use of public lands will also continue to cause disturbance problems for eagles in the future. Disturbance to nesting bald eagles would largely be mitigated under this alternative. There would be some cumulative effects to foraging bald eagles that were displaced due to weed control activities under this alternative, because birds would be displaced to other areas that would likely have human activities such as fishing and boating. They could also be discouraged from foraging in these areas. Recreational activities are currently not high enough to prevent bald eagles from finding adequate forage, but could increase to that level within the next 15 years. However, the disturbance and displacement of foraging eagles resulting from this alternative would be discountable because of effective mitigation measures, and the localized, short duration nature of activities.

This alternative would have no direct or indirect effect upon the forage base for eagles or their habitat, and would therefore not have any cumulative effect.

Bald Eagle - Alternative 4 - Cumulative Effects

The herbicides proposed for use are water-soluble and do not bio-accumulate, so cumulative toxic effects to bald eagles resulting from bio-accumulation would not occur. The potential for disturbance and displacement would be greater compared to Alternative 3 (No Action), but would have very slight cumulative effects due to the localized nature and short duration of proposed activities. This alternative would have no direct or indirect effect upon the forage base for eagles or their habitat, and would not have any cumulative effect.

Direct and Indirect Effects – Sensitive Species

Sensitive Species - Herbicide Toxicity, Alternative 1 (Proposed Action), Direct and Indirect Effects. Even though the goshawk has been removed from the sensitive species list, it is still included in this section because it is a Management Indicator Species for the Forest.

The probability would be greater for this alternative than for all other alternatives that sensitive species including the peregrine falcon, northern goshawk, western big-eared bat, and flammulated owl would contact herbicides. The only expected overlap between wolverine habitat and treatment areas would be on big-game winter ranges. However, wolverines would not be expected to contact herbicides because they use big game winter ranges while carrion is available during the winter and early spring, before herbicides would be used. Toxic effects to sensitive species due to the use of herbicides under this alternative are unlikely. Species such as the peregrine falcon, northern goshawk, western big-eared bat, and flammulated owl could occasionally ingest prey that had been sprayed with herbicides because they forage in areas that may receive treatment with herbicide. The herbicides proposed for use have not been found to bio-accumulate or bio-magnify. The toxicity of herbicides proposed for use is low (Table 3-14), as is the chance of these species receiving doses great enough to cause toxic effects. However, this must be qualified by the fact that there is uncertainty regarding the toxicity of some herbicides and inert ingredients.

Sensitive Species - Habitat Modification, Alternative 1 (Proposed Action), Direct and Indirect Effects

The short-term impacts of herbicides on vegetation could cause localized decreases in the abundance of insects, birds, and small mammals that are prey for peregrine falcons, goshawks, western big-eared bats, and flammulated owls. These impacts would be more widespread than those under Alternative 3 (No Change from Current Action), due to the much larger area proposed for treatment. However, populations of these prey species depend on native vegetation and would begin recovering in treated areas within 2-3 years of herbicide treatment (Rice *et al.*, 1997, page 631). This alternative would result in more acres of weed infestation successfully treated compared to the Alternative 3, and the long-term availability of forage for these species would be improved.

Sensitive Species – Disturbance And Displacement, Alternative 1 (Proposed Action), Direct and Indirect Effects

The probability of disturbance and displacement of sensitive species under this alternative would be slightly larger than for all other alternatives, due to the use of aerial spraying. The effects would be temporary and localized due to the short duration of aerial spraying. Breeding activities of sensitive species would not be affected because weed control would generally not occur in close proximity to expected nesting areas for species that are sensitive to disturbance such as peregrine falcons and goshawk. No aerial spraying within one mile of known peregrine nests is proposed, although it could be in the future. With mitigation measures that prohibit aerial spraying less than one mile of an active peregrine falcon nest from April 1-August 15 (a good approximation of their nesting dates in southwest Montana) incorporated, this alternative would be consistent with management recommendations for this species because other weed management activities would be within the scope of activities that historically occurred.

Sensitive Species - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 2 (No Herbicides), Direct and Indirect Effects

There would be no toxic effects to sensitive species under this alternative because no herbicides would be used.

The short-term impacts of weed treatment on forage availability for peregrine falcons, goshawks, western big-eared bats, and flammulated owls would be less than under all other alternatives because biocontrol using species-specific agents rather than broad-spectrum herbicides that kill a variety of plants would be the most widespread treatment method. Long-term negative effects of this alternative to sensitive species habitat would be greater than those expected under the Alternative 3 (No Action), because weed treatments would be less likely to contain the spread of weeds.

The potential for disturbance or displacement of sensitive species would be very low because biological control would be the treatment method affecting the most acres. Little human activity is associated with biological control.

Sensitive Species, Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 3 (No Change from Current Management), Direct and Indirect Effects

The effects of this alternative would be similar to those described in Alternative 1, except that there would be a lower chance of sensitive species contacting herbicides due to the lower number of acres proposed for treatment and the lack of aerial spraying.

The short-term effects of this alternative upon sensitive species habitat would be similar to those described under Alternative 1, except they would be less widespread due to the much smaller area proposed for treatment. Over the long term, forage availability for these species would decline because the amount of acreage treated would be insufficient to limit the spread of weed infestations.

The probability of disturbance and displacement of sensitive species under this alternative would be smaller than under Alternative 1, due to the lower number of acres proposed for treatment and the lack of aerial spraying. Some disturbance and displacement of sensitive species could still result from weed treatments, but the effects would be temporary and localized. As described in Alternative 1, mitigation measures would be applied to prevent disturbance to breeding goshawks.

Sensitive Species - Herbicide Toxicity, Habitat Modification, Disturbance and Displacement – Alternative 4 (No Aerial Application), Direct and Indirect Effects Herbicide toxicity

The effects of this alternative would be similar to those described in Alternative 1, except that there would be a lower chance of sensitive species contacting herbicides due to the lack of aerial spraying.

The negative short-term and positive long-term effects of this alternative upon sensitive species habitat would be slightly lower than those for Alternative 1, due to the lack of aerial spraying. Otherwise, their effects would be similar to those described under Alternative 1.

The probability of disturbance and displacement of sensitive species under this alternative would be smaller than under Alternative 1, due to the lack of aerial spraying. Some disturbance and displacement of sensitive species could still result from weed treatments, but the effects would be temporary and localized. As described in Alternative 1, mitigation measures would be applied to prevent disturbance to breeding goshawks.

Cumulative Effects – Sensitive Species

Sensitive Species, Cumulative Effects - Alternative 1 (Proposed Action)

Cumulative effects to sensitive species resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because the herbicides proposed for use are rapidly excreted and do not bio-accumulate. Cumulative effects resulting from disturbance would be slightly greater than other alternatives due to the larger area of treatment proposed, but would still have minimal impacts. This alternative would have the greatest probability of containing the spread of weeds, and would do the most to maintain suitable native vegetation that provides habitat for sensitive species. Cumulative impacts on sensitive species habitat over the next 15 years would be lowest under this alternative.

Sensitive Species, Cumulative Effects - Alternative 2 (No Herbicides)

No herbicides would be used, so there would be no cumulative toxic effects. Disturbance from weed treatment activities proposed under this alternative would have the least cumulative effects on sensitive species because it would involve the fewest activities with the potential to cause disturbance. This alternative would contribute more to cumulative effects on sensitive species habitat than all other alternatives because it would be the least likely to contain the spread of weeds and continued habitat degradation would result over the next 15 years.

Sensitive Species, Cumulative Effects - Alternative 3 (No Change from Current Management)

The analysis area for sensitive species was Madison, Gallatin, Park, Sweet Grass, Carbon, and Meagher Counties, Montana. This area was chosen because it is a large area that provides a full variety of the habitats available to the wolverine, peregrine falcon, northern goshawk, western big-eared bat, and flammulated owl in southwest Montana. The temporal bounds for the analysis were the past 10 years and 15 years into the future, because weed infestations have changed rapidly and it is difficult to predict how their spread beyond that timeframe would affect sensitive species habitat.

Weed control with herbicides is an activity that has been occurring for years in the analysis area, and undoubtedly will continue for many years into the future. Private landowners, county governments, and other state and federal agencies all use herbicides to control weeds. However, the herbicides proposed for use are water-soluble and do not bio-accumulate. Although they may occasionally contact herbicides, no toxic cumulative effects to the wolverine, peregrine falcon, northern goshawk, western big-eared bat, and flammulated owl are expected under this alternative.

The continued spread of weeds on other public and private lands would lead to loss of native vegetation that supports prey populations for the wolverine, peregrine falcon, northern goshawk, western big-eared bat, and flammulated owl. Forest Service projects such as timber sales and prescribed fires, road maintenance, recreational activities and vehicle use, special use permits (both recreation events and non-recreation), livestock grazing, and summer home residence may contribute to the spread of weeds. Recently adopted Best Management Practices (Forest Service Manual 2080) for preventing weed spread are incorporated as mitigation measures in project plans, which would help limit weed spread from Forest Service actions. This alternative would contribute somewhat to cumulative effects on these species because it would be insufficient to contain most weed infestations and continued habitat degradation would result, although the degree to which populations of sensitive species would be impacted is difficult to predict.

Disturbance from human activities has been identified as a problem for some sensitive species, such as the western big-eared bat (Reel et al. 1989, page 39). Although a variety of sensitive species are subject to disturbance from human activities, the impacts of these effects are unknown. Disturbance from weed treatment activities proposed under this alternative would have very low cumulative effects on sensitive species due to the very small area that would be treated compared to the large area subject to disturbance by other human activities.

Sensitive Species, Cumulative Effects - Alternative 4 (No Aerial Application)

The herbicides proposed for use are water-soluble and do not bio-accumulate, so cumulative toxic effects to sensitive species resulting from bio-accumulation would not occur. The potential for disturbance and displacement would be greater compared to the No Action Alternative, but would still have slight cumulative effects because of the very small area that would be treated compared to the large area subject to disturbance by other human activities. This alternative would contribute less to cumulative effects on sensitive species than the No Action Alternative because it would be more likely to contain the spread of weeds and maintain native vegetation.

Direct and Indirect Effects – Management Indicator Species

Management Indicator Species (MIS) - Herbicide Toxicity, Alternative 1 (Proposed Action), Direct and Indirect Effects

The chances of elk contacting herbicides would be greater under this alternative than for all other alternatives, because this alternative proposed the most herbicide use. Most herbicide use would occur in elk habitat, and elk would be likely to occasionally ingest sprayed vegetation or walk through vegetation that had been sprayed. There would be a small additional risk of elk being directly sprayed during aerial herbicide application. The toxicity of herbicides proposed for use is low, as are the chances of elk receiving doses great enough to cause toxic effects. However, this must be qualified by the fact that there is uncertainty regarding the toxicity of some herbicides and inert ingredients.

Management Indicator Species (MIS) - Habitat Modification, Alternative 1 (Proposed Action), Direct and Indirect Effects

This alternative would involve the greatest short-term impacts but also the most long-term benefits to elk populations, because this alternative proposed the most acreage of weed treatment. Forage availability would temporarily decrease in areas treated with herbicides, but would begin recovering within two to three years of herbicide treatment (Rice et al. 1997, page 631). Over the long term, fewer acres of weeds would go untreated under this alternative than for all others.

Management Indicator Species (MIS) - Disturbance And Displacement, Alternative 1 (Proposed Action), Direct and Indirect Effects

The probability of disturbance and displacement of elk under this alternative would be slightly larger than under Alternative 4 (No Aerial Application), due to the use of aerial spraying. The effects would still be temporary and localized due to the short duration of aerial spraying.

Management Indicator Species (MIS) - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 2 (No Herbicides), Direct and Indirect Effects

There would be no toxic effects to MIS under this alternative because no herbicides would be used.

The short-term effects to elk habitat would be less than under all other alternatives because biocontrol using species-specific agents rather than broad-spectrum herbicides that kill a variety of plants would be the most widespread treatment method. Long-term negative impacts to elk habitat would be greater for this alternative than all others, because the treatments proposed would be the least likely to contain the spread of weeds.

The potential for disturbance or displacement of elk would be very low because biological control would be the treatment method affecting the most acres. Little human activity is associated with biological control.

Management Indicator Species (MIS), Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 3 (No Change from Current Management), Direct and Indirect Effects

The chances of elk contacting herbicide would be lower than under Alternative 1, because the number of acres treated would be lower. The chances of elk experiencing toxic effects if they did contact herbicides are low, and are described in detail under Alternative 1.

Under this alternative, there would be a smaller short-term loss of elk forage in areas treated with herbicides until native vegetation began recovering within 2-3 years of herbicide treatment (Rice et al. 1997, page 631) compared to Alternative 1. Degradation of elk winter ranges on the Forest would likely lead to lower long-term elk populations compared to Alternative 1, because the treatments proposed would be less effective at containing the spread of weeds.

Some disturbance and displacement of elk would be expected to result from weed treatments. These effects would be temporary and localized, and adjacent areas would normally contain suitable habitat for displaced animals.

Management Indicator Species (MIS) - Herbicide Toxicity, Habitat Modification, Disturbance and Displacement – Alternative 4 (No Aerial Application), Direct and Indirect Effects

The chances of elk contacting herbicide would be slightly lower than under Alternative 1, because there would be no aerial spraying. The chances of elk experiencing toxic effects if they did contact herbicides are low, and are described in detail under Alternative 1.

The short and long-term effects of this alternative would be similar to those under Alternative 1. The difference is that no aerial spraying would occur, so over the short term there would be fewer acres of vegetation impacted by herbicides but over the long-term treatments would be less successful at maintaining native forage plants on important elk winter ranges.

Disturbance and displacement of elk would be similar to that described under Alternative 1, only slightly lower due to the lack of aerial spraying.

Cumulative Effects - Management Indicator Species

Management Indicator Species, Cumulative Effects - Alternative 1 (Proposed Action)

Cumulative effects to elk resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because the herbicides proposed for use are rapidly excreted and do not bio-accumulate. Cumulative effects resulting from disturbance would be slightly greater than other alternatives due to the larger area of treatment proposed, but would still have minimal impacts. This alternative would have the greatest probability of containing the spread of weeds, and would do the most to maintain quality elk winter range within the analysis area. Cumulative impacts on elk habitat over the next 15 years would be lowest under this alternative.

Management Indicator Species, Cumulative Effects - Alternative 2 (No Herbicides)

No herbicides would be used, so there would be no cumulative toxic effects. The potential for disturbance and displacement of elk would be minimal and contribute the least towards cumulative effects on elk compared to all other alternatives. This alternative would contribute more towards cumulative effects on elk habitat than all other alternatives because it would be the least likely to contain the spread of weeds in elk winter range.

Management Indicator Species, Cumulative Effects - Alternative 3 (No Change from Current Management),

Cumulative effects to elk were analyzed for the Madison, Gallatin, Bridger, Emigrant, Absaroka, and Crazy Elk Management Units (EMU's). EMU's were delineated in the Statewide Elk Management Plan for Montana as a collection of hunting districts that share similar ecological conditions and encompass the yearlong range of major elk populations (Youmans 1992, page 3). This area was chosen because it contains all seasonal ranges for elk on the Gallatin National Forest. The temporal bounds for the analysis were the past 10 years and 15 years into the future, because weed infestations have changed rapidly and it is difficult to predict how weed spread beyond that timeframe would affect elk habitat.

Weed control with herbicides is an activity that has been occurring for years in the analysis area, and undoubtedly will continue for many years into the future. Private landowners, county governments, and other state and federal agencies all use herbicides to control weeds. However, toxic effects to elk associated with this use have not been identified. The herbicides proposed for use are water-soluble and do not bio-accumulate, so cumulative toxic effects to elk resulting from bio-accumulation under this alternative would not occur.

A large variety of human activities occur in the analysis area, many of which have the potential to disturb or displace elk. Disturbance from weed treatment activities proposed under this alternative would have very low cumulative effects on elk due to the small number of acres that would be treated compared to the large area subject to disturbance by other human activities.

Elk populations are generally robust in the analysis area. Private land development is probably the main threat, but public land winter range is also available. The quality of public lands winter ranges may become more important in the future as private lands winter ranges are lost to development. Forest Service projects such as timber sales and prescribed fires, road maintenance, recreational activities and vehicle use, special use permits (both recreation events and non-recreation), livestock grazing, and summer home residence may contribute to the spread of

weeds. The continued spread of weeds on elk winter ranges will likely decrease forage availability and ultimately elk populations in the future. Recently adopted Best Management Practices (Forest Service Manual 2080) for preventing weed spread are incorporated as mitigation measures in project plans, which would help limit weed spread from Forest Service actions. The continued spread of weeds on elk winter ranges could decrease forage availability and ultimately elk populations within the next 15 years, and this alternative could therefore contribute to cumulative effects on elk.

Management Indicator Species, Cumulative Effects - Alternative 4 (No Aerial Application)

The herbicides proposed for use are water-soluble and do not bio-accumulate, so cumulative toxic effects to elk resulting from bio-accumulation would not occur. The potential for disturbance and displacement would be greater compared to the No Action Alternative, but would still have discountable cumulative effects because of the very small area that would be treated compared to the large area subject to disturbance by other human activities. This alternative would contribute less towards cumulative effects on elk habitat than Alternative 3 (No Action) because it would be more likely to contain the spread of weeds in elk winter range over the next 15 years.

Direct and Indirect Effects – Migratory Birds and Biodiversity

Migratory Birds and Biodiversity - Herbicide Toxicity, Alternative 1 (Proposed Action), Direct and Indirect Effects

The probability would be greater for this alternative than for all other alternatives that migratory birds would come into contact with herbicides. Many species of birds inhabiting grasslands and sagebrush shrubsteppe habitats would be likely to ingest herbicides by consuming prey or plant matter that had been sprayed. Dermal absorption of herbicides through contact with treated vegetation would also occur. These habitats would also be the most likely to be subjected to aerial spraying. The toxicity of herbicides proposed for use is low, as are the chances of these species receiving doses great enough to cause toxic effects. However, this must be qualified by the fact that there is uncertainty regarding the toxicity of some herbicides and inert ingredients.

Migratory Birds and Biodiversity - Habitat Modification, Alternative 1 (Proposed Action), Direct and Indirect Effects

Temporary impacts on vegetation resulting from weed treatment could cause localized decreases in biodiversity and the abundance of insects, birds, small mammals, and seeds that are essential forage for migratory birds. Cover for nesting and protection from predators would decrease. These short-term impacts would be larger than under all other alternatives because the largest number of acres would be treated. However, cover and forage would begin recovering in treated areas within two to three years of herbicide treatment (Rice *et al.*, 1997, page 631). This alternative proposed the most aggressive treatment of weeds, and therefore the most long-term benefit to migratory birds by maintaining native vegetation, as discussed in Chapter 3, page 3-33.

Migratory Birds and Biodiversity - Disturbance And Displacement, Alternative 1 (Proposed Action), Direct and Indirect Effects

Because of the large area proposed for treatment compared to the No Change from Current Action Alternative, disturbance and displacement of migratory birds would be more likely to occur. Weeds treatment by people on foot and on ATV's would displace some nesting birds in sagebrush or grassland habitats, and nests would occasionally be destroyed or abandoned. Nests

of smaller passerine species such as sprague's pipits, lark sparrows, and Brewer's sparrows are difficult to detect and would occasionally be destroyed by being stepped or driven on. These would be isolated incidents and would have minimal impact on populations of the species involved. There would be additional disturbance resulting from aerial spraying, but this would be temporary and localized. Nest abandonment would be unlikely to result from aerial spraying.

Migratory Birds and Biodiversity - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 2 (No Herbicides), Direct and Indirect Effects

There would be no toxic effects to birds under this alternative because no herbicides would be used.

The short-term impacts of weed treatment on biodiversity, forage availability, and cover would be less than all other alternatives because biocontrol using species-specific agents rather than broad-spectrum herbicides that kill a variety of plants would be the most widespread treatment method. The long-term availability of forage and cover for birds inhabiting grassland and sagebrush habitats would likely decline the most under this alternative, along with biodiversity, because the treatments proposed would be the least likely to maintain and restore native vegetation. The potential for disturbance or displacement of migratory birds would be very low because biological control would be the treatment method affecting the most acres. Little human activity is associated with biological control.

Migratory Birds and Biodiversity, Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 3 (No Change from Current Management), Direct and Indirect Effects

The chances of migratory birds contacting herbicide would be lower than under Alternative 1, because the number of acres treated would be lower and no aerial spraying would occur. The chances of them experiencing toxic effects if they did contact herbicides are low, and are described in detail under Alternative A.

Temporary impacts on cover and forage for migratory birds would be lower than under Alternative 1, due to the lower number of acres treated. In the long-term, forage availability and cover for these species would also be lower because the treatments would be less effective at limiting the spread of weed infestations. Weeds would continue to out-compete native vegetation in many areas, leading to decreased biodiversity, along with less cover and forage for migratory birds in grassland and sagebrush steppe habitats.

The probability of disturbance and displacement of migratory birds under this alternative would be smaller than under Alternative 1, due to the lower number of acres proposed for treatment and the lack of aerial spraying. As described in detail under Alternative 1, some disturbance and displacement of sensitive species could still result from weed treatments but the effects would be temporary and localized.

Migratory Birds and Biodiversity - Herbicide Toxicity, Habitat Modification, Disturbance and Displacement – Alternative 4 (No Aerial Application), Direct and Indirect Effects

The chances of migratory birds contacting herbicide would be lower than under Alternative 1 because the number of acres treated would be lower and no aerial spraying would occur. The chances of them experiencing toxic effects if they did contact herbicides are low, and are described in detail under Alternative 1.

Temporary impacts on cover and forage for migratory birds would be slightly lower than under Alternative 1, due to the lack of aerial spraying. In the long-term, forage availability and cover for these species would also be slightly lower because the treatments would be less effective at limiting the spread of weed infestations.

The potential for disturbance and displacement of migratory birds under this alternative would be similar to that under Alternative 1 because the number of acres treated would be similar. The main difference is that there would be no aerial spraying, so overall disturbance would be slightly lower.

Cumulative Effects – Migratory Birds and Biodiversity

Migratory Birds and Biodiversity, Cumulative Effects - Alternative 1 (Proposed Action)

Cumulative effects to migratory birds resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because the herbicides proposed for use are rapidly excreted and do not bio-accumulate. The potential for cumulative effects resulting from disturbance would be slightly greater than other alternatives due to the larger area of treatment proposed, but would still have minimal impacts. This alternative would have the greatest probability of containing the spread of weeds, and would do the most to maintain biodiversity and suitable native vegetation that provides habitat for migratory birds within the analysis area. Cumulative impacts on migratory bird habitat over the next 15 years would be lowest under this alternative.

Migratory Birds and Biodiversity, Cumulative Effects – Alternative 2 (No Herbicides)

No herbicides would be used, so there would be no cumulative toxic effects. Disturbance from weed treatment activities would contribute very little towards cumulative effects on migratory birds, because the lowest amount of potentially disturbing activities would be involved compared to all other alternatives. This alternative would have the greatest cumulative effects on migratory birds and biodiversity because it would be the least likely to contain the spread of weeds and maintain native vegetation within the analysis area.

Migratory Birds and Biodiversity, Cumulative Effects - Alternative 3 (No Change from Current Management)

The analysis area for migratory birds was Madison, Gallatin, Park, Sweet Grass, Carbon, and Meagher Counties, Montana. This area was chosen because it is a large area that provides a full variety of the habitats available to migratory birds in southwest Montana. The temporal bounds for the analysis were the past 10 years and 15 years into the future, because weed infestations have changed rapidly and it is difficult to predict how weed spread beyond that timeframe would affect migratory bird habitat.

Weed control with herbicides is an activity that has been occurring for years in the analysis area, and undoubtedly will continue for many years into the future. Private landowners, county governments, and other state and federal agencies all use herbicides to control weeds. Other pesticides including organophosphates and carbamates that have been implicated in migratory bird mortality are in use in the area (Greater Yellowstone Bald Eagle Working Group 1996, page 15). However, the herbicides proposed for use are water-soluble and do not bio-magnify.

Therefore, the herbicide treatments proposed under this alternative would not contribute to toxic cumulative effects to migratory birds resulting from other pesticide use.

A large variety of human activities occur in the analysis area, many of which have the potential to disturb or displace migratory birds. Disturbance from weed treatment activities proposed under this alternative would have very low cumulative effects on migratory birds due to the small number of acres that would be treated compared to the large area subject to disturbance by other human activities.

The continued spread of weeds on other public and private lands would lead to loss of biodiversity and native vegetation that provides essential habitat for migratory birds. Forest Service projects such as timber sales and prescribed fires, road maintenance, recreational activities and vehicle use, special use permits (both recreation events and non-recreation), livestock grazing, and summer home residence may contribute to the spread of weeds. Recently adopted Best Management Practices (Forest Service Manual 2080) for preventing weed spread are incorporated as mitigation measures in project plans, which would help limit weed spread from Forest Service actions. This alternative would contribute somewhat to cumulative effects on migratory birds because it would be insufficient to contain most weed infestations and continued habitat degradation would result, although the degree to which migratory bird populations would be impacted is difficult to predict.

Migratory Birds and Biodiversity, Cumulative Effects - Alternative 4 (No Aerial Application)

The herbicides proposed for use are water-soluble and do not bio-accumulate, so cumulative toxic effects to migratory birds resulting from bio-accumulation would not occur. The potential for disturbance and displacement of migratory birds would be greater compared to Alternative 3 (No Action), but would still have discountable cumulative effects because of the very small area that would be treated compared to the large area subject to disturbance by other human activities. This alternative would contribute less towards cumulative effects on migratory bird habitat and biodiversity than Alternative 3 (No Action) because it would be more likely to contain the spread of weeds and maintain native vegetation within the analysis area over the next 15 years.

Table 4-12. Summary of the potential risk of toxic effects to wildlife resulting from herbicide use under each of the alternatives.

	Alt. 1- Proposed Action	Alt. 2-No herbicides	Alt. 3-No Action	Alt. 4 – No Aerial Application
Grizzly Bear	Low*	None	Low	Low
Gray Wolf	Low	None	Low	Low
Bald Eagle	Low	None	Low	Low
Sensitive Species+	Low	None	Low	Low
MIS (elk)	Low	None	Low	Low
Migratory Birds	Low	None	Low	Low

*Low risk means that animals may contact herbicides but are unlikely to experience toxic effects due to the low toxicity of herbicides proposed for use. No risk means that animals would not contact herbicide.

+Goshawk, peregrine falcon, flammulated owl, wolverine, western big-eared bat

Table 4-13. Summary of the potential effects weed management alternatives on wildlife habitat under each of the alternatives. Effects were a combination of short-term impacts of the treatments versus the long-term impacts of invasive weeds.

	Alt. 1- Proposed Action	Alt. 2-No herbicides	Alt. 3-No Action	Alt. 4 – No Aerial Application
Grizzly Bear	Low*	Moderate	Moderate	Low
Gray Wolf	Low	High	Moderate	Low
Bald Eagle	None	None	None	None
Sensitive Species+	Low	Moderate	Moderate	Low
MIS (elk)	Low	High	Moderate	Low
Northern Goshawk	Low	Moderate	Moderate	Low
Migratory Birds	Low	Moderate	Moderate	Low

*Low means that negative effects to populations of the species would be unlikely to occur. Moderate means that negative effects to populations of the species could occur but the likelihood is uncertain. High means that negative effects to populations of the species would be likely to occur.

+ Peregrine falcon, flammulated owl, wolverine, western big-eared bat

Table 4-14. Summary of the potential disturbance and displacement effects on wildlife under each of the alternatives.

	Alt. 1- Proposed Action	Alt. 2-No herbicides	Alt. 3-No Action	Alt. 4 – No Aerial Application
Grizzly Bear	Moderate*	Low	Low	Moderate
Gray Wolf	Low	Low	Low	Low
Bald Eagle	Moderate	Low	Low	Moderate
Sensitive Species+	Moderate	Low	Low	Moderate
MIS (elk)	Moderate	Low	Low	Moderate
Northern Goshawk	Moderate	Low	Low	Moderate
Migratory Birds	Moderate	Low	Low	Moderate

*Low impact means that animals may occasionally be disturbed or displaced, but with mitigation incorporated these effects would be discountable. Moderate impacts mean that animals would likely be disturbed or displaced by project activities, but effects would still be minimal with mitigation applied.

+ Peregrine falcon, flammulated owl, wolverine, western big-eared bat

Consistency with Forest Plan and other Laws, Regulations and Policies - Wildlife

The Gallatin Forest Plan (USFS, 1987, page II-18) contains the following Forest-wide standard: “big game winter range will be managed to meet the forage and cover needs of deer, elk, moose and other big game species in coordination with other uses. Habitat for deer and elk will be managed to provide for slight increases in populations.” Additionally, the Forest Plan (USFS, 1987, pages II-3 and II-4) has objectives that “management of wildlife habitat will emphasize forage and cover needs on big game winter ranges”, and “non-game and small game needs will be enhanced by providing for vegetative diversity and protecting special habitat components.” Alternatives 1 and 4 would best meet the intent of these standards and objectives by doing the most to maintain native vegetation that is a critical habitat component for most wildlife.

All alternatives would be consistent with the Migratory Bird Treaty Act, the Final Conservation Strategy for Grizzly Bears within the Greater Yellowstone Area (IGBC, 2003, page 41), and the Greater Yellowstone Bald Eagle Management Plan (Greater Yellowstone Bald Eagle Working Group, 1996, pages 24-25). A Biological Assessment discussing effects of the Preferred

Alternative will be prepared and submitted to the U.S. Fish & Wildlife Service to comply with the Endangered Species Act.

WILDERNESS AND INVENTORIED ROADLESS AREAS

Direct and Indirect Effects, Alternative 1 (Proposed Action), Wilderness And Inventoried Roadless Areas

Weeds in Wilderness would not be treated with aerial applications of herbicides in this alternative (or any alternative considered in this decision).

Aerial applications would be considered in roadless lands on 67.3 acres of yellow toadflax near West Yellowstone. The activity would be of short duration, less than one day, and is not adjacent to Wilderness area.

Natural Integrity and Apparent Naturalness

Where weed treatment is effective, there will be short-term evidence including dead or wilting plants and areas of disturbed soils where plants have been pulled up or grubbed out. Where plants are dead or dying, and spraying was marked with dye, some people may recognize the weeds were sprayed, which may not appear natural.

This alternative would be the most aggressive and effective alternative in controlling weeds in Wilderness and roadless, because of the multi-faceted treatment options (including herbicides), and the larger number of acres treated. This alternative would create the most improvements in natural integrity by restoring native vegetation to weed infested sites.

In Wilderness, 665 acres of herbicide treatment could occur initially. Approximately 597 acres would be treated with herbicides in Inventoried Roadless Areas (IRAs). The effects on natural integrity would be an overall improvement of these areas as invading noxious weeds are excluded from wildlands and replaced with native plants (see the vegetation section). Apparent naturalness of treatment areas will improve as the evidence of noxious weeds decreases and is replaced with native vegetation. See the effects discussions under vegetation, wildlife and fish, and watershed for an estimate of the direct effects to these resources.

Herbicide treatment would decrease establishment and expansion of aggressive species in wildland areas, and reduce weed related impacts. The visual impact of spraying would be temporary and on most sites only last a few hours or less. Dying and wilting weed plants following herbicide treatment could be apparent. However, this appearance would be short-lived as surrounding vegetation would screen dead plants or blend in with native vegetation, as it grew dormant. Some desirable native vegetation could also be killed along with the weeds depending on the type of herbicide used.

Biological control with insects would only be used on large established weed patches, and would not be noticeable. Some people may notice areas where weeds were pulled, but it would likely not affect the apparent naturalness of the areas.

Cultural control would consist of treating cheatgrass with herbicide and then planting native grasses on 94 acres in the Wilderness and approximately 881 acres in roadless areas. These acres are scattered over a large area, with numerous small patches. The treatment would utilize hand

crews to treat the weeds and plant the grass seed. Treatments would take only a few days work on each site to complete, and the size of the treatment will depend upon available funds.

Remoteness and Solitude

Aerial spraying would not occur in Wilderness areas.

Aerial spraying of herbicides within Inventoried Roadless areas would reduce feelings of remoteness and solitude during the one day within each area required to accomplish this work. Public traffic would be limited to these areas during spraying – which would help mitigate any effect to the sense of remoteness or solitude. The public may encounter weed crews during hand spraying operations in Wilderness, or roadless lands, which may affect some people's sense of remoteness, and their opportunity for solitude. This effect would be very short term (typically only several days), and backcountry crews treating weeds would be small (typically 1-4 people).

The use of biological controls would not affect remoteness or solitude. Where weeds are pulled by hand, or chopped/grubbed recreationists may happen upon a work crew and have a reduced feeling of solitude. Treating large infestations with mechanical treatments would require larger crews and longer stays than treating with herbicides, which may have a greater effect on the sense of remoteness and opportunities for solitude. Again, impacts would be short term, with crews being in one area typically no longer than a week.

Grazing as a weed treatment method is only proposed along the Gallatin River (near Decker Flat or Karst Ranch), and this site is not within Wilderness or Inventoried Roadless Areas.

Primitive Recreation Opportunities

With aerial herbicide application, treated areas would be closed to public use until it is safe for them to enter these areas, thus restricting the overall recreational opportunity during this time. Treatment would most likely occur during spring through fall. The public would be kept out of treatment areas for approximately 24-48 hours at a time, reducing opportunities for recreation during those periods.

Mechanical or biological treatments, because of their limited extent and minor impacts, will not impact opportunities for primitive recreation.

Table 4-15. Summary of acres by treatment type for Wilderness and Roadless Areas.

Alternative 1: Proposed Action		
Wilderness	Treatment Type	Acres
	Aerial	0
	Biological Control & Herbicides	331.9 ac., Canada thistle, musk thistle, spotted knapweed and Dalmatian toadflax
	Cultural Treatment & Herbicide	94.8 ac., cheatgrass
	Herbicide	665.5*
	Mechanical Treatment & Herbicide	2.4
Roadless	Treatment Type	Acres
	Aerial	67.3 ac., Dalmatian toadflax
	Biological Control & Herbicides	229.1 ac., Canada thistle, musk thistle, spotted knapweed and Dalmatian toadflax
	Cultural Treatment & Herbicide	881.4 ac., cheatgrass
	Herbicide	597.4
	Mechanical Treatment & Herbicide	6.9

Alternative 2: No Herbicides		
Wilderness	Treatment Type	Acres
	Biological Control	721.3 ac., Canada thistle, musk thistle, spotted knapweed and Dalmatian toadflax
	Cultural Treatment	94.8 ac., cheatgrass
	Mechanical	3.9
	No Treatment	274.7
Roadless	Treatment Type	Acres
	Biological Control	557.3 ac., Canada thistle, musk thistle, spotted knapweed and Dalmatian toadflax
	Cultural Treatment	881.4 ac., cheatgrass
	Mechanical	13.7
	No Treatment	329.6
Alternative 3: No Action, No Change from Current Management		
Wilderness	Treatment Type	Acres
	Biological Control & Herbicides	50.0 ac., Canada thistle, musk thistle, spotted knapweed and Dalmatian toadflax (limited to the currently approved East Dam treatment area).
	Herbicide	20
	Mechanical Treatment & Herbicide	13.3
	No Treatment	1011.9
Roadless	Treatment Type	Acres
	Biological Control & Herbicides	42.1 ac., Canada thistle, musk thistle, spotted knapweed and Dalmatian toadflax
	Herbicides	59.0
	Mechanical & Herbicides	0.4
	No Treatment	1680
Alternative 4: No Aerial		
Wilderness	Treatment Type	Acres
	Biological Control & Herbicides	331.9 ac., Canada thistle, musk thistle, spotted knapweed and Dalmatian toadflax
	Cultural Treatment & Herbicide	94.8 ac., cheatgrass
	Herbicide	665.5*
	Mechanical Treatment & Herbicide	2.4
Roadless	Treatment Type	Acres
	Biological Control & Herbicides	294.1 ac., Canada thistle, musk thistle, spotted knapweed and Dalmatian toadflax
	Cultural Treatment & Herbicide	881.4 ac., cheatgrass
	Herbicide	597.4
	Mechanical Treatment & Herbicide	6.9
	No Treatment	2.3

* Note: see mitigation common to all alternatives. This acreage figure in Table 6 represents the current inventory of weeds where herbicides are the most effective treatment option. In all applications a “minimum tool analysis” would be used to determine the treatment option which would have the least impact on Wilderness values while effectively controlling the weeds which may include a combination of herbicides, biological, or mechanical treatments. See appendix G for an example of a minimum tool decision tree.

Direct and Indirect Effects, Alternative 2 (No Herbicide), Wilderness And Inventoried Roadless Areas

The effects between Alternatives 2 and 3 differ in that no herbicide would be used, resulting in more acres (721 acres of thistle and knapweed in the Wilderness and 557 acres in roadless) being treated with biological controls, 94 acres of cultural treatment in the Wilderness, and 881 acres in Inventoried Roadless Areas (plant native grass species in areas with cheatgrass). See Table 4-15. The effectiveness of both treatment types will be compromised because herbicides would not be used to suppress the established weeds.

The deliberate introduction and establishment of natural weed enemies (biological controls) are designed to reduce the plant's competitive or reproductive capacities. Its purpose is generally not eradication, but rather a reduction in densities and rate of spread kept at an acceptable level. It has been argued that introduction of an exotic insect into a Wilderness setting is a human manipulation of a natural process. Biological controls have a different magnitude of effect on the resource than do encroaching weeds. The weeds affect everything in a naturally functioning system from wildlife populations, to water runoff patterns. The exotic insects only directly affect the host weed species. This method is most effective on dense weed infestations over large areas, and would thus have limited effectiveness in the Absaroka Beartooth or Lee Metcalf Wilderness Areas where target species are localized and in small patches.

In that biological controls would likely have limited application in Wilderness, the effects between Alternative 3 (No Action) and this alternative are largely the same.

Natural Integrity and Apparent Naturalness

This alternative has the potential to have the largest negative effect on naturally functioning ecosystems, and apparent naturalness in Wilderness and roadless lands. Weeds would only be treated with mechanical or biological controls in this alternative, both of which have limited applications for some species. Weeds would eventually occupy all suitable habitats, significantly changing the natural integrity of these lands and their apparent naturalness. See the vegetation section for a thorough discussion of uncontrolled weed population direct effects on the ecosystem, and the discussion under Alternative 3.

Remoteness and Opportunities for Solitude

Effects to remoteness and solitude under this alternative would be limited to backcountry recreationists encountering weed control crews who were primarily treating weeds with mechanical methods. The effect would be short term and isolated. Recreationists would not encounter any weed spraying crews, nor aerial applications in this alternative. Treating large infestations with mechanical treatments would require larger crews and longer stays than treating with herbicides, which may have a greater effect on the sense of remoteness and opportunities for solitude by increasing chances for encounters. Again, impacts would be short term, with crews in one area typically no longer than one week.

Direct and Indirect Effects, Alternative 3 (No Change from Current Management), Wilderness And Inventoried Roadless Areas

Noxious weed control in Wilderness is currently only accomplished by hand grubbing and pulling. Hand control projects have focused on pulling only small patches of mullein, houndstongue, and spotted knapweed. The Forest currently has no blanket authority to use herbicides for weed control in Wilderness. Typically, less than two acres are treated per year in Wilderness using hand control methods (pulling, grubbing and packing out weeds). Under this alternative 1,011 acres would likely not be treated because they were not covered under previous NEPA decisions for use of herbicides. Focused information and education programs, hand control projects, strict controls on weed free feed requirements for recreational livestock have all had limited success in controlling the advancement of noxious weed infestations in Wilderness. Monitoring over the last several decades proves that weed populations are expanding despite these efforts at education and hand eradication.

The East Dam knapweed infestation on the Livingston RD is one exception to the “no herbicide treatments” in Wilderness under this alternative. Currently clopyralid (a selective herbicide that only kills plants in the following families: *Asteraceae*, *Fabaceae*, and *Polygonaceae*) is being used to treat 20 acres under a stand alone NEPA decision to treat knapweed (USDA, 1992). The East Dam EA also allows for 13 acres to be treated with hand control methods and biological control insects on 50 acres of spotted knapweed in the Absaroka Beartooth Wilderness.

Limited weed control efforts (101 acres) using herbicides, hand control methods, and biological controls are occurring in the roadless portions of the Forest. Out of the 101 acres, 59 acres of weeds would be treated with herbicides in Inventoried Roadless Areas under this alternative, 42 acres would likely be treated with biological controls and less than one acre per year with mechanical treatments (grubbing, pulling, etc.) See Table 6 for a summary of acres treated within Wilderness and Inventoried Roadless Areas for each alternative.

Natural Integrity and Apparent Naturalness

Expanding weed populations negatively affect the natural integrity of a landscape by displacing native vegetation. This species composition change has a ripple effect throughout the ecosystem. As a weed monoculture develops, natural diversity of plant species is drastically reduced, a direct effect to natural integrity. Weed invasions increase erosion, reduce water quality, and effect indigenous wildlife (Asher, 1995). “Nonnative invasive plants invade Wilderness and other natural areas throughout North America and invasive organisms as a group are now considered the second worst threat to biodiversity, behind only habitat loss and fragmentation”(Randall, 1999).

Under the No Action Alternative noxious weeds would spread at varying rates depending on the weed species, competing vegetation, disturbance history, and presence of vectors (water, recreationists, animals and vehicles). Under this alternative, it is likely that noxious weeds would eventually infest most suitable habitats within Wilderness, including sites that are presently weed-free. In roadless lands, spread would also go largely unchecked, though there is currently limited authority for herbicide control outside of Wilderness. Unchecked spread of noxious weeds would result in the unavoidable deterioration of the natural condition of the Wilderness and adjoining land diminishing the recreational experience and wildland values. Backcountry travelers who are knowledgeable about plant communities would be aware of the changing landscape, and would not meet their expectations for experiencing an intact ecosystem. The intent of the Wilderness Act and the Montana Wilderness Study Act to maintain natural integrity and preserve naturally functioning ecosystems would not be realized with this alternative.

Remoteness and Solitude

Effects to remoteness and solitude under this alternative would be limited to backcountry recreationists encountering weed control crews who were primarily treating weeds with mechanical methods. In some cases recreationists may encounter crews applying herbicides using stock or trail vehicles outside of Wilderness, which could influence a user’s sense of remoteness or solitude. These effects would be short term, limited to a few days in the summer. There would be no long term effects to remoteness or opportunities for solitude using either hand control methods, or limited chemical treatments outside of Wilderness.

Direct and Indirect Effects, Alternative 4 (No Aerial Application), Wilderness And Inventoried Roadless Areas

The effects of Alternatives 1 and 4 are identical in designated Wilderness.

Overall the effects of Alternative 1 and Alternative 4 are identical outside of Wilderness with a few exceptions: without the aerial treatment option, backcountry users would never be subjected to the visual/noise intrusions of helicopter or fixed wing spraying operations. This would be an improvement over Alternative 1 in terms of limiting direct effects to opportunities for solitude and a sense of remoteness.

Lack of aerial treatment as an option in this alternative could negatively effect natural integrity of roadless lands over time. Large weed infestations of yellow toadflax and other species may be very difficult to treat with ground spraying methods because of lack of access and steep slopes in some roadless areas. Limited ground treatment with herbicide could allow these populations to grow rapidly, impacting the natural integrity of the landscape. See previous discussions.

Cumulative Effects to Wilderness And Roadless Areas

Several reasonably foreseeable past present and future activities could contribute to cumulative effects to natural integrity, apparent naturalness, opportunities for solitude and remoteness in Wilderness, Wilderness Study Areas and Inventoried Roadless Areas. The analysis area for this discussion is the entire Gallatin National Forest. Effects are similar in all alternatives. Differences in cumulative effects between alternatives are more an issue of magnitude tied primarily to opportunities for solitude, than presence or absence of effect.

Generally speaking, recreation use is increasing on the Gallatin National Forest. Increasing recreational use and its effects have recently been documented in a report written to assess changed condition in the Hyalite Porcupine Buffalo Horn Wilderness Study Area (HPBH) (Schlenker, 2002). Increasing recreation pressure from all sorts of users including hikers, horseback riders, mountain bikers, and off-highway vehicle enthusiasts contribute to a decreased sense of solitude in the Hyalite Porcupine Buffalo Horn Area. Recent land and access acquisitions, have affected the remoteness of the HPBH. These same users are vectors for spreading weeds in the Wilderness Study Area, affecting natural integrity. Elsewhere on the Forest in Wilderness and in Inventoried Roadless lands, recreation use is also increasing with similar effects. Travel management decisions to be made in the near future will affect these use patterns to a degree. Those effects are unknown at this point, as a decision on new travel regulations have yet to be made. The current pattern of increasing motorized recreation use of Forest trails has lead to user conflicts and issues relating to remoteness and opportunities for solitude in the Wilderness Study Area and in Inventoried Roadless Areas. A recent lawsuit, and the current editorial debate in the local newspaper provides testament to the complexity of this issue. Comment received during scoping for the Gallatin Forest Travel Plan revision indicates that spread of weeds, decreasing opportunities for solitude, and maintaining primitive recreation opportunities are issues for many users.

Management of wildfire, Wildland Fire for Resource Benefits, and prescribed fire also has potential cumulative effects on the natural integrity of Wilderness, Wilderness Study Area and Inventoried Roadless Areas. Fire, in whatever form, creates ready seedbeds for weeds to become established. A recent fire located largely within the HPBH burned over 25,000 acres in 2002. This area is ripe for expanding weed infestations. Several other large wildfires have burned on the Forest in the last 5 years. Fire control practices themselves can exacerbate weed problems at camps and staging areas. Prescribed burning can have a similar effect. In addition, fuels are often

pretreated in prescribed burn areas, which may negatively affect the apparent naturalness of the area by leaving unnatural appearing stumps and slash. Many forms of fire have the beneficial effects of returning fire – a natural disturbance process – to a landscape that is dependent on fire, helping regenerate healthy stands of native vegetation.

Prevention and education programs, whether with the general public, or with special use permittees have beneficial effects on limiting the spread of weeds on public land. Some special use activities (e.g. range allotments, linear rights of way, recreation events) may have a negative effect on apparent naturalness, the sense of remoteness, opportunities for solitude, and natural integrity in Wilderness Areas, the Wilderness Study Areas, or Inventoried Roadless Areas.

Irreversible and Irretrievable Commitment of Resources

Under Alternatives 2 and 3, once weeds become well established in Wilderness and Inventoried Roadless Areas, eradication would probably never occur, resulting in an irreversible loss of natural integrity and apparent naturalness.

Consistency with Forest Plan and other Laws, Regulations and Policies

All alternatives are consistent with management direction found in the Forest Plan (Management Area 4, page III-10), the Wilderness Act, and proposed Roadless Area Conservation Rule. All alternatives are consistent with FSM 21009.14 (13.4) for pesticide use in wilderness areas as long as the Regional Forester approves the annual pesticide use plan.

WILD AND SCENIC RIVERS

This analysis will examine the potential effects of weed treatments on eligible Wild and Scenic Rivers on the Gallatin National Forest. The issue identified is: would proposed weed treatments effect the outstandingly remarkable values identified for the eligible Wild and Scenic River segments on the Forest thereby potentially affecting their future designation?

Direct and Indirect Effects, Alternative 1 (Proposed Action) and Alternative 4 (No Aerial Application), Wild and Scenic Rivers

Effects for Alternatives 1 and 4 are the same, as no aerial spraying is proposed within any eligible Wild and Scenic River Corridor.

There would be no substantial direct effects in Alternatives 1 or 4 to the outstandingly remarkable attributes that make these rivers eligible for inclusion in the system.

Noxious weeds are present along all of these streams, and are prolific along the Gallatin and Boulder Rivers (knapweed and oxeye daisy in particular). Weeds are often spread with water as the vector. These established weed populations are difficult to treat effectively within close proximity to water. To date, only hand pulling treatments have been used. In Alternatives 1 and 4, weeds within 50 feet of these rivers would be treated with herbicides that are approved for aquatic applications. .

Indirectly, the effective treatment of weeds along these corridors would improve scenery, and protect fish and wildlife values by restoring the native vegetation component.

Direct and Indirect Effects, Alternative 2 (No Herbicides) and Alternative 3 (No Change from Current Management), Wild and Scenic Rivers

The effects for Alternatives 2 and 3 would be the same. Under the No Action Alternative (3) no aquatic approved herbicides are currently being used to treat weeds along the river corridor, as would be the case in Alternative 2 – no herbicides at all.

There would be no direct effects to the outstandingly remarkable features of these rivers in either alternative. See the fish and wildlife sections for detailed descriptions of direct effects. Indirectly, the lack of aggressive weed control may affect the natural appearance (scenery) of these corridors, as weeds occupy all suitable habitats. The presence of weeds could have a negative effect on the experience of some recreationists who expect a natural environment without the presence of exotic plant species. Weeds can also increase sediment level, thus effecting fish populations. Also, weeds can decrease forage quality, thus displace wildlife in the river corridor.

Cumulative Effects to Wild and Scenic Rivers

For all alternatives, there is likely to be some cumulative effects within the river corridors as recreation use increases. Increasing recreation use would likely increase the spread of weeds, which would affect the values of scenery, and potentially increase soil erosion which could affect the fishery and wildlife values.

A proposed addition of a hydropower generation plant to the Hegben Lake Dam is being evaluated at this time for its potential to affect the outstandingly remarkable values of recreation and fisheries along the Madison River. Should there be any identified effects, they would have a cumulative effect with unchecked weed infestations that would impact recreation and fisheries.

Consistency with Forest Plan and other Laws, Regulations and Policies

All Alternatives are consistent with the goals and objectives of the Gallatin National Forest Plan for eligible river segments to protect and maintain their potential classification.

RESEARCH NATURAL AREAS

Research Natural Areas (RNA) and Special Interest Areas (SIA) are designated areas representing major, natural timber types or other plant communities in an unmodified condition. Invasive plants and the control of invasive plants may have a detrimental impact on RNAs and SIAs. The East Fork Mill Creek RNA and the Black Sands SIA have invasive plants within and adjacent to these protected areas.

Direct and Indirect Effects, Alternatives 1 (Proposed Action) and Alternative 4 (No Aerial Application)

Both of these alternatives would have the same treatment for the RNA and SIA. Aerial application is excluded from the RNA and SIA (Chapter 2 – Environmental Protection Measures). These alternatives propose to treat weeds that pose a threat to the plant communities within the RNA and SIA. The treatment would involve spot application of herbicide treatment in all RNAs and SIAs at risk to weed invasion.

The overall goal of RNA management is to maintain the full suite of ecological processes associated with the natural communities and conditions for which the RNA is designed to protect. Until recently, the primary course of action was to leave RNAs alone. However, with the emphasis on ecosystem management, more attention is being placed on restoration of natural processes such as fire, and control of invasive alien species, which alter the composition, and functioning of natural communities (Natural Heritage Program 2004). Weed treatments would protect the natural ecological composition of the RNA and SIA, and protect their identified values for research or special interest. Since weeds have been located adjacent to the RNA, effective treatment of those areas would help protect the RNA by helping to eliminate establishment of noxious and invasive weeds within them.

Proposed adaptive management activities include the identification and treatment of weeds that may enter the RNA through natural sources (e.g. wind, wildlife, fire). Following identified mitigation measures, effects from treatment of new locations would be the same as those already identified. If future additional treatment is needed within the RNAs, concurrence of the Research Station Director and the Forest Supervisor will ensure that herbicide use is consistent with FSM and Forest Plan direction.

Direct and Indirect Effects, Alternative 2 (No Herbicides)

Biological control could be used when effective agents are available, however the weeds would always be present (biological control agents never eradicate their host). Effective biological control agents are only available for a few weed species. Mechanical pulling of small patches of non-rhizomatous weeds would be implemented where practical. The majority of our most aggressive weed species spread via their roots so pulling is not an effective method of control unless all of the roots are removed and the patch is very small. Also, extensive ground disturbance within the RNAs or SIA is not appropriate because of the damage to the resource that is being protected. Similarly grazing with sheep or goats is not compatible with the goal of preservation for potential research, so would not be implemented in the RNA or SIA. Under Alternative 2 most weeds would continue to encroach into these areas. This alternative would not provide opportunities to prevent the introduction of noxious weeds.

Direct and Indirect Effects, Alternative 3 (No Change from Current Management)

Neither the RNA or SIA would be treated for weed control, the weeds would continue to expand and diminish the unique plant values within and adjacent to these areas.

Cumulative Effects – Research Natural Areas and Special Interest Areas

Under all alternatives, there are no past, present, or reasonably foreseeable actions that, along with the proposed activities within the RNAs or SIA, would cumulatively increase the risk of noxious weed spread, with the exception of wildfire. Cumulative effects may occur when weed-spreading activities occur next to RNAs. Under Alternatives 1 and 4 effective treatments of weeds would maintain the ecological integrity and research value of the areas. Under Alternatives 2 and 3, the long-term lack of effective treatment of potentially new infestations, along with the likelihood that weeds would eventually spread from outside the RNAs into them, poses a risk to both the research value and biological diversity of RNAs.

Consistency with Laws and Policies – Research Natural Areas and Special Interest Areas

Forest Plan Direction and Individual Establishment Records

All of the alternatives are consistent with the Forest Plan. All alternatives are consistent with direction in the Establishment Records by proposing specific control against target organisms, and by taking measures to control or eradicate these populations.

None of the alternatives contains grazing as a weed control method within RNAs or SIA, which is consistent with Forest Plan Management Area 21 standard (Forest Plan page III-63).

FSM 4063 – Research

Alternatives 1 and 4 would be consistent with the Forest Service Manual 4063 by removing exotic plant or animal life. Alternatives 2 and 3 would either not be consistent with the manual or would be least effective in following management direction.

Mitigation Measures

- If any treatment with herbicide is planned within RNA boundaries, concurrence must be obtained through the Research Station Director and Forest Supervisor. This includes any future treatment need of new infestations. Since SIA are designated by the Forest and not on a Regional level, the Forest Supervisor has authority to approve all projects within the SIA. A concurrence letter from the Research Station Director is not needed for SIA (Steve Shelly, personal communication, 2004).
- No motorized access will be allowed except on the few exceptions where roads exist as identified in the individual establishment record for each RNA or SIA.
- Wilderness area management will take precedence over RNA or SIA direction when proposed weed control activities are identified for an RNA or SIA within designated wilderness boundaries.
- No aerial spraying will be allowed to control any current or future weed infestation unless specific project mitigation is incorporated to meet policy standards and guidelines and concurrence has been obtained through the Research Station Director and Forest Supervisor.

RECREATION

Direct and Indirect Effects - Alternatives 1 (Proposed Action) and Alternative 4 (No Aerial Application), Recreation

Direct and indirect effects on recreation resulting from implementation would include short-term (one to seven days) encounters with herbicide treatment crews, short-term odors from some herbicides, and visual impacts from wilting plants. Additional effects resulting from these alternatives would be the protection of adjacent non-infested areas and preservation of intact plant communities, which would enhance the recreation experience. Concern over herbicides may cause some Forest users to choose to recreation in areas that have not been recently treated with herbicides. All weed treatment activities would be conducted in compliance with Gallatin Forest

Travel Plan regulations, which allow for administrative use. When cross-country motorized travel is necessary to facilitate weed control, there will be short-term visual impacts in the form of tracks created by laying down grasses. In dry years, these tracks could remain visible throughout the season. While in wetter years the tracks could be erased, by rains and re-growth, before the fall.

All known weed infestations in dispersed sites, permitted use sites, special use sites, rental cabin sites, summer home sites and campgrounds would be treated in these alternatives. Signs will be posted in recreational areas notifying the public of the herbicide used and stating the safe re-entry period as specified on the herbicide label (usually when the herbicide is dry on the plant surface).

Under Alternatives 1 and 2, herbicide treatments would decrease established and expansion of aggressive weed species into non-infested areas and reduce weed-related impacts on recreation. The visual impact of spraying would be temporary and on most sites only last a few hours. Dying and wilting plants following herbicide treatment would be apparent. However, this appearance would be short-lived as surrounding vegetation would screen dead plants or blend with native vegetation, as it grew dormant.

Long-term improvements include an overall reduction of stiff plant stalks and sharp bristle and increase in the variety and amount of native flora. Treating invasive weeds would be an improvement in the overall quality of the recreational sites. Areas with aerial treatment are not near recreation sites or trails so this activity will not have an impact on recreational users.

Direct and Indirect Effects - Alternative 2 (No Herbicides) and Alternative 3 (No Change from Current Management), Recreation

Under Alternative 2 No Herbicides would be used to treat the weeds so only small infestations would be pulled. Most of the weed patches would not be treated or control would be limited to biological control insects (which have minimal effectiveness). Consequently the long-term impact of limited weed control will be a substantial increase in weed density throughout most recreation sites, which will spread into adjacent areas.

Under Alternative 3 No Change from Current Management, most recreation sites are currently being treated with herbicides and this would continue. Under the Forest Service Manual (1950, 31b.5.a), the chief of the Forest Service has excluded the action of applying registered herbicides in campgrounds or recreation sites from NEPA requirement of a decision document and of a project file (Fed Register Vol. 57, 1992). To comply with the herbicide labels the sites treated in recreational areas will be signed to notify the public of a safe re-entry period (usual when the herbicide has dried on the plant). Roads leading to recreation sites would not be treated so weeds would spread into adjacent areas.

Cumulative Effects - Recreation

Cumulative effects from activities described at the beginning of this chapter would continue to impact recreation, affecting the location where and times when people can recreate at various locations across the Gallatin National Forest without being displaced by herbicide applications. Effects on recreation under any of the alternatives would be minor and short-term (one to seven days). While visitor displacement is the most likely direct effect of weed treatment, short-term (one to three years) visual impacts from cross-country motorized travel for the purpose of herbicide application are also possible. Also, an aggressive weed control program (as in Alternatives 1 and 4) will maintain the native plants and current visual quality of native plant

communities. While the less aggressive weed control alternatives (2 and 3) will continue to see an increase in weed species and a decrease in native plants resulting in a diminished visual quality for the landscape.

Consistency with Forest Plan and other laws and Policies – Recreation

All alternatives are consistent with the Forest Plan (Management Area 5, page III-14 & 15). A management goal for Management Area 5 is to “Maintain and improve the wildlife values and the natural attractiveness of these areas to provide opportunities for public enjoyment and safety.” Effects from herbicide treatments will be of short duration, less than one day. Areas inside campgrounds and other developed recreation sites that are treated with herbicides will be posted to notify for public safety.

HUMAN HEALTH

This issue addresses the concern that weed control may have a detrimental impact on human health. More specifically, the impacts that mechanical control such as pulling, and herbicide control (both ground and aerial spraying) may have on human health.

Direct and Indirect Effect, All Alternatives, Mechanical Treatment, Human Health

Potential risks to human health from mechanical weed control methods are very low and include emissions from gasoline or diesel powered equipment, burns, allergies, back injuries and skin irritation from direct contact with plants by individuals doing the work.

Some invasive weed species can cause allergies and minor skin irritations in a few individuals. Some species of invasive weeds, such as thistles, cause minor scrapes and irritations, and there are other more serious complications that may result from hand pulling. For example, leafy spurge contains a latex-bearing sap that irritates human skin and rarely causes blindness in humans upon contact with the eye (Callihan *et al.*, 1991). There have also been claims (not medically supported) that hand pulling of knapweed may result in the formation of tumors on the hands. Highly allergic individuals can have serious complications when exposed to allergens (weeds or pollen), including constriction of the airway and anaphylactic shock, the significance of which should not be underestimated since forest workers would be working some distance from medical assistance.

Approximately 10 to 15 percent of the U.S. population suffers from allergy symptoms from invasive weed species such as knapweed. Knapweed is a common and powerful allergen that peaks in August (Gillespie and Hedstrom, 1979). Allergies to weeds such as knapweed may complicate or trigger asthma. It may take up to two years after getting a person's allergies under control to see a benefit in reduced asthma symptoms (Nielson, 1999).

While there is some potential for health effects associated with mechanical treatment of weeds, required personal protective equipment such as gloves, long sleeved shirts, boots and safety glasses along with personal hygiene, would prevent injuries or irritation, and therefore no human health effects are anticipated by mechanical removal of weeds.

Direct and Indirect Effect, All Alternatives, Cultural Treatments, Health Effects

Potential human health risks associated with cultural control methods include exposure to dust and chaff during seeding operations. Allergic reaction can result from exposure of seed and chaff when handling seeds; however, gloves, long sleeved shirts, boots, and other personal protective equipment, as needed, would prevent injuries or irritations. Therefore, no human health effects are anticipated by cultural control methods.

Direct and Indirect Effect, All Alternatives, Biological Treatments, Health Effects

Biological treatments would result in no known risks to human health.

Direct and Indirect Effect, Alternatives 1, 3 and 4, Herbicide Treatments

The following primary reference literature was used to analyze potential human health risks associated with ground and aerial applications of herbicides:

- The Risk Assessment for Herbicide Use in Forest Service Regions 1, 2, 3, 4 and 10, and on Bonneville Power Administration Sites (USFS, 1992).
- Assessing the Safety of Herbicides for Vegetation Management in the Missoula Valley Region – A question and Answer Guide to Human Health Issues, (Felsot, 2001).
- Risk assessments completed by the Forest Service under contract with Syracuse Environmental Research Associates (SERA) for 2,4-D, picloram, clopyralid, dicamba, hexazinone, sulfometuron methyl, metsulfuron methyl, triclopyr, imazapic, and imazapyr. (1996b-d; USFS, 1997a-b; USFS, 1998a-b; USFS, 1999a-c; USFS, 2000b; USFS, 2001a; USFS, 2003a-c; USFS, 2004a-f).

Three levels of analyses were used in the above risk assessment process: 1) a review of toxicity test data (i.e., acute, chronic, and sub-chronic) for herbicides proposed for use on the project to determine dosage that could pose a risk to human health (see Chapter 3, pages 3-46 to 3-51); 2) an estimate of exposure levels to which workers (applicators) and general public may be exposed during treatment operations (see Table 4-16); and 3) comparison of dose levels to toxicological thresholds developed by Environmental Protection Agency to determine potential health risks.

Toxicity test data on laboratory animals is available for herbicides proposed for use in this analysis. Most tests have been conducted under Environmental Protection Agency pesticide registration/re-registration requirements for use in the United States. The Environmental Protection Agency uses test data to determine conditions for use of herbicides in the United States.

Label restrictions on herbicides are developed to mitigate, reduce, or eliminate potential risks to humans and the environment. Label information and requirements include: Personal Protective Equipment; User Safety; First Aid; Environmental Hazards; Directions for Use; Storage and Disposal; General Information; Mixing and Application Methods; Approved Uses; Weeds Controlled; and Application Rates.

Analysis of herbicide use in this EIS assumes compliance with the product label during handling and application. Additional environmental protection measures are typically developed by Forest Resource specialist to further reduce potential risks to human health and the environment during application of herbicides. These measures are implemented during analysis and at time of

application to ensure mitigation is greater than required by US Environmental Protection Agency label requirements.

Factors Affecting Hazard Of Herbicide –

1.) Method of Application

How herbicides are applied can have a direct impact on the potential for human health effects. According to the risk assessments completed on herbicide usage on forest lands (USFS, 1995; 1996b-d; USFS, 1997a-b; USFS, 1998a-b; USFS, 1999a-c; USFS, 2000b; USFS, 2001a; USFS, 2003a-c; USFS, 2004a-f;) herbicides applicators are at a higher risk than the general public from herbicide use. The risk assessments compared risks to workers for all types of application, including aerial, backpack, ground-mechanical, and hand applications. Lower risks were estimated for aerial and ground-mechanical application as compared to other methods, even though the total amount of herbicide applied in a given day was higher. Risks associated with backpack and hand application of herbicides were estimated to be the highest, due to workers receiving repeated exposures that may remain on the worker's skin for an extended time period.

The US Environmental Protection Agency, in its re-registration of picloram (US EPA, 1995), also noted that the highest risk for herbicide applicators was for those using the backpack application method. The lowest risk was for aerial and ground-boom applicators.

2.) Length of Exposure

The magnitude of a dose that is hazardous to health depends on whether a single dose is given all at once (acute exposure), multiple doses are given over longer periods (chronic exposure), or regularly repeated doses or exposures over periods ranging from several days to months (sub-chronic). The US Environmental Protection Agency develops reference doses (RfD), which are an estimate of a daily dose over a 70-year life span that a human can receive without an appreciable risk of deleterious effects (US EPA, 1989). Reference doses include a "safety factor" where the No Observed Effect Level (NOEL) is divided by a factor, usually 100, to account for uncertainty and hypersensitive individuals. The 100-value is derived by including a safety margin of 10 for extrapolating study results from mammals to humans, and an additional safety factor of 10 for variation in population response to a particular compound.

The reference dose is a conservative threshold of toxicity relative to this analysis because it assumes daily exposure over a 70-year life span. Actual worker exposure for herbicide treatments in this project would typically be between 20 to 80 days each year for substantially less than 70 years. The reference dose is also calculated from the No Observed Effect Level, assuming humans are 100 times more sensitive than animals to the chemical tested.

Potential doses to workers or the public from application of herbicides would be transitory. Lifetime reference doses are used here as a convenient and conservative comparison for determining significance of human doses. Lifetime reference dose values are based on daily feeding studies, whereas workers and the general public would not be exposed daily over a lifetime. Maximum duration of exposure for workers on a yearly basis was estimated in the range of 10 to 40 days for commercial applicators (US EPA, 1995). This may be on the lower end of the range as treatments of weeds in spring and fall have become more popular.

3.) Route of Exposure

Substances tested for acute toxicity are usually administered by pumping a chemical down a tube into an animal's stomach. From this route of exposure, an oral LD₅₀ (lethal dose that kills 50 percent of a test population, measured in one milligram of herbicide per kilogram of animal weight) can be estimated. Exposure during chronic testing usually involves placing the chemical in the animal's food, and then measuring the amount of food eaten during each 24-hour period (US EPA, 1996a, b).

Test substances are also applied to the shaved skin of an animal to estimate a dermal LD₅₀. About 10 percent of the animal's body surface is exposed to a chemical covered by a patch for 24 hours. In acute exposure studies, whether by oral or dermal routes, animals are monitored for range of adverse responses for 14 days following dosing (US EPA, 1996c).

Skin acts as a protective barrier to limit and slow down movement of a chemical into the body. Studies of pesticides applied to the skin of humans indicate that for many people, only about 10 percent or less passes into the blood. In contrast, adsorption of chemicals from the small intestine is quicker and more complete than from the skin (Ross *et al.*, 2000)

Required personal protective equipment used by workers during herbicide application (gloves, waterproof boots, long sleeved shirts and pants) is designed to reduce exposure to sensitive areas on the body. Use of personal protective equipment as required by the Forest Service job hazard analysis would protect worker health.

4.) Toxicity of Herbicides

A comparison of toxicity and the risk of being exposed to herbicides from typical scenario is shown in Table 4 –16. More information on herbicide toxicity is available in Chapter 3 pages 3-46 to 3-51, and on <http://www.fs.fed.us/foresthealth/pesticide/risk.shtml>. Toxicological studies using animals involves purposeful exposure to dosages required to cause an effect (i.e. tumors, changes in immunity, etc.), or to establish a Lowest Observed Effect Level (LOEL) or a No Observed Effect Level (NOEL). This often requires administration of relatively high doses of a chemical in order to document an effect or lack thereof. The causal dose in many toxicological studies is significantly greater than what an applicator might be exposed to while applying herbicides or the public may be exposed to walking through a treated field or living adjacent to treated land. Therefore, concluding that an applicator may experience neurological effects because a study in rats showed such connection, may lead to an erroneous conclusion because the dose administered to the rat is in no way representative to what an applicator may be exposed to when applying an herbicide. In addition, the method of exposure to herbicides in animal studies is uniquely different than that of a worker or person of the general public, possibly leading to a causal effect. In animal studies, herbicides are commonly pumped into stomachs, put directly into food, or placed directly on shaved skin. Herbicide applicators and the general public are clothed and do not purposely ingest herbicides under the same conditions as animals studies of toxicological significance.

Table 4-16. Comparison of Herbicide Toxicity (Reference Dose as used in the SERA Risk Assessments for Chronic and Acute Toxicity); and Risk of Exposure for the General Public (Risk assessment assumes woman wearing shorts and short sleeves is in contact with contaminated vegetation for 1 hour shortly after application of herbicides and remains on skin for 24 hours), and Risk to Workers (assumes worker spraying weeds with a backpack sprayer for 7 hours per day).
 Source: USFS, 1996b-d; USFS, 1997a-b; USFS, 1998a-b; USFS, 1999a-c; USFS, 2000b; USFS, 2001a; USFS, 2003a-c; USFS, 2004a-f; <http://www.fs.fed.us/foresthealth/pesticide/risk.shtml>.

Herbicide	RfD (mg/kg/day) Chronic /Acute	Estimated Exposure to Public Woman Dermal contaminated vegetation central dose rate Reference Dose (RfD)	Estimated Exposure to Worker ¹ Backpack sprayer central dose rate mg/kg/day
Glyphosate ²	2 / 2	Below RfD; 0.00219	Below RfD; 0.0263
Picloram	0.2 / 0.2	Below RfD; 0.00459	Below RfD; 0.000112
Hexazinone ³	0.05 / 0.05	Below RfD; 0.011	Below RfD; 0.0263
Clopyralid ⁴	0.15 / 0.75	Below RfD; 0.000503	Below RfD; 0.00459
2,4-D ⁵	0.01 / 0.01	Below RfD; 0.00262	0.0131
Dicamba ⁶	0.045 / 0.1	Below RfD; 0.00087	Below RfD; 0.00394
Chlorsulfuron	0.02 / 0.25	Below RfD; 0.0000196	Below RfD; 0.000735
Metsulfuron methyl	0.25 / 0.25	Below RfD; 0.0000048	Below RfD; 0.000394
Triclopyr ⁷	0.05 / 1	Below RfD; 0.003 ³	Below RfD; 0.03 ³
Sulfometuron methyl	0.02 / 0.87	Below RfD; 0.0000185	Below RfD; 0.0000591
Imazapyr	2.5 / 2.5	Below RfD; 0.00115	Below RfD; 0.002
Imazapic	0.5 / 0.5	Below RfD; 0.000651	Below RfD; 0.00131

RfD = Reference Dose; Units expressed as milligrams of herbicide per kilogram of body weight = mg/kg;

¹ Exposures under typical exposure scenarios. If other exposure scenarios may exceed the RfD, it will be noted.

² Glyphosate slightly exceeds RfD for child drinking contaminated water after an accidental spill at upper exposure scenarios

³ Hexazinone – worker at upper exposure scenario slightly exceeds RfD; central and upper exposure scenario for children exceeds RfD (assumes naked child accidentally sprayed with herbicide over entire body); women with direct spray at upper exposure scenario slightly exceeds RfD,

⁴ Clopyralid - exceeds RfD for child drinking contaminated water after an accidental spill.

⁵ 2,4-D exceeds RfD for workers in central and upper exposure scenarios for backpack, broadcast and aerial applications (workers must wear personal protective equipment to reduce exposure levels), central and upper exposure scenario for children exceeds RfD (assumes naked child accidentally sprayed with herbicide over entire body); also consuming food/water sprayed with 2,4-D will exceed RfD.

⁶ Dicamba is at the RfD for broadcast sprayer at higher exposure scenarios, slightly exceeds the RfD for a child at higher exposure scenario (assumes naked child accidentally sprayed over entire body), and greatly exceeds RfD for child drinking contaminated water after an accidental spill at upper exposure scenarios.

⁷ Triclopyr - upper exposure scenarios for worker slightly exceeds RfD, and for general public upper exposure scenarios exceed RfD, and exceeds RfD for child drinking contaminated water after an accidental spill at upper exposure scenarios.

Estimates of exposure to workers and the general public of herbicides applied to forest lands have been reported under various conservative exposure scenarios (USFS, 1996b-d; USFS, 1997a-b; USFS, 1998a-b; USFS, 1999a-c; USFS, 2000b; USFS, 2001a; USFS, 2003a-c; USFS, 2004a-f). The most reasonable interpretation of the risks associated with application of most herbicides on forest lands is that, except for accidental exposures or extremely atypical and perhaps implausible exposures scenarios (i.e. acute direct spray entirely covering a naked child), the use of herbicides

on forest lands would not pose an identifiable risk to workers or the general public. Exposures under typical exposure scenarios (those following guidelines on the label) would be at or below the reference dose, a dose level determined to be safe by US Environmental Protection Agency over a lifetime of daily exposure.

There are exceptions worth noting that may help identify protective measures that may help identify protective measures that could be instituted when applying herbicides. USFS (1997b) reports that over a range of plausible application rates, workers may be exposed to hexazinone at levels that exceed the reference dose. Likewise, there is reasonable concern that workers applying triclopyr over a prolonged period of time in the course of a single season and/or several seasons may be at risk of impaired kidney functions (USFS, 1996c; USFS, 2003c). The Forest Service (USFS, 1998a) reports that if 2,4-D were applied directly to fruits and vegetables at anticipated application rates, the consumption of vegetables would be undesirable and could lead to health effects. They point out; however, that the likelihood of such an exposure seems remote when applying on forest lands. Also, the Forest Service (USFS, 1998a) reports that exposure levels for workers involved in ground or aerial application of 2,4-D may exceed the reference dose slightly, based on upper limits of exposure. They go on to indicate that 2,4-D can be applied safely, (exposure doses below the reference dose) if effective methods are used to protect workers and minimize exposure (personal protective equipment). The Forest Service (USFS, 1999a) also reported that there is no evidence that typical exposures to picloram would lead to a dose level that exceeds the reference dose or level of concern with the exception of wearing contaminated gloves for one hour, which results in estimates of absorbed doses that exceed the reference dose.

Acute Toxicity

Acute toxicity is measured by the LD50, defined as the dosage of toxicant expressed in milligrams per kilogram of body weight, which is lethal to 50 percent of animals in a test population within 14 days of administration (USFS, 1992). Since potential exposure levels to workers and the general public associated with use of herbicides on forestlands have been estimated to be at or below US Environmental Protection Agency reference doses, dosages would not exceed acute toxicity dose levels when applying herbicides on forestland.

Sub-Chronic and Chronic Toxicity

There is considerable information on sub-chronic and chronic effects due to exposure to herbicides in controlled animal studies. The information suggests that the herbicides proposed for use by the Forest are not carcinogenic, and there is no evidence to suggest that herbicides proposed for use by the forest would result in carcinogenic mutagenic, teratogenic, neurological or reproductive effects based on anticipated exposure levels to worker and the public (Arbuckle 1999; Charles *et al.*, 1996; Faustini, 1996; Ibrahim *et al.*, 1991; Mattsson, 1997; Mustonen, 1986; Infoventures, 1995a-j; OSU, 1996a-h; USFS, 1996b-d; USFS, 1997a-b; USFS, 1998a-b; USFS, 1999a-c; USFS, 2000b; USFS, 2001a; USFS, 2003a-c; USFS, 2004a-f, <http://www.fs.fed.us/foresthealth/pesticide/risk.shtml>).

1.) Synergistic Interactions

Concerns are occasionally raised about potential synergistic interactions of herbicides with other herbicides in the environment or when they are mixed during application (tank mixing). Synergism is a special type of interaction in which the combined impact of two or more herbicides is greater than the impact predicted by adding their individual effects. The Risk Assessments for Herbicide Use in Forest Service Regions 1, 2, 3, 4 and 10 and on Bonneville

Power Administration Sites, 1992, addresses the possibility of a variety of such interactions. These include the interactions of the active ingredients in an herbicide formulation with its inert ingredients, the interactions of these herbicides with other herbicides in the environment, and the cumulative impacts of spraying as proposed with other herbicide spraying to which the public might be exposed.

No one can guarantee the absence of a synergistic interaction between herbicides and / or other chemicals to which workers or the public might be exposed. For example, exposure to benzene, a known carcinogen that comprises 1 to 5 percent of automobile fuel and 2.5 percent of automobile exhaust, followed by exposure to any of these herbicides could result in unexpected biochemical interactions (USFS, 1992). Analysis of the infinite number of materials a person may ingest or be exposed to in combination with chemicals is outside the scope of this analysis. That being said, there is some indications that the co-exposure to 2,4-D and picloram may induce effects not associated with 2,4-D or picloram alone (USFS, 1998a; Cox, 1998, OSU, 1996b).

2.) Impurities, Adjuvant and Inert Ingredients in Herbicide Formations

During commercial synthesis of some pesticides, by products can be produced and carry over into the product eventually formulated for sale. Occasionally byproducts or impurities are considered toxicologically hazardous, and their concentrations must be limited so that potential exposures do not exceed levels of concern (Felsot, 2001).

Technical grade picloram (prior to mixing with other inert ingredients) and clopyralid contains hexachlorobenzene (HCB) as a byproduct of the synthesis of the active ingredients (USFS, 1999c, 2004d). HCB is also a byproduct of chlorinated solvents used extensively in industry and occasionally around the home. HCB was registered as a fungicide until banned by EPA over concerns that it may be carcinogenic. As a result, Environmental Protection Agency has imposed a limit of 100 parts per million (ppm), HCB in Tordon®. The manufacturer of Tordon® has set its own manufacturing standards even lower and reportedly maintains HCB levels in formulated picloram at 50 ppm or less (i.e. 50 milligrams per liter of formulation). Average concentrations of HCB in picloram have been estimated at 8 ppm (US EPA, 1995). Therefore, HCB comprises on 0.000005 percent of the Tordon® formulation, which is then further diluted when the spray solution is prepared in accordance with the label.

Given the dilution of formulations by water in the final spray solution, estimates of HCB exposure from use of picloram or clopyralid containing products have shown that resulting residues in the environment and bystander exposure levels do not exceed current background levels. Longer-term dose estimates for the general public exposed to HCB in clopyralid were below the general background exposure to HCB in the environment by factors of about 25,000 to several million (USFS, 1999c; USFS, 2004d). The central estimates of worker exposure to HCB under normal conditions were estimated to be lower than the background levels of exposure by factors of about 1,000. Likewise, the exposure assessments based on the use of picloram by the USFS have been estimated to result in long-term predictions for the general public that are below background doses of HCB due to environmental contamination by factors of about 1,400 to seven million (US FS, 1999c; USFS, 2004d). Thus, for commercially sold products which are more dilute than technical grade products, there appears to be no basis for asserting that the use of clopyraid or picloram in accordance with the label by the Forest Service would result in substantial increases in the general exposure of either workers or members of the general public to HCB.

Another concern is potential presence of dioxin in formulations containing chlorinated chemicals. Dioxins are a group of chemicals involving 76 different types of related molecules called congeners, each having from two to eight chlorine atoms. The toxicity of each of the types of dioxin molecules is different. The toxic potency is determined by spatial arrangement of the chlorine atoms in a molecule rather than mere presence of chlorine. Of all of the congeners, one – TCDD (2,3,7,8-tetrachloro-para-dibenzodioxin), is the most potent. All other congeners are considered 10 to 10,000 times less potent than TCDD. Congeners with the greatest number of chlorine atoms are the least potent (Van den Berg *et al.*, 1998).

TCDD and a few other dioxin congeners are byproducts of the synthesis of trichlorophenol. Most of the other dioxin congeners contain more chlorine than TCDD but are byproducts of the combustion of biomass (e.g., wood) and municipal waste. Dioxin congeners have always been in the environment as a result of natural fires and volcanic eruptions, and burning coal, wood, and gasoline (Alcock *et al.*, 1998; Gribble, 1994). Thus, dioxin congeners are ubiquitous, but with the exception of TCDD, their potency is quite low and not of much toxicological concern (Safe, 1990).

TCDD is a byproduct of the active ingredient in 2,4,5-T. This herbicide was used as a mixture with 2,4-D to defoliate vegetation during the Vietnam War. In the past, a few imported formulations of 2,4-D were shown to contain some highly chlorinated dioxin congeners, the same congeners found in the environment and believed to be primarily the result of combustion processes. Compared to TCDD, the biological activity of the other congeners is low, and absent direct ingestion of these compounds in the diet, they are unlikely to be absorbed through the skin. Current quality control procedures during manufacturing have essentially eliminated any dioxin congeners of concern from domestic 2,4-D formulations. Thus, use of 2,4-D products manufactured in the U.S., whether at home or in agriculture and forestry, do not contaminate the environment with the dioxin congener of greatest regulatory concern, TCDD (US EPA, 1997; Chapter 8 of the Draft Dioxin Assessment).

The proprietary nature of herbicide formulations limits the understanding of the risks posed by inert ingredients and adjuvant in herbicide formulations. Unless the compound is classified as hazardous by the US Environmental Protection Agency, the manufacturer is not required to disclose its identity. It could be suggested that the inert ingredients in these herbicides are not toxic, or their toxicity would be reported to the Environmental Protection Agency. This would hold true if considerable toxicological testing of inert ingredients has been done. That, however, has not been the case. The Environmental Protection Agency is increasing the testing requirements for inert ingredients, but in many cases, the inert ingredients currently in use have not been tested rigorously and their toxicity is not well characterized. That being said, studies on the toxicity of technical grade formulations, which often contains the inert ingredients, account for the toxicity of the inert ingredients, and as has been reported here, these studies show that the use of herbicides by the Forest Service would not expose workers or the public to levels of concern.

Literature does report considerable information on types of inert ingredients and adjuvant present in herbicides proposed for use by the Forest. As noted in the Forest Service Risk Assessment (USFS, 1997b), Velpar L®, the trade name for hexazinone, contains 40-45 percent ethanol, and eye irritant and a considerable toxin if ingested. It has been reported the most common impurities of technical grade 2,4-D include other phenoxyacetic acids, a variety of chlorinated phenols, and possibly low levels of nitrosamines in amine salts (Ibrahim *et al.*, 1991). Transline, the commercial formulation of clopyralid contains clopyralid as the monoethanolamine salt and isopropyl alcohol, an approved food additive (USFS, 1999c). Both Tordon22 and 22K contain the

potassium salt of picloram (24.4 percent), the remaining consisting of polyglycol 26-2, the DOW name for polyethylene glycol, a widely used family of surfactants, considered to have low toxicity and frequently used in the formulation of ointments and cosmetics (MCCHB, 2001).

The Forest Service risk assessment (USFS, 1996c; USFS, 2003c,) reports that Garlon® formulations of triclopyr contain ethanol and kerosene. Technical formulations of imazapyr contain isopropyl alcohol and isopropanolamine salts of imazapyr (USFS, 1999b; 2004a). Glyphosate has been reported to contain small amounts of nitrosamine, and N-nitroglyphosate (USFS, 1996d; 2003a). Roundup, a formulation of glyphosate, contains the surfactant polyoxyethyleneamine, and contains 1,4-dioxane, classified by the US Environmental Protection Agency (US EPA) as a probable human carcinogen. However, carcinogenic studies of Roundup® by the US EPA have shown the herbicide to be non-carcinogenic (USFS, 1996a). The Forest Service (USFS, 2003c) reports the inert ingredients in Escort®, which contains metsulfuron methyl, are confidential. They do report; however, the inert ingredients in Escort® are not classified by US EPA as toxic.

Many herbicide formulations contain dyes. The use of dyes can be beneficial in that they can color vegetation, making it less likely for an individual to inadvertently or un-intentionally consume contaminated vegetation. The presence of a dye in herbicide formulations may also make it easier for workers to see when they have been contaminated and allow for prompt remedial action.

Significant technological advances have been made with respect to dyes available for pesticide applicators. Several water soluble dyes of low toxicity are available, and their use can provide an added level of safety for the workers and the public. One such dye Hi-Light™ is currently used in the Forest. This dye is non-toxic, dissolves quickly and thoroughly in water-based herbicides, and breaks down in sunlight or dissipates in rain, and therefore does not appreciably migrate from the point of use (Becker Underwood, 2003).

Surfactants are also commonly used in herbicide formulations. Surfactants are added to herbicides to improve herbicide mixing and the absorption or permeation of the herbicide into the plant. Like dyes and other inert ingredients, there is often limited information on the types of surfactants used and the toxicity of surfactants, especially since the industry considers the surfactant to play a key role in the effectiveness of the herbicide formulations. Most knowledge of surfactants is kept as proprietary information, and not disclosed. USFS (1997a), which attempted to assess the effects of surfactant formulations on the toxicity of glyphosate, reported that toxicity of glyphosate alone was about the same as the toxicity when mixed with surfactant, and greater than the toxicity of the surfactant alone. Whether this same pattern would hold true of other herbicides having the same or different surfactants is unknown. If so, the toxicological studies performed on herbicide formulations (which contain the inert ingredients and surfactants) may accurately portray the toxicity and risks posed to humans by the surfactant.

Researchers have found a correlation between acute toxicity and carcinogenic potency (Zeise *et al.*, 1984, Metzger *et al.* 1989, and Goodman *et al.*, 1991), and acute toxicity data can be used to give an indication of overall toxicity. The court in *NCAP v. Lyng*, 844 F.2d 598 (9th Cir 1988) decided that this method of analysis provided sufficient information for a decision maker to make a reasoned decision. In *SRCC v. Robertson*, Civ. No. S-91-217 (E.D. Cal., June 12, 1992) and again in *CATs v. Dombeck*, Civ. S-00-2016 (E.D. Cal., Aug 31, 2001) the district court upheld the adequacy of the methodology described above for disclosure of inert ingredients and additives.

Endocrine Disruption

The endocrine system includes tissues and hormones that regulate metabolism, growth, and sexual development. The Food Quality Protection Act requires the Environmental Protection Agency to develop tests to screen for chemicals with the potential to mimic hormones. Chemicals that do mimic hormones and cause biochemical changes in tissues are called endocrine disruptors or hormonally active agents.

The concern over hormonally active agents is due to the fact that the endocrine system is intimately linked with the brain and the immune system. All three systems communicate with one another to affect body development and functioning. Adverse effects on this network have been blamed for a variety of maladies ranging from cancer to infertility to behavior problems (Felsot, 2001).

Chemicals, other than our own hormones, can interact with components of the endocrine system. Scientists have discovered that many kinds of chemicals, including natural food biochemicals as well as industrial chemicals and a few pesticides, can mimic the action of the hormones estrogen or testosterone. Concern has also been expressed about potential effects of the thyroid hormone during early development (Felsot, 2001).

Two general types of tests are used to screen chemicals of endocrine disrupting abilities. The most widely used tests are in-vitro tests. These tests are conducted in a test tube or dish using cells and in some cases the actual protein receptors, enzymes, and genes involved in the biochemistry of the endocrine system. In-vitro tests can be used to quickly screen large numbers of chemicals for their ability to interact with different biochemical components of the endocrine system.

Positive in-vitro tests, however, do not necessarily indicate that a substance would actually disrupt hormone functioning in a whole organism. In-vitro screening tests are properly used to determine which chemicals should be subjected to a second type of test, the in-vivo or “live animal” test. In-vivo tests use whole animals that are fed various doses of chemical. In some cases, the chemical is injected beneath the skin or directly into the body cavity. Developmental and reproductive toxicity studies with live animals over several generations are especially useful for determining if a substance adversely affects the endocrine system.

With one exception, the drug DES (diethylstilbesterol), all chemicals that have been tested in-vitro are thousands to millions of times less potent than the natural estrogen hormone (estradiol) (Felsot, 2001). Also, as exhibited by estradiol, all chemicals tested in-vitro, appear to show definitive threshold effects (i.e., NOEL) for estrogenic activity. No pesticides, food biochemicals, or other synthetic chemicals have definitively shown greater and/or different in-vitro effects at low doses as compared to higher doses. Although our natural hormones function at very miniscule levels in the body, endocrine disrupter tests have shown that interactions of hormone receptors with natural and synthetic chemicals are still related to dose during exposure. Even chemicals capable of interacting with the endocrine system at sufficiently high doses have not been found biologically active at low doses (US EPA, 1997).

In the in-vivo (live animal) studies to date, only a handful of chemicals, including natural food biochemicals, a few pesticides, and several industrial chemicals show endocrine disrupting effects (Felsot, 2001). The in-vivo experiments usually involve feeding pregnant rats or mice one or more doses of a chemical. With one exception, the drug DES, any effects that have been observed

were in test with doses at least thousands of times greater than environmental or dietary concentrations.

In virtually all published cases where a series of doses are tested in-vivo, endocrine effects did not occur below some threshold dose (US EPA, 1997). The EPA concluded with exceptions (e.g. diethylstilbestrol) a causal relationship between exposure to a specific environmental agent and an adverse effect on human health operation via an endocrine disruption mechanism has not been established.

Chemically Sensitive Individuals

A small percentage of the population may have a hypersensitivity to a wider variety of pesticides, perfumes, household cleaners, construction products or industrial chemicals, including the herbicides proposed for use by the Forest. These people are generally aware of their sensitivities and would not be allowed to work on herbicide spray crews or in treated areas. Until either safe re-entry periods, or a period they feel is adequate based on their personal knowledge of their sensitivity, has passed. Safe re-entry in areas where herbicides have been applied is stated on the herbicide label and is generally when the herbicide has dried on the leaf surface. Hypersensitive individuals may also be subject to effects from gasoline engine exhaust, gasoline powered weed mowers, and automobiles used for invasive weed control and public used both in and outside the weed treatment areas.

Uncertainty

With exception of accidental exposures or exposures under very conservative and somewhat implausible exposure scenarios, workers and the general public should not be exposed to a herbicide at concentrations that result in adverse health effects. This conclusion is predicated on forest service employees wearing appropriate personal protection, applying herbicides in accordance with the label, and implementing the job hazard analysis program to be used on this project. By doing so, possible exposure by contact or through drift would result in potential dose below that determined to be safe by the EPA over a lifetime of daily exposure. It is also predicated on the finding, back by toxicological studies, that a person can be exposed to some amount of a contaminant and not have an adverse effect (i.e. the dose determines the effect).

All of the herbicides proposed for use by the Forest must be registered for use by the EPA and the Montana Department of Agriculture. Registration of these herbicides and Federal regulations adopted to protect workers and the general public has required more scientific information and justification for use of herbicides. Nevertheless, there are many reports in the scientific literature and sections of this report that document associations between herbicide exposure and alterations of the immune system, autoimmune disorders, and increases in the probability of carcinogenesis. MCCHB (2001), Citron (1995), US EPA (1995), and Glover-Kerkvliet (1995) are just a few references that provide information on such effects. The body of literature on herbicide effects raises concerns about additive and synergistic effects of exposure to more than one herbicide, unstudied or unknown consequences of low-level chronic exposures, toxicity of inert ingredients, by-products or contaminants of herbicides, and uncertainties about the health effects of sensitive populations. There is also the realization that it is difficult, if not impossible, for government or any scientific agency to fully evaluate a chemical and all the potential combinations of them to ensure that there would not be an adverse effect.

It would be inappropriate to suggest that use of herbicides to control noxious weeds is without risk to workers and the general public. If herbicides are used, there is the possibility of workers

and general public exposure, no matter how many mitigation measures are implemented. All chemical exposure results in some level of health risk, the risk primarily being a function of the dose, or amount a person or organism is exposed to over a period of time.

It is equally inappropriate to conclude that any exposure, regardless of dose, would result in an effect. It is easy to find a report showing a health effect caused by the exposure to a herbicide or any other chemical. The toxicological studies are purposely done using high doses to demonstrate an effect. It is the herbicides that show effects at low levels of exposure or those levels anticipated when in use that should raise concern. With respect to this project, the potential dose received by the worker or the public does not approach the exposure levels shown to cause acute or chronic toxicity in the literature. Acute effects occur at doses thousands to tens of thousands of times higher than those estimated for the worker or public for this project. Likewise, chronic effects reportedly occur at doses significantly higher than that expected for this project.

There are simply too many variables (receptor sensitivity, dose received, use of personal protection, etc.) for anyone to predict with 100 percent certainty the potential health risk of herbicide use and exposure. What is known is that through a process of continual review of toxicological data on herbicides, the Environmental Protection Agency (EPA), using very conservative assumptions, has determined a dose they believe would not result in an adverse health effect for herbicides proposed for use on this project. We know that there are studies which show that exposure to the herbicides proposed for use at high doses can cause deleterious effects. We also know that risk assessments have been completed to determine the estimated dose a worker or person of the general public might be exposed to under varying exposure scenarios. Most important, we know through a comparison of EPA established safe doses and estimated exposures that the estimated dose that people might be exposed to through use of a herbicide on this project would be below that determined to be safe by the EPA for a lifetime of daily exposure. Therefore, no health effects and risks to workers and the public are anticipated by the use of herbicides by the Forest.

Herbicide Drift

1.) Dynamics

Spray drift is largely a function of droplet particle size, release height, and wind speed (Teske and Thistle, 1999). Other factors that control drift, to a lesser degree, include the type of spray nozzle used, the angle of the spray nozzle, and the length of the boom. The largest particles, being the heaviest, would fall to the ground sooner than smaller sizes upon exiting the sprayer. Medium size particles can be carried beyond the sprayer swath (the fan shape spray under a nozzle), but all particles would deposit within a short distance of the release point. The physics of sprayers dictates that there would always be a small percentage of spray droplets small enough to be carried in wind currents to varying distances beyond the target area. Because the small droplets are a minor proportion of the total spray volume, their significance beyond field boundary rapidly declines as they are diluted in increasing volumes of air (Felsot, 2001).

Drift characteristics differ between pesticides. With herbicides proposed in this analysis, it is not critical to coat the entire leaf since some of the product can be absorbed by the plant roots and good efficacy can be achieved by larger droplets on leaves of the target plant. Therefore, herbicide drift can be intentionally reduced by generating larger droplets without reducing efficacy.

Spray nozzle diameter, pressure, amount of water in the tank mixture, and release height of the spray are important controllable determinants of drift potential by virtue of their effect on the spectrum of droplet sizes emitted from the nozzles (Felsot, 2001; Teske and Thistle, 1999). Meteorological conditions such as wind speed and direction, air mass stability, temperature and humidity and herbicide volatility also affect drift.

Commercial drift reduction agents are available that are designed to reduce drift beyond the capabilities of the determinants previously described. These products create larger and more cohesive droplets that are less apt to break into smaller particles as they fall through the air. They reduce the percentage of smaller lighter particles that are the size most apt to drift off the treatment area.

Wind speed increases the concentration of drifting droplets leaving the treated area if the wind is adverse (blowing away from the release point in the treatment area). If the wind is favorable (blowing into the treatment area) drift can be reduced. Numerous studies have shown that over 90 percent of spray droplets land on the target area, and about 10 percent or less move off-target, and that the droplets that move off-target most typically deposit within 100 feet of the target area (Felsot, 2001; Yates *et al.*, 1978; Robinson and Fox, 1978; Teske and Thistle, 1999).

2.) Herbicide Drift from Aerial Applications

Drift deposition on surfaces measured downwind from aerial spray sites is typically less than one percent, and often less than 0.1 percent, of on site deposition (Yates *et al.*, 1978; Robinson and Fox, 1978; Teske and Thistle, 1999). Drift deposition from ground equipment can be one-tenth of that from aerial application at comparable distances from a spray site (Yates *et al.*, 1978).

Less information is available on the concentrations of herbicides that remain airborne at greater distances from application sites. Robinson and Fox (1978) measured airborne concentrations of herbicides at various distances from aerial spray plots. Under conditions designed to reduce drift, these researchers did not detect airborne levels of herbicides beyond 100 feet downwind of 500 foot wide spray plots (detection limit of 0.1 microgram – there are about 28 million micrograms in an ounce).

These researchers also measured ambient air concentrations of 2,4-D at seven stations in eastern Washington where several million acres of wheat are treated with herbicides annually. Ambient concentrations of non-volatile fractions of 2,4-D typically averaged 0.1 to 0.2 milligrams/cubic meter during periods of heavy application. Imazapic and clopyralid, the herbicides most likely to be used by the Forest, are also non-volatile herbicides, and long-range drift of these compounds may exhibit similar dynamics as the non-volatile fractions of 2,4-D. Therefore, the ambient concentrations of imazapic or clopyralid from the proposed projects may be similar to the concentrations measured by Robinson and Fox.

Numerous investigations of factors affecting drift from aerial applications are reported in scientific literature (DiTomaso, 1999; Yates *et al.*, 1978; Robinson and Fox 1978; Teske and Thistle, 1999; Teske *et al.*, 2000; Maybank *et al.*, 1978). Three of the most comprehensive studies are discussed below.

3.) RAHUFs Drift Estimations

The 1992 Risk Assessment for Herbicide Use in Forest Service Regions 1, 2, 3, 4 and 10 and on Bonneville Power Administrations Sties (RAHUFs), determined spray drift distances downwind

of an application site for aerial, back pack, and ground mechanical application equipment. The detailed methodology used in this study is included in USFS (1992). The results of RAHUFs spray drift analysis indicated “low” health risk to the public from ground and aerial applied herbicides. “Low risk” was defined in the study as drift from the herbicides that presents a less than one in a million systemic, reproduction or cancer risk. Spray drift from hand application equipment was found to be negligible.

4.) AGDRIFT / Felsot Drift Estimations

Felsot (2001) used the EPA/USDAFS AGDRIFT model to simulate herbicide sprays for several application scenarios, including a truck mounted spray boom set at two heights and a helicopter at two heights. These simulations included crosswinds blowing at ten and six mph. The model output was an estimated amount (percent of that applied) that deposited a defined distance from the edge of a spray swath. A spray deposition curve was developed to calculate a dose that a bystander could potentially receive if standing within the drift zone of an application. The whole body surface area was assumed exposed to drifting spray (highly conservative), and the bystanders were assumed to be an adult weighing 70 kilograms and a child weighing 10 kilograms. Absorption of the depositing dose was assumed to be 10 percent. Calculations were made to determine the percentage of the depositing spray that a child could be exposed to on a daily basis over 70 year life span and be within the EPA safety guidelines as defined by the reference dose (i.e., the “safe dose”). The study estimated that for aerial application, the equivalent safe deposits corresponded to distances from the edge of the spray field of 0 and about 60 feet for clopyralid picloram, and 2,4-D. For a ground application, the child would receive a safe dose level of 2,4-d at 27 feet from the sprayed field edge.

5.) Mormon Ridge Field Drift Monitoring

In this study, herbicides were aerially applied with aircraft to the Mormon Ridge winter range in 1997 and 1999. Mormon Ridge presented a difficult treatment scenario in that it is extremely steep, has rolling topography, considerable microclimate variability and aerial application occurred upslope of Mormon Creek, a bull trout –spawning stream. Mormon Creek flows along the bottom of the roughly three miles by ½ to ¾ - mile wide treatment area.

Picloram was aerial applied on Mormon Ridge in 1997. Buffer zones and water quality were monitored and continuous automated water samples collected. Analysis of the water samples (conducted by the Montana Department of Public Health and Human Services Chemistry Lab) indicated no herbicide entered the stream to a detection level of 0.1 parts per billion (USFS, 1996a). The Maximum Contamination Level as set by the EPA for drinking water is 500 parts per billion (Dow AgroSciences, 1999). No picloram was detected in Mormon Creek when tested at a level 5,000 times lower than the EPA Maximum Contamination Level. Drift cards were also placed along Mormon Creek to monitor drift. The cards indicated no detectable drift reached the creek.

The Mormon Ridge pilot project area was also aerial treated with picloram three growing seasons after the initial application to control invasive weeds that germinated from the soil seed bank after the herbicide decomposed. Drift cards used during this subsequent treatment did not detect picloram in the riparian aerial spray buffer.

6.) Spray Drift Summary

Based on the above information aerial herbicide applications would have a short-term, very localized impact as a result of drift. Most of the drift would settle to within 100-200 feet of the point of release in adverse conditions. Herbicide spray drift from aerial treatments under Alternative A would not significantly affect the health of the general public or adversely affect water quality, provided environmental protection measures are implemented to avoid drift toward persons and sensitive resources. Application should be made when there is an organized wind less than 6 mph blowing away from sensitive area. This practice combined with a buffer adjacent to sensitive areas and a drift reduction agent would likely result in no significant offsite drift. Significance in this context refers to concentrations above US EPA established “safe” levels.

Direct Effects, Alternative 1 (Proposed Action), Herbicides on Health Effects

Alternative 1 proposed to treat 255 acres with aerial spray, and up to 5179 acres with ground applied herbicides. Potential for public exposure to herbicides under Alternative 1 is low since most project areas are remote and away from population centers. Most of the ground based treatment sites are small weed patches along roadside edges. Once the herbicide dries on the plant there is little risk that the chemical will transfer to people or animals. When applied to vegetation the herbicides are very dilute, below the toxicity level of the chemical. When herbicides are used in campsites, the area will be posted notifying the public when the site was sprayed and when re-entry is safe (as defined by the product label, usually 24 to 48 hours).

Public exposure from aerial application is very low because the areas would be closed during application. Signs will be placed in the area prior to aerial spraying and during re-entry period, and adjacent landowners will be notified in advance of aerial application. Ground crews will be onsite during spraying to verify that people are not in the area and to monitor spray conditions and drift cards. Aerial application would be prohibited when winds are greater than 6 mph; or blowing toward sensitive areas or private lands. Sensitive areas would be protected by the use of buffer zones (300 feet from all water with aerial treatments).

Even without mitigation measures, herbicide treatments (both aerial and ground) occur infrequently (aerial treatment once every three years if needed, ground treatments once per year) and the public would not receive daily exposures above the US EPA reference doses, a dose considered safe by the EPA over a lifetime of daily exposure. No adverse health effects are anticipated for the general public based on estimates of exposure, estimates of drift, and the mitigation measures that would be implemented under this alternative. .

Potential for workers to be exposed to herbicides would be high because most of the work will be completed with ground-based applications. The more time spent applying herbicide the greater the risk of a spill, accident or mishap. Mitigations that require the workers to use personal protective equipment when working with herbicides will minimize risk of exposure application or an accident.

Direct Effects, Alternative 2 (No Herbicides), Herbicides on Health Effects

Since herbicides will not be used in this alternative there will be no health risk from herbicides. However, there will be a continued increase in weed spread and consequently an increase in weed pollen. People with allergies to these weed species will be affected.

Direct Effects, Alternative 3 (No Change from Current Management), Herbicides on Health Effects

Under this alternative weeds would continue to spread on the Forest. People with allergies, asthma and minor skin irritations caused by certain weed would be affected. Herbicides would be use on 346 acres, but the general public would not be exposed to herbicides at doses that are considered toxic.

Direct Effects, Alternative 4(No Aerial Application) Herbicides on Health Effects

Alternative 4 is the same as Alternative 1 except for 255 acres of aerial treatment that would be treated with backpack sprayers, biological control agents or not treated in any manner. Since the amount of herbicide being used is very similar to Alternative 1 there is no measurable difference, in terms of exposure or risk to human health, between these two alternatives.

Cumulative Effects to Human Environment

Past, present and reasonably foreseeable activities that may have cumulative effects on human health include weed control efforts on adjacent private and public lands. Based on the results of risk assessments performed by the Forest Service, the ongoing and future activities are not expected to result in exposures to workers and the general public at doses that exceed the reference dose. Therefore, under Alternatives 1, 3 and 4, no cumulative adverse health effects are anticipated for workers and the general public, provided herbicides are applied in accordance with the label as proposed. There are no anticipated cumulative health effects associated with biological, mechanical, or cultural treatment of weeds.

Inherent to having confidence in these conclusions is an understanding of what a reference dose is (how safe it is) and how it is determined. The Environmental Protection Agency (EPA) develops reference doses for chemicals including the herbicides proposed for use by the Forest Service. The reference dose is defined by the EPA as an estimate of daily dose over a 70-year life span that a human can receive without an appreciable risk of deleterious effects. A reference dose is determined by subjecting animals to exposures of a substance and determining the Lowest Observable Effects Level (LOEL) and the No Observable Effects Level (NOEL) from the entire body of scientifically supported animal studies performed for that substance. The NOEL represents the dose the EPA believes would not result in an effect. Reference dose calculated by dividing the NOEL, a level or dose already thought to not cause an effect, by a “safety factor” usually 100, to account for extrapolation of animal data to humans and sensitive individuals. Therefore the reference dose for a chemical is a dose at least 100 times lower than that shown to have an effect in any animal study performed with the subject chemical. With respect to herbicide applications, it has been estimated in nearly all cases that the dose a worker or a person of the general public would be exposed to would be below the reference dose, except for somewhat implausible exposure scenarios (spray over entire naked body, or wearing heavily contaminated gloves for an extended period).

Consistency with Forest Plan and other Laws, Regulations and Policies

All alternatives are consistent with Environmental Protection Agency, Occupational Health and Safety Administration, and Forest Service regulations regarding pesticide use and worker safety.

POSSIBLE CONFLICT WITH OTHER PLANS AND POLICIES

Montana noxious weed laws direct County control authorities to make all reasonable efforts to develop and implement a noxious weed program. The lack of adequate weed

control under the No Change from Current Management Alternative (Alternative 3) and No Herbicide Alternative (Alternative 2) would conflict with these State and County weed control plans and policies. Alternatives 1 and 4 indicate that the Forest Service is committed to the management of noxious and undesirable weeds in the Gallatin National Forest.

None of the alternatives would conflict with State and Federal water or air quality regulations or with US. Fish and Wildlife Service recovery plans for threatened and endangered species. A biological assessment of potential effects of the preferred alternative of potential effects of the preferred alternative to threatened and endangered species will be completed for the final EIS.

CHAPTER 5

CONSULTATION, REFERENCES AND GLOSSARIES:

CONSULTATION

Public Participation Summary

Public Participation specific to the Gallatin National Forest Noxious and Invasive Weed Control EIS Project is summarized in this chapter. The summary describes the public involvement, identifies persons and organizations contacted during preparation of the EIS, and specifies time frames for accomplishing goals in accordance with 40 CFR 1506.6

Public involvement in the EIS process includes the necessary steps to identify and address public concerns and needs. The public involvement process assists the agencies in: (1) broadening the information base for decision making; (2) informing the public about the Proposed Action and the potential long-term impacts that could result from the project; and (3) ensuring that public needs are understood by the agencies.

Public participation in the EIS process is required by NEPA at three specific points: the scoping period, review of Draft EIS, and receipt of the Record of Decision.

Implementation

The public scoping period was initiated with the publication of a Notice of Intent (NOI) in the Federal Register on January 17, 2003. The NOI summarized the Proposed Action and a determination by the agencies that an EIS would be necessary for analysis of the proposal. A legal notice was published in the Bozeman Chronicle on January 12, 2003. Also, a scoping package that included a project summary was mailed to various agencies, groups, and individuals announcing the scoping period and describing the Proposed Action. In addition, this project has been listed in the Gallatin Forest NEPA Quarterly Report since October 2003. This project is also described on the Gallatin web page
<<http://www.fs.fed.us/r1/gallatin/index.php?page=projects>>.

For the Draft EIS was distributed as follows: a Notice of Availability was published in the Federal Register for the comment period. Also, a news release was provided at the beginning of the 45-day comment period on the Draft EIS to local news media. The Draft EIS was distributed to interested parties identified in the updated EIS mailing list.

Criteria and Methods by which Public Input is Evaluated

Comments received from the public are reviewed and evaluated by the Forest Service to determine if information provided in the comments would require a formal response or contain new data that may identify deficiencies in the EIS. Steps were then initiated to correct such deficiencies and to incorporate the information into the analysis.

Consultation with Others

The following organizations and agencies were consulted during preparation of the EIS:
U.S. Fish and Wildlife Service

U.S. Environmental Protection Agency
 Montana Department of Fish Wildlife and Parks
 Montana Department of Environmental Quality
 Crow Tribe

List of Preparers and Reviewers

Interdisciplinary Team	Resource Area	Title
Susan LaMont	Team Leader & Herbicide Effects	Forester, M.S. Forest Management Experience: 18 years Forest Service
Lynn Burton	Vegetation	Rangeland Management, BS Range Experience: 25 years Forest Service
Scott Barndt	Fisheries and Amphibians	Fisheries Biologist, M.S. Fish Biology Experience: 3 years Forest Service, 10 years State of Montana and USFWS
Mark Story	Hydrologist	Hydrologist, M.S Watershed Management; Experience: 30 years Forest Service
Andy Pils	Wildlife Issues	Wildlife Biologist, M.S. Fish and Wildlife Management Experience: 3 years Forest Service, 2 years BLM
Henry Shovic	Soils and Ground Water	Soils Science, PhD Soils Experience: 25 years Forest Service
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Steve Christiansen	NEPA Specialists	NEPA Specialist, B.S Forestry Experience: 25 years Forest Service
Marna Daley	NEPA Specialists	Forest Writer/Editor, BS Communication Experience: 10 years Forest Service

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LIST OF ACRONYMS

EA	Environmental assessment
EIS	Environmental Impact Statement
EPS	Environmental Protection Service
FSM	Forest Service Manual
NEPA	National Environmental Protection Act
NOI	Notice of Intent
OHV	off-highway vehicle
ROD	Record of Decision
USC	United States Code
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish Wildlife Service
USGA	United States Geologic Survey
WSA	Wilderness Study Area

GLOSSARY

Acre-feet. The volume required to cover one acres to a depth of one foot, which is equivalent to 43560 cubic feet.

Acute Toxicity. The toxicity of a material determined at the tend of 24 hours; toxicity that causes injury or death from a single dose or exposure

Chronic Toxicity. The toxicity of a material determined beyond 24 hours and usually after several weeks of exposure.

Dermal Toxicity. Toxicity of a material as tested on the skin, usually on the shaved belly of a rabbit; the property of a pesticide to poison an animal or human when absorbed through the skin.

Electrical Conductivity (or Specific Conductance). The ability of water or a soil-water paste to transmit electrical current used to estimate ion concentration.

Endangered Species. Species in danger of extinction throughout all or a significant portion of its range.

Evapotranspiration (ET). The portion of precipitation returned to the air through evaporation and transpiration.

Flux. Volume of groundwater per unit time that travels through a solid permeable medium, such as alluvium and bedrock.

Hydraulic Conductivity (K). A coefficient of proportionality describing the rate at which water can move through a permeable medium.

Hydraulic Gradient. For groundwater, the rate of change of total height per unit of distance of flow at a given point and in a given direction.

Hydrograph. A graph that shows some property of groundwater or surface water as a function of time.

Hydrophytic Vegetation. The total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present.

Irretrievable. Typically used to describe renewable resources that are lost for a period of time such as timber production from land that has been converted to use for a ski area or other activity.

Irreversible. Usually used to describe use of nonrenewable resources such as extraction of minerals or removal of cultural resources where the resource is, for all intents and purposes, lost. This term is also applicable to loss of future options or alternatives based on present decisions.

LD50. A lethal dose for 50 percent of the test organisms. The dose of toxicant producing 50 percent mortality in a population. A value used in presenting mammalian toxicity, usually oral toxicity, expressed as milligrams of toxicant per kilogram of body weight *mg/kg).

Mitigation. Actions to avoid, minimize, reduce, eliminate, replace, or rectify the impact of a management practice.

Peak Flow. The greatest flow attained during large precipitation event.

pH. The negative $\log_{10}$ of hydrogen ion activity in solution; measure of acidity or alkalinity of a solution.

Scoping. Procedures by which agencies determine the extent of analysis necessary for a proposed action (i.e., the range of actions, alternatives, and impacts to be addressed; identification of significant issues related to a proposed action; and the depth of environmental analysis, data, and task assignments needed).

Sediment Load. The amount of sediment (sane, silt, and fine particles) carried by a stream or river.

Significant. As used in NEPA, requires consideration of both context and intensity. Context means that the significance of an action must be analyzed in several contexts such as society as a whole, and the affected region, interests, and locality. Intensity refers to severity of impacts (40 CFR 1508.27).

Storage Coefficient (S). Volume of water that an aquifer releases from storage per unit surface area of aquifer per unit decline in the component of hydraulic head normal to the surface: S is dimensionless.

Total Suspended Particulate (TSP). Particulates less than 100 microns in diameters (Stoles equivalent diameter).

Total Dissolved Solids (TDS). Total amount of dissolved material, organic or inorganic, contained in a sample of water.

Total Suspended Solids (TSS). Undissolved particles suspended in liquid.

Transmissivity (T). The rate at which water will flow through a vertical strip of aquifer one foot wide and extending through the full saturated thickness, under a hydraulic gradient of 1.0.

INDEX

- 2,4-D:** 1-3, 1-11, 2-7 to 2-9, 2-26, 3-10, 3-16, 3-21, 3-34, 3-48 to 3-50, 4-6, 4-9, 4-23, 4-62 to 4-68, 4-73, 4-74, 6-10, 6-11, 6-19, 6-23, 6-24
- Amphibians:** 2-3, 3-1, 3-16, 3-19 to 3-22, 3-28, 4-21, 4-24, 4-25, 4-26, 4-36, 6-2, 6-5
- Bald eagle:** 2-23, 3-27 to 3-31, 3-41, 4-27, 4-35 to 4-38, 4-47 to 4-49, 6-14, 6-15
- Bighorn sheep:** 2-23, 3-38, 4-27, 6-2, 6-8, 6-15
- Biological controls or biocontrol:** 1-3, 1-10 to 1-13, 2-10, 2-12, 2-21, 3-1, 3-7, 3-39, 3-40, 4-9, 4-51 to 4-54, 6-6, 6-8, 6-9
- Birds:** 3-16, 3-25 to 3-36, 4-35 to 49, 6-14
- Boreal toad:** 3-23, 4-26,
- Chlorsulfuron:** 1-11, 2-7, 2-9, 3-10, 3-34, 3-49, 3-50, 4-65, 6-23
- Clopyralid:** 1-11, 2-7, 2-9, 3-10, 3-16, 3-21, 3-34, 3-49, 3-50, 4-3, 4-7, 4-54, 4-62 to 4-68, 4-73, 4-74, 6-4, 6-7, 6-10, 6-11, 6-18, 6-19
- Cost:** 1-7, 1-8, 1-12, 2-9, 2-11, 2-14 to 2-17, 3-2, 3-36, 4-3, 6-6
- Cutthroat trout:** 2-17, 3-16, 3-17, 3-19 to 3-23, 4-23, 4-25, 4-26, 6-10,
- Dicamba:** 1-11, 2-7, 2-9, 3-10, 3-16, 3-21, 3-34, 3-49 to 3-51, 4-62, 4-65, 6-10, 6-21
- Drift:** 2-1, 2-2, 2-10, 2-17 to 2-20, 3-21, 3-22, 3-51, 3-52, 4-8, 4-11 to 4-13, 4-22, 4-26, 4-71, to 4-76, 6-2 to 6-6, 6-10, 6-15, 6-23, 6-24
- Elk:** 3-25, 3-26, 3-31, 3-38, 4-32 to 4-45, 4-49, 6-2
- Endangered:** 2-13, 3-3, 3-17, 3-24 to 3-31, 4-4, 4-26, 4-50, 4-76, 6-13 to 6-15
- Flammulated owl:** 3-29, 3-30, 4-39, 4-41, 4-48, 4-49
- Glyphosate:** 1-11, 2-7, 2-9, 2-20, 3-10, 3-16, 3-48, 4-3, 4-7, 4-11, 4-12, 4-23, 4-65, 4-69, 6-22
- Goshawk:** 2-3, 2-4, 2-10 to 2-23, 3-1, 3-29, 3-3, 4-1, 4-27, 4-38 to 4-41, 4-48, 4-49
- Grazing:** 1-9 to 1-13, 3-4, 3-9, 3-20 to 3-26, 3-31, 3-40, 3-44, 4-2, 4-9, 4-13, 4-27 to 4-35, 4-41, 4-44, 4-48, 4-51, 4-58, 4-49, 6-8
- Grizzly bear:** 3-25, 3-31, 3-40, 4-27 to 4-32, 4-49, 6-8, 6-14, 6-15
- Groundwater:** 2-4, 2-7, 2-20, 3-13 to 3-15, 4-15, 4-19 to 4-22, 4-26, 6-7, 6-9, 6-10
- Handpulling:** 1-3, 1-7, 1-8, 1-12,
- Herbicides:** 1-1, 1-3, 1-11 to 1-15, 2-2 to 2-11, 3-4, 3-9 to 3-25, 3-33 to 3-36, 3-44 to 3-52, 4-1 to 4-76, 6-2 to 6-25
- Hexazinone:** 1-11, 2-7, 2-9, 3-21, 3-35, 3-48 to 3-51, 4-62, 4-65 to 4-68, 6-19, 6-20
- Human health:** 1-2, 1-11, 2-2, 2-25, 3-16, 3-36, 3-46 to 3-48, 4-61 to 4-63, 4-75, 6-2, 6-17
- Imazapic:** 1-11, 2-7, 2-9, 3-10, 3-21, 3-35, 4-62, 4-65, 4-73
- Imazapyr:** 1-11, 2-7, 2-9, 3-10, 3-16, 3-21, 3-35, 3-49 to 3-51, 4-62, 4-65, 4-69, 6-21
- Inert ingredients:** 3-34, 3-48, 4-28 to 4-36, 4-39, 4-42, 4-45, 4-67 to 4-71, 6-15
- Inventoried roadless areas:** 2-4, 3-36 to 3-41, 4-1, 4-50 to 4-56
- Lynx:** 3-26, 3-27, 6-14
- Management indicator species:** 3-1, 3-21, to 3-24, 3-29, 3-31, 4-1, 4-22 to 4-26, 4-38, 4-42 to 4-45, 6-4
- Mechanical:** 1-1, 1-7, 1-8, 1-12 to 1-16, 2-4, 2-6, 2-11 to 2-16, 2-21, 3-1, 4-4, 4-23, 4-24, 4-36, 4-51 to 4-54, 4-58, 4-61, 4-63, 4-76
- Monitoring:** 1-7, 1-11, 1-13, 1-15, 2-1, 2-4, 2-9 to 2-23, 3-10, 3-32, 3-37 to 3-44, 4-26, 4-53, 4-74, 6-3 to 6-7, 6-10, 6-12, 6-16, 6-24
- Native plant:** 1-3 to 1-5, 1-10, 1-13, 2-10, 2-11, 2-29, 3-4 to 3-16, 4-2, 4-4 to 4-10, 4-15, 4-50, 4-60, 4-61
- Peregrine falcon:** 3-28 to 3-29, 4-27, 4-39 to 4-41, 4-48, 4-49
- Picloram:** 1-11, 2-1, 2-7, 2-9, 2-21, 3-10, 3-14, 3-16, 3-21, 3-49, 3-51, 4-6, 4-9, 4-21, 4-23, 4-62 to 4-68, 4-74, 6-4, 6-7, 6-8, 6-10, 6-11, 6-17, 6-18, 6-23, 6-24
- Prevention:** 1-3, 1-11, 1-12, 1-16, 2-16, 4-2, 4-20, 4-56, 6-6, 6-7, 6-11, 6-15, 6-16, 6-25
- Sediment:** 1-4, 3-16 to 3-23, 4-21, 4-23, 4-24, 4-57

Sensitive: 1-3, 1-5, 1-7, 1-12, 2-2, 2-4, 2-8 to 2-13, 2-17, 2-19, 2-20, 2-23, 2-25, 3-1, 3-3, 3-16 to 3-34, 4-1, 4-4, 4-9 to 4-14, 4-25, 4-26, 4-38 to 4-42, 4-49, 4-63, 4-64, 4-70 to 4-76, 6-3, 6-4, 6-7, 6-9, 6-11, 6-16

Soil: 1-4 to 1-13, 2-4, 2-7 to 2-12, 2-20, 2-25, 3-1, 3-4, 3-12 to 3-18, 3-23, 3-34, 4-1, 4-7, 4-8, 4-11 to 4-15, 4-20 to 4-24, 4-57, 4-74

Sulfometuron methyl: 1-11, 2-7, 2-9, 3-16, 3-21, 3-48 to 3-51, 4-62, 4-65, 6-20, 6-21

Threatened: 1-5, 2-13, 3-3, 3-24, 3-25, 3-31, 4-4, 4-12, 4-26, 4-31, 4-76, 6-13 to 6-15

Triclopyr: 1-11, 3-10, 3-36, 3-49, 3-50, 4-4, 4-12, 4-26, 4-31, 4-76, 6-18

Water quality: 1-2, 1-3, 1-12, 2-3, 2-4, 2-13, 2-17, 2-25, 3-13 to 3-23, 4-15, 4-21, 4-24 to 4-26, 4-54, 4-74, 6-4, 6-7, 6-10, 6-17

Wilderness: 1-2, 1-3, 1-7, 2-4, 2-7, 2-9, 2-13, 2-19 to 2-21, 2-26, 3-1, 3-2, 3-16, 3-22, 3-36 to 3-45, 4-1, 4-50 to 56, 4-59

Wildlife: 1-2 to 1-8, 1-13, 2-2, 2-3, 2-21 to 2-23, 3-1, 3-3, 3-16 to 3-46, 4-2, 4-8, 4-25 to 4-27, 4-33, 4-48 to 4-61, 6-2, 6-5, 6-6, 6-7, 6-13, 6-14

Wolf: 3-1, 3-11, 3-12, 3-26, 4-27, 4-32 to 4-39, 4-49,

Wolverine: 3-30, 4-39 to 4-41, 4-49

Response to Comments Received on the Invasive and Noxious Weeds Draft EIS

I. Introduction

This document summarizes issues and concerns from comments received on the Invasive and Noxious Weed Draft EIS (DEIS), and identifies the agency's response to the concerns.

On July 17, 2004, the Notice of Availability appeared in the Federal Register. This officially started the 45-day comment period for the draft EIS. A legal notice was published in Bozeman Daily Chronicle on July 18, 2004. On July 28, 2004 a news release was mailed to 35 potentially individuals, groups and newspapers. Copies of the draft EIS were mailed to 13 agencies or individuals. In addition, a letter was mailed to announce the availability of the opportunity to comment on the draft EIS to 285 individuals. The following content analysis is in compliance with the National Environmental Policy Act (NEPA) and is designed to inform responsible officials of the potential environmental consequences of this project.

II. List of People who Commented on the DEIS, a Summary of their Comments, and the Agencies Response. Copies of the comment letters are available at the end of this Chapter.

Letter #	Agency, Organization, or individuals	Date Received
1	B.Sachau	7/31/2004
2	David Schulz, Madison County Commissioner	8/9/2004
3	John Wardell, Montana Office, Director US EPA,	8/20/200
4	Robert Stewart US Depart of the Interior	8/25/2004
5	Tony Tweedale - Alliance for Wild Rockies Jeff Juel – Ecology Center	8/30/2004

B.Sachau bk1492@aol.com
 15 Elm St
 Florham Park, NJ 07932

A complete copy of this letter is available at the end of this Chapter.

1-1. This plan is wasteful; we should let the weeds alone.

Response: Thank you for your comment but the control of noxious weeds is legally required as stated in the EIS on page 1-13.

1-2. I am opposed to burning.

Response: Burning is not proposed in the project.

David Schulz
Madison County Board of Commissioners
PO Box 278
Virginia City, MT 59755

A complete copy of this letter is available at the end of this Chapter.

- 2-1. Regarding effects of herbicides on human health: training to safely apply herbicides; use of label required personal protective equipment; and use of properly maintained application equipment greatly limits health risk to human. Science does generally understand what happens to herbicides as they are used and then broken down.

Response: We agree with your assessment regarding the risk of herbicides on human health. Mitigation measures to reduce exposure to herbicides are addressed in the EIS on pages 2-18 through 2-23. Also, the risk of herbicide impacting human health was addressed on pages 3-46 through 3-51, and pages 4-61 through 4-76.

- 2-2. Non-target species must be evaluated, particularly aerial application of herbicide.

Response: The concern regarding non-target plant species and aerial application is a very important and was addressed in the EIS on pages 4-7 through 4-15. In addition, the EIS listed numerous mitigation measures to control the risk of herbicide drift from aerial application on pages 2-18 and 2-19.

- 2-3. Some herbicides are labeled for use near water. Waterways are a natural transportation means for weed seed spread. Management of some level in these areas is imperative for long-term control.

Response: It is true that waterways are a significant vector for weeds. The current management direction (based on the 1987 Gallatin National Forest Noxious Weeds EIS) does not allow for the use of herbicides with 10 feet of water; as a result, many of the waterways on the Gallatin National Forest have weed patches that are spreading seed down stream. In the EIS, Alternatives 1 and 4 allow for the use of aquatically approved herbicides adjacent to the waters edge but not directly into the water. Although, the aquatically approved herbicides have not been found to be toxic to insects, fish or amphibians; there is still a concern regarding oxygen depletion from decaying vegetation if the herbicide was applied directly into the water. Limiting the amount of herbicide within a watershed, as addressed in Appendix D, reduces the risk of herbicides impacting aquatic resources.

- 2-4. What are the effects on wildlife if we do not control weeds?

Response: The impact of invasive weeds on wildlife habitat was addressed in the EIS on page 1-6, and pages 4-28 through 4-49. Invasive weeds can reduce available forage for many wildlife species. On the Lolo National Forest (which has a high concentration of invasive weeds), about 20 percent of the wintering elk, deer and bighorn sheep are at severe risk from weed invasion due to lost forage production (USFS. 2001b. page I-2).

- 2-5. Is the environmental consequence of using the entire toolbox to manage weeds greater than that of doing nothing or very little?

Response: The purpose for completing the EIS was to answer this very question. This EIS studied a range of alternatives, which considered the environmental effects of using all of the different weed management tools, and the effects of using only a few tools. The trade-offs between the alternatives are summarized in the EIS on pages 2-24 to 2-25.

John Wardell
Montana Office, Director
US EPA, Region 8, Montana Office
Federal Building, 10 west 15th St. Suite 3200
Helena, MT 59626

A complete copy of this letter is available at the end of this Chapter.

- 3-1. We consider it important to ensure adequate measures are incorporated into aerial application to mitigate risks of adverse health and environmental effects (e.g., avoid drift of herbicides to aquatic areas or other sensitive areas). Table 2-11 appears to recognize the need to avoid drift of herbicides to non-target areas.

Response: We agree that herbicide drift into non-target areas must be negligible. The mitigation measures, listed in Table 2-11, that address aerial application and drift reduction have been used successfully on other National Forests in Montana. For example, the Lolo National Forest (Kulla, A. 2003) used aerial spray in 1993 administrative pasture (160 acre), also in 1997 and 1999 on the Mormon Ridge Winter Range project (900 acres), and then ten different projects in 2002. The mitigation measures were shown to be effective (USFS. 2001b. page I-8) and consequently were incorporated into this EIS.

Factors that effect drift (particle size, release height, wind speed, use of drift agents, nozzle pressure, nozzle size and orientation, and humidity) have been studied extensively and are summarized in Table 3-23 (EIS, page 3-53). Pages 4-72 through 4-76 in the EIS address the risk associated with herbicide drift.

Appendix G – Aerial Spray Recommendations/Drift Model Result was included in the final EIS. This appendix includes additional recommendations for aerial application and results from drift model predictions.

- 3-2. We support a strong monitoring program that tracks the effects of invasive plants on natural resources, effectiveness of control, and presence of herbicides in surface and ground water in high-risk areas. We encourage the Forest to track weed infestations, control actions, and effectiveness of control action in a Forest-level database.

Response: We agree that a strong monitoring program can be useful in assessing the effectiveness of the program, as stated in the EIS on page 2-17. The Forest Service is in the process of building a database (including spatial data) that will track the weed infestations over time, and the control actions implemented. Eventually, the effectiveness of the control action can be determined by comparing the infestation (over time) with the control action. Currently, the Gallatin National Forest has the existing weed data entered into the database (both tabular and spatial). We will continue to update the database as new sites are discovered. In the summer of 2005,

we will start to incorporate site-specific treatment data into the spatial and tabular database.

- 3-3. We are pleased that monitoring of water samples is included to detect the presence of herbicides from drift, leaching or runoff. Aquatic monitoring is important to validate that herbicide application protocols and environmental protection measures are effective. The Forest may also want to consider monitoring for herbicide concentrations in soils, soil microbiologic assays or assessments of soil fertility.

Response: The EIS describes water quality monitoring on page 2-17. Direct soil monitoring is not specified in the EIS, because studies geographically near and environmentally similar have concluded there are no measurable effects on soils from the levels of pesticide use on the Gallatin National Forest (EIS, Chapter 3, page 3-15).

- 3-4. The EIS states that seventeen of 108 watersheds have been identified with potentially “high” risk of water contamination due to surface run-off. Include more information in the final EIS on what special mitigation measures to avoid water contamination in “high” risk areas. It is not clear what measures are proposed in such “high” risk areas beyond those listed in Table 2-11. We also recommend that information be disclosed in the final EIS showing aquatic toxicity of the proposed herbicides for the fish species present in the areas to be treated.

Response: In the EIS, Tables 2-12 and 4-10 lists the maximum amount of picloram (in pounds/year) for each of the 17 “high” risk watersheds. Limiting the total amount of picloram used in a watershed, along with mitigation measures in Table 2-11 (mitigation measures numbers 1, 2, 10, 11, 12, 13, 14, 18, 32, 33, 34, 35 and 36), in-stream concentrations should remain below 0.12 ppm. Negative impacts to sensitive or Management Indicator aquatic species should not occur since mitigation measures in Table 2-11 (mitigation measures number 36) provide significant protection and all standardized values used in the model were extremely conservative.

See response 3-26 for the aquatic toxicity to fish response.

- 3-5. Additional measures that may further mitigate potential environmental effects of proposed weed treatment include:

1. Operators should calibrate spray equipment at regular intervals to ensure proper rates of herbicide applications.

Response: This mitigation measure has been added to the final EIS, page 2-19, mitigation measure number 16.

2. Field inspectors who will be present during aerial application should be trained and equipped with personal protective equipment to follow the label.

Response: The mitigation measure (number 10) from page 2-19 of the EIS which states “Field inspectors will provide on-site monitoring for drift and label compliance” has been modified to reflect this concern.

3. A more selective herbicide (clopyralid) should be use in conifer associated communities to reduce impacts on non-target vegetation;

Response: You're absolutely correct, more selective herbicides should be used to reduce impacts to non-target vegetation. Alternatives 1 and 4 were developed to allow for the use of selective herbicides, the current management direction (Alternative 3) does not.

4. The 300 foot streamside buffer should specify application of the buffer to wetlands as well as streams;

Response: We agree and have added this to the mitigation measure number 1 (EIS, page 2-18) applicable to Alternatives 1 and 4.

5. Aquatic areas and buffers should be delineated and reviewed with the pilot prior to aerial application;

Response: This mitigation measure was included in Table 2-11, number 3 (EIS, page 2-18).

6. Only treatment methods that target individual noxious weed plants should be done in riparian and wetland areas (depending on the targeted weed species, manual control or hand pulling may be one of the best options). We also noted that herbicide application technique of hand or manual wipe-on is not mentioned as an option to control individual plants adjacent to streams or sensitive aquatic sites.

Response: We agree that individual plants should be targeted whenever possible. In Alternatives 1 and 4 we have attempted to target individual plants through the use of hand pulling, the use of spot herbicide treatment (including wipe-on wick applicator as was mentioned in the EIS on page 2-8) and discourage the use of broadcast treatment within riparian area. However, in riparian areas where the weed infestation is extensive, the entire patch will be treated with herbicides that are approved for aquatic use (only under Alternatives 1 and 4). When working in large patches of weeds with high density, it is inevitable that some non-targeted plants will be impacted with the herbicide treatment. Only aquatic approved herbicides will be used next to riparian areas because they are less toxic to aquatic organism.

3-6. We believe a 300 feet buffer provides an adequate safety zone to reduce risk of drift and runoff of potentially toxic herbicides to streams and wetlands during aerial applications.

Response: The 300 feet buffer for aerial application is the standard mitigation measure being used on all Forest Service weed control projects. The EIS listed this mitigation on page 2-18. Monitoring on the Lolo National Forest demonstrated this mitigation measure to be effective in preventing herbicide from reaching streams (USDA. 2001b. page I-8).

3-7. We suggest that the weed coordinators review and coordinate with fisheries biologists and botanist to assure sensitive fisheries and plants are protected. Future plant surveys need to be conducted on all new sites and by qualified surveyors.

Response: Only the wildlife biologists will review the entire program annually because wildlife species are mobile and use a variety of habitats. Since sensitive

aquatic and plant species remain in the same general location from year to year, the analysis completed in this EIS for the existing weed populations has already addressed existing sensitive fisheries and plants. If a new weed patch is identified then the risk to sensitive plants or aquatic organisms will be evaluated as identified in Table 2-6 of the EIS. Trained staff will conduct all future sensitive plants and amphibian surveys.

- 3-8. We suggest that the Bitterroot Noxious Weed Treatment Project EIS be reviewed for additional environmental protection measures to include in this EIS.

Response: Mitigation measures that have shown to be effective on the Bitterroot, Beaverhead – Deerlodge, Helena, and the Lolo National Forest Weed Treatment EIS's were incorporated into the Gallatin National Forest Weeds FEIS (EIS, pages 2-18 to 2-23).

- 3-9. Correct the discrepancy for the following: page 2-4, Table 3, Alternative 1, 255 acres aerial treatment and 5179 ground treatment; and page 4-74, Alternative 1, 459 acres aerial and 5390 acres ground.

Response: Since the numbers on page 2-4 of the EIS are correct; the numbers on page 4-74 were updated in the final EIS.

- 3-10. With limited available funding, and if aerial treatment is the most cost-effective control method, why are aerial treatment sites not included in the fiscally realistic portrayal of the Forest weed program.

Response: Aerial treatment is proposed for locations where access is limited and where other resource concerns (such as aquatic resources, sensitive plants, raptor nest sites, physical limitation of the aircraft, and social limitations) do not preclude the use. In addition, the use of aerial treatment needs to match the weed management goal. Aerial treatment works well where the weed management goal is to improve wildlife habitat through suppression of weeds and to increase the production of grasses, but less so where the goal is weed eradication. A single herbicide treatment will release the grasses from competition with weeds and increase the forage production substantially (Lolo National Forest Big Game Winter Range and Burned Area Weed Management Final EIS, page I-8), but will not permanently eradicate weeds from the site. Areas where the weed management goal is "eradication" will require the prevention of all seed production and vegetative growth for many consecutive years. Eradication is not a realistic goal when infestations are large, more than an acre in size, due to the difficulty in maintaining a zero tolerance level over such a large area of land. Finally, the use of aerial treatment will be based on the treatment priority system (EIS, Table 2-1, page 2-5) and available funding.

- 3-11. We encourage the forest to track weed infestation, control actions, and effectiveness of control action on a Forest-level weed database. Also, identify where the long-term herbicide test plots and biological control plots are located.

Response: The Forest Service is starting to implement a national database that will track the information identified above. As for the location of the herbicide test plot and the biological control plots, their location is identified in project file.

- 3-12. We suggest adding a discussion on the probable causes of invasive weed establishment on the Gallatin Forest. By describing why weeds are on the forest, better mitigation for preventing weed spread can be developed.

Response: Invasive weeds can spread by many different vectors: people, wind, water, and wildlife. Once introduced into an area, many species are so aggressive they do not need a disturbance to become established, however, weeds will spread more quickly in disturbed areas. Preventing weed introduction and weed spread was addressed in the EIS on page I-11 and Appendix A– Best Management Practices for Weed Control. Appendix A includes an extensive list of weed prevention activities that are already being implemented throughout all National Forests in Montana. The decision to implement these prevention activities and incorporate them into the Forest Service Manual 2080 was made by the Regional Forester, in 2001. Appendix A also contains prevention recommendations for aquatic weed prevention that were not listed in the FS Manual 2080.

- 3-13. The Forest Service may also want to consider groundwater monitoring in wells that are in close proximity to application sites. Monitoring is needed to validate that herbicide application protocols and environmental protection measures are effective in preventing herbicide transport to surface and ground water, and avoiding impacts to wildlife and non-target plant communities. We generally recommend that sensitive streams adjacent aerial herbicide treatment areas be monitored to validate that herbicide transport to aquatic area does not occur, particularly monitoring for picloram and clopyralid, since these herbicides are highly mobile, relatively persistent and toxic. It would be appropriate to focus such monitoring on waters in the “high” risk watersheds shown in Table 4-10 (page 4-21). Monitoring in Hyalite and Bozeman Creek may also be helpful to document that water contamination does not occur in the municipal watershed.

The monitoring program should display sampling locations relative to area of herbicide treatment, parameter to be monitored, methodologies to be use, frequency, pattern and number of samples to be collected, etc.

The aquatic monitoring program should be more completely described in the EIS to assure that project effects on water quality and public health will be detected, and to allow the adequacy of the monitoring program to be evaluated.

Response: Under Alternatives 1 and 4, the Gallatin National Forest has a low to moderate potential for groundwater contamination from foliar-applied herbicides (EIS, page 4-20). The areas of higher risk can be mitigated with herbicide selection to minimize the contamination potential. The monitoring section on page 2-17 describes an adaptive approach to surface water, and if appropriate, ground water (well) monitoring. The Gallatin National Forest has initiated cooperative surface water quality monitoring of herbicides with the US Fish and Wildlife Service in Helena with the focus on ground treatments in the Hyalite Creek drainage. The adaptive monitoring approach will expand to well monitoring depending on surface water herbicide monitoring results. See Chapter 4, Soils and Groundwater (pages 4-15 to 4-20) and Appendix E for more information.

- 3-14. The Forest Service may also want to consider monitoring for herbicide concentrations in soils, and soil microbiologic assays or assessments of soil fertility. If soil fertility is low, it may be helpful to apply slow release fertilizers to increase growth of native vegetation.

Response: Direct soil monitoring is not specified in the EIS. This is because studies geographically near and environmentally similar have concluded there are no measurable effects on soils from the levels of pesticide used on the Gallatin National Forest (EIS, Chapter 3, page 3-15).

Soil fertility is low on the Forest (Davis and Shovic. 1984). However, increasing fertility levels were not considered except for localized treatment of tall larkspur. This is because of our intent to preserve as natural a system as possible, and fertilizer could have detrimental effects on those “normal” ecosystems. Also, many weed infestations are on landscapes not favorable to application equipment (steep, rocky, inaccessible from roads).

- 3-15. Why does Alternative 2 not consider treating larkspur with non-herbicide techniques such as fertilizer, mineral supplements, sheep grazing and native insects.

Response: Alternative 2 does not include the use of chemical treatments (which includes chemical fertilizers) but does include Silent Herder® mineral and native biological control agents (EIS, page 2-6). The grazing with sheep or goats is limited to mitigation measures on page 2-21. Most of the Gallatin National Forest will not be able to use sheep or goat grazing because it is within the nine miles of bighorn sheep habitat (a mitigation measure designed to prevent the spread of disease) or within the grizzly bear recovery area.

- 3-16. As a general practice, EPA suggests prioritizing perimeter weed infestations such as around trail heads and roadsides before treating interior weed infestations.

Response: That is consistent with the EIS on page 2-5. However, if the trailhead or road is in the interior and considered a source for weed spread then these areas could also be considered a priority.

- 3-17. Would application rates of less than 1 quart/acre of picloram effectively control leafy spurge? Table 2-5 shows treating more than twice a year, would it be appropriate to limit application to once a year? Tordon® label recently developed for wick or carpet application. Wick application is very effective at targeting particular weeds adjacent to surface waters, wetlands or protected plants.

Response: Leafy spurge has a deep rhizomatous root system that is hard to kill so the one-quart per acres rate is the recommended rate and is consistent with the label. In some situations, a newly established patch with a limited root system can be controlled with 1 pint per acre. Table 2-5 in the EIS shows different times that the plant is susceptible to herbicides and not intended to mean repeat applications. The Tordon® label limits applications to one time per year. Our mitigation measure for using Tordon® is very conservative, to reduce the risk of accidents in high-risk areas, we have chosen to not use Tordon® within 50 feet of water or protected plants. Other chemicals with less toxicity or leachability will be used near water.

- 3-18. Please provide a detailed description of how Forest Service employees or contractors will be certified throughout the duration of the project to use Restricted Use Pesticides. Also registration for Access is cancelled and Table 2-4 should be updated.

Response: Forest Service employees and contractors that use restricted-use chemicals will be certified and licensed by Montana Department of Agriculture. Table 2-4 will be corrected and Access will be deleted from the table.

- 3-19. There appears to be inconsistency between Table 3-5, which show acres at risk to invasive weeds, and the listing of more prevalent weeds on page S-1 of the EIS Summary.

Response: Table 3-5 on page 3-9 shows areas at risk, while page S-1 shows existing weeds. Acres at high risk to weed invasion means, that if the weeds are introduced into the area, the weeds have the potential to permanently alter the vegetative composition and structure. The list of acres with existing weeds describes what weeds are currently present.

- 3-20. Since spotted knapweed is relatively easy to kill with herbicides, use lower rates and more selective low toxicity herbicides.

Response: This is reflected in the EIS, Table 2-5, page 2-8.

- 3-21. It may be helpful to add a list of those weed species that can be effectively hand-pulled (i.e. those without large taproots and rhizomatous root systems).

Response: This is reflected in the EIS, Table 2-5, page 2-8.

- 3-22. Sites selected for application of biological control agents should be protected from other management actions that could negatively influence the agents. These sites can function as collection point for redistribution.

Response: A criteria for selecting biological control sites is the probability that the site will not be disturbed. However, there are no guarantees that the site will not be disturbed. Many sites already function as collection points for redistribution.

- 3-23. It would be helpful if information regarding the presence of sensitive features in weed treatment areas were tabulated for each treatment area (rare plants, aquatic areas, T&E species, downstream public water supplies). Are Hyalite Creek and Bozeman Creek watersheds the only watershed in the Forest with proposed weed treatments that provide public water supplies (page 3-24)? Are there any other sensitive waters near herbicide treatment areas, including potable, agricultural, and recreational uses of surface and groundwater immediately downstream or down gradient for herbicide application area? Will all possible precautions be taken to avoid contamination of potable water supplied with weed control chemicals?

Response: Information regarding the presence of sensitive features in weed treatment areas is available spatially with GIS and has been used extensively throughout this environmental analysis. Spatial data consisting of weed location and treatment type; proximity to rare plants, sensitive aquatic area, soil types, hydrologic data, sensitive aquatic species and some sites with threatened and endangered species are included in the EIS or project record. Currently, Hyalite and Bozeman Creeks are the only municipal watersheds with proposed weed treatments. To avoid any possibility of contaminating water source (regardless of its use) the analysis used in this EIS was very conservative and designed to protect all watersheds (see EIS, Table 2-12

mitigation measure numbers 31, 32, 33, and 35; pages 4-15 through 4-25, Appendix D, and Appendix E). All possible precautions will be taken to avoid contamination of potable water supplies (Table 2-11, mitigation measure number 31).

- 3-24. For the Relative Aquifer Vulnerability Evaluation hazard assessment on page 4-13, it would appear helpful to have a list of areas with existing weed infestation in areas at “high” risk to ground water contamination so that planning could be initiated to develop the appropriate special mitigation measures and to assure that these areas are not overlooked. It is not clear what measures are proposed in such area above and beyond the environmental protection measures identified in table 2-11.

Response: See Table 4-9 (EIS, Chapter 4, page 4-16) for a list of watersheds having existing weeds in “high” risk areas. Also, see Appendix E for a map of the areas at high risk to ground water contamination. This information is also included in the Record of Decision. Currently, there are only two watersheds (Denny, and Upper Taylor) that have both a high number of acres (more than 640 acres) at high risk to ground water contamination and more than 20 acres of existing weeds. These weed patches are between the high water mark and surface water. All weed patches between the high water mark and surface water will either be pulled or will be spot treated with an aquatically approved herbicide and those with low leachability.

- 3-25. Adequate precautions or mitigation measures must be taken to avoid drift of herbicide to sensitive fishery water during ground or aerial application. If any of the “high” risk streams involve sensitive aquatic species it would further support the need for special mitigation measures to minimize risk of herbicide transport to such water.

Response: Since fisheries resources are extremely important, the mitigation measures were designed to protect all streams and not just those with “sensitive fisheries.” We considered it unacceptable to impact any streams, wetlands or groundwater with herbicides. To protect this resource we used mitigation measures that have been successfully used by the Lolo National Forest, and have been shown to be effective in protecting aquatic species. The Lolo National Forest used these mitigation measures while treating Mormon Creek, which contains a bull-trout spawning stream, and monitoring revealed no measurable level of herbicide entered the creek (USFS. 2001b. page I-8).

That being said, none of the areas proposed for aerial spraying are adjacent to sensitive fisheries. A future proposal for aerial spraying will invoke the decision tree (Table 2-6), and possibly additional mitigation measures to further protect sensitive species, along with the standard mitigation already part of this proposal (Table 2-11). However, mitigation measures in Table 2-11, including the decision tree (Table 2-6), and herbicide application limits (Table 2-12 and Appendix D) were designed specifically to protect sensitive species. For example, the risk analysis for picloram and other herbicides used toxicity values for cutthroat trout, which is both a Gallatin National Forest sensitive species and is the fish species most sensitive to picloram. Mitigation resulting from the risk analysis was specifically designed to protect cutthroat trout, and thereby offer sufficient protection for other species.

- 3-26. We recommend that information be disclosed in the FEIS showing aquatic toxicity of the proposed herbicides for the fish species present in the areas to be treated. It would also be helpful if relative toxicity of proposed herbicides to fish and aquatic life were identified.

This information is available at the National Pesticide Telecommunication Network website <http://npic.orst.edu/tech.htm>. Also, the comment letter on pages 10 and 11 has specific information for Picloram, 2,4-D, Clopyralid, Dicamba and Metsulfuron-methyl.

Response: Thank you for providing information about the National Pesticide Telecommunication Network website; it is an excellent resource. Toxicity values are not available for all fish species present in the treatment areas so surrogates as closely related to those present must be used. However, toxicity for the sensitive fish species, cutthroat trout, was disclosed (Chapter 3, page 3-21) for the herbicide most toxic to aquatic life, picloram; which was thus used to determine allowable application rates for watersheds based on its toxicity to cutthroat trout. Relative aquatic toxicity of the herbicides was also generally discussed relative to picloram in the same location. A table showing the relative toxicity of proposed herbicides to fish, the soil half-life; the solubility; and a reference to the above mentioned website will be inserted at this location in Appendix D.

- 3-27. We also suggest that the EIS disclose other general characteristics and effects of the proposed herbicides for use in this project. See tables from the Helena National Forest DEIS Noxious Weed Treatment project providing information on general characteristics and effects of herbicides. We recommend that a table showing “General Characteristics of Herbicides to be Used” show the chemical properties of different chemical forms (salt vs. acid) of herbicides, since properties vary with different chemical formulation. For example, it is important to know that picloram and clopyralid are toxic and mobile herbicides with a high potential for leachability and thus a high potential to be transported to surface and ground waters.

Response: A table showing the following general characteristics have been added to Appendix D: toxicity to trout; soil half-life; potential for mobility; and solubility for each of the proposed herbicides. This table shows a range of values to account for different chemical formulations. The EIS has many tables showing the general characteristics and effects of herbicides to be used in this project (see Table 3-14 on pages 3-34 to 3-36, Tables 3-20, 3-32 and 3-33 on pages 3-49 to 3-51, and Table 4-16 on page 4-65).

- 3-28. The EIS indicates that the analysis shows herbicide applications in all but a few 6th code HUCs on the Forest should remain well below the “safe” concentrations and pose little risk to fisheries (page 4-21). Table 4-10 (page 4-21) show 17 of 108 watershed where some risk for exceeding the “safe” concentration in surface waters, however, by following the restrictions on the maximum amount of herbicides that can be used within any watershed (6th order HUC) within any year (Table 4-10) the EIS states that instream concentrations should remain below 0.12 ppm (picloram) and negative impacts to sensitive or MIS aquatic species should not occur. This analysis appears reasonable, however, as stated in the EIS (page 4-22) it will be very important that safety and mitigation measures identified in the EIS are used during project implementation.

Response: The mitigation measures identified in the EIS will be implemented during the life of the project.

- 3-29. We note that the environmental protection measures in Table 2-11 (page 2-22) state that no ester formulations of herbicides will be used due to fish toxicity concerns, however in the table in Appendix D showing the maximum amount of herbicides that can be used

within any watershed includes identification of the maximum amount of 2,4-D ester to be used in each watershed. There would appear to be no need to specify this if no ester formulations are to be used.

Response: Reference to 2,4-D ester was removed from Appendix D.

- 3-30. We note that sometimes a significant source of pollutant loading occur in unlisted tributaries, and TMDLs (Total Maximum Daily Load) must account for all sources of pollution, hence the need to identify and address sources throughout the watershed, including unlisted waters. ...Although none of the 303(d) listed waters identify herbicides as a cause for impairment, we recommend that the Gallatin National Forest contact the Planning, Prevention, and Assistance Division of the MDEQ (i.e., Carol Mackin, Federal Consistency Coordinator at 444-7425 in Helena, MT) to ensure that TMDL requirements are adequately addressed with the proposed Gallatin Noxious and Invasive Weed Control Project. For your information, we believe that with proper use of herbicides and environmental protection measures, significant adverse effects to surface water quality including water bodies on the 303(d) list, should not occur.

Response: Carol Mackin of Montana DEQ was contacted on 11/3/2004 concerning TMDL requirements and Federal consistency and responded on 11/9/2004. The analysis, TMDL schedule, mitigation measures, and BMP's were reviewed with the advice that the Gallatin Noxious and Invasive Weed Treatment Project EIS adequately address TMDL requirements and that any pollution loading reductions will be credited to future TMDL planning efforts. None of the 303(d) listed waters on the Gallatin National Forest identify herbicides as a cause for impairment.

- 3-31. Noxious weeds can spread by vehicles. The Forest Service may want to consider some restrictions on vehicles to reduce potential for re-infestation of the area by noxious weed after treatments. Also, if sufficient vegetation is killed during ground disturbing activities (e.g., by prescribed burning) it may warrant re-vegetation efforts. Burning followed by application of appropriate herbicides can provide effective weed control. We suggest that such considerations be evaluated for during development of direction and plans for prescribed burning. Another option for preventing the introduction of noxious weeds is to require cattle and horses, especially those coming from areas with noxious weeds, to be penned and fed weed free hay for several days prior to being released on public lands.

Response: Off road motor vehicle use is already restricted by the January 2001, The Off-Highway Vehicle Record of Decision and Plan Amendment for Montana, North Dakota and Portions of South Dakota. The Off-Highway Vehicle decision was intended to limit the amount of resource damage and resulting weed spread caused by motor vehicles. Additional travel management decisions are being addressed in the Gallatin National Forest Travel Plan EIS, and not in the Invasive Weeds EIS (EIS, pages S-8, 1-15, 1-16). The use of re-vegetation is already addressed in the EIS (pages 1-11, 2-10, 2-11, and Appendix A). Guidelines for weed control and the development of plans for prescribed burning are already addressed in Appendix A, pages A-14 through A-16. Requiring domestic animals to be penned and fed weed free hay prior to entering public lands is not feasible, especially during hunting season, when the use of horses is very high and the number of Forest Service staff is very limited.

- 3-32. We suggest including appendices with aerial spray recommendations and mitigation measures. We are enclosing a copy of the Aerial Spray Recommendation and Mitigation measures Appendix from the Lolo National Forest. For your information, we are also enclosing a copy of an Aquatic Resources Implementation Monitoring Form for Aerial Treatment of Noxious Weed with Herbicides that was used in the Bitterroot Noxious Weed Treatment Project. This implementation monitoring is intended to help direct and document attention on the need to take actions to avoid and transport of herbicides to surface waters

Response: Thank you for the copies of the appendices; they were incorporated into a new appendix specifically designed to address the aerial spray project. Since these recommendations, checklists, and monitoring forms continue to be improved as we gain experience with aerial spraying, we will use the most pertinent versions at the time of the project implementation. Most of the aerial spray recommendation and mitigation measures listed in EIS page 2-18 and 2-19 were a synthesis of other National Forest's environmental analysis (including the Lolo, Bitterroot, Beaverhead-Deerlodge, and Helena).

- 3-33. For improving public understanding and disclosure we recommend that herbicide specimen labels, material safety data sheets be included in the FEIS Appendices.

Response: The most current information is readily available on the internet. For example, the National Pesticide Information Center posts labels and material safety data sheet on their web page < <http://npic.orst.edu/tech.htm> >. Placing a copy in the FEIS will become dated and thus misleading. Using the current label is required for safe and legal use of the product.

- 3-34. Please be aware that certain pest control activities described the EIS may fall under EPA's Worker Protection Standards if, (1) the U.S. Forest Service is the "employer" in control of the "operation" and the operation involves or is related to commercial production of timber or timber products, (2) the U.S. Forest Service is using WPS-labeled pesticides, and (3) the pesticide application in question are related to production of timber/timber products and they are not covered by one of exception or exemptions.

Response: The use of herbicide in the EIS is not related to the production of timber or timber products, so this is not applicable.

- 3-35. We believe the draft and final EIS should include the Biological Assessment, and the final EIS should include the associated FWS Biological Opinion or formal concurrence for the following reason: (1) NEPA requires public involvement and full disclosure of all issues upon which a decision is to be made; (2) the CEQ Regulations for implementing the Procedural Provisions of NEPA strongly encourage the integration of NEPA requirements with other environmental review and consultation requirements so that all procedures run concurrently; (3) the Endangered Species Act (ESA) consultation process can result in the identification of reasonable and prudent alternatives to preclude jeopardy, and mandated reasonable and prudent measures to reduce incidental take.

EPA recommends that final EIS and Record of Decision not be completed prior to the completion of ESA consultation.

We also note that the EIS discussing threatened/endangered terrestrial wildlife species does not mention threatened/endangered plants, fish, or insects. If no other endangered or threatened species exist within or downstream of Gallatin National Forest Boundaries, EPA suggests including a sentence stating this.

Response: A Biological Assessment was prepared for the Selected Alternative. The deciding officer selects the alternative only after reviewing public comment on the draft EIS. This Biological Assessment was submitted to the U.S. Fish & Wildlife Service as required under Section 7 of the Endangered Species Act. The resulting concurrence letter has been incorporated into the Final EIS. The Section 7 consultation was completed prior to the issuance of the final EIS and Record Of Decision.

There are no species of plants, fish, or insects on the list of threatened, endangered, and candidate species for the Gallatin National Forest. All species on this list were addressed in the draft EIS.

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A copy of this letter is available at the end of this Chapter.

- 4-1. Concerned about herbicide impact on threatened and endangered species (migratory birds, grizzly bears, lynx, and wolves). Proposed not using herbicides with potential to cause severe dermal irritation, especially eye injury, not be applied aerially.

Response: An analysis of the impacts of herbicides as well as other associated project activities to threatened and endangered species was included in the Biological Assessment. The conclusion was that risk of eye injury to threatened and endangered species from use of these herbicides was very low and none of the herbicides have severe dermal toxicity. These herbicides have other characteristics that make them very desirable for weed treatment, such as low toxicity, selectivity (only impact a few plant species thus reducing impacts to non-target plant species), low risk of developing herbicide resistance in weed species, and/or approval for aquatic use. Therefore, this suggestion was not incorporated into the mitigation measures

- 4-2. Recommend more detail to the effects of application to Canada lynx. Under Affected Environment, page 3-27, approximately 9 percent or 1000 acres of known weed infestation occurs in sub-alpine forest typical of lynx habitat. Most of the infestation occurs in clear-cuts that are not considered suitable to meet lynx resource needs. In clear-cuts that are considered potential lynx habitat, then develop a treatment plan to retain as many woody plants as possible. Retention of shrub and tree components covered in the CLCAS page 7-11 and 7-6.

Response: We recognize that weed treatments must be designed to retain native trees and shrubs for a variety of reasons. In addition to protecting habitat for lynx,

bald eagles, and other wildlife, weed treatments in clear cuts that do not inhibit regeneration of native trees and shrubs would also facilitate weed control. This is because most weeds cannot grow under the dense forest cover, and therefore do not persist once regeneration is advanced enough to shade out the weeds. The mitigation measure in the draft EIS has been reworded for the final EIS to reflect the fact that herbicide use will be designed to minimize the potential for mortality of native trees and shrubs. More specifically, use herbicides that do not kill trees and shrubs, or stay away from the root uptake zone (the radius of a circle equal to the tree height).

- 4-3. In the Decision Tree for New Weed Location on pages S-6 and 2-13: Moving from weed location “No” to Threatened, Endangered or Sensitive species present “Yes”, replace “Mitigation” with “Further Action - if adverse effects are likely, consultation with the US Fish Wildlife Service will be Necessary.

Response: Thank you for your suggestion; this has been incorporated into the final EIS (Table 1, on page S-6; and Table 2-6, page 2-13).

- 4-4. Avoid introduction of sheep or goats outside of Grizzly Bear Management Situation 1, if this cannot be avoided then the mitigation measures listed in the EIS would minimize grizzly bear depredation.

Response: Although the mitigation measures listed in the EIS would minimize the risk of sheep or goat depredation there is always a risk that an incident may occur. As an added mitigation measure, that the use of sheep or goats inside the grizzly bear recovery area will be prohibited. It is important to realize that the mitigation measure designed to prevent the spread of disease to bighorn sheep requires a nine-mile separation, and will essentially prohibit the use of sheep or goats south of Interstate 90 (well outside of the grizzly bear recovery zone).

- 4-5. Recommend adding the following mitigation measure for Alternative 1: aerial spraying in a bear management subunit should be coordinated with other administrative uses to avoid exceeding aggregated allowed use within secure habitat.

Response: This mitigation measure has been incorporated into the final EIS (Table 2-11, mitigation measure number 7, page 2-18).

- 4-6. Montana Bald Eagle Management Plan, guidelines for Zone III includes the use of pesticides, which pose no hazard to eagles. We recommend that aerial and broadcast herbicide spray located within 2.5 miles of active nest be prohibited. This would minimize adverse effects due “uncertainty regarding toxicity of some herbicides and inert ingredients” as well as minimizing aerial drift and unexpected direct exposure.

Response: An analysis of the impacts of herbicides as well as other associated project activities to threatened and endangered species was included in the Biological Assessment. The conclusion was, that the risk of adverse effects to bald eagles from aerial and broadcast herbicide application was very low. Aerial and broadcast application of herbicides are important tools for treating weeds, and given the very low risk to eagles, this suggestion was not incorporated as mitigation.

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- 5-1. We request that the Forest Service fully evaluate a prevention-focused alternative. It is important that prevention-focused weed management – i.e. sufficient seed vector interception – has the only chance of success.

Response: We agree that prevention is an extremely important tool in weed management. These measures currently exist and therefore they were not made part of the alternatives considered in the EIS. For example, your concern regarding Off-Highway Vehicles acting as a major vector of weeds has been minimized by the implementation of the 2001 Off-Highway Vehicle Record of Decision, which restricted the use of off-road vehicles. The Gallatin Forest implemented the OHV decision in 2002 by posting signs that prohibit travel off designated routes, and by hiring ATV rangers to patrol and enforce the travel restrictions. The Forest is also in the process of revising the Travel Plan that may result in further travel restrictions. The risk of weed spread from vehicle travel is currently being addressed through the Gallatin National Forest Travel Management Plan EIS.

In addition to restricting OHV use, the Regional Forester for the Northern Region incorporated other prevention activities (listed in Appendix A) into the Forest Service Manual in 2001. The Gallatin National Forest is currently implementing and will continue to implement these prevention activities. Please review Appendix A, to see a complete list of all the prevention activities currently covered by the Forest Service Manual.

A prevention alternative that prohibits activities that are authorized under existing public laws, regulations, permits, and the Gallatin Forest Plan is beyond the scope of this EIS and will not be considered (EIS, page 2-3). As these ongoing activities are reviewed in the future, the issue of invasive weeds will be evaluated if it pertains to the project. If the project causes an increase in weeds, the project will be modified to reduce the risk of spreading weeds.

- 5.2 The EIS lacks even a minimally – comprehensive monitoring program. Data on soil chemistry, hydrology, microclimates, vegetation, and even on species competition, is necessary for every ecological niche where weeds might establish; to inform you where and when a given control technique may succeed.

Response: The monitoring section in the EIS is presented on page 2-17. To monitor the weed population and the effectiveness of the treatment, the Forest Service is in the process of developing a standardized national database (using both spatial and tabular information). Currently, the Gallatin Forest has entered the data for existing weeds (both spatial and tabular) into the national database. As new weed infestations are discovered, they will be mapped and site characteristic information will be recorded into the database. Details regarding mapping standards and data attributes can be found in the project file. Starting in the summer of 2005, treatment data for each site will also be recorded. The database and maps will help document the effectiveness of the treatment by comparing the weed infestation (size and density) over time. Since the national database is in a GIS (Geographic Information System) compatible format, correlations between treatment types and attributes such as soil

chemistry, hydrology, microclimates, and vegetation can be derived through spatial modeling.

- 5-3. There is a large data gap regarding the adverse effects of pesticides, which the Forest Service has not adequately addressed. The data used by EPA in the pesticide registration process is of poor quality, and it is no surprise that EPA registers these pesticides for use. Our Appendix 1 summarizes much of the studies published in independent peer-reviewed journals, occasionally by government agencies, which contradict the database assembled for the registration of these herbicides. Specifically, your Table 3-22, which completely summarizes your evaluation of the chronic toxicity risks, as well as conclusions of the herbicide risk assessments that you relied on; both which relied entirely on the chronic toxicity tests during registration. For every cell of table 3-22 our main appendix cites multiple and far more valid (independently published) results that contradict the cell's claim of "No Effect", "Unlikely", or "Unknown." It is ridiculous to claim these four categories of chronic toxicity (carcinogenic, teratogenic, reproductive and mutagenic) can evaluate safety. Moreover, the chemical risk assessment relied on testing only the effects of very high doses, instead of the actual-experienced doses.

Response: We agree that Table 3-22 in the EIS needed clarification, so it was revised in the final EIS to better display the information summarized in the Infoventure's fact sheets. The intent of Table 3-22 was to briefly summarize the chronic effects information used by EPA to evaluate toxicity, with respect to establishing NOAEL (no observable adverse effects level) and reference doses. The EIS acknowledges that there is a level of uncertainty regarding unknown effects of herbicides (page 4-71) due to a lack of data. Literature cited in your appendices was reviewed and incorporated into the project record. Our response to this information is described below.

EPA uses both peer-reviewed and industry funded research from independent research facilities to evaluate toxicity (<http://www.epa.gov/pesticides/factsheets/riskassess.htm>). Many of the herbicides are being re-registered by EPA, and recent independent peer-reviewed literature was included in the evaluation process. The Forest Service risk assessment also reviewed literature (peer-reviewed, industry funded, and Confidential Business Information) to evaluate toxicity (SERA. 2001. Preparation of Environmental Documentation of Risk Assessment).

EPA uses carcinogenic, teratogenic, reproductive and mutagenic when evaluating chronic effects; along with effects to hormone disruption, immune system, and nervous system. The EIS considered four types of chronic toxicity on pages 3-48 to 3-51, plus the effects of hormone disruption on pages 4-70 through 4-71, and effects of other chemical endpoints or impurities of the herbicide on page 4-67 to 4-69. EPA intentionally uses a range of dosage levels in their dose-response assessment, for the purpose of establishing exposure limits, and determining the level of "no observable adverse effects" (<http://www.epa.gov/pesticides/factsheet/riskassess.htm>). EPA then establishes mitigation measures to reduce the amount of exposure. Many of the effects cited in your appendices are at dosages beyond the acceptable exposure levels. This is not intended to minimize the health effects concerns; rather, explain the risk assessment process and why there are studies that have documented effects from the herbicides.

Comments made in your Appendices are addressed in the following section.

- 5-3.1) The draft EIS (Table 3-22) claims that picloram has “unknown” carcinogenic properties but it contains hexachlorobenzene (HCB) contaminants; a potential carcinogenic compound. Also, in Table 3-22 of the draft EIS claims that picloram has “no effect” teratogenic or reproductive effects, and “unlikely” to have mutagenic effects; but studies have shown this is not true. The EPA Reference Dose is at 0.07 mg/kg/day, but the FS uses 0.2.

Response. Table 3-22 has been revised in the final EIS to improve the documentation of chronic effects as cited in Infoventures. For more information regarding chronic toxicity, refer to project file (USFS. 2003b); or http://www.fs.fed.us/foresthealth/pesticide/risk_assessments/03431601b_picloram.pdf. We acknowledge that EPA is requiring additional studies on the effects of picloram.

The risk assessment in the EIS (page 4-67) acknowledge that hexachlorobenzene (HCB) is present in picloram, in low concentrations, and that it causes cancer in the mammal species and classified as a potential human carcinogen by EPA. The risk of exposure to HCB in the environment is low because it is present in very low concentrations (workers are expected to receive exposures to levels below general background levels by a factor of 2 to 5, and general public by a factor of 50 to 10,000) (USFS. 2003b. page xiv).

In 1993, the Office of Pesticide Programs RfD Peer Review Committee of the EPA recommended a No Observable Effects Level at 20 mg/kg/day, an uncertainty factor of 100 was added, and a Reference Dose calculated, the chronic RfD is 0.20 mg/kg/day (US EPA. 1995. Picloram. RED. page 23).

The risk of workers or the general public being exposed to picloram (acute exposure) is well below the EPA reference dose of 0.2 mg/kg/day (USFS. 2003c. pages xiii and xiv).

- 5-3.2) Table 3-22 in the draft EIS claims that triclopyr has “No Effect” carcinogenic, teratogenic, reproductive, and mutagenic effects, but studies show this is not true.

Response: Table 3-22 has been revised in the final EIS to improve the documentation of chronic effects. For more information regarding chronic toxicity, refer to the project file (USFS. 2003c); or http://www.fs.fed.us/foresthealth/pesticide/risk_assessments/0303_triclopyr.pdf. We recognize that the following studies have indicated some chronic effects from triclopyr at high dosage levels:

- That triclopyr carcinogenicity studied in mice found an increase in symptoms at the higher doses tested (US EPA. 1998. page 10);
- That triclopyr affected dogs at the 20 mg/kg/day but not at the lower doses (US EPA. 1998. page 9).
- That triclopyr caused maternal and developmental toxicity at 100 mg/kg/day in rabbits but not at the lower doses (US EPA. 1998. page 12);

- That triclopyr caused a higher frequency of embryo loss at the middle and highest doses (7 and 70 mg/kg/day) (US EPA. 1998. page 15).

For the central exposure scenarios, the risk of the general public being exposed (acute) to triclopyr is below the reference dose of 0.05 mg/kg/day (USFS. 2003c. page 3-22). Workers that were involved in broadcast application could expect approximately 0.0224 mg/kg/day (USFS. 2003c. page 3-15). Backpack sprayers would expect an average acute exposure of 0.0131 for Garlon 3A®.

- 5-3.3 Table 3-22 in the draft EIS claims the clopyralid has “no effect” on carcinogenic, teratogenic, reproductive, and mutagenic effects, but data gaps and studies show this is not true.

Response: Table 3-22 has been revised to improve the documentation of chronic effects, as cited in Infoventures. For more information regarding chronic toxicity, refer to USFS. 2004d, in the project file; or http://www.fs.fed.us/foresthealth/pesticide/risk_assessments/120504_clopyralid.pdf We recognize that the following studies have indicated some chronic effects from clopyralid:

- Four studies on mice and rats indicate that no evidence carcinogenic activity has been detected (USFS. 2004d. page 3-3);
- At doses of 100 mg/kg/day various reproductive and teratogenic effects have been observed in different species and bioassays; but not at lower doses (USFS. 2004d. page 3-3).
- Technical grade clopyralid has an average concentration of less than 2.5 ppm of hexachlorobenzene as a contaminant, which is classified as a potential carcinogen.

The risk of workers or the general public being exposed (acute) to clopyralid is well below the reference dose of 0.15 mg/kg/day (USFS. 2004d. pages xi and xii).

- 5-3.4 Table 3-22 in the draft EIS claims the 2,4-D has “unknown” carcinogenic, and “unlikely” teratogenic, reproductive, and mutagenic effects, but studies show this is not true. Also, 2,4-D is always contaminated with carcinogenic dioxin 2,3,7,8 – TCDD.

Response. Table 3-22 has been revised to improve the documentation of chronic effects, as cited in Infoventures. For more information regarding chronic toxicity, refer to USFS, 1998a, 2,4-D, in the project file; or http://www.fs.fed.us/foresthealth/pesticide/risk_assessments/091702_24d.pdf. We recognize that the following studies have indicated chronic effects from 2,4-D:

The EIS does discuss the issue of dioxin and 2,4-D on page 4-68. In addition, the following Extoxnet publication documents the presence of dioxins in 2,4-D: “...A subsequent study of 2,4-D manufactured in the United States found very little dioxin contamination. Measurable amounts of one form of the compound (2,7 DCDD) were found in 3 of 30 samples, with traces of other isomers. The

amounts found do not have biological significance.”

<http://pmep.cce.cornell.edu/profiles/extoxnet/24d-captan/24d-ext.html>.

We acknowledge that at high doses of 2,4-D there are effects to carcinogenic, teratogenic, reproductive, and mutagenic test animals. Also, the EPA has requested additional studies for carcinogenic, teratogenic and mutagenic effects.

The risk of workers being exposed (acute) to 2,4-D is at or slightly above the reference dose of 0.01 mg/kg/day (USFS. 1998a. pages xv and xvi). Backpack sprayers have an estimated exposure of 0.013 mg/kg/day, while upper limits of estimated exposure are 0.08. Wearing protective personal equipment will reduce the amount of exposure for the workers. The general public is below the reference dose at 0.002 and 0.0087 mg/kg/day (central and high exposure levels).

- 5-3.5 Table 3-22 in the draft EIS claims that hexazinone has “unlikely” for carcinogenic, teratogenic, and reproductive, and “no effect” for mutagenic effects, but studies show this is not true.

Response. Table 3-22 has been revised to improve the documentation of chronic effects, as cited in Infoventures. For more information regarding chronic toxicity, refer to USFS, 1997b, in the project file; or http://www.fs.fed.us/foresthealth/pesticide/risk_assessments/091702_hexazinone.pdf. We recognize that the following studies have indicated some chronic effects from hexazinone:

We acknowledge that hexazinone can have carcinogenic, teratogenic and reproductive effects at high doses, and that one out of four mutagenic tests was positive.

The risk of workers or the general public being exposed (acute) to hexazinone is well below the reference dose of 0.05 mg/kg/day (USFS.1997b. page xii).

- 5-3.6 Table 3-22 in the draft EIS claims that all sulfonureas (metsulfuron methyl, sulfometuron methyl and chlorsulfun) has “no effect” for all categories,” except sulfometuron methyl is “unlikely” for reproductive, but studies show this is not true.

Response: Table 3-22 has been revised to improve the documentation of chronic effects, as cited in Infoventures. For more information regarding chronic toxicity, refer to USFS 2004f, in the project file; or http://www.fs.fed.us/foresthealth/pesticide/risk_assessments/121404_Sulfometuron.pdf. We recognize that the following studies have indicated chronic effects from sulfonureas:

The following quote from, Sulfometuron methyl – Human Health and Ecological Risk Assessment (USFS. 2004f), summarizes many of your concerns: “... The most common signs of toxicity involve changes in blood consistent with hemolytic anemia (i.e., a lysis or destruction of blood cells that results in a decreased number of red blood cells) and decreased body weight gain. It is

plausible that hemolytic anemia caused by sulfometuron methyl is attributable, at least partially, to the metabolism of sulfometuron methyl to sulfomamide and saccharin. In a 1-year dog feeding study, several effects, in addition to those on the blood, were observed, including increased alkaline phosphatase activity, increased serum cholesterol (females only), decreased serum albumin and creatinine, as well as changes in liver and thymus weight. These effects, however, were not clearly attributed to sulfometuron methyl exposure. In chronic feeding studies with rats and mice and in several in vitro assays, sulfometuron methyl did not display carcinogenic or mutagenic activity.

There is some concern for the potential reproductive and teratogenic effects of sulfometuron methyl. Gavage studies in rabbits suggest that sulfometuron methyl exposure may increase the number of fetuses with anomalies as well as the proportion of fetal anomalies per litter. In addition to the two teratogenicity studies in rabbits, there are three reproductive studies involving dietary exposure of rats to sulfometuron methyl, in which effects were observed in dams (decreases in maternal body weight gain associated with decreased food consumption) and offspring (decreased fetal weight, decreased numbers of pups, and decreased brain weights)....”

The risk of the general public being exposed (acute) to sulfometuron is well below the reference dose of 0.02 mg/kg/day (USFS, 2004f, page xiii). The average acute exposure for workers is 0.000591 for backpacks and 0.0011 for boom sprayers.

- 5-3.7** Table 3-22 in the draft EIS claims that imazapyr has “unknown” effect for carcinogenic and reproductive; and “no effect” for teratogenic and mutagenic, but studies show this is not true.

Response: Table 3-22 has been revised to improve the documentation of chronic effects, as cited in Infoventures. For more information regarding chronic toxicity, refer to USFS, 2004a, in the project file; or http://www.fs.fed.us/foresthealth/pesticide/risk_assessments/121804_Imazapyr.pdf We recognize that the following studies have indicated chronic effects from imazapyr:

- Tests show effects to brain thyroid and adrenal tumors in test animals at high doses;
- The EPA classified imazapyr as Group E – evidence of non-carcinogenicity, when exposed to doses below the toxicity response threshold.

The risk of workers or the general public being exposed (acute) to imazapyr is well below the reference dose of 2.5 mg/kg/day (USFS, 2004a, page xiii).

- 5-3.8** Table 3-22 in the draft EIS claims that dicamba has “no effect” for carcinogenic, teratogenic and mutagenic; and “unlikely” for reproductive, however, studies show this is not true. Concerned that 2,7DCDD (dioxin) is a reproductive toxicant.

Response: Table 3-22 has been revised to improve the documentation of chronic effects, as cited in Infoventures. For more information regarding chronic toxicity,

refer to USFS, 2004, in the project file; or http://www.fs.fed.us/foresthealth/pesticide/risk_assessments/112404_dicamba.pdf. We recognize that the following studies have indicated effects from dicamba:

From the four teratogenicity studies, one with rats and three with rabbits (USFS. 2004. page 3-6), it was determined that rabbits were more sensitive than rats, with a NOAEL level of 3 mg/kg/day for rabbits and 400 mg/kg/day for rats.

Some studies have noted an increase in soft tissue sarcomas and non-Hodgkin's lymphomas in test animals exposed to phenoxy herbicides (USFS. 2004. page 3-6).

At doses above the chronic and reproductive NOAEL (no observed-adverse effect levels, 50 mg/kg/day chronic, 25 mg/kg/day reproductive), dicamba may have neurotoxic effects (USFS. 2004. page xii).

The risk of workers or the general public being exposed (acute) to dicamba is well below the reference dose of 0.045 mg/kg/day (USFS. 2004. page xiii).

- 5-3.9 Table 3-22 in the draft EIS claims that glyphosate has “no effect” for carcinogenic, teratogenic and mutagenic; and “unlikely” for productive; but studies show this is not true.

Response: Table 3-22 has been revised to improve the documentation of chronic effects, as cited in Infoventures. For more information regarding chronic toxicity, refer to USFS, 2003a, in the project file; or http://www.fs.fed.us/foresthealth/pesticide/risk_assessments/04a03_glyphosate.pdf. We recognize that the following studies have indicated chronic effects from Glyphosate:

- Some studies have found an increase in non-Hodgkin's lymphoma, but EPA determined that the study does not establish a definitive link to cancer (USFS. 2003a. page 3-17);
- Tumors have been observed in some of the chronic toxicity studies, but the results were not conclusive (USFS. 2003a. page 3-16);
- Studies found teratogenic, reproductive and mutagenic effects at high doses (USFS. 2003a. page 3-13);
- Health effects associated with contaminants: Glyphosate contains the contaminant N-nitroso glyphosate (NNG) at 0.1 ppm or less (for more than 92% of those samples). EPA concluded that NNG content of glyphosate was not toxically significant. None of the recent reviews on the toxicity of glyphosate cite contamination with NNG as a concern. Another contaminant is 1,4-Dioxane, a known cancer-causing agent, is a common constituent of ethoxylated surfactants. 1,4-Dioxane is almost non-detectable in the Roundup® formulation (USFS. 2003a. pages 3-25 and 3-26). The risk of being exposed to cancer causing doses is extremely low.

Glyphosate was classified by the EPA as “Group E: Evidence of non-carcinogenicity for humans” which is also consistent with the assessment by World Health Organization (USFS. 2003a. page 3-16).

The risk of workers or the general public being exposed (acute) to glyphosate is well below the EPA reference dose of 2 mg/kg/day (USFS. 2003a. page xv).

- 5-4. The EIS needs to consider the possibility of toxicity from chemical mixtures (e.g. herbicide formulations, and mixtures of herbicide active ingredients. We submit Appendix 2; our own collection of literature on this subject.

Response: The EIS does consider the synergistic interaction of herbicides (pages 4-66 to 4-67). We reviewed your Appendix 2 and we agree that there is synergistic interaction with herbicides, and with other chemicals. The health risks associated with different combinations are uncertain at this point in time. Mitigation measures to limit the amount of exposure to herbicides are listed in Table 2-11 on pages 2-18 to 2-20, and in Appendix B of the EIS.

- 5-5. We note that more than most of the National Forests in Montana, you have relied on the junk non-science of Dr. Felsot. We dispute these claims by attaching Appendix 3, a critique of his paper. It effectively shows almost all of his conclusions that you are relying on are false.

Response: The Gallatin National Forest Weeds EIS referred to Dr. Felsot's paper for the following conclusions:

- 1.) "Occasionally by products or impurities are considered toxicologically hazardous, and their concentrations must be limited so that potential exposures do not exceed levels of concern (Felsot. 2001. page 28) (EIS, page 4-67)."

The comments in Appendix 3 of your letter do not seem to refute this conclusion.

- 2.) The EIS (page 4-70) does refer to Dr. Felsot's summary on endocrine disruption. Your Appendix 3 suggests that Dr. Felsot's analysis does not account for "man made hormone disrupting chemicals" being more persistent in the body than natural hormones, and that the body maybe more effected by them.

You then summarized the issue, quite well: "... the evidence is not yet sufficient to conclusively demonstrate whether or not humans are affected by hormone disrupting chemicals. Moreover, another recent prestigious review of the hormone disruption hypothesis, this time looking specifically at low level effects, found significant and varied evidence for low dose hormone disruption, though again conservatively insisting that the evidence in this new field is not yet sufficient to assign low-dose causation to hormone disrupting chemicals."

The EIS addressed this uncertainty on page 4-71.

- 3.) The EIS also referenced Dr. Felsot's paper with regard to drift and risk of exposure (draft EIS, Page 4-72), but this was not addressed in your critique of Dr. Felsot's report.

- 5-6. Consider our Appendix 4, another incomplete review of the resistance literature on herbicides.

Response: The EIS does address herbicide resistance on page 3-10. We reviewed your Appendix 4 and agree that weed resistance is a concern. On the Weed Science

web-page <<http://www.weedscience.org/in.asp>> the following five invasive weed species of interest to the Gallatin Forest were listed as having confirmed cases of resistance:

Species	Number of Confirmed Cases	Location	Herbicide
Canada thistle	2	Europe	2,4-D
Field bindweed	1	Kansas	chlorsulfuron
Scentless chamomile	2	Europe	2,4-d
Tall Buttercup	1	Australia	MCPA
Yellow starthistle	1	Idaho	picloram

Rotating between “chemical family” and preferably by “mode of action” helps to minimize development of herbicide resistant weeds as shown in Table 3-6 of the EIS. Alternative 3 (No change from Current Management) is limited to the use of only two herbicides (2,4-D and picloram) so it is more vulnerable to the development of resistance. Alternatives 1 and 4 are less vulnerable to herbicide resistance because they allow for the rotation of herbicides with different “mode of action” and “chemical families.”

- 5-7. Our Appendix 5 shows clearly the ability of pesticides to drift farther than you and other National Forests have estimated, and summarizes much documented damage from drift and volatilization. We acknowledge that the USFS field tests, such as on the Lolo National Forest Mormon Ridge project, seem to show little drift from aerial and ground herbicide application, but we have to date seen no data proving that you effectively monitored for drift. Not only is it possible for much of an application to pass overhead of your drift monitors if they are too close to the target area, it appears that you did not monitor for anything but course visible droplets.

Response: We agree that herbicides can drift and vaporize; but, the amount of drift or vaporization can be minimized by using mitigation measures listed in the EIS, pages 2-18 and 2-19. Herbicide drift was addressed in the EIS on pages 4-71 through 4-76. Your concern regarding inversions, and the associated problem with drift, has been addressed with a new mitigation measure that states not to spray during an inversion (mitigation measure number 14, page 2-19). Appendix G, Aerial Spray Recommendations, was added to the Final EIS to help identify other recommendations for reducing drift.

The concern regarding drift from fine spray droplet size can be effectively mitigated by using larger droplet size (nozzle type – fan not hollow cone, pump pressure, nozzle orientation – staggered and backwards so less wind shear, boom height, and drift reduction agent). Detailed information about selecting the correct nozzle to reduce risk is available in the project file and in the internet <<http://www.extension.iastate.edu/Publications/IPM68.pdf>>. A drift reduction agent such as Sta-Put™, an isopropanol, will reduce the amount of drift and has minimal impact on human health or the environment. The material Safety data sheet for Sta-Put, warns that the product is a mild skin and eye irritant to humans, essentially non-toxic to rainbow trout and sheepshead minnow, and slightly toxic to mysid shrimp and daphnia (project record).

As stated in your Appendix 5, the recommended droplet size for herbicide is between 250 and 400 microns, and the literature sites problems with drift when droplet size is < 200 microns (which is more appropriate for insecticides and fungicides). While it is true, nozzles produce a range of droplet sizes, and that a nozzle with a large orifice generally produces more large droplets, some of the spray droplets are small and prone to drift. Selecting the correct combination of nozzle design and nozzle pressure will reduce the percent of solution with small droplets to less than 2 to 8 percent of the volume of solution sprayed

<http://pesticidesafety.uiuc.edu/newsletter/html/200401c.html> . This is a very small amount of spray volume, diluted over a large area, which does not produce a measurable effect. Using drift cards, to measure the deposition pattern for the vast majority of the spray volume, is the most effective tool available to monitor drift.

Likewise, vaporization of herbicides can be reduced: avoid using ester formulations (this is the reason the Gallatin Forest is not proposing to use ester formulations); and, avoid spraying during high temperature and low humidity (above 90 degrees Fahrenheit and below 50 percent relative humidity).

- 5-8. We ask the Gallatin National Forest to take a harder look at the potential adverse impacts of the use of herbicides, while analyzing a prevention-first, monitoring-heavy, true Integrated Weed Management program. We emphasize your rare opportunity – due to relatively low weed infestation – to do so; and doing so would create a fascinating natural experiment on the competing weed management philosophies that National Forests in Montana have considered.

Response: Alternative 2 (No-Herbicides) addressed the tradeoff between using and not using herbicides. We agree that prevention is a very effective tool; and, it is already being implemented on the Gallatin National Forest (see Appendix A in the draft EIS for an extensive list of prevention activities). A “prevention-first” alternative that prohibits activities authorized through previous decisions (such as the Gallatin National Forest plan, or other laws and regulations, that authorize multiple uses on National Forest lands) is outside the scope of this EIS (EIS, pages 1-15, 1-16, and 2-3). See our response to comment 5-1 for more information. Our approach to an integrated weed management program is described in the EIS on page 1-7.

- 5-9. Our Appendix 6 presents research regarding low dose toxicity. “A single pesticide application may give exposed organisms the right amount of poisons to cause a disease in the long term, even if it is not a persistent, bioaccumulative toxin (PBT).”

Response: The low-dose theory, advanced by some researchers, hypothesizes that a variety of biological effects might occur from very low exposures to compounds even when no effects are seen at higher exposure levels. The implication of this type of research is not clearly understood at this point in time. The draft EIS acknowledged that there is uncertainty (page 4-71), within the scientific community, regarding the effects of low level chronic exposure.

This next section contains copies of
the comments letters.

Mailroom R1 Gallatin
Sent by: Pamela Bentley
08/02/2004 09:18 AM

To Susan G Lamont/R1/USDAFS@FSNOTES
cc Steve Christiansen/R1/USDAFS@FSNOTES
bcc
Subject Re: public comment on fed register of 7/16/04 vol 69 no 136
page 42722

Bk1492@aol.com



Bk1492@aol.com
07/31/2004 06:02 AM

To: mailroom_r1_gallatin@fs.fed.us
cc:
Subject: public comment on fed register of 7/16/04 vol 69 no 136 page 42722

us epa er fri 6653-6
eis 040321 draft eis gallatin invasive weed

1-1
1-2
i think this plan is wasteful. maybe you should just let the weeds alone. it takes many manhours to attack weeds. i also want to oppose burning. burning the forest is a terrible, horrid, anti environmental action. burning releases air particulates which causes heart attacks, genetic malformations and asthma in children, plus other health problems for people and wildlife. it drives wildlife out of their homes. NO BURNING EVER.

B. SACHAU
15 ELM ST
FLORHAM PARK NJ 07932

Madison County Board of CommissionersCommissioners

C. Ted Coffman
 Frank G. Nelson
 David Schulz

PO Box 278,
 Virginia City, MT 59755

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Phone: (406)843-4277

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August 6, 2004

Noxious Weed Control Project
 Hebgen Lake Ranger District Office
 P.O. Box 520
 West Yellowstone, MT 59758

USDA FOREST SERVICE		
Hebgen Lake Ranger District		
West Yellowstone, MT		
AUG 9 2004		
Ranger: _____	All: _____	File: _____

Friends,

Thank you for the opportunity to comment on the proposed Gallatin National Forest Noxious and Invasive Weed Control Plan. As with many other areas of Montana, noxious and invasive Weeds severely threaten the native vegetation in this area. Landowners and land managers strive to maintain. Noxious Weeds will remain a serious problem until we all recognize and prioritize this issue as the greatest threat to our natural resource. In this behalf, alone, education is our most valued tool.

Your letter offering opportunity to comment first refers to four questions.

- 1) Regarding effects of herbicides on human health, training to safely and properly apply herbicides, use of label required personal protective equipment, use of quality & properly maintained application equipment greatly limit health risk to humans. Science does generally understand what happens to herbicides as they are used and then break down. Science does not know what will occur if we allow all noxious weeds to spread uncontrolled. This same science has extensively reviewed effects of herbicides on human health over time but can only assume what human health concerns will arise if all vegetation is displaced with invasives. 2-1
- 2) Non-target species must be evaluated in considering control, particularly aerial application of herbicide. However, aerial equipment remains one of the most effective and efficient methods available. Site specific control should be used. Remember, most noxious weeds displace other vegetation. The rare plants may already have been removed. And, if they are not and control is restricted by concern for these plants, spreading noxious or invasive weeds will eventually out-compete and displace them. 2-2
- 3) Some herbicides are labeled for use near water. Care and yet persistence in control is essential to manage these areas. Waterways are a natural transportation means for weed seed spread. Management of some level in these areas is imperative for long-term control. 2-3
- 4) What are the effects on wildlife if we do not control noxious and invasive weeds? Abundant healthy native vegetation is a necessity for their existence. 2-4

I encourage support for and implementation of "Alternative 1". This methodology permits utilization of most weed management methods available today. Alternative 4 is a

F-6

Madison County Board of CommissionersCommissioners

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.....
 Noxious Weed Control Project - 08-08-04

reasonable means of managing weeds. However, Alternative 1 allows the latitude to use aerial herbicide control. This would benefit weed control in areas heavily infested as well as where severe terrain limits adequate management. Further, as wildlife and other animals carry weed seed into areas that are not roaded, aerial control offers another reasonable method to address these sites. (Again, non-target species, etc. need to be evaluated.)

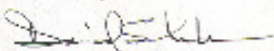
Education and prevention are key in managing weeds. When persons on the land understand the severity of noxious weeds, can identify those weeds and are trained in one or more control means several things occur. They reduce probability of weed establishment and/or spread. Further, they dialog this greater issue with others, who in turn are part of the undefined management team as well. Third, we all benefit from a healthier resource.

Recently, I was part of a team spending time in western Montana reviewing some very quality weed management projects. We reviewed projects on Federal lands as well as private. They are successful because everyone interested in the area is part of the cooperative management team. Fortunately, they are addressing new invaders aggressively. Unfortunately, they have so much spotted knapweed, they can not prioritize that weed in their management plan in all of the management areas. We must not allow that to occur in our area.

Question - Is the environmental consequence of using the entire tool box to manage weeds greater than that of doing nothing or very little. I believe we have too much at stake in regard to the future health of our vegetation resource to not be aggressive.

Thank you for the opportunity to comment.

Sincerely,



David Schulz, Madison County Commissioner
 Chair of the Montana Weed Summit

Cc: Dave Burch, Weed Coordinator
 Montana Dept. of Agriculture

30 August 2004

Public comment: GNF Noxious and Invasive Weed Control Project

Hebgen Lake RD
Gallatin NF, USFS
W. Yellowstone, MT

by email to: comments-northern-gallatin@fs.fed.us

Dear GNF staff:

We, the Alliance for the Wild Rockies and the Ecology Center, have reviewed the Gallatin NF's (GNF) July 2004 draft EIS (DEIS), 'Noxious and Invasive Weed Control Project', and we submit these comments on it in the hope that the GNF's current relative freedom from weeds will embolden you to implement an effective weed control program now, before it is too late to effectively control weeds.

We know of many affirmations and of no disputes from the USFS that human activity has been the primary cause of the growth of weeds in all NF; and that recreational activity--primarily ORVs--has been the main cause of that weed spread. The hyper-elongated shape of most of the GNF's proposed herbicide application areas also indicate that. It is thus evident that prevention-focused weed management--i.e. sufficient seed vector interception--has the only chance of success; so we call on you now to fully evaluate a prevention-focused alternative.

In fact, in coordination with the other Montana NF that are implementing Forest-wide plans to attack various stages of weed infestation, a natural experiment offers. By adopting the only prevention-oriented integrated weed management plan of these NF, a comparison of the effectiveness of these opposing management models may answer the all-important question of which management model actually minimizes weeds. That all these NF already plan increased weed monitoring would facilitate the experiment.

However, there are more fundamental reasons to adopt a prevention-oriented weed management plan. To our knowledge, all prevention-oriented pest management programs are integrated pest management (IPM) programs. Far more than the random use of different weed management techniques (but with heavy reliance on herbicides) that Montana NF weed plans have claimed integrated weed management (IWM) to be; IPM/IWM relies utterly on data, to reveal the most effective management technique in a given environment. While little monitoring is needed to make clear that prevention is highly effective, intensive monitoring *is* crucial to control existing pests, e.g. weeds.

This DEIS lacks even a minimally-comprehensive monitoring program. Data on soil chemistry, hydrology, micro-climates, vegetation and even on species competition is necessary for every ecologic niche where weeds might establish; to inform you where and when given control techniques may succeed. Field experiments have shown that native grasses in the U.S. West can re-invade niches taken over by southern/eastern European weeds, when such variables were altered.¹ Research by famed ecologist David Tilman has shown that it is not simply the ability of a plant to compete for the resources in a given micro-niche that determines its invasiveness, rather it is the ratio of resources used to resources available that predicts the invasiveness of plant species.² Information is the key to success.

In short, we believe that the GNF's relative lack of weeds provides a rare opportunity to perform a natural experiment to prove whether a prevention-focused and truly integrated weed management (IWM) approach (with the necessary monitoring) will minimize weeds; compared to the back-end approach of reliance on herbicides and random application of other controls, that the other Montana NF are implementing. How *can they* be successful, when so many new weed seeds are constantly being brought into their Forests?!

--

There is one additional characteristic of real IPM programs: their minimization of the pesticide tool. This is in part because the data gaps of the adverse effects of pesticides are orders-of-magnitude larger than users, such as the USFS, have thus far admitted (we recently submitted a Data Quality Act (DQA) petition with the USDA to make you account for this). Many USFS scientists have some feel for the complexity and delicacy of biology, so--especially when you consider that humanity has barely begun to investigate chemical toxicity (especially on most of nature--only effects on vertebrates have begun)--there is logically no chance that these new molecules, so foreign to biology, will be mostly benign.

¹ Seabloom et al. 2003 Proceedings Ntl Acad Sci:100:13384 et seq.

² Summarized in: D. Tilman 27 Jul. 2004 'Niche Tradeoffs, Neutrality and Community Structure: a stochastic theory of resource competition, invasion and community assembly' PNAS:101:30:10854-61.

In fact, all chemicals follow a disturbing pattern of chronic exposure safety testing. For example, during pesticide registration (pre-market approval), the party with typically tens of millions to billions of dollars riding on their pesticide being declared safe enough to use performs all the toxicity and related tests. These are of such poor quality that, despite EPA's Good Laboratory Practice (GLP) guidelines, they fail to be accepted for publication in independent scientific journals (with extremely rare exceptions). No surprise then that EPA's Office of Pesticide Programs (OPP)--a fully captured agency with one of the fastest revolving doors--registers these pesticides for use, using FIFRA's vague "no unreasonable risk" standard and FIFRA's mandate to consider the easy-to-quantify economic benefit to the pesticide manufacturer (while ignoring the unquantified costs, and the unquantified benefits of alternatives). Only then, after sale begins, can legitimate scientists in academe begin to investigate the real risks of pesticides (the alacrity and extent of that work depends on each pesticide's popularity).

That work enables us to present to you the ultimate proof that the above allegations are true. Our [Appendix 1](#) summarizes much of that work for your herbicides (i.e. studies published in independent peer-reviewed journals; occasionally by government agencies). It overwhelmingly contradicts the self-interested (non-science) database assembled for the registration of these herbicides, that you have once again relied on. The self-interested (non-science) purpose of registration easily explains why the conclusions of the two data sets are so entirely opposed.

Specifically, your Table 3-22, pg. 3-49, completely summarizes your evaluation of the chronic toxicity risks, as well as the conclusions of the herbicide risk assessments that you also relied on; both which relied entirely on the chronic toxicity tests during registration. For every cell of this table (the 11 herbicides, times four chronic toxicity categories) our main appendix cites *multiple and* far more valid (independently published) results that contradict the cell's claim of 'No Effect', 'Unlikely' or 'Unknown'. Moreover, we have never comprehensively searched the literature (except for 2,4-D's mutagenicity and carcinogenicity), so obviously there are many more contradictory results to refute the registration-based claims; which frankly are inane.

Beyond this large independent database are mountains of data gaps. It is ridiculous to claim that four categories of chronic toxicity can evaluate safety. Even with the current acceleration of the biologic sciences, it will be at least several decades before enough health endpoints are identified to adequately determine what toxicity tests can fully assess safety; *especially for exposures occurring during the far, far more complex period of development*. Moreover, for almost a century chemical risk assessment has relied on the absurdity (though it benefits the chemical manufacturers and users) of testing only the effects of very high doses, instead of the actually-experienced doses (for the few chronic effects that are currently tested). Rationally, such overwhelming ignorance should elicit only caution; e.g. here: IWM.

Due to public concern, all the Montana NF weed plans including this one have addressed the possibility of toxicity from the chemical mixtures (e.g. herbicide formulations, and mixes of herbicide active ingredients) that organisms are actually exposed to (whereas safety tests are performed on individual chemicals). These USFS assessments have missed almost all the published literature on this subject, instead often relying on assessments such as Dr. Felsot's (see immediately below). We submit to you [Appendix 2](#), our own collection of literature on this subject. Without even performing a specific search, we know of some 40 studies (*just on herbicides!*) that show mixture toxicity (some are clear examples of actual synergistic effect, because enough comparison was done to see if the toxicity was greater-than-additive). Once again, the USFS has failed to take a hard look at knowledge of adverse impacts, as required by NEPA and the Data Quality Act.

Finally here, we note that more than most of Montana NF, you have relied on the junk non-science of Dr. Felsot. We dispute these claims by attaching [Appendix 3](#), a critique of his paper; it effectively shows almost all his conclusions that you are relying on are false.

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That toxicity situation is one reason why IPM programs de-emphasize the pesticide tool. **Far more fundamentally however, IPM exists because of natural selection.** The more reliance that is placed on a single technique, the more that selection pressure (survival of the fittest) responds to create resistance to that technique. Mankind has foolishly chosen to rely massively on pesticides; and to the extent that scientists have looked for resistance to pesticides, they have found that it's increasing exponentially, across all the forms of life that we are trying to suppress--just as theory predicted. Consider our [Appendix 4](#), another incomplete review of the resistance literature for herbicides. Because in our non-comprehensive look at this literature we have found so far no examples--even poor quality or unpublished--of pesticide resistance *not* developing; you should assume that there are many more published studies showing herbicide resistance than we present.

Finally, because it is not disputed that your planned **aerial** application of herbicides has far more adverse effects to non-target flora and fauna than does ground-applied herbicide, we present you with our Appendix 5, again an incomplete summary of the literature that shows clearly the ability of pesticides to drift farther than you and other NF have estimated; and summarizes much documented damage from drift and volatilization that the herbicides you plan to use have caused. We acknowledge that USFS field tests, such as on the Lolo NF's Mormon Ridge, seem to show little drift from aerial and ground herbicide applications, but we have to date seen no data proving that you effectively monitored for drift. Not only is it possible for much of an application to pass overhead of your drift monitors if they are too close to the target area, but it appears that you did not monitor for anything but coarse (visible) droplets.

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In conclusion, we ask the GNF to take a much harder look at the potential adverse impacts of the main tool it currently plans to use, herbicides; but to do so while analyzing a prevention-first, monitoring-heavy, true IWM program to attack weeds with. We emphasize your rare opportunity--due to relatively low weed infestation--to do so; and say again that doing so would create a fascinating natural experiment on the competing weed management philosophies that NF in Montana have considered.

Sincerely,

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Attached:

Appendix 1: Chronic Toxicity critique
Appendix 2: Herbicide Mixtures--Additive and Synergistic Toxicity
Appendix 3: Felsot Report critique
Appendix 4: Growing Resistance to herbicides
Appendix 5: Drift: distance; harm

APPENDIX 1: CHRONIC TOXICITY CRITIQUE

PICLORAM (TORDON, GRAZON)

DEIS Claim: "Carcinogenic: Unknown"

What the Literature Says: The National Toxicology Program and World Health Organization (WHO's Int'l Agency for Research on Cancer, IARC) cancer assays are both regarded as the gold standard of cancer tests. Both of these independent tests found liver tumors in picloram exposed test animals, with IARC additionally finding thyroid tumors.³ NTP concluded carcinogenicity evidence was equivocal; IARC concluded that picloram shows limited evidence of carcinogenicity and is currently unclassifiable. However, picloram's manufacture result in hexachlorobenzene (HCB) contamination; HCB is a probable human carcinogen according to EPA's Office of Pesticide Program's 1997 list of chemicals evaluated for carcinogenic potential, which estimates that HCB in picloram alone accounts for 70% of EPA's allowable risk for HCB exposure.⁴ The exposure to HCB of ground applicators of picloram to exceed EPA's acceptable cancer risk level by ten-fold.⁵ HCB causes cancer in test animals at very low doses: 0.02 ppb in drinking water is calculated to cause cancer in one-in-a million animals.

DEIS Claim: "Teratogenic: No Effects"

What the Literature Says: Picloram caused umbilical hernias at all dose levels and multiple skeletal malformations at both high and low doses,⁶ while male rats suffered atrophied testicles.⁷ Picloram plus 2,4-D ('Tordon 202c' brand) is a very potent teratogen when fed to parent test animals--even to the father alone.⁸

DEIS Claim: "Reproductive: No Effects"

What the Literature Says: A re-review of National Cancer Institute testicular slides of picloram exposed rats and mice determined that many of the animals had testicular atrophy,⁹ after initially finding no atrophy; a result that the manufacturer Dow disputed. Dow did find increased miscarriages at picloram the higher test dose/s,¹⁰ and the State of California found increased embryo loss for the potassium salt formulation of the picloram molecule.¹¹ Picloram plus 2,4-D ('Tordon 202c' brand) is a very potent reproductive toxicant when fed to parent test animals--even to the father alone.¹² The same two a.i. sold as the 4Tordon75D formulation are severely toxic to test animal testicles.¹³

DEIS Claim: "Mutagenic: Unlikely"

What the Literature Says: The National Toxicology Program found that chromosome aberrations and sister chromatid exchanges (SCEs) increased in frequency in hamster ovary cells exposed to picloram.¹⁴ Picloram twice again tested positive for mutagenicity in tests.¹⁵

³ NTP 1997 Report TR-23, 1978; also the IARC picloram monograph.

⁴ EPA/OPP 1996 Picloram RED.

⁵ EPA/OPP 1996 Picloram RED.

⁶ California Dpt. of Food & Agriculture Medical Toxicology Branch 1988 'Summary of Toxicological Data, Picloram' Sacramento CA.

⁷ EPA/Office of Drinking Water (ODW) 1988 'Picloram Health Advisory' Wash. DC.

⁸ Described in the subsection 'MIXTURE TOXICITY AND SYNERGY TOXICITY', immediately after the critiques of individual herbicide of the FEIS' Summary Table.

⁹ M. Reuber 1981 'Carcinogenicity of Picloram' J. Toxicol. & Env. Health:7:2:207-222.

¹⁰ EPA 1995 (Picloram RED).

¹¹ Calif. DF&A 1988.

¹² P. Blakley et al. 1989--3 papers.

¹³ Oakes et al. 2002.

¹⁴ Calif. DF&A 1988.

¹⁵ Muhammed et al. 1993 Mutat. Res.:426:2:193-199; and Verikat et al. 1995 Environ. Mol. Mutagen.:25:1:67-76.

It is worth noting that EPA's official non-cancer safe dose estimate (RfD) for picloram is 0.07 mg/kg of body weight per day, found in EPA's Integrated Risk Information System (IRIS) database. But the main Q-RA that the USFS is relying on uses a picloram RfD almost 3 times higher (less safe), 0.2 mg/kg b.w./day (which happens to be the same as Dow's, the manufacturer of picloram. Nevertheless, there are a few modeled exposures in that Q-RA (which models exposures of pesticide applicators, the general human population, aquatic and terrestrial organism) that exceed the more lenient RfD. How many more would exceed it if they had used the stricter RfD?

TRICLOPYR (GARLON, TURFLON)

DEIS Claim: "Carcinogenic: No Effects"

What the Literature Says: Triclopyr's carcinogenicity has been studied in rats and mice. In both species, feeding of triclopyr significantly increased the frequency of breast cancer.¹⁶

DEIS Claim: "Teratogenic: No Effects"

What the Literature Says: Triclopyr caused kidney defects in dogs at 1/10th the dose that the manufacturer Dow found other effects, but Dow persuaded EPA that dog's excretion of triclopyr is slower than humans'; so EPA called this a "non-toxic" response and approved triclopyr for use at the necessary application rates.¹⁷

DEIS Claim: "Reproductive: No Effects"

What the Literature Says: Triclopyr caused reproductive effects in tests on rabbits and mice species.¹⁸ Its major metabolite, TCP, disrupts the development of the nervous system that occurs in fetuses, infants, and children. TCP inhibits the growth of nerve cells at just 0.2 ppm, and it accumulates in the brains of primates. 2 ppm of TCP inhibits mitochondrial function, and TCP has various other chronic effects and is mobile and persistent, as this family of herbicides generally are.¹⁹

DEIS Claim: "Mutagenic: No Effects"

What the Literature Says: In a study of female rats mated with males who had been dosed with triclopyr, the frequency of embryo loss increased at the middle and high dose (7 and 70 mg/kg).²⁰

CLOPYRALID (LONTREL-T, TRANSLINE, STINGER, CONFRONT)

DEIS Claim: "Carcinogenic: No Effects"

What the Literature Says: EPA has registered this herbicide (i.e. determined there is no unreasonable risk) without even evaluating carcinogenicity; and as of 1998 there was no public information available regarding carcinogenicity.²¹ Because many cancers involve physical damage to DNA--i.e. mutagenicity--it seems likely that this carcinogenicity data gap is related to clopyralid's mutagenicity data gap, below.

¹⁶ EPA/OPP 1996. 'Carcinogenicity Review for Triclopyr' Wash. DC.

¹⁷ EPA/OPP 1998 'RED, Triclopyr' Wash. DC.

¹⁸ EPA/OPP 1998 (triclopyr RED).

¹⁹ Hunter et al. 1999 'Gestational exposure to chlorpyrifos: Comparative distribution of trichloropyrrolidinol in the fetus & the dam' Toxicol. Appl. Pharmacol. 158:16-23. (TCP is also a common metabolite of insecticide chlopyrifos).

²⁰ EPA/OPP 1998 (triclopyr RED).

²¹ EPA/OPP 1998 'List of chemicals evaluated for carcinogenic potential', a June 10 internal memo. See also personal communication to Caroline Cox (NCAP) from Rick Whitting, EPA/OPP on Nov. 19 1998, described in Cox Winter 2000 J. Pesticide Reform:20:4:12-19.

DEIS Claim: "Teratogenic: No Effects"

What the Literature Says: hydrocephaly and "[multiple] skeletal abnormalities were evident at all dose levels tested."²² A single ingested dose of clopyralid after 1 hr. caused certain rat gastrointestinal cells to intensively secrete hormones. The cells' cytoplasm and secretory granules were covered with vacuoles.²³

DEIS Claim: "Reproductive: No Effects"

What the Literature Says: EPA's reviewer called clopyralid's reproductive effects "substantial" and occurring in the mother rabbit at all dose levels.²⁴

DEIS Claim: "Mutagenicity: No Effects"

What the Literature Says: The major medicine & toxicology databases were searched by plaintiffs for published independent literature on clopyralid mutagenicity; and none was found. Plaintiff's FOIA-requested EPA's clopyralid mutagenicity data. A 1982 EPA internal memo on the registration of a clopyralid product indicates that three Dow (the manufacturer) mutagenicity studies found clopyralid to be non-mutagenic. However, a 1987 EPA memo summarizing a clopyralid mutagenicity study states that that study is of unacceptable quality (then, a 1991 EPA summary memo states why the additional data that EPA required makes this study (finding no mutagenicity) valid.²⁵ Overall, it is notable that clopyralid has a complete data gap for mutagenicity in the published scientific literature, whether independently peer-reviewed or not--such widely used chemicals are almost always have mutagenicity tests results published. All that is known is that the manufacturer claims that it is not mutagenic (there is no indication that EPA audited or investigating these studies), and that other chemicals in the clopyralid family--picloram and triclopyr--are.

2,4-DICHLOROPHENOXY ACETIC ACID (2,4-D)

DEIS Claim: "Carcinogenic: Unknown"

What the Literature Says: **[Note: most of this literature review is at end of this Appendix 1]**

We note that the robust, somewhat overwhelming evidence correlating NHL with chlorophenoxy exposure is generally thought to be due in significant part to 2,4-D's contamination with dioxins. Contrary to many USFS assertions, 2,4-D is *always* contaminated with the most toxic, highly carcinogenic dioxin, 2,3,7,8-TCDD.²⁶ This famous dioxin is a potent multi-organ known human carcinogen, including a very robust correlation of NHL with chlorophenoxy herbicide manufacture and application workers.²⁷ Also, the amine forms of 2,4-D are highly contaminated (without dispute) with various of the highly mutagenic, carcinogenic nitrosamines.

DEIS Claim: "Teratogenic: Unlikely"

²² EPA/OPP 1991 '(clopyralid): Review of Rabbit Teratology Study Submitted by the Registrant', internal memo from T. McMahon, Mar. 20.

²³ V. Iaglov & I. Ptashkas 1989 'The Reaction of Endocrine Cells of the Gastrointestinal Tract in Response to exposure to 3,6-dichloropicolinic acid' Biull. Eksp. Biol. Med. 107:6:758-61.

²⁴ EPA/OPP 1991 (clopyralid review memo). **Also:** C. Cox Winter 1998 Editorial J. Pesticide Reform:18:4:inside front cover.

²⁵ Personal communication 24 Dec. 2002, EPA/OPPTS FOIA response to Tony Tweedale, Missoula MT.

²⁶ EPA/Off. Research & Development (ORD) 1998 'Inventory of Sources of Dioxins in the U.S.' Wash. DC (summarizing the multiple analytical results that prove this. 2,4-D is a natural precursor molecule to this dioxin's formation).

²⁷ EPA/ORD Sept. 2000 'Dioxin Reassessment Part III: Integrated Summary and Risk Characterization' external review draft (summarizing many positive epidemiologic correlation studies for NHL).

What the Literature Says: Both 2,4-D salts (including the amine) were teratogenic when the Ntl. Cancer Institute tested them before 1970.²⁸ Embryo deaths and kidney & urogenital defects resulted in 2,4-D experiments.²⁹ Increased spontaneous abortions resulted in a 2,4-D experiment.³⁰ Supernumerary ribs resulted from 2,4-D dosing.³¹ Tests on rats showed 2,4-D caused multiple rib malformations and slow backbone formation at higher doses--the same category of defects as found, inter alia, in the following epidemiology studies.³² In human populations, 2,4-D is significantly associated with spontaneous abortions in women exposed 3 months prior to conception, possibly from 2,4-D in the semen of farmers.³³ Throughout rural Minnesota, birth defects were more frequent when parents were carefully estimated to have been exposed to one of the two currently registered chlorophenoxy herbicides, usually 2,4-D.³⁴ Those results were just confirmed in a different population, finding that human conception during the spring herbicide spraying season in 147 high wheat-producing counties (88% of wheat acreage uses chlorophenoxy herbicides (mostly 2,4-D, some MCPA) led to five times the rate of musculoskeletal & circulatory birth defects, compared to low/non-wheat producing rural counties; while year-around conceptions in the chlorophenoxy-using counties resulted in just twice the rate of birth defects. Birth certificates, used here, are known to significantly underreport birth defect, which would affect the high-defect 2,4-D using counties more. The more the several different pesticides used in the low/non wheat-producing rural counties cause birth defects (as many pesticides do), the more the birth defect correlation found with 2,4-D would be underreported.³⁵ In traditional high dose (ppm) animal studies, 2,4-D caused bleeding of the abdominal cavity of rat fetuses.³⁶

DEIS Claim: "Reproductive: Unlikely"

What the Literature Says: 2,4-D is found in the semen of agricultural workers.³⁷ Men with higher body burdens of 2,4-D had significant levels of semen abnormalities.³⁸ Sperm quality and quantity were severely affected in 32 farmers using 2,4-D (urinary verification);³⁹ corroborated by the Minnesota farmers teratogenicity study where in addition birth frequency was half that of non-exposed farmers, and leutenizing hormone levels were too high.⁴⁰ Semen and sperm quality & quantity were poorer in men with elevated 2,4-D burdens in rural (yet not occupational users of pesticides) mid-Missouri men, vs. the semen of men of urban Minnesota areas with low 2,4-D levels.⁴¹ A single high dose of 2,4-D caused a 29% reduction in DNA synthesis in the testis of mice.⁴² 2,4-D alters testicular Leydig cells.⁴³ High subchronic doses of 2,4-D caused testicular atrophy in rats.⁴⁴ Women using chlorophenoxy herbicides

²⁸ Reported in Trial, Nov. 1983 p. 97; and J. Schardein ed. 1983 Chemically Induced Birth Defects 2nd Ed., New York:Marcel Dekker.

²⁹ D. Fofana et al. 2000 'Prenatal Developmental Effects of Pure 2,4-D Acid on the Rat' Congen.Anomal.:40:287-296.

³⁰ T. Arbuckle et al. 1999 'Exposure to Chlorophenoxy Herbicides and the Risk of Spontaneous Abortions' Epidemiology:10:752-760.

³¹ N. Chernoff et al. 1990 'Effects of Chemically Induced Maternal Toxicity On Prenatal Development In the Rat' Teratology:42:651-658.

³² EPA/OPP 1996 '2,4-D Acid: Review of Chronic Toxicity/Carcinogenicity...' 23 May docket memo to the Special Review & Re-registration Branch. Also Chernoff et al. 1990 Teratology 42:651-658.

³³ T. Arbuckle et al 2001 'An Exploratory Analysis of the Effect of Pesticide xposure in the Risk of Spontaneous Abortion in an Ontario Farm Population' Env. Health Perspectives:109:851-857.

³⁴ Garry et al. 1996.

³⁵ Schreinemachers July 2003.

³⁶ ExToxNet 1996 '2,4-D Pesticide Information Profile', Extension Toxicology Network; available <http://extoxnet.orst.edu/pips/24-D.htm>, accessed 30 July 2004.

³⁷ T. Arbuckle et al. 1999 '2,4-D Acid Residues in Semen of Ontario Farmers' Reprod. Toxicol.:13:6:421-9.

³⁸ Swan et al. Sept. 2003.

³⁹ Lerda & Rizzi 1991 'Study of Reproductive Function in Persons Occupationally Exposed to 2,4-D Acid' Mut. Res. 262:47-50.

⁴⁰ Garry et al. 1996.

⁴¹ S. Swan et al. 2003 'Geographic Differences in Semen Quality of Fertile US Males' Environmental Health Perspectives111:4:414-420. **And** Shanna Swan et al. Sept. 2003 'Semen Quality in Relation to Biomarkers of Pesticide Exposure' Env. Health Perspectives:111:12:1478-1484.

⁴² J. Seiler 1979 'Phenoxyacids As Inhibitors of Testicular DNA synthesis in Male Mice' Bull. Env. Contam. & Toxicol.:21:1&2:89-92.

⁴³ R.C. Liu et al. 1996 'The Leydig Cell Function in Vitro' Fundam. & Applied Toxicol.:30:102-8.

⁴⁴ J. Charles et al. 1996 'Comparative Subchronic Studies on 2,4-D Acid, Amine & Ester in Rats' Fundam. & Applied Toxicol.:33:2:161-5.

(and organophosphate insecticides) had significantly lower fecundity.⁴⁵ Picloram plus 2,4-D ('Tordon 202c' brand) is a very potent reproductive toxicant when fed to parent test animals--even to the father alone.⁴⁶ The same two a.i. sold as the Tordon75D formulation are severely toxic to test animal testicles.⁴⁷ A retrospective study of infertile women found they were almost 27 times(!) more likely to have mixed or applied herbicides (but not insecticides) than fertile women (and 3.3 times more likely to have used fungicides); after adjustment for confounding variables (though living on a farm, ranch or in a rural home reduced the likelihood of infertility; the strong health and fertility of agricultural residents is well known).⁴⁸

DEIS Claim: "Mutagenic: Unlikely"

What the Literature Says: **[Note: this literature review is at the end of this Appendix 1]**

HEXAZINONE (VELPAR, PRONONE)

DEIS Claims: "Carcinogenic: Unlikely"

What the Literature Says: Evidence of carcinogenicity is equivocal.⁴⁹ Hexazinone tested negative for carcinogenicity except in mice at the 300 mg/kg b.w./day dose.⁵⁰

DEIS Claims: "Teratogenic: Unlikely"

What the Literature Says: Maternal dosing of rats above 400 mg/kg b.w./d caused birth defects.⁵¹ Some developmental effects also occurred at higher dosing levels.⁵²

DEIS Claims: "Reproductive: Unlikely"

What the Literature Says: Reproductive effects occurred at the mid and high dose levels--hardly "unlikely".⁵³

DEIS Claims: "Mutagenic: No Effects"

What the Literature Says: The RED Facts summary says one mutagenicity test was positive. However some live animal mutagenicity tests were "inconclusive".⁵⁴

It is worth noting that hexazinone's RfD ("safe" dose) is 0.033 mg/kg b.w./day.⁵⁵ The NOEL the RfD is based on was 10 mg/kg b.w./d, significantly lower than the doses above causing teratogenicity and cancer. It was noted that the NOEL study was not an acceptable chronic exposure study, so that the real NOEL is unknown. Therefore an extra 3-fold "safety" factor was added to the RfD (total 300-fold safety factors), as though this data gap were actually a known quantity. In any case, the hexazinone RED Facts summary cites a different NOEL, 5 mg/kg b.w./day--half that other "NOEL". Using that true (lowest

⁴⁵ K. Curtis et al. 1999 'The Effect of Pesticide Exposure on Time to Pregnancy' Epidemiology 10:112-117.

⁴⁶ P. Blakley et al. 1989--3 papers.

⁴⁷ Oakes et al. 2002.

⁴⁸ A. Greenlee et al. 2003. 'Risk factors for female infertility in an agricultural region' Epidemiology:14:429-436.

⁴⁹ EPA/OPP 1994 'RED Hexazinone Facts Summary'.

⁵⁰ Weed Society of America (WSA)1994 Herbicide Handbook 7th Ed.

⁵¹ WSA 1994.

⁵² EPA/OPP 1994 (Hexazinone RED Summary).

⁵³ EPA/OPP 1994 (Hexazinone RED Summary).

⁵⁴ Weed Soc. 1994.

⁵⁵ USFS & Bonneville Power Admin. 1992 'Risk Assessment for Herbicide Use...'.

known) NOEL, but the same safety factors (because this NOEL was derived from just a 1 yr dosing regime), hexazinone's RfD should be 0.0167 mg/kg b.w./day; i.e. all risk estimates would double (assuming, as always, that a lower NOEL is not discovered).

METSULFURON METHYL, SULFOMETURON METHYL (OUST) AND CHLORSULFURON (GLEAN, TELAR)

DEIS Claims: All three sulfonureas (SUs) "No Effect" in all four categories (except sulfometuron methyl (Oust): "Reproductive: Unlikely").

What the Literature Says: Sulfometuron methyl disrupts reproduction in several ways. Both rats and dogs had various testicular abnormalities, including testicular atrophy.⁵⁶ Sulfometuron methyl also caused smaller litters in both rats and rabbits.⁵⁷ Similar effects occurred in the test of a SU drug.⁵⁸

As to carcinogenicity and mutagenicity: although DuPont's mutagenicity tests on sulfometuron methyl were negative, sulfometuron methyl metabolizes to saccharin,⁵⁹ a mutagen and potent carcinogen (though controversial as to carcinogenicity in humans). One of the known ingredients in sulfometuron methyl (and likely in other SU herbicide formulations), therefore untested during registration, is polyvinyl pyrrolidone, which causes various cancers (mostly sarcomas) in mice, rats and rabbits when tested by the International Agency for Research on Cancer.⁶⁰ The blood of dogs chronically dosed with sulfometuron methyl in feed is severely affected, both red and white (immune) cells. Anemia was very evident. Anemia is strongly associated with leukemia, and cancer of the immune system. The liver and kidneys were also affected in these studies.⁶¹

SUs, such as these three herbicides, stimulate human insulin secretion, which must be kept in balance to avoid disease. Diabetes is a complex disease, associated inter-alia with heart disease. SU herbicides (which also are used as diabetes drugs) affect the critical sodium pump of myocardial cells and have been associated with cardiovascular mortality in humans.⁶² In the many people who take sulfoamide antibiotics, taking an SU drug for diabetes will cause hypoglycemia, as sulfoamide antibiotics inhibit the metabolism of the SU drug.⁶³ SUs can affect thyroid hormone production and balance.⁶⁴

The imidazolinone and SU families of herbicides, whose mechanism of action is acetolactase synthase (ALS) enzyme inhibition in plants, are applied at remarkable low rates. Broad spectrum SU's such as Oust put vast tracts of native vegetation at tremendous risk.⁶⁵ Following unwanted crop reductions in regions where SUs were being used, EPA did controlled field tests of chlorsulfuron. Fruit yields were reduced at levels as low as a thousand times less than the recommended application rate. At less than one hundredth the application rate, various crops suffered yield loss.⁶⁶ But EPA's phytotoxicity tests when registering pesticides does not consider SU's mode of action which attacks plant reproduction (it doesn't consider 80% of a plant's life cycle).⁶⁷ Benlate, a fungicide apparently contaminated with SU's

⁵⁶ EPA/OPP 1 Dec. 1983 'E. I. DuPont Oust Weed Killer', internal memo of A. Arce to R. Taylor, Wash. D.C. Also EPA/OPP 23 Feb. 1993 'Sulfometuron Methyl-Evaluation of two-generation,...', internal memo of R. Fricke to L. DeLuise, Wash. D.C.

⁵⁷ EPA/OPP 23 Feb. 1993 Sulfometuron methyl memo; also EPA/OPP 26 Oct. 1981 'Registration of new pesticide: Oust Weed Killer', internal memo of W. Dykstra to R. Taylor, Wash. D.C.

⁵⁸ Seyler et al. 1992 *Reprod. Toxicol.*:6:447-452.

⁵⁹ EPA/OPP 6 Sept. 1991 'Pesticide environmental fate one-line summary: sulfometuron methyl', Wash. D.C.

⁶⁰ IARC 1999 'N-Vinyl-2-pyrrolidone and polyvinyl pyrrolidone' IARC Monographs:71:1181.

⁶¹ EPA/OPP 1983 Memo from A. Arce to R. Taylor of E. I. DuPont, 13 Oct. (document ID#353-UNR).

⁶² Dennis Kim & Steven Edelmana 22 Feb. 2001. An answer by MD's to a Q&A on Medscape's web site (<http://www.medscape.com>).

⁶³ D. Juurlink et al. (2 Apr. 2003) 'Drug-Drug Interactions Among Elderly..' *JAMA*:289:13:1652-8 (refer's 24-30).

⁶⁴ R. Guazelli et al. 1968 *Acta Diabetol. Latina*:5:614-623; and: J. Hershman et al. 1968 *J. Clinical Endocrin.*:28:1605-1610.

⁶⁵ Short & Colburn 1999 *Toxicol. & Industrial Health*:15:240-275 (summarizing all this data).

⁶⁶ J. Fletcher, T. Pfleeger & H. Ratsch 1993 'Potential environmental risks with the new sulfonurea herbicides' *Environ. Sci. Technol.* 27:2250-2252. **Also** J. Fletcher et al 1995 *Physiol. Plantarum*:94:261-7 **and** J. Fletcher 1996 *Env Toxicol & Chem*:15:1189-96.

⁶⁷ *Journal of Pesticide Reform* Fall '96 16:3:10-11.

made at the same DuPont plant, has generated a flood of lawsuits for unexpected damage to crops.⁶⁸ This would be consistent with the extraordinarily low rates this herbicide works at, for either target or non-target vegetation. Despite the extreme potency of SU and imidazolinones family of herbicides, weeds are growing resistant to them, as is inevitable (see our discussion of resistance)--73 documented species have shown resistance, so far.⁶⁹

IMAZAPYR (ARSENAL, CHOPPER, ASSAULT...etc.) AND IMAZAPIC (PLATEAU, CADRE, ...)

DEIS Claims: "Carcinogenic: Unknown"

What the Literature Says: Though judged that there is evidence imazapyr is *not* a carcinogen, those tests did show increased brain, thyroid and adrenal tumors in the test animals. Yet EPA found that except for the brain tumors, the increases were not greater those found in other tests.⁷⁰ This appears to leave open the possibility that the increase was statistically significant and that imazapyr should have been classified as a possible or actual carcinogen, especially considering the registrant controlled the test. As to the brain tumors, EPA allowed Amer. Cyanamid to re-analyze the pathological slides, after which EPA agreed with a finding that there was evidence of one additional brain tumor in both the dosed and the control animals, which caused the overall increase in brain tumors to move below the level of statistical significance.⁷¹ Even short of fraud, it is unusual for an accepted cancer assay result to have its raw results changed on re-analysis.

Similarly with imazapic, it was classified by EPA as Group E--evidence of non-carcinogenicity--even though the pesticide registration test showed more thyroid tumors and cancers than the unexposed rats.⁷² The only other ingredient in imazapic formulations which EPA has disclosed so far⁷³ is crystalline silica, a potent known human carcinogen when inhaled⁷⁴ (as can happen after an application dries).

DEIS Claim: "Reproductive: Unknown; Teratogenic & Mutagenic: No Effects"

As of 1996 there was no public information available on whether reproductive risks were unreasonable enough not to register imazapyr (first registered in 1984, reviewed in 1992). The chronic effects test literature for imazapyr does include lung edema, kidney cysts, blood cell malformation, brain congestion and brain and thyroid cancers and adrenal tumors.⁷⁵

Similarly for imazpic the registration test for reproductive/developmental effects showed increasing rate of undeveloped ribs in rabbits,⁷⁶ but EPA says the same effect was observed in unexposed test animals from other tests in the same lab--ignoring that the control rabbits in this test, i.e. under the exact same conditions as the exposed rabbits--did not develop this defect, much less in a dose/response manner. In the registration general chronic effects test imazapic caused muscle degeneration at all dose levels, anemia at the mid & hi dose levels, liver enlargement at the mid & hi-doses (with enzymes that mark liver disease at the hi-dose), and elevated cholesterol at the mid-dose level only.⁷⁷

In addition to acute toxicity to non-target plants, a variety of other impacts have been reported.⁷⁸ These include hazards to endangered species, increased susceptibility to disease, and disruption of nutrient

⁶⁸ Multinational Monitor Jul./Aug. '93, p.4.

⁶⁹ I. Heap 2002 (i.e. the Weed Science Soc. Amer., <http://www.weedscience.org>).

⁷⁰ EPA/OPP 1991 'Peer Review of Imazapyr' Oct. 2. memo from W. Dykstra.

⁷¹ C. Cox 1996 'Imazapyr Herbicide Fact Sheet', J. Pesticide Reform 16:3:16-17.

⁷² EPA/OPP/HED 2001 'Imazapic: Report of the Hazard Identification Review Cmtee Memo from W. Dykstra to W. Donovan'. Wash, DC May 3.

⁷³ C. Cox 2003 'Imazapic Factsheet' J Pesticide Reform:23:3:10-14 (see p. 10-11, 'Inerts').

⁷⁴ Int'l Agency for Research on Cancer (IARC) 1997 'Monograph 68:41; avail. at: <http://cie.iarc.fr/htdocs/monographs/vol68/silica.htm>

⁷⁵ EPA/OPP 1989, '90 & '91 (2 Data Evaluation Reports & a Peer Review, all for imazapyr, by EPA's W. Dykstra).

⁷⁶ EPA/OPP/HED 2001.

⁷⁷ EPA/OPP/HED 2001.

⁷⁸ Cox 1996 (Imazapyr Fact Sheet).

cycling in soil. Separate NOELs exist of 50 and 150-175 mg/kg bw/d.⁷⁹ Obviously the latter is not the NOEL; the former is, unless there is an even lower NOEL. Therefore imazapyr's non-cancer health risks were underestimated at least 3-fold. It's interesting to note that a herbicide with an all but identical structure, imazapic, has a RfD of just 0.05 mg/kg b.w./day, according to its manufacturer BASF.⁸⁰ Thus its NOEL is no more than 5 mg/kg bw/d (i.e. taking away the RfD's minimum 100-fold safety factor). This is some 30 times lower than the NOEL of imazapyr, structurally similar.

This imidazolinone family herbicide has a mechanism of action on plants the same as the sulfonurea family (inhibition of acetolactate synthase enzyme, ALS, essential to production of three amino acids that mammals rely on plants for), thus it harms native vegetation at similarly minute doses as the SUs (e.g. 1/100th an ounce/acre or 1/18th to 1/135th the recommended application rate, already extraordinarily low).⁸¹ In the temporal and geographic vicinity of organophosphate insecticides, these herbicides are even more (synergistically) potent.⁸²

DICAMBA (BANVEL, part of TRIMEC, ...)

DEIS Claim: "Carcinogenicity: No Effects"

What the Literature Says: Dicamba is akin to the 2,4,-D molecule. As with 2,4-D, exposure to dicamba is strongly associated with Non-Hodgkin's Leukemia, NHL--and farmer's use of dicamba is associated with a doubling of their NHL,⁸³ as are the dioxin contaminants that their manufacture creates. The predominant dioxin found in dicamba is 2,7-DCDD, which causes several cancers in lab animals and numerous other defects.⁸⁴ The amine salt version of dicamba is contaminated with potent oxidative-damage carcinogens such as dimethyl nitrosamine.⁸⁵

DEIS Claim: "Teratogenic: No Effects"

What the Literature Says: Several birth defects are caused by dicamba (and/or its potent contaminants) at low doses.⁸⁶

DEIS Claim: "Reproductive: Unlikely"

What the Literature Says: Spontaneous abortions/fetal resorptions occur in rabbits at fairly low dose, above 3 mg/kg body weight/day.⁸⁷ Mallard egg development is stunted.⁸⁸ The contaminant 2,7-DCDD (a dioxin) is also a reproductive toxicant, among its numerous potent effects.⁸⁹

DEIS Claim: "Mutagenicity: No Effects"

What the Literature Says: Dicamba significantly increases DNA unwinding, unscheduled DNA synthesis

⁷⁹ Weed Society of America 1994 'Herbicide Handbook' 7th Ed.

⁸⁰ USFS 2001 'LNF BGWR&BAWM FEIS'; see table IV-16, p. IV-50 & 51.

⁸¹ J. Burns et al. 1999 'ALS Inhibitors Increase Eth[j]ene Production & Cause Fruit Drop in Citrus' Hort Science:34:908-10 **and** EPA/OPPT/EEB 1995 'Env. Risk assmnt. for the Use of Imidilazolinone Type herbicide CADRE on Peanuts. Memo from A. Maciorowski to R. Taylor, Registration Div.' Wash. DC 25 Aug. **and** S. Ranayke & D. Shaw 1992 'Effects of Harvest-Aid Herbicides on Sicklepod...' Weed Technol.:6:985-9; **also** J. Fletcher 1993 (using SUs).

⁸² R. Hartzler et al. 2000; **also see** the Plateau DG & Cadre DG labels by BASF Corp. 2000 & 2002, which warn of crop loss (see <http://cdms.net>).

⁸³ K. Cantor 1992 Cancer Res. 52:2447-2455.

⁸⁴ J. Huff et al. 1991 Env. Health Perspectives 93:247-270.

⁸⁵ Pure & Applied Chem. 52:499-526 1980 Int'l Union of P&AC (IUPAC).

⁸⁶ EPA/ODW 1968 'Dicamba Health Advisory' Wash. DC. Also Federal Registers 48:52:11,113-4 and 11,119-20)

⁸⁷ EPA/ODW 1988.

⁸⁸ Hoffman et al. 1984 Arch. Env. Contam. & Toxicol.:13:15-27.

⁸⁹ Khera & Ruddick 1973, Adv. Chem. Ser.:120:70-84.

and causes sister chromatid exchanges.⁹⁰ Four earlier studies also show it is mutagenic, including in applicators.⁹¹

GLYPHOSATE (ROUNDUP)

DEIS Claim: "Carcinogenicity: No Effects"

What the Literature Says: After a dispute with the manufacturer Monsanto over interpreting the Monsanto's glyphosate carcinogenicity studies, which showed at least some evidence of various cancers, EPA's conditional conclusion in the 1980's was that glyphosate shows some evidence of non-carcinogenicity, pending further study.⁹² One EPA OPP staff person termed Monsanto's data suspicious, given the need to protect health.⁹³ Since that suspicious dispute, glyphosate exposure has since been associated with non-Hodgkin's lymphoma, NHL, in a small non-significant case-control group.⁹⁴ There exists an un-cited reference to a 1999 study of Swedish farmers, where glyphosate use correlates with a more than doubled rate of NHL. A recent Swedish study of the rare hairy cell leukemia (HCL, a form of NHL), found that people who were occupationally exposed to glyphosate formulations had a threefold higher risk of HCL, and a similar risk for NHL.⁹⁵ Glyphosate is again associated with significantly elevated risk of the rare hairy cell leukemia.⁹⁶ A 2003 study confirmed the association of glyphosate exposure with increased incidence of non-Hodgkin's lymphoma.⁹⁷ Even an industry study found 'somewhat elevated' rates of various cancers in mice given glyphosate.⁹⁸ Roundup is a potent steroid hormone disrupter.⁹⁹ EPA warned the Drug Enforcement Agency in 1985 that glyphosate increases male animal kidney tumors, in a dose-dependent manner.¹⁰⁰ Overall, it's interesting to note that immune suppression is strongly associated with cancers of the immune such as NHL & HCL, and glyphosate mutagenicity studies also support this association.¹⁰¹

DEIS Claim: "Teratogenic: No Effects"

What the Literature Says: Minnesota farm families that used Roundup regularly had statistically significant increases in birth defects (and a 3-fold increase in neuro-developmental disorders). That study also found a tentative association with attention deficit/hyperactivity disorder (ADD/ADHD).¹⁰² A study of pregnant rats given glyphosate in their drinking water showed that this exposure caused changes in the activity of three enzymes in their fetuses--enzymes related to energy production were affected in the liver, heart, and brain.¹⁰³ Preconception glyphosate (among other herbicide exposures)

⁹⁰ P. Perocco et al. 1990 *Env. Mol. Mutag.* 15:131-135.

⁹¹ Plewa et al. 1984; Ma 1984; Yoder et al 1973 *all in Mut. Res.* (138:233-245; 138:157-167; 21:325-330); and Puaztal 1986 *Acta Botany Hung.* 32:163-168.

⁹² EPA/OPP 1991 'Second Peer Review of Glyphosate', internal Memo from W. Dykstra & G. Ghali, Oct. 30. Also 3 preceding OPP documents on this issue, all cited in C. Cox 1998 'Glyphosate Factsheet' *J. Pesticide Reform*:18:3:3-16.

⁹³ EPA/OPP 1985 'Use of Historical Data in determining the Weight-of-the-Evidence From Kidney Tumor Incidence in the Glyphosate...and Some Remarks on False Positives', internal Memo from Herbert Lacayo 26 Feb.

⁹⁴ Hardell & Eriksson 1999.

⁹⁵ M. Nordstrom, L. Hardell et al. 1998 'Occupational exposures, animal exposure and smoking as risk factors for hairy cell leukemia evaluated in a case-control study'. *British Journal of Cancer* 77:11:2048-2052 (for both studies).

⁹⁶ L Hardell et al. 2002 'Exposure to pesticides as a risk factor for non-Hodgkin's lymphoma and hairy cell leukemia: pooled analysis of two Swedish case-control studies' *Leuk. Lymphoma*:43:1043-1049.

⁹⁷ A DeRoos et.al. 2003 'Integrative assessment of multiple pesticides as risk factors for non-Hodgkin's lymphoma among men' *Occup. Environ. Med.*:60:11-17.

⁹⁸ K. Pavkov & J. Turnier 1986 '2-Year Chronic Toxicity & Oncogenicity Dietary Study With SC-0224 in Mice'. Report # T-11813, Farmington: Stauffer Chemical Co.

⁹⁹ Walsh et al 2000 *Env. Health Perspectives*:108:769-776.

¹⁰⁰ *Pesticide & Toxic Chemical News* 14 Aug. '85, p.8.

¹⁰¹ Hardell & Eriksson 1999.

¹⁰² V. Garry et al June 2002 'Birth defects, season of conception, and sex of children born to pesticide applicators living in the Red River Valley of Minnesota, USA' *Env Health Perspectives*:110(Suppl. 3):441-9.

¹⁰³ Daruich et al. 2001 'Effect of herbicide glyphosate on enzymatic activity in pregnant rats and their fetuses' *Environ. Res./Sect. A* 85:226-231.

was associated with a 20-40% relative increase in adverse birth outcomes; and glyphosate specifically was associated with late abortion, regardless of when exposure occurred.¹⁰⁴

DEIS Claim: "Reproductive: Unlikely"

What the Literature Says: In rats, glyphosate reduced sperm counts at the two highest doses tested. In male rabbits, glyphosate at doses of 1/10 and 1/100 of the lethal dose increased the frequency of abnormal and dead sperm.¹⁰⁵ Human father's use of glyphosate correlates with increased miscarriages and premature births in farm families.¹⁰⁶ Women's exposure to glyphosate among other herbicides and insecticides before conception is associated with a 20-40% increased risk of spontaneous abortion after conception, with older women's apparent risk being much higher for at least some of the pesticides.¹⁰⁷ A case report of frequent menstruation from a student using a track where glyphosate was sprayed.¹⁰⁸ Contrary to the label's claim of safety to pets if used as directed, a case report of dog miscarriage from a man's glyphosate-sprayed yard.¹⁰⁹ In a study of female rabbits given glyphosate orally during pregnancies, glyphosate caused a "slight" decrease in fetal weight in all three treated groups.¹¹⁰

DEIS Claim: "Mutagenic: No Effects"

What the Literature Says: Mice injected with glyphosate and Roundup witnessed increased frequency of chromosome damage and DNA damage increased in bone marrow, liver, and kidney.¹¹¹ In fruit flies, Roundup and Pondmaster both increased the frequency of sex-linked, recessive lethal mutations, showing that the formulation is very mutagenic.¹¹² The 1997 study, also testing the a.i. vs. the formulation, found that human lymphocytes showed an increase in the frequency of sister chromatid exchanges following exposure to glyphosate in all but the lowest doses.¹¹³ Glyphosate caused sister-chromatid exchanges in human lymphoid cells.¹¹⁴ Even in studies by the manufacturer, it caused a variety of chromosome aberrations and gene mutations in mice lymphoid cells,¹¹⁵ supporting the above correlations with immune cancers.

Ironically, Monsanto, the exclusive manufacturer, markets glyphosate by emphasizing it is allegedly far safer than other herbicides, e.g.: "God's herbicide [because it's] -- safer than salt". The EPA and the NY Attorney General took enforcement action for false and illegal claims of safety under FIFRA and FTC marketing rules, after such violations were brought to their attention.¹¹⁶ As NCAP notes, glyphosate has been shown to be toxic in every standard category of toxicology testing.¹¹⁷

In addition to glyphosate/Roundup's toxicity, Denmark recently banned most uses of it after their Denmark & Greenland Geological Research Institution found it not degraded by soil microbes--as long claimed by Monsanto and widely believed--but rather they found it in shallow groundwater at 0.54 ug/L

¹⁰⁴ Arbuckle et al. 2001.

¹⁰⁵ M. I. Yousef et al. 1995. 'Toxic effects of carbofuron and glyphosate on semen characteristics in rabbits' J. Env. Science Health/sec. B 30:4:513-534.

¹⁰⁶ D. A. Savitz, 1997. American Journal of Epidemiology:146:1025-103.

¹⁰⁷ Arbuckle et al. 2001.

¹⁰⁸ Barnard & Heauser in NCAA Sports Sciences Education Newsletter Vol. 2 Fall 1995.

¹⁰⁹ J. of Pesticide Reform Fall '98, letters.

¹¹⁰ EPA/Off. of Toxic Substances 1980 'Glyphosate submission of rat teratology, rabbit teratology' Reg. #524-308.

¹¹¹ C. Bolognesi et al. 1997 'Genotoxic activity of glyphosate and its technical formulation Roundup' J. Agricultural Food Chemicals 45:1957-1962.

¹¹² P. Kale. et al. 1995. 'Mutagenicity testing of nine herbicides and pesticides currently used in agriculture' Environ. Mol. Mutagen. 25:148-153. Also Peluso et al. 1998 Environ. Mol. Mutagen. 31:55-59.

¹¹³ C. Bolognesi. et al. 1997.

¹¹⁴ N. Vigfusson & E. Vyse 1980 'The Effect of the Pesticides...and Roundup on Sister-Chromatid Exchanges in...' Mutag. Res.:79:53-57.

¹¹⁵ J. Majeska & D Matheson. Reports #T-10848, #T-11018 on compound R-50224 in 1982, and reports #T-12661, #T-12662 (the chromosome aberrations result) on compound SC-0224 in 1985 ; Farmington: Stauffer Chemical Co.

¹¹⁶ NCAMP 1997 Technical Rpt. 12:2.

¹¹⁷ C. Cox Fall 1998 'Glyphosate Factsheet' J. of Pesticide Reform:18:3:3-16.

concentration.¹¹⁸ Monsanto claims that its detection in groundwater at one meter below the surface does not show it reaches drinking water. Also contradicting the general supposition by herbicide proponents that these pesticides are not persistent are studies showing how herbicides such as glyphosate, 2,4-D and picloram/triclopyr/clopyralid harm fruits and vegetables composted with mulch that had been treated with those herbicides.¹¹⁹

Recently one of us reviewed essentially all the published literature on 2,4-D's **carcinogenicity and mutagenicity**, for comments submitted on EPA's 2,4-D risk assessments (prepared for 2,4-D's re-registration). We copy below those comments (including whole abstracts), noting that they thus are almost a complete summary of that literature:

2,4-D Carcinogenicity/Mutagenicity Literature Review

2,4-D and CANCER

The great number of evaluations of 2,4-D's carcinogenicity alone belly your Class D categorization, which is designed for less-studied chemicals. Evaluation of this evidence compels a carcinogenicity classification of at least Class C, when it is recognized that the studies performed for registration are of low quality: mostly unpublished; with only a small handful published in reputable journals.

Below we summarize, by category, the published literature--both positive and negative results; all quality of journals. In each category, positive toxicity findings heavily and consistently outweigh the negative findings. In accordance with your carcinogenicity guidelines--considering the weight of the evidence (epidemiology, experimental, mechanistic; and the quality of peer-review)--we conclude that 2,4-D is clearly a Class C carcinogen. Please justify your classification, including why you have not considered the quality the evidence (as measured by the proxy of the quality of peer review).

POSITIVE RESULTS/GENERAL

The International Agency for Research on Cancer--one of the two 'gold standards' in the world that does carcinogen assessments--has classified chlorophenoxy herbicides as possible human carcinogens since 1987 (International Agency for Research on Cancer 1987 'Chlorophenoxy Herbicides' IARC Monographs:(Suppl 7):156; <http://www-cie.iarc.fr/htdocs/monographs/suppl7/chlorophenoxyherbicides.html>, accessed Jan. 2004). We ask that you explicitly justify your 'D' classification in light of IARC's expertise in carcinogenicity and in the face of the overwhelming weight of the evidence in the published, independent peer-review literature; summarized below.

We note than an old, but still large review showed that 2,4-D in particular (among chlorophenoxy herbicides and other pesticides) consistently showed a dose/response relation to non-Hodgkin's Lymphoma--i.e. the greater or longer the measured or estimated exposure, the greater the likelihood of acquiring NHL (Sheila Zahm & A. Blair 1992 'Pesticides and non-Hodgkin's Lymphoma' Cancer Research:52:19:5485a-5488a). The following abstract, presumably to a review, seems to us a fair summary of our findings in reviewing this published literature:

Reuber MD. 1983 Dec 1. Carcinogenicity and toxicity of 2,4-dichlorophenoxy-acetic acid. Sci Total Environ 31:203-18. Abstract: 2,4-Dichlorophenoxyacetic acid (2,4-D) is carcinogenic in male and female rats and probably also in mice. Male and female rats ingesting 2,4-D developed increased incidences of malignant neoplasms. Lymphosarcomas were increased in rats of both sexes, and neoplasms of the mammary gland in female rats. Male rats also had carcinomas of the endocrine organs. 2,4-D isooctyl ester was carcinogenic for the lymphoreticular system in female mice. 2,4-D and 2,4-dichlorophenol also were promoters of neoplasms of the skin in mice. Male mice given 2,4-D isopropyl ester developed an increased incidence of neoplasms of the lung. 2,4-D also is mutagenic and teratogenic in animals and causes poisoning in animals and human beings.

Even if your experimental studies had been of the highest quality, we may have identified a critical factor that they ignored (as do all typical chronic toxicology studies, which are designed not to search for almost any toxicity): ***the timing of the dose***. The two studies below find that 2,4-D is not carcinogenic when 2,4-D exposure

¹¹⁸ A.L. Schmidt 10 May 2003 'Poisonous Spray on Course Towards Drinking Water' Politiken, Denmark (avail.: <http://politiken.dk/VisArtikel.sasp?PageID=269614>).

¹¹⁹ R Stocker et al. Nov. 1999 'Residual Effects of Herbicide-Treated E. Crassipes Used as a Soil Amendment' Hydrobiologia:415:329-33; **and** see media reports of this problem caused by the picloram/triclopyr/clopyralid.

occurs after weaning, but that it is when the exposure occurs earlier:

Parfieniuk A, Musiatowicz B, Sulik M. 1993 May 3-10. [Some parameters of Guerin cancer growth after exposure to Pielik (sodium salt of 2,4-dichlorophenoxyacetate)]. Pol Tyg Lek 48:414-6.
 Abstract: Herbicide Pielik (sodium 2,4-dichlorophenoxyacetate) was tested with the aid of Guerin cancer animal model in 129 Wistar rats. An effect of this herbicide on the cancer growth dynamic (size and weight of the tumor), its malignancy (lymphatic nodes involvement), tumor-dependent animal cachexia (real body weight), and survival of rats depending on exposure period have been analysed. Aqueous solution of the herbicide was administered to animals of groups II, IV, V, and VI in the dose of 200 mg/kg body weight daily (1/3 LD50). Young rats were exposed to the herbicide during pre- and postnatal period till the death (groups III, IV and VI in the 80th day of life. Exposure to the herbicide was continued. Rats of all groups were sacrificed in the 16th, 20th, and 42nd day after implantation of Guerin cancer. Eight animals of each group were kept alive to assess survival. **Accelerated growth of the tumor was noted in the animals exposed to the herbicide for the prolonged period of time (before and after birth). The same daily dose administered to the animals after weaning and continued to the 16th, 20th, and 42nd day of tumor development (group IV) has not significant effect on tumor growth rate.** An increase in the incidence as well as earlier onset of metastases to axillary and groin lymphatic nodes were seen in group VI in comparison with the control animals (group III).

Sulik M, Matus A, Musiatowicz B, Sulkowska M, Kemona A, Kisielewski W, Sobaniec-Lotowska M, Barwujuk-Machala M. 1996. The effect of a herbicide--sodium salt of 2,4-dichlorophenoxyacetic acid on guerin carcinoma. Roczn Akad Med Białymst 41:347-62.
 Abstract: The effect of sodium salt of 2,4-dichlorophenoxyacetic acid, being an active component of herbicide "PIELIK", upon the development of Guerin carcinoma implanted in male Wistar rats, was studied. 192 animals were divided in to 6 equal groups: I-animals which obtained physiological salt solution; II-rats exposed to the herbicide in postlactational period; III-animals with Guerin carcinoma, non exposed to the herbicide; IV- rats exposed to the herbicide in postlactational period+Guerin carcinoma; V- animals exposed to the herbicide from prenatal period to the end of an experiment, without Guerin carcinoma; VI-the same as in V group, but with Guerin carcinoma. The effect of the herbicide on tumor growth dynamism (diameters and mass), degree of tumour malignancy (metastases to lymph nodes), animals survival time and morfological changes in the primary tumour and in metastases was evaluated. Basing of the results obtained, it was stated that this herbicide accelerates the development of Guerin carcinoma and reduces the survival time in the rats exposed to it in the prenatal and postnatal period. **However, it does not significantly influence the growth of the carcinoma in the rats exposed only in the postlactational period.**

Regarding the di-ethanol-amine (DEA) form of 2,4-D, we protest strongly your intention not to allow public comment on the data that industry has promised to submit on DEA carcinogenicity. As you mentioned, cocaine DEA and possibly free DEA show some evidence of carcinogenicity according to the premier evaluators, IARC and the NTP. Please arrange for public notice and comment before finishing your evaluation of this chemical.

We fail to understand the logic of your conclusion, "Cancer Aggregate Risk" (p. 79). Since you believe that there is insufficient evidence to classify 2,4-D as a carcinogen, how on Earth can you claim that "The endpoint selected for the cPAD will be protective of the possible carcinogenic activity of this chemical."??

POSITIVE RESULTS/IMMUNE CANCERS

Although all cancers involve a failure of the immune system to detect and destroy cancerous cells (proliferating--i.e. uncontrolled replication); the cells of the immune system itself may begin to proliferate and turn cancerous. Over 100 papers in the published literature show that 2,4-D alters the immune system. Thus it is no surprise that so much evidence showing 2,4-D to be carcinogenic to the immune system. So the EPA must weigh especially heavy the extensive published literature on cancer that we summarize below.

It indicates quite overwhelmingly that 2,4-D causes cancer in people and animals and that it is mutagenic and cytogenic (two mechanisms of cancer). The epidemiologic subset associating 2,4-D with cancers of human blood and immune systems is large--and strongly positive according to one recent review (Susan Osburn (ed.) 2001 'Do Pesticides Cause Lymphoma?' Lymphoma Association of America, Chevy Chase MD; 51 pg.).

POSITIVE RESULTS/NON-HODGKIN'S LYMPHOMA (NHL)

Environ Health Perspect. 2003 Nov;111(14):1704-6. Is the decline of the increasing incidence of non-Hodgkin lymphoma in Sweden and other countries a result of cancer preventive measures? Hardell L, Eriksson M. Department of Oncology, University Hospital, Orebro, Sweden. lennart.hardell@orebroll.se
 Is the decline of the increasing incidence of non-Hodgkin lymphoma (NHL) in Sweden and other countries a result of cancer preventive measures? The yearly age-standardized incidence of NHL increased significantly in Sweden during 1971-1990, for men an average of 3.2% and for women 3.1%. The corresponding figures for 1991-2000 were -0.8% and -0.2%, respectively. A decline of the increasing incidence has also been seen in other countries, such as the United States, Finland, and Denmark. Immunosuppression is one established risk factor for NHL,

possibly with interaction with Epstein-Barr virus. Phenoxyacetic acids and chlorophenols, both pesticides, have been associated with NHL. Use of these chemicals was banned in Sweden in 1977 and 1978, respectively. Also, persistent organic pollutants such as polychlorinated biphenyls, hexachlorobenzene, chlordanes, and dioxins have been shown to increase the risk. Exposure of the whole population occurs predominantly through the food chain. Exposure to such chemicals was highest in the 1960s and 1970s. Because of regulation in the 1970s, exposure has declined substantially in the population. The change in incidence of NHL in Sweden and other countries may serve as a good example of how prohibition and limitation of exposure may be reflected in cancer statistics some decades later. PMID: 14594618 [PubMed - indexed for MEDLINE]

Zahm SH, Weisenburger DD, Babbitt PA, Saal RC, Vaught JB, Cantor KP, Blair A. 1990 Sep . A case-control study of non-Hodgkin's lymphoma and the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) in eastern Nebraska. *Epidemiology* 1:349-56.

Abstract: To evaluate the role of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) in the development of non-Hodgkin's lymphoma (NHL), we conducted a population-based, case-control study in 66 counties in eastern Nebraska. Telephone interviews were conducted with 201 white men diagnosed with NHL between July 1, 1983, and June 30, 1986, and with 725 controls. There was a 50% excess of NHL among men who mixed or applied 2,4-D (odds ratio [OR] = 1.5; 95% confidence interval = 0.9, 2.5). The risk of NHL increased with the average frequency of use to over threefold for those exposed 20 or more days per year (p for trend = 0.051). Adjusting for use of organophosphate insecticides lowered the risk estimate for frequent users (OR = 1.8), but adjustment for fungicide use increased the risk estimate (OR = 4.5). Simultaneous adjustment for organophosphates and fungicides yielded an OR of 3.1 for farmers who mixed or applied 2,4-D more than 20 days per year. Risk also increased with degree of exposure, as indicated by application method and time spent in contaminated clothing, but not with the number of years of 2,4-D use or failure to use protective equipment. Although other pesticides, especially organophosphate insecticides, may be related to NHL, the risk associated with 2,4-D does not appear to be explained completely by these other exposures.

Cantor KP, Blair A, Everett G, Gibson R, Burmeister LF, Brown LM, Schuman L, Dick FR. 1992. Pesticides and other agricultural risk factors for Non-Hodgkin's lymphoma among men in Iowa and Minnesota. *Cancer Res* 52:2447-2455.

Abstract: Data from an in-person interview study of 622 white men with newly diagnosed non-Hodgkin's lymphoma and 1245 population-based controls in Iowa and Minnesota were used to measure the risk associated with farming occupation and specific agricultural exposures. Men who ever farmed were at slightly elevated risk of non-Hodgkin's lymphoma (odds ratio = 1.2, 95% confidence interval = 1.0-1.5) that was not linked to specific crops or particular animals. Elevated risks were found, with odds ratio generally 1.5-fold or greater, for personal handling, mixing, or application of several pesticide groups and for individual insecticides, including carbaryl, chlordane, dichlorodiphenyltrichloroethane, diazinon, dichlorvos, lindane, malathion, nicotine and toxaphene. Associations were generally stronger for first use prior to 1965 than more recently, and when protective clothing or equipment was not used. Small risks were associated with the use of the phenoxyacetic acid herbicide 2,4-dichlorophenoxyacetic acid, but the risks did not increase with latency of failure to use protective equipment. Exposure to numerous pesticides poses problems of interpreting risk associated with a particular chemical, and multiple comparisons increase the chances of false-positive findings. In contrast nondifferential exposure misclassification due to inaccurate recall can bias risk estimates toward the null and mask positive associations. In the face of these methodological and statistical issues, the consistency of several finding, both within this study and with observations of others, suggests an important role for several insecticides in the etiology on non-Hodgkin's lymphoma among farmers.

Keywords:

Fontana A, Picoco C, Masala G, Prastaro C, Vineis P. 1998. Incidence rates of lymphomas and environmental measurements of phenoxy herbicides: ecological analysis and case-control study. *Arch Environ Health* 53:384-387. Abstract: The authors conducted an ecological study of the distribution of malignant lymphomas in a rice-growing area in northern Italy. They considered data on concentrations of phenoxy herbicides in soil and water and found the highest incidence of non-Hodgkin's lymphoma in subjects who lived in an area where 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid existed in very high concentrations. During 1985-1988, the incidence of non-Hodgkin's lymphoma in males in the most-polluted municipalities was twice as high as was noted for the remaining less-polluted territories. During 1991-1993, non-Hodgkin's lymphoma was higher by 60%. The authors also conducted a population-based case-control study. They found an association between employment of women in rice-growing jobs (particularly as rice weeder) and risk of non-Hodgkin's lymphoma (odds ratio = 1.9; 95% confidence interval = 0.6, 6.0). Work in rice fields was correlated strongly with residence in polluted areas. The authors did not detect an association between area of residence or occupation and incidence of Hodgkin's disease. Keywords:

Cancer. 1999 Mar 15;85(6):1353-60. Comment in: * Cancer. 1999 Aug 15;86(4):729-31.

A case-control study of non-Hodgkin lymphoma and exposure to pesticides. Hardell L, Eriksson M. Department of Oncology, Orebro Medical Center, Sweden.

BACKGROUND: The incidence of non-Hodgkin lymphoma (NHL) has increased in most Western countries during the last few decades. Immunodeficient conditions are established risk factors. In 1981, the authors reported an increased risk for NHL following exposure to certain pesticides. The current study was designed to further elucidate the importance of phenoxyacetic acids and other pesticides in the etiology of NHL. METHODS: A population-based case-control study in northern and middle Sweden encompassing 442 cases and twice as many controls was performed. Exposure data were ascertained by comprehensive questionnaires, and the questionnaires were supplemented by telephone interviews. In total, 404 cases and 741 controls answered the questionnaire. Univariate

and multivariate analyses were performed with the SAS statistical data program. RESULTS: Increased risk for NHL was found for subjects exposed to herbicides (odds ratio [OR], 1.6; 95% confidence interval [CI], 1.0-2.5) and fungicides (OR, 3.7; 95% CI, 1.1-13.0). Among herbicides, the phenoxyacetic acids dominated (OR, 1.5; 95% CI, 0.9-2.4); and, when subclassified, one of these, 4-chloro-2-methyl phenoxyacetic acid (MCPA), turned out to be significantly associated with NHL (OR, 2.7; 95% CI, 1.0-6.9). For several categories of herbicides, it was noted that only exposure during the most recent decades before diagnosis of NHL was associated with an increased risk of NHL. Exposure to impregnating agents and insecticides was, at most, only weakly related to NHL. CONCLUSIONS: Exposure to herbicides in total, including phenoxyacetic acids, during the decades before NHL diagnosis resulted in increased risk for NHL. Thus, the risk following exposure was related to the latency period. Fungicides also increased the risk for NHL when combined, but this group consisted of several different agents, and few subjects were exposed to each type of fungicide. PMID: 10189142 [PubMed - indexed for MEDLINE]

Hardell L, Eriksson M, Degerman A. 1994 May 1. Exposure to phenoxyacetic acids, chlorophenols, or organic solvents in relation to histopathology, stage, and anatomical localization of non-hodgkins lymphoma. *Cancer Res* 54:2386-2389.

Abstract: Results on 105 cases with histopathologically confirmed non-Hodgkin's lymphoma (NHL) and 335 controls from a previously published case-control study on malignant lymphoma are presented together with some extended analyses. No occupation was a risk factor for NHL. Exposure to phenoxyacetic acids yielded, in the univariate analysis, an odds ratio of 5.5 with a 95% confidence interval of 2.7-11. Most cases and controls were exposed to a commercial mixture of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid. Exposure to chlorophenols gave an odds ratio of 4.8 (2.7-8.8) with pentachlorophenol being the most common type. Exposure to organic solvents yielded an odds ratio of 2.4 (1.4-3.9). These results were not significantly changed in the multivariate analysis. Dichlorodiphenyltrichloroethane, asbestos, smoking, and oral snuff were not associated with an increased risk for NHL. The results regarding increased risk for NHL following exposure to phenoxyacetic acids, chlorophenols, or organic solvents were not affected by histopathological type, disease stage, or anatomical site of disease presentation. Median survival was somewhat longer in cases exposed to organic solvents than the rest. This was explained by more prevalent exposure to organic solvents in the group of cases with good prognosis NHL histopathology. [References: 29] Number of References 29

Keywords:

Br J Ind Med. 1981 Feb;38(1):27-33. Soft-tissue sarcomas and exposure to chemical substances: a case-referent study. Eriksson M, Hardell L, Berg NO, Moller T, Axelsson O. In 1977 several patients were seen with soft-tissue sarcomas and previous exposure to phenoxy acids. This clinical observation resulted in a cases-referent (case-control) study being undertaken which showed that exposure to phenoxy acids or chlorophenols, which are chemically related, gave a roughly six-fold increase in the risk for this type of tumour. A further case-referent study of soft-tissue sarcomas has now been performed to confirm these earlier findings and also to obtain further information on the effects of different phenoxy acids. This new investigation gave an increase of the same magnitude in the risk for soft-tissue sarcomas after exposure to phenoxy acids or chlorophenols, but this risk related also to exposure to phenoxy acids free from impurities, such as polychlorinated dibenzodioxins and dibenzofurans. PMID: 7470401 [PubMed - indexed for MEDLINE]

McDuffie HH, Pahwa P, McLaughlin JR, Spinelli JJ, Fincham S, Dosman JA, Robson D, Skinnider LF, Choi NW. 2001 Nov. Non-hodgkin's lymphoma and specific pesticide exposures in men: cross-canada study of pesticides and health. *Cancer Epidemiology, Biomarkers & Prevention* 10:1155-1163.

Abstract: Our objective in the study was to investigate the putative associations of specific pesticides with non-Hodgkin's Lymphoma [NHL; International Classification of Diseases, version 9 (ICD-9) 200, 202]. We conducted a Canadian multicenter population-based incident, case (n = 517)-control (n = 1506) study among men in a diversity of occupations using an initial postal questionnaire followed by a telephone interview for those reporting pesticide exposure of 10 h/year or more, and a 15% random sample of the remainder. Adjusted odds ratios (ORs) were computed using conditional logistic regression stratified by the matching variables of age and province of residence, and subsequently adjusted for statistically significant medical variables (history of measles, mumps, cancer, allergy desensitization treatment, and a positive history of cancer in first-degree relatives). We found that among major chemical classes of herbicides, the risk of NHL was statistically significantly increased by exposure to phenoxyherbicides [OR, 1.38; 95% confidence interval (CI), 1.06-1.81] and to dicamba (OR, 1.88; 95% CI, 1.32-2.68). Exposure to carbamate (OR, 1.92; 95% CI, 1.22-3.04) and to organophosphorus insecticides (OR, 1.73; 95% CI, 1.27-2.36), amide fungicides, and the fumigant carbon tetrachloride (OR, 2.42; 95% CI, 1.19-5.14) statistically significantly increased risk. Among individual compounds, in multivariate analyses, the risk of NHL was statistically significantly increased by exposure to the herbicides 2,4-dichlorophenoxyacetic acid (2,4-D; OR, 1.32; 95% CI, 1.01-1.73), mecoprop (OR, 2.33; 95% CI, 1.58-3.44), and dicamba (OR, 1.68; 95% CI, 1.00-2.81); to the insecticides malathion (OR, 1.83; 95% CI, 1.31-2.55), 1,1,1-trichloro-2,2-bis (4-chlorophenyl) ethane (DDT), carbaryl (OR, 2.11; 95% CI, 1.21-3.69), aldrin, and lindane; and to the fungicides captan and sulfur compounds. In additional multivariate models, which included exposure to other major chemical classes or individual pesticides, personal antecedent cancer, a history of cancer among first-degree relatives, and exposure to mixtures containing dicamba (OR, 1.96; 95% CI, 1.40-2.75) or to mecoprop (OR, 2.22; 95% CI, 1.49-3.29) and to aldrin (OR, 3.42; 95% CI, 1.18-9.95) were significant independent predictors of an increased risk for NHL, whereas a personal history of measles and of allergy desensitization treatments lowered the risk. We concluded that NHL was associated with specific pesticides after adjustment for other independent predictors. [References: 47] Number of References 47

Keywords:

Vineis P, Faggiano F, Tedeschi M, Ciccone G. 1991 Mar 6. Incidence rates of lymphomas and soft-tissue sarcomas and environmental measurements of phenoxy herbicides. *J Natl Cancer Inst* 83:362-3. [ABSTRACT: FOUND

SIGNIFICANT ASSOCTN. NHL W/ AREAS OF HIGH SOIL & WATER 2,4-D LEVELS VS. LOW LEVELS:

Weisenburger DD. 1990. Environmental epidemiology of non-Hodgkin's lymphoma in eastern Nebraska. *Am J Ind Med* 18:303-5.

Abstract: The incidence of non-Hodgkin's lymphoma (NHL) is increased in many counties in eastern Nebraska. Histologic analysis has revealed a twofold increase in the clinically aggressive, diffuse large cell subtype of NHL. To investigate the possible association between NHL and agricultural exposures, a population-based case-control study was conducted in eastern Nebraska in 1985. Telephone interviews were conducted with 201 men having histologically confirmed NHL and 725 controls. Among men, the use of the herbicide 2,4-D was associated with a 50% increased risk of NHL (OR 1.5, 95% CI 0.9, 2.4). Personal exposure to 2,4-D more than 20 days per year increased the risk threefold (OR 3.3, 95% CI 0.5, 22.1). Several classes of insecticides were also associated with increased risk: organophosphates (OR 1.9, 95% CI 1.1, 3.1), carbamates (OR 1.8, 95% CI 1.0, 3.2), and chlorinated hydrocarbons (OR 1.4, 95% CI 0.8, 2.3). As a result of intense agrichemical use, extensive contamination of shallow groundwater by nitrate and atrazine has also occurred in eastern Nebraska. A twofold increased incidence of NHL is present in counties with greater than 20% of the wells contaminated by nitrate (greater than 10 ppm) and in counties with intense fertilizer use. These findings suggest that NHL in eastern Nebraska may be related to the use of pesticides and nitrogen fertilizers.

Wiklund K, Lindefors BM, Holm LE. 1988 Jan. Risk of malignant lymphoma in Swedish agricultural and forestry workers. *Br J Ind Med* 45:19-24.

Abstract: The risk of malignant lymphoma after possible exposure to phenoxy acid herbicides was studied in 354,620 Swedish men who, according to a national census in 1960, were employed in agriculture or forestry. The cohort was divided into subcohorts according to assumed exposure and compared with 1,725,645 Swedish men having other economic activities. All were followed up in the Cancer-Environment Register between 1961 and 1979. Non-Hodgkin lymphoma was found in 861 men in the study cohort. The relative risk was not significantly increased in any subcohort, did not differ significantly between the subcohorts, and showed no time related increase in the total cohort or any subcohort. Hodgkin's disease was found in 355 men in the study cohort. Relative risks significantly higher than unity were found among fur farming and silviculture workers where the relative risks were 4.45 and 2.26, respectively. All five cases in the former group were engaged in mink farming. A time related rising trend in relative risk was found in the silviculture subcohort. Elsewhere the relative risk did not diverge from unity and no time related trend was discernible.

Zahm SH, Weisenburger DD, Babbitt PA, Saal RC, Vaught JB, Cantor KP, Blair A. 1990. A Case-Control Study of Non-Hodgkin's Lymphoma and the Herbicide 2,4-Dichlorophenoxyacetic Acid (2,4-D) in Eastern Nebraska. *Epidemiology* 1:349-356.

Abstract: To evaluate the role of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) in the development of non-Hodgkin's lymphoma (NHL), we conducted a population-based, case-control study in 66 counties in eastern Nebraska. Telephone interviews were conducted with 201 white men diagnosed with NHL between July 1, 1983, and June 30, 1986, and with 725 controls. There was a 50% excess of NHL among men who mixed or applied 2,4-D (odds ratio [OR] = 1.5; 95% confidence interval = 0.9, 2.5). The risk of NHL increased with the average frequency of use to over threefold for those exposed 20 or more days per year (p for trend = 0.051). Adjusting for use of organophosphate insecticides lowered the risk estimate (OR = 4.5). simultaneous adjustment for organophosphates and fungicides yielded an OR of 3.1 for farmers who mixed or applied 2,4-D more than 20 days per year. Risk also increased with degree of exposure, as indicated by application method and time spent in contaminated clothing, but not with the number of years of 2,4-D use or failure to use protective equipment. Although other pesticides, especially organophosphate insecticides, may be related to NHL, the risk associated with 2,4-D does not appear to be explained completely by these other exposures. **Keywords:**

Scand J Work Environ Health. 1994 Feb;20(1):42-7.

Non-Hodgkin's lymphoma and agricultural practices in the prairie provinces of Canada.

Morrison HI, Semenciw RM, Wilkins K, Mao Y, Wigle DT.

Bureau of Chronic Disease Epidemiology, Laboratory Centre for Disease Control, Health Canada, Ottawa.

OBJECTIVES--The aim of this study was to provide an update of a cohort study (1971-1985) that previously reported a significant trend in the risk of non-Hodgkin's lymphoma among male Saskatchewan farm operators according to fuel-oil expenditures and herbicide spraying for farms less than 1000 acres (2570 hectares) by including two additional Canadian prairie provinces, two additional years of follow-up, and data from the 1981 Census of Agriculture. **METHODS--**Information on farmers from 1971 records of the Census of Agriculture was linked to 1971 records of the Census of Population, to 1981 records of the Census of Agriculture, and to death records. Poisson regression was used to estimate risks according to herbicide spraying and fuel and oil expenditures. **RESULTS--**The addition of a further two years of follow-up resulted in lower risk estimates associated with herbicide spraying for Saskatchewan. No excess risk was observed between herbicide spraying and non-Hodgkin's lymphoma for Alberta or Manitoba in the 1971 data. However, a significantly increased risk of non-Hodgkin's lymphoma according to acres sprayed with herbicides was observed for the three provinces combined when the herbicide spraying data from the 1981 Census of Agriculture was used [$>$ or = 380 acres ($>$ or = 939 hectares) sprayed, rate ratio 2.11, 95% confidence interval 1.1-3.9]. **CONCLUSIONS--**Although the current results are not entirely consistent with the original Saskatchewan analysis, they support the overall finding of an association between herbicides and risk of fatal non-Hodgkins lymphoma. Prospective cohort studies are needed to overcome the limitations of existing epidemiologic studies.

PMID: 8016598 [PubMed - indexed for MEDLINE]

Med Lav. 1990 Nov-Dec;81(6):499-505.

Mortality study of Canadian male farm operators: cancer mortality and agricultural practices in Saskatchewan.

Ritter L, Wigle DT, Semenciw RM, Wilkins K, Riedel D, Mao Y.
Health Protection Branch, Health and Welfare Canada, Ottawa, Ontario.

The present investigation involved an analysis of approximately 70,000 male Saskatchewan farm operators, a subset of the 365,000 Canadian farm operators to be investigated in the Canadian Farm Operator Mortality Study. The results of the Saskatchewan analysis indicate that during the interval studied, overall mortality among Saskatchewan farmers was 25% lower than that for all Saskatchewan men, and that, during the same time interval, the risk of death from all types of cancer was also about 25% lower among Saskatchewan farmers than to all Saskatchewan men. Although the present study indicates that overall mortality of death from cancer was 25% lower among Saskatchewan male farmers, there was a relationship between non-Hodgkin's lymphoma mortality and acres sprayed for weeds; a similar risk relationship between expenditures on fuel oil and risk of death from non-Hodgkin's lymphoma was also evident. The magnitude of risk for Saskatchewan farmers is probably greater than that reflected in the estimates in this study, due to the likelihood of misclassification of exposure. There is a particular need for further studies in this area to improve the quantification of farming-related exposures, and to study the exposure history of individuals who develop non-Hodgkin's lymphoma. PMID: 2100765 [PubMed - indexed for MEDLINE]

POSITIVE RESULTS/NHL ANALOGUE: CANINE MALIGNANT LYMPHOMA (CML)

In addition to falsely denigrating and ignoring the quality of peer review (including post-publication) in independent journals, The Industry Task Force is strangely silent about the this 1995 follow-up to the 1991 Hayes et al. CML study.

Hayes HM, Tarone RE, Cantor KP. 1995. On the association between canine malignant lymphoma and opportunity for exposure to 2,4-dichlorophenoxyacetic acid. *Environ Res* 70:119-125.

Abstract: In response to criticisms raised regarding a case-control study of canine malignant lymphoma, the results of several ancillary analyses are reported. The case-control study demonstrated a significant association between risk for canine malignant lymphoma and the opportunity for exposure to 2,4-dichlorophenoxyacetic acid herbicides. It is demonstrated that risk estimates do not vary by type of control group (i.e., tumor control or nontumor control group), by method of response (i.e., self-administered or telephone interview), or by geographic area. Questions related to the potential for referral bias, supposed inconsistencies in subject responses regarding frequency of herbicide use, and ambiguities regarding exposure classification are also examined.

Keywords:

Hayes HM, Tarone RE, Cantor KP, Jessen CR, McCurnin DM, Richardson RC. 1991. Case-control study of canine malignant lymphoma: Positive association with dog owner's use of 2,4-dichlorophenoxyacetic acid herbicides. *J Natl Cancer Inst* 83:1226-1231.

Abstract: A hospital-based case-control study of companion dogs examined the risk of developing canine malignant lymphoma associated with the use of chemicals in the home. The present study suggests that human health implications of 2,4-D exposure in the home environment should receive further investigation.

Keywords:

Sternberg SS. 1992 Feb 19. Canine malignant lymphoma and 2,4-dichlorophenoxyacetic acid herbicides. *J Natl Cancer Inst* 84:271. [letter? get it..]

In addition, the following study strongly supports 2,4-D carcinogenicity to pets in close contact with it; such exposure is proven by the study after it:

J Am Vet Med Assoc. 2004 Apr 15;224(8):1290-7. Herbicide exposure and the risk of transitional cell carcinoma of the urinary bladder in Scottish Terriers. Glickman LT, Raghavan M, Knapp DW, Bonney PL, Dawson MH. Department of Veterinary Pathobiology, School of Veterinary Medicine, Purdue University, West Lafayette, IN 47907-2027, USA.

OBJECTIVE: To determine whether exposure to lawn or garden chemicals was associated with an increased risk of transitional cell carcinoma (TCC) of the urinary bladder in Scottish Terriers. DESIGN: Case-control study.

ANIMALS: 83 Scottish Terriers with TCC (cases) and 83 Scottish Terriers with other health-related conditions (controls). PROCEDURE: Owners of study dogs completed a written questionnaire pertaining to exposure to lawn or garden chemicals during the year prior to diagnosis of TCC for case dogs and during a comparable period for control dogs. RESULTS: The risk of TCC was significantly increased among dogs exposed to lawns or gardens treated with both herbicides and insecticides (odds ratio [OR], 7.19) or with herbicides alone (OR, 3.62), but not among dogs exposed to lawns or gardens treated with insecticides alone (OR, 1.62), compared with dogs exposed to untreated lawns. Exposure to lawns or gardens treated with phenoxy herbicides (OR, 4.42) was associated with an increased risk of TCC, compared with exposure to untreated lawns or gardens, but exposure to lawns or gardens treated with nonphenoxy herbicides (OR, 3.49) was not significantly associated with risk of TCC.

CONCLUSIONS AND CLINICAL RELEVANCE: Results suggest that exposure to lawns or gardens treated with herbicides was associated with an increased risk of TCC in Scottish Terriers. Until additional studies are performed to prove or disprove a cause-and-effect relationship, owners of Scottish Terriers should minimize their dogs' access to lawns or gardens treated with phenoxy herbicides. PMID: 15112777 [PubMed - indexed for MEDLINE]

Reynolds PM, Reif JS, Ramsdell HS, Tessari JD. 1994 Apr-May. Canine exposure to herbicide-treated lawns and

urinary excretion of 2,4-dichlorophenoxyacetic acid. *Cancer Epidemiol Biomarkers Prev* 3:233-7.

Abstract: A recent study by Hayes et al. (*J. Natl. Cancer. Inst.*, 83: 1226-1231, 1991) found an increased risk of malignant lymphoma associated with exposure to 2,4-dichlorophenoxyacetic acid (2,4-D) in pet dogs. We conducted a study to determine the extent to which dogs absorb and excrete 2,4-D in urine after contact with treated lawns under natural conditions. Among 44 dogs potentially exposed to 2,4-D-treated lawns an average of 10.9 days after application, 2,4-D concentrations greater than or equal to 10.0 micrograms/l were found in 33 dogs (75%) and concentrations of ≥ 50 micrograms/l were found in 17 (39%). Among 15 dogs with no known exposure to a 2,4-D-treated lawn in the previous 42 days, 4 (27%) had evidence of 2,4-D in urine, 1 at a concentration of ≥ 50 micrograms/l. The odds ratio for the association between exposure to a 2,4-D-treated lawn and the detection of ≥ 50 micrograms/l 2,4-D in urine was 8.8 (95% confidence interval, 1.4-56.2). Dogs exposed to lawns treated within 7 days before urine collection were more than 50 times as likely to have 2,4-D at concentrations ≥ 50 micrograms/l than dogs with exposure to a lawn treated more than 1 week previously (odds ratio = 56.0; 95% confidence interval, 10.0-312.2). The highest mean concentration of 2,4-D in urine (21.3 mg/l) was found in dogs sampled within 2 days after application of the herbicide. (ABSTRACT TRUNCATED AT 250 WORDS)

POSITIVE RESULTS/MULTIPLE MYELOMA

Am J Ind Med. 1992;22(3):305-12. Malignant lymphoproliferative diseases in occupations with potential exposure to phenoxyacetic acids or dioxins: a register-based study. Eriksson M, Hardell L, Malmer H, Weiner J. Department of Oncology, University Hospital, Umea, Sweden. The Swedish Cancer Environment Register (CER) is a linkage of census data (e.g., on occupations) with the Swedish Cancer Register. It has been used in different studies to generate hypotheses on occupational risk factors for malignant tumors. In this study the risk for malignant lymphoma and multiple myeloma in occupations with potential exposure to phenoxyacetic acids or other related substances were investigated. An increased standardized incidence ratio (SIR) of 1.3 for multiple myeloma was verified in farmers (no. of cases = 335). This finding applied to both sexes, and the SIR increased over successive time periods. Regarding malignant lymphoma an increased SIR of 1.2 was found in farmers (no. = 227) for the latest time period studied (i.e. 1979-1984). When non-Hodgkin's lymphoma was studied separately, an increased risk (SIR = 1.2) was found only in carpenters (no. = 149), whereas for Hodgkin's disease, sawmill workers (no. = 10) had an increased SIR of 2.1. Physicians also had an elevated risk for malignant lymphoma. A major shortcoming in register studies such as CER is that no individual exposure data on different agents are available. Lack of an association between an occupation and a specific malignant disease, therefore, may not be taken as evidence that persons within that occupation are not at increased risk for that disease. PMID: 1519615 [PubMed - indexed for MEDLINE]

POSITIVE RESULTS/LEUKEMIA

Brown LM, Blair A, Gibson R, Everett GD, Cantor KP, Schuman LM, Burmeister LF, Van Lier SF, Dick F. 1990 Oct 15. Pesticide exposures and other agricultural risk factors for leukemia among men in Iowa and Minnesota. *Cancer Res* 50:6585-91.

Abstract: Mortality surveys and death certificate studies have suggested an association between leukemia and farming. To investigate whether exposure to carcinogens in an agricultural setting is related to risk of leukemia, the authors conducted a population-based case-control interview study of 578 white men with leukemia and 1245 controls living in Iowa and Minnesota. Consistent with recent mortality studies, there were slight, but significant, elevations in risk for all leukemia [odds ratio (OR) 1.2] and chronic lymphocytic leukemia (OR 1.4) for farmers compared to nonfarmers. There were no significant associations with leukemia for exposure to specific fungicides, herbicides (including 2,4-D and 2,4,5-T), or crop insecticides. However, significantly elevated risks for leukemia of greater than or equal to 2.0 were seen for exposure to specific animal insecticides including the organophosphates crotoxyphos (OR 11.1), dichlorvos (OR 2.0), and famphur (OR 2.2) and the natural product pyrethrins (OR 3.7) and the chlorinated hydrocarbon methoxychlor (OR 2.2). There were also smaller, but significant, risks associated with exposure to nicotine (OR 1.6) and DDT (OR 1.3). This finding of elevated risks for insecticides used on animals deserves further evaluation.

Schreinemachers DM. 2000 Sep. Cancer mortality in four northern wheat-producing states. *Environ Health Perspect* 108:873-881.

Abstract: Chlorophenoxy herbicides are used both in cereal grain agriculture and in nonagricultural settings such as right-of-ways, lawns, and parks. Minnesota, North Dakota, South Dakota, and Montana grow most of the spring and durum wheat produced in the United States. More than 90% of spring and durum wheat is treated with chlorophenoxy herbicides, in contrast to treatment of approximately 30% of winter wheat. In this ecologic study I used wheat acreage as a surrogate for exposure to chlorophenoxy herbicides. I investigated the association of chlorophenoxy herbicides with cancer mortality during 1980-1989 for selected counties based on level of agriculture (greater than or equal to 20%) and rural population (greater than or equal to 50%). Age-standardized cancer mortality rates were determined for grouped counties based on tertiles of wheat acreage per county or for individual counties for frequently occurring cancers. The cancer sites that showed positive trends of increasing cancer mortality with increasing wheat acreage were esophagus, stomach, rectum, pancreas, larynx, prostate, kidney and meter, brain, thyroid, bone, and all cancers (men) and oral cavity and tongue, esophagus, stomach, liver and gall bladder and bile ducts, pancreas, cervix, ovary, bladder, and other urinary organs, and all cancers (women). Rare cancers in men and women and cancers in boys and girls were studied by comparing counties above and below the median of wheat acreage per county. There was increased mortality for cancer of the nose and eye in both men

and women, brain and leukemia in both boys and girls, and all cancers in boys. These results suggest an association between cancer mortality and wheat acreage in counties of these four states. [References: 52] Number of References 52 Keywords:

Swaen GMH, van Amelsvoort LGPM, Slangen JJM, Mohren DCL. 2004 May. Cancer mortality in a cohort of licensed herbicide applicators. *International Archives of Occupational & Environmental Health* 77:293-295. Abstract: Objectives. In order to expand our knowledge on the possible long-term health effects of exposure to herbicides, we updated the follow-up of a cohort of 1,341 licensed herbicide applicators in the Netherlands. The earlier report indicated that there might be an increased risk for multiple myeloma in this group. Although that finding was statistically significant, the result was based on a small number of cases. Methods. We expanded the follow-up from 1 January 1988 to 1 January 2001, which added 13 years to the follow-up. We now report on the causes of death of 196 exposed workers. Results. Our findings indicate that licensed herbicide applicators were at an increased risk for skin cancer mortality [standardized mortality ratio (SMR)=357.4, 95% confidence interval (CI) 115.1-827.0]. It is not clear if this excess of skin cancer should be attributed to herbicide exposure or to excess exposure to sunlight. [References: 12] Number of References 12 Keywords:

POSITIVE RESULTS/SOFT TISSUE SARCOMAS (STS); BRAIN; AND OTHER **NON-IMMUNE** CANCERS

BRAIN CANCER

The authors of this un-translated paper consistently find correlate phenoxy herbicides with cancers, so perhaps this study does; and being relatively recent it may focus on 2,4-D:

Lakartidningen. 1997 Feb 26;94(9):728-31. [Increased incidence of brain tumors. A study of Swedish children and adolescents aged 0-19] [Article in Swedish] Hardell L, Tondel M, Flodin U, Skoldestig A, Axelson O, Jakobsson S, Eriksson M, Carlsson G. Onkologiska kliniken, Regionsjukhuset, Orebro. PMID: 9091748 [PubMed - indexed for MEDLINE]

...The chronic tox. Study done for registration, finding astrocytomas in (male only?) rats.

When administered in rabbits' drinking water, the sodium salt of 2,4-D caused an increase in the number of chromosomes, **brain cells with too many chromosomes** and cells with multiple chromosome sets: K. Atanasov 1992 'Effect of the herbicide Schprithormit' (salt in 2,4-D) *Animal Science* 29:54-61. [ALSO LISTED IN 'POSITIVE RESULTS/MUTAGENICITY']

Brusco A, Saavedra JP, Garcia G, Tagliaferro P, Deduffard AME, Duffard R. 1997 Apr. 2,4-dichlorophenoxyacetic acid through lactation induces astrogliosis in rat brain. *Molecular & Chemical Neuropathology* 30:175-185. Abstract: Comparison of astroglial immunoreactivity in mesencephalon, cerebellum, and hippocampus of 25-d-old rat pups exposed to 2,4-dichlorophenoxyacetic acid (2,4-D) through the mother's milk was made using a quantitative immunohistochemical analysis. A glial reaction was detected at the level of serotonergic nuclei and extreme astrogliosis in the hippocampus and cerebellum. A quantitative analysis of reactive astrocytes was performed by using GFAP and S-100 protein as specific markers. The study showed a significant increase in their number, size, number of processes, and density of immunostaining in 2,4-D-exposed animals. Exposure to 2,4-dichlorophenoxyacetic acid on the first days of life modifies the astroglial cytoarchitecture in parallel to previously described neuronal changes. [References: 28] Number of References 28 Keywords:

Garcia G, Tagliaferro P, Bortolozzi A, Madariaga MJ, Brusco A, de Duffard AME, Duffard R, Saavedra JP. 2001 Dec. Morphological study of 5-HT neurons and astroglial cells on brain of adult rats perinatal or chronically exposed to 2,4-dichlorophenoxyacetic acid. *Neurotoxicology* 22:733-741. Abstract: 2,4-D is a chlorophenoxyherbicide used worldwide. We have studied the morphological alterations of 5-HT neurons and glial cells in the mesencephalic nuclei of adult rats exposed to 2,4-D both perinatally (during pregnancy, and lactation) and chronically, (during pregnancy, lactation and after weaning) with quantitative methods. pregnant rats were daily, exposed to 70 mg/kg of 2,4-D from gestation day, (GD) 16 to post-natal day, (PND) 23 through diet. After weaning, pups were assigned to one of two sub-groups: T1 (fed with untreated diet until PND 90) and T2 (maintained with 2,4-D diet until PND 90). Brain sections were immunocytochemically, stained using poly,clonal anti-5-HT anti-GFAP and anti-S-100 protein antibodies as cells markers. 2,4-D exposure during pregnancy and lactancy, (T1 group) produced an increase in 5-HT neuronal area and immunoreactivity (IR) in the mesencephalic nuclei studied. However, with the chronical 2,4-D exposure (T2 group) only, the 5-HT neuronal area from the dorsal raphe nucleus (DRN) was increased, suggesting an adaptable response of 5-HT neurons in median raphe nucleus (MRN). The presence of reactive astrocytes in mesencephalic nuclei and in hippocampus were also different for the two 2,4-D exposure designs, showing the existence of a correspondence between neuronal changes and astrogliosis. Results support evidences that 2,4-D alters the serotonergic system and that 5-HT neurons of each mesencephalic nuclei show different responses to the 2,4-D exposure designs which are parallel to astrogliosis. (C) 2001 Elsevier Science Inc. All rights reserved. [References: 55] Number of References 55 Keywords:

EPA is also studying, as part of its Special Review consideration of banning it, 2,4-D's strong association with brain

cancers in animal experiments. 2,4-D interferes with the thyroxine hormones¹²⁰ and estrogen.¹²¹ Thyroxine is the critical molecule in the development of the brain,¹²² while estrogen plays an important role in brain function.¹²³ Finally, 2,4-D has been associated with breast and other cancers in humans.¹²⁴

POSITIVE RESULTS/STS AND UNSPECIFIED CANCERS:

JAMA. 1986 Sep 5;256(9):1141-7. Erratum in: * JAMA 1986 Dec 26;256(24):3351.

Agricultural herbicide use and risk of lymphoma and soft-tissue sarcoma. Hoar SK, Blair A, Holmes FF, Boysen CD, Robel RJ, Hoover R, Fraumeni JF Jr.

A population-based case-control study of soft-tissue sarcoma (STS), Hodgkin's disease (HD), and non-Hodgkin's lymphoma (NHL) in Kansas found farm herbicide use to be associated with NHL (odds ratio [OR], 1.6; 95% confidence interval [CI], 0.9, 2.6). Relative risk of NHL increased significantly with number of days of herbicide exposure per year and latency. Men exposed to herbicides more than 20 days per year had a sixfold increased risk of NHL (OR, 6.0; 95% CI, 1.9, 19.5) relative to nonfarmers. Frequent users who mixed or applied the herbicides themselves had an OR of 8.0 (95% CI, 2.3, 27.9) for NHL. Excesses were associated with use of phenoxyacetic acid herbicides, specifically 2,4-dichlorophenoxyacetic acid. Neither STS nor HD was associated with pesticide exposure. This study confirms the reports from Sweden and several US states that NHL is associated with farm herbicide use, especially phenoxyacetic acids. It does not confirm the case-control studies or the cohort studies of pesticide manufacturers and Vietnam veterans linking herbicides to STS or HD.

[THE ERRATUM IS NO MORE THAN A CHANGE IN THE TITLE OF THE MAIN RESULTS TABLE.]

Hardell L, Sandstrom A. 1979 Jun. Case-control study: soft-tissue sarcomas and exposure to phenoxyacetic acids or chlorophenols. Br J Cancer 39:711-7.

Abstract: In 1977 a number of patients with soft-tissue sarcomas and previous exposure to phenoxyacetic acids were described. Following from these observations a matched case-control study was made. Exposure to chlorophenols was also included in this study. The results showed that exposure to phenoxyacetic acids or chlorophenols gave an approximately 6-fold increase in the risk for this type of tumour. It was not possible to determine, however, whether the carcinogenic effect was exerted by these compounds or by impurities such as chlorinated dibenzodioxins and dibenzofurans that in almost all cases were part of the commercial preparations.

J Natl Cancer Inst. 1990 Mar 21;82(6):486-90. Comment in: * J Natl Cancer Inst. 1990 Nov 21;82(22):1785-6. Exposure to dioxins as a risk factor for soft tissue sarcoma: a population-based case-control study. Eriksson M, Hardell L, Adami HO. Department of Oncology, University Hospital, Umea, Sweden.

In a case-control study including 237 cases with soft tissue sarcoma and 237 controls, previous jobs and exposures to different agents, including pesticides, were assessed. Exposure to phenoxyacetic acids or chlorophenols gave a statistically significant increased rate ratio (RR) of 1.80 [95% confidence interval (CI) = 1.02-3.18] for soft tissue sarcoma. Exposure to phenoxyacetic acids of all types gave a nonsignificantly increased RR of 1.34 (95% CI = 0.70-2.56). During the 1950s, exposure to 2,4,5-trichlorophenoxyacetic acid gave a threefold significantly increased risk. High-grade exposure to chlorophenols, which are also contaminated by dioxins, gave an RR of 5.25 (95% CI = 1.69-16.34). The increased risk was thus attributed to dioxin-contaminated phenoxyacetic acids or chlorophenols that gave an RR of 2.43 (95% CI = 1.30-4.54). PMID: 2313720 [PubMed - indexed for MEDLINE]

Cancer. 1988 Aug 1;62(3):652-6. The association between soft tissue sarcomas and exposure to phenoxyacetic acids. A new case-referent study. Hardell L, Eriksson M. Department of Oncology, University Hospital, Umea, Sweden.

A case-referent study on soft tissue sarcomas (STS) was conducted, to see if previous findings regarding an association between exposure to phenoxyacetic acids or chlorophenols and this tumor type could be reproduced. Fifty-five male STS patients were thereby compared with 220 living and 110 dead population-based referents. Furthermore, another referent group consisting of 190 patients with another type of malignant disease was used in order to evaluate any influence of recall bias on the results. To obtain information about exposure to the studied chemicals, as well as about any other exposures that might be of interest, questionnaires were used, and if necessary these were completed over the phone by an interviewer who had no information regarding case-referent status. All analysis and interpretation of exposure data were done in a blinded manner. Exposure to phenoxyacetic acids gave a roughly three-fold increased risk for STS, thereby confirming previous findings, whereas exposure to chlorophenols was not associated with STS in this study. PMID: 3390800 [PubMed - indexed for MEDLINE]

Lakartidningen. 1981 Aug 19;78(34):2862-3. [Phenoxyacetic acid, chlorophenols and cancer] [Article in Swedish] Hardell L, Eriksson M. PMID: 7321672 [PubMed - indexed for MEDLINE]

Br J Cancer. 1981 Feb;43(2):169-76. Malignant lymphoma and exposure to chemicals, especially organic solvents, chlorophenols and phenoxy acids: a case-control study. Hardell L, Eriksson M, Lenner P, Lundgren E.

¹²⁰ Endocrinology 71:1-6 and 72:327-333. Also J. Toxicol & Env. Health/Part A 54:21-36

¹²¹ Fund. Applied Toxicol. 30:102-108.

¹²² Porterfield 1994 'Vulnerability of the Developing Brain to Thyroid Abnormalities: env. insults...' Env. Health Perspectives 102(Suppl. 2):125-130.

¹²³ Friedrich 2002 'Teasing Out Estrogen's Effect on the Brain' J Amer. Medical Ass. 287:1:29-30.

¹²⁴ For an extensive bibliography see http://envirocancer.cornell.edu/Bibliography/Pesticide/bib.2_4-D.cfm

A number of men with malignant lymphoma of the histiocytic type and previous exposure to phenoxy acids or chlorophenols were observed and reported in 1979. A matched case-control study has therefore been performed with cases of malignant lymphoma (Hodgkin's disease and non-Hodgkin lymphoma). This study included 169 cases and 338 controls. The results indicate that exposure to phenoxy acids, chlorophenols, and organic solvents may be a causative factor in malignant lymphoma. Combined exposure of these chemicals seemed to increase the risk. Exposure to various other agents was not obviously different in cases and in controls. PMID: 7470379 [PubMed - indexed for MEDLINE]

Lakartidningen. 1979 Oct 31;76(44):3872-5. [Case- control study of malignant mesenchymal soft tissue tumors and exposure to chemical substances] [Article in Swedish] Eriksson M, Hardell L, Berg NO, Moller T, Axelson O. PMID: 529930 [PubMed - indexed for MEDLINE]

Kogevinas M, Kauppinen T, Winkelmann R, Becher H, Bertazzi PA, Buenodemesquita HB, Coggon D, Green L, Johnson E, Littorin M, Lynge E, Marlow DA, Mathews JD, Neuberger M, Benn T, Pannett B, Pearce N, Saracci R. 1995. Soft tissue sarcoma and non-hodgkins lymphoma in workers exposed to phenoxy herbicides, chlorophenols, and dioxins - TWO nested case-control studies. *Epidemiology* 6:396-402.

Abstract: We examined the effect of exposure to chemicals present in the production and spraying of phenoxy herbicides or chlorophenols in two nested case-control studies of soft tissue sarcoma and non-Hodgkin's lymphoma. Eleven sarcoma and 32 lymphoma cases occurring within an international cohort were matched for age, sex, and country of residence with 55 and 158 controls, respectively. Exposures to 21 chemicals or mixtures were estimated by three industrial hygienists who were blind to the subject's case-control status. Excess risk of soft tissue sarcoma was associated with exposure to any phenoxy herbicide [odds ratio (OR) = 10.3; 95% confidence interval (CI) 1.2-91] and to each of the three major classes of phenoxy herbicides (2,4-dichlorophenoxyacetic acid, 2,4,5-trichlorophenoxyacetic acid, and 4-chloro-2-methylphenoxyacetic acid), to any polychlorinated dibenzodioxin or furan (OR = 5.6; 95% CI = 1.1-28), and to 2,3,7,8-tetrachlorodibenzo-p-dioxin (OR = 5.2; 95% CI = 0.85-32). Sarcoma risk was not associated with exposure to raw materials or other process chemicals. In the non-Hodgkin's lymphoma study, associations were generally weaker than those found in the study on sarcoma. These findings indicate that workers exposed to phenoxy herbicides and their contaminants are at a higher risk of soft tissue sarcoma. Keywords:

Lancet. 1991 Oct 26;338(8774):1027-32. Comment in: * Lancet. 1991 Nov 30;338(8779):1392-3.

Cancer mortality in workers exposed to chlorophenoxy herbicides and chlorophenols.

Saracci R, Kogevinas M, Bertazzi PA, Bueno de Mesquita BH, Coggon D, Green LM, Kauppinen T, L'Abbe KA, Littorin M, Lynge E, et al. Unit of Analytical Epidemiology, International Agency for Research on Cancer, Lyon, France.

Epidemiological studies have revealed an increased risk of cancer, notably soft-tissue sarcomas and non-Hodgkin's lymphomas, in people occupationally exposed to chlorophenoxy herbicides, including those contaminated by 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin (TCDD). We report here a historical cohort study of mortality in an international register of 18,910 production workers or sprayers from ten countries. Exposure was reconstructed through questionnaires, factory or spraying records, and job histories. Cause-specific national death rates were used as reference. No excess was observed in all-cause mortality, for all neoplasms, for the most common epithelial cancers, or for lymphomas. A statistically non-significant two-fold excess risk, based on 4 observed deaths, was noted for soft-tissue sarcoma with a standardised mortality ratio (SMR) of 196 and 95% confidence interval (CI) 53-502; this was concentrated as a six-fold statistically significant excess, occurring 10-19 years from first exposure in the cohort as a whole (SMR = 606 [165-1552]) and, for the same time period, as a nine-fold excess among sprayers (SMR = 882 [182-2579]). Risks appeared to be increased for cancers of the testicle, thyroid, other endocrine glands, and nose and nasal cavity, based on small numbers of deaths. The excess of soft-tissue sarcomas among sprayers is compatible with a causal role of chlorophenoxy herbicides but the excess does not seem to be specifically associated with those herbicides probably contaminated by TCDD.

Publication Types: * Clinical Trial * Multicenter Study PMID:1681353 [PubMed - indexed for MEDLINE]

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NEGATIVE RESULTS/GENERAL

We believe that many of these authors have enormous financial ties to the 2,4-D industry, irrespective of what journal they have managed to get their studies published in. For example Gavazza, lead investigator of most of the negative CML findings below, was hired by the 2,4-D Industry Task Force to investigate the positive CML findings that had undergone high quality peer review. Other than these questionably-published CML negative results, it is highly notable that there are hardly any negative results published, no matter the quality of the journal.

NEGATIVE RESULTS/NHL AND ASTROCYTOMA

Bond GG, Wetterstroem NH, Roush GJ, McLaren EA, Lipps TE, Cook RR. 1988 Feb. Cause specific mortality among employees engaged in the manufacture, formulation, or packaging of 2,4-dichlorophenoxyacetic acid and related salts. *Br J Ind Med* 45:98-105.

Abstract: Mortality is reported to the end of 1982 for 878 chemical workers potentially exposed to 2,4-dichlorophenoxyacetic acid (2,4-D) at any time between 1945 and 1983. Observed mortality was compared with

expected levels based on adjusted rates for United States white men and for other male employees from this manufacturing location who were not exposed to 2,4-D. Because of a recently reported increased incidence of astrocytomas in male rats fed the highest dose level of 2,4-D, special attention was given to deaths from brain neoplasms in the cohort. None was observed. The absence of an increased risk of brain cancer in people exposed to 2,4-D is supported by studies of other exposed populations and those studies are briefly reviewed. Moreover, in the present study, analyses by production area, duration of exposure, and cumulative dose showed no patterns suggestive of a causal association between 2,4-D exposure and any other particular cause of death.

NEGATIVE RESULTS/NHL

Bloemen LJ, Mandel JS, Bond GG, Pollock AF, Vitek RP, Cook RR. 1993 Dec. An update of mortality among chemical workers potentially exposed to the herbicide 2,4-dichlorophenoxyacetic acid and its derivatives. *J Occup Med* 35:1208-12.

Abstract: Four years of additional mortality follow-up through 1986 are reported for a previously studied cohort of 878 chemical workers who were potentially exposed to 2,4-dichlorophenoxyacetic acid (2,4-D) and its derivatives between 1945 and 1983. Observed mortality was compared with expected levels based on death rates of the US population and of 36,804 "unexposed" workers from the same manufacturing location. Non-Hodgkin's lymphoma (NHL) was a particular focus of the study because of a suggested association with 2,4-D exposure in some case-control studies. For the total observation period, the standardized mortality ratios for all causes and for malignant neoplasms were 92 and 91, respectively. Analyses using the internal comparison group yielded virtually identical results. The initial study had found two deaths from NHL, both of which occurred under circumstances (ie, short latency and modest exposure) which made it less plausible that they were related to 2,4-D exposure. No new deaths from NHL were observed in the extended follow-up period and mortality for this cause showed a nonstatistically significant excess (standardized mortality ratio, 196; 95% confidence interval 24 to 708) for the total observation period. Analyses by production area, and by two different measures of exposure, combined with two different approaches to account for latency, did not show patterns suggestive of a causal relationship between exposure to 2,4-D or its derivatives and any particular cause of death. Keywords:

Burns CJ, Beard KK, Cartmill JB. 2001 Jan. Mortality in chemical workers potentially exposed to 2,4-dichlorophenoxyacetic acid (2,4-d) 1945-94: an update. *Occupational & Environmental Medicine* 58:24-30.
Abstract: Objective-To update and add to a previously identified cohort of employees potentially exposed to the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D). The putative association between 2,4-D and non-Hodgkin's lymphoma has been debated for more than a decade. Methods-Cohort members were male employees of The Dow Chemical Company who manufactured or formulated 2,4-D any time from 1945 to the end of 1994. Their mortality experience was compared with national rates and with more than 40 000 other company employees who worked at the same location. Results-330 Deaths were observed among 1517 people compared with 365 expected (standardised mortality ratio (SMR)=0.90, 95% confidence interval (95% CI) 0.81 to 1.01). There were no significantly increased SMRs for any of the causes of death analyzed. When compared with the United States rates, the SMR for non-Hodgkin's lymphoma (NHL) was 1.00 (95% CI 0.21 to 2.92). The internal comparison with other Dow employees showed a non-significant relative risk of 2.63, (95% CI 0.85 to 8.33). Death was attributed to amyotrophic lateral sclerosis (ALS) for three cohort members. Compared with the other company employees, the relative risk was 3.45 (95% CI 1.10 to 11.11). The cases were employed in the manufacture or formulation of 2,4-D at different periods (1947-9, 1950-1, and 1968-86), and for varying durations of time (1.3, 1.8, and 12.5 years). Conclusion-There was no evidence of a causal association between exposure to 2,4-D and mortality due to all causes and total malignant neoplasms. No significant risk due to NHL was found. Although not an initial hypothesis, an increased relative risk of ALS was noted. This finding is unsupported by other animal and human studies. [References: 48] Number of References 48
Keywords:

Wiklund K, Holm LE. 1986 Feb. Soft tissue sarcoma risk in Swedish agricultural and forestry workers. *J Natl Cancer Inst* 76:229-34.

Abstract: The risk of soft tissue sarcoma following possible exposure to phenoxy acid herbicides was studied in 354,620 Swedish men, who were employed in agriculture or forestry according to a national census in 1960. This cohort was further divided into six subcohorts, on assumed exposure to phenoxy acid herbicides. The most commonly used phenoxy acid in Sweden was (4-chloro-2-methylphenoxy)acetic acid (CAS: 94-74-6). The reference cohort encompassed 1,725,845 Swedish men employed in other industries. All persons were followed up in the cancer-environment register during the period 1961-79. A total of 331 cases of soft tissue sarcomas was observed in the study cohort and there were 1,508 cases in the reference group [relative risk (RR), 0.9; 95% confidence interval, 0.8-1.0]. No subcohort of agricultural or forestry workers showed any significantly increased RR, nor was there any significant difference in RR between the subcohorts. Despite the greatly increased use of phenoxy acid herbicides from 1947 to 1970, no time-related increase in the RR of soft tissue sarcoma was found in the total cohort or in any of the subcohorts.

NEGATIVE RESULTS/NHL ANALOGUE: CANINE MALIGNANT LYMPHOMA (CML)

Edwards MD, Pazzi KA, Gumerlock PH, Madewell BR. 1993. C-n-ras is activated infrequently in canine malignant lymphoma. *Toxicol Pathol* 21:288-291.

Abstract: Activated c-N-ras alleles have been detected in human lymphoma specimens. The aim of the present study was to determine the frequency of c-N-ras mutational activation in canine malignant lymphoma. DNA was

isolated from 28 canine malignant lymphoma specimens collected from 28 separate dogs and examined for c-N-ras mutations by polymerase chain reaction amplification and direct sequencing. The tumors were naturally occurring and derived from 20 dogs with known exposures to the phenoxy herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) and from 8 dogs with no known exposure to the herbicide. An oncogenically activating mutation was found in 1 dog without known 2,4-D exposure. The mutation was a 13th codon, second position transition that would result in a glycine-to-aspartate amino acid substitution. The results of this study demonstrate that, similar to the human, c-N-ras mutations are uncommon in dogs with malignant lymphoma and that there is no association between 2,4-D exposure and activation of c-N-ras in the dog.

Keywords:

Gavazza A, Presciuttini S, Barale R, Lubas G, Gugliucci B. 2001 May-2001 Jun 30. Association between canine malignant lymphoma, living in industrial areas, and use of chemicals by dog owners. J Vet Intern Med 15:190-195. Abstract: A case-control study was carried out to determine whether residential exposure to environmental pollutants increased risk for canine lymphoma in pet dogs. One hundred one cases with cytologically or histologically confirmed lymphoma diagnosed at a veterinary teaching hospital between the middle of 1996 and the middle of 1998 were examined. Controls were obtained by choosing twice the number of dogs without neoplastic disease, with overlapping distributions of province of residence, age, sex, and breed. Information regarding animal management, residence type, professional or hobby use of chemicals by owners, and treatment with herbicides or other pesticides in the area frequently visited by the dogs was obtained with a multiple-choice questionnaire by telephone interview. Two variables were positively and independently associated with the disease, namely residency in industrial areas (odds ratio [OR]: = 8.5; 95% confidence interval [CI]. 2.3-30.9) and use of chemicals by owners, specifically paints or solvents (OR = 4.6; 95% CI. 1.7-12.6). A significantly lower value of the mean age of disease onset was found in the group of dogs at risk in comparison with the group of all other dogs (6.1 +/- 0.4 years, n = 36 versus 7.5 +/- 0.4 years, n = 65, respectively; P = .008). Variables describing animal care and pesticide use were either not associated with the disease or were uninformative. We suggest that canine lymphoma may be considered a sentinel of potentially hazardous situations for humans, because of the relatively short latency between exposure and disease onset. [References: 27] Number of References 27

Keywords:

Kaneene JB, Miller R. 1999 Jun. Re-analysis of 2,4-d use and the occurrence of canine malignant lymphoma. Veterinary & Human Toxicology 41:164-170.

Abstract: An independent scientific review panel had concerns involving study design, analysis and interpretation of results in a case-control study investigating the relationship between canine malignant lymphoma (CML) and the use of 2,4-D herbicide. To address these concerns, a re-analysis was done to examine 2,4-D use and its association with CML. This case-control study re-analyzed the data using the exposure definition used in the original study, re-analyzed the data using a redefinition of exposure, and conducted a dose-response analysis with the redefined exposure criteria. Our results agreed with the original author's analyses that no effects were found when stratifying by survey method and geographic region, and that there were no significant differences between separated and pooled control groups. However, we did not confirm a dose-response relationship between 2,4-D use and CML. Additionally, the occurrence of CML was not found significantly associated with the use of 2,4-D. [References: 4] Number of References 4

Keywords:

O'Brien DJ, Kaneene JB, Getis A, Lloyd JW, Swanson GM, Leader RW. 2000 Nov 16. Spatial and temporal comparison of selected cancers in dogs and humans, michigan, usa, 1964-1994. Prev Vet Med 47:187-204. Abstract: Our aim was to investigate the geographic and time distributions of some biologically similar neoplasms in dogs and humans living in Michigan, USA, between 1964 and 1994. Our objective was to describe and compare the patterns of cancer in the two species while assessing the strength and dependence of those patterns. In this retrospective, registry-based study, histologically confirmed incident human and canine cancer cases were mapped, and second-order (K function) spatial analysis and one-dimensional nearest neighbor temporal analysis were performed on residence addresses and dates of hospital discharge/diagnosis. Included in the study were all 528 incident cases of canine lymphosarcoma, mammary adenocarcinoma, melanoma and spindle-cell sarcomas diagnosed at a veterinary teaching hospital between 1964 and 1994 having residence addresses in Ingham, Oakland, and Wayne Counties; and a stratified random sample of 913 incident human cases of comparable cancers diagnosed during the same time period from the same counties. Results suggest that processes determining spatial aggregation of cases in dogs and humans were not independent of each other, did not act uniformly over different geographic areas, operated at spatial scales <2000 m regardless of species, and tend to act upon dogs more strongly at shorter distances than on humans. Little evidence of interspecies concurrence of temporal clustering was found. (C) 2000 Elsevier Science B.V. All rights reserved. [References: 57] Number of References 57

Keywords:

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MECHANISMS OF CANCER

MUTAGENICITY (DNA/CHROMOSOME DAMAGE)

(Most apoptosis/cell-cycle disruption papers are listed in 'cancer/other mechanisms', below. Of course, mutagenicity and cell-cycle (cell replication) disruptions lead to more diseases than just cancer, but cancer is a

major endpoint of such damage. The later especially leads to cancer, as both cancer and some cell-cycle disruption involve uncontrolled cell replication.

The weight of the evidence in this subset is notably in opposition to your conclusion. We found just two published results indicating that 2,4-D is not mutagenic. Considering quality, there is just one, as the other (published as three sequential papers) is authored by consultants paid by the 2,4-D industry, and published in a journal that accepts authors with horrible conflicts of interests. In contrast, we found 15 published papers showing that 2,4-D is mutagenic (all in journals with quality peer review).

Given that 19 of the 20 valid published studies of 2,4-D's mutagenicity prove that it is a mutagenic chemical, and that the weight of the evidence shows it is at least a possible human carcinogen, it is very important that you consider your own (one author) recent study finding that 13 of 13 carcinogens acting through mutagenic mechanisms were on average five to 60 times more potent as carcinogens when the pups were dosed before weaning than when the animals were exposed as adults; at all test doses and in every test (D. Hattis et al. Aug. 2004 'Age-Related Differences in Susceptibility to Carcinogenesis: a quantitative analysis..' *Env. Health Perspect.* 112:11:1152-8). Obviously, neither the FQPA's 10-fold allowance for child sensitivity, nor your cancer guideline's 10-fold allowance for infants, are sufficient protection, at least for mutagenic carcinogens; yet in this RA you recklessly have decided that children need no such protection from the mutagenic carcinogen 2,4-D. This study and the two studies above showing that 2,4-D is a carcinogen if the animals are dosed early in life (which you failed to test for) all emphasize how poorly all your RAs, including this one, protect children; even though children's exposure to 2,4-D is ubiquitous.

POSITIVE RESULTS/MUTAGENIC

Arias E. 2003 Jul. Sister chromatid exchange induction by the herbicide 2,4-dichlorophenoxyacetic acid in chick embryos. *Ecotoxicology & Environmental Safety* 55:338-343.

Abstract: As genetic damage may result from exposure to agricultural chemicals, it seemed appropriate to assess the genotoxic potential of 2,4-dichlorophenoxyacetic acid (2,4-D), a widely used broad-leaf herbicide, using a test system that may provide some indications on the genetic risk to animal species in the wild. In the present study, sister chromatid exchange (SCE) induction and cell cycle kinetics alterations by 2,4-D in 4-day old chick embryos were evaluated. Both a commercial herbicide formulation containing 37% 2,4-D isooctyl ester as active ingredient and pure 2,4-D were tested. Chick embryos were treated with 0, 0.5, 1, 2, or 4 mg 2,4-D. Test solutions were applied to the inner shell membrane on day 0 of incubation. Either commercial formulation or pure 2,4-D induced a dose-related increase in SCE frequency over the concentration range from 0 to 4 mg/embryo. Significantly higher SCE frequency was seen for the 4-mg group of embryos treated with the commercial product. A slightly higher SCE value was observed for the vehicle group (acetone-treated embryos) compared with the negative controls (untreated embryos). Significant inhibition of cell cycle progression was evident in both experimental groups and was generally dose related. The extent of changes in cell kinetics was similar in both groups, although somewhat more marked in the group treated with pure 2,4-D. The present findings corroborate the positive results from recent *in vivo* rodent studies. (C) 2003 Elsevier Science (USA). All rights reserved. [References: 36] Number of References 36

Keywords:

Ateeq B, Farah MA, Ali MN, Ahmad W. 2002 Feb 15. Clastogenicity of pentachlorophenol, 2,4-d and butachlor evaluated by allium root tip test. *Mutation Research-Genetic Toxicology & Environmental Mutagenesis* 514:105-113.

Abstract: The meristematic mitotic cells of *Allium cepa* is an efficient cytogenetic material for chromosome aberration assay on environmental pollutants. For assessing genotoxicity of pentachlorophenol (PCP), 2,4-dichlorophenoxyacetic acid (2,4-D) and 2-chloro-2,6-diethyl-N-(butoxymethyl) acetanilide (butachlor), 50% effective concentration (EC50), c-mitosis, stickiness, chromosome breaks and mitotic index (MI) were used as endpoints of genotoxicity. EC50 values for PCP and butachlor are 0.73 and 5.13 ppm, respectively. 2,4-D evidently induced morphological changes at higher concentrations. Some changes like crochet hooks, c-tumours and broken roots were unique to 2,4-D at 5-20 ppm. No such abnormalities were found in PCP and butachlor treated groups, however, root deteriorated and degenerated at higher concentrations (<3 ppm) in PCP. MI in 2,4-D showed a low average of 14.32% followed by PCP (19.53%), while in butachlor it was recorded 71.6%, which is near to the control value. All chemicals induced chromosome aberrations at statistically significant level. The highest chromosome aberration frequency (11.90%) was recorded in PCP at 3 ppm. Large number of c-mitotic anaphases indicated that butachlor acts as potent spindle inhibitor, whereas, breaks, bridges, stickiness and laggards were most frequently found in PCP showing that it is a potent clastogen. (C) 2002 Elsevier Science B.V. All rights reserved. [References: 30] Number of References 30

Keywords:

Figgs LW, Holland NT, Rothmann N, Zahm SH, Tarone RE, Hill R, Vogt RF, Smith MT, Boysen CD, Holmes FF, VanDyck K, Blair A. 2000 Apr. Increased lymphocyte replicative index following 2,4-dichlorophenoxyacetic acid herbicide exposure. *Cancer Causes Control* 11:373-80.

Abstract: OBJECTIVE: Evaluate peripheral blood lymphocyte proliferation (replicative index:RI) and micronuclei frequency (MF) among 2,4-D herbicide applicators. METHODS: Twelve applicators spraying only 2,4-D provided a blood and urine specimen upon enrollment, several urine samples during the spraying season, and a blood specimen at the study's end. Nine controls provided blood and urine specimens upon enrollment and at the study's end. Gas chromatography/tandem mass spectroscopy determined urinary 2,4-D levels and standard *in-vitro* assays

determined RI and MF scores. Applicator RI and MF were compared before and after spraying and with controls. RESULTS: Applicators contributed 45 urine specimens with concentrations ranging from 1.0 to 1700 (microg 2,4-D/g creatinine/L urine) that logarithmically (ln) increased as spraying time increased. Applicator RI increased after spraying ($p = 0.016$), independent of tobacco and alcohol use, and demonstrated a weak dose-response with increasing urinary 2,4-D levels ($p = 0.15$). Among 2,4-D applicators, pre-exposure complete blood counts and lymphocyte immunophenotypes were not significantly different from post-exposure measurements. CONCLUSION: Urinary 2,4-D concentration, an exposure biomarker, may be associated with lymphocyte replicative index, a cell proliferation biomarker.

Holland NT, Duramad P, Rothman N, Figgs LW, Blair A, Hubbard A, Smith MT. 2002 Nov 26. Micronucleus frequency and proliferation in human lymphocytes after exposure to herbicide 2,4-dichlorophenoxyacetic acid in vitro and in vivo. *Mutation Research-Genetic Toxicology & Environmental Mutagenesis* 521:165-178.

Abstract: Widespread use of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) and its association with non-Hodgkin's lymphoma (NHL) and other cancers has raised public concern. Here, micronucleus (MN) formation has been used as a biomarker of genotoxicity, and replicative and mitotic indices (MIs) as biomarkers of cell cycle kinetics in human lymphocytes. Cells were cultured either as whole blood or isolated lymphocytes and treated with pure or commercial forms of 2,4-D at doses between 0.001 and 1 mM for 48 h. Exposure to 2,4-D produced a minimal increase in MN in whole blood and even smaller one in isolated lymphocyte cultures. This induction took place only at levels approaching cytotoxicity and was accompanied by a significant inhibition of replicative index (RI). At a low (0.005 mM) dose of commercial 2,4-D, a small, marginally significant increase in RI (12-15%) was found in two independent sets of experiments ($P = 0.052$). Additionally, we found that lymphocyte RI was more affected by commercial 2,4-D containing 9.4% of the chemically pure 2,4-D, than with an equal concentration of the latter suggesting that other ingredients present in the commercial pesticide may be responsible or may enhance the effect of 2,4-D. Mitotic index, however, did not show any significant change with either commercial or pure 2,4-D. The lymphocytes of 12 male applicators exposed solely to 2,4-D during a 3-month period had a significantly higher RI than the same group prior to exposure and than a control group ($P < 0.01$), in accordance with the in vitro finding of increased RI at low doses. (C) 2002 Elsevier Science B.V. All rights reserved. [References: 61] Number of References 61

[NOTE THE SUPER-LOW (5 PICOMOLE) DOSE EFFECT]

Kaya B, Yanikoglu A, Marcos R. 1999. Genotoxicity studies on the phenoxyacetates 2,4-d and 4-cpa in the drosophila wing spot test. *Teratogenesis, Carcinogenesis, & Mutagenesis* 19:305-312.

Abstract: The phenoxyacetates 2,4-D and 4-CPA were evaluated for genotoxicity using the *Drosophila melanogaster* wing spot test, which assesses for somatic mutation and recombination events. Third-instar larvae trans-heterozygous for two recessive mutations affecting the expression of wing trichomes, multiple wing hairs (mwh), and flare (flr) were treated by chronic feeding with different concentrations of the two chemicals. Feeding lasted until pupation of the surviving larvae and the genotoxic effects induced were evaluated in adults for the appearance of wing-blade cell clones with the mwh, flr or mwh-flr phenotypes. Exposure to 2,4-D, at the highest concentration evaluated (10 mM), induced a weak but significant increase in the frequency of two of the categories of recorded spots: large single and total spots; in contrast, the 4-CPA treatments failed to induce any significant increase in the frequency of evaluated spots. When the heterozygous larvae for mwh and the multiple inverted TM3 balancer chromosome were treated with the chemicals, no increases were detected, either after the 2,4-D nor the 4-CPA treatments. (C) 1999 Wiley-Liss, Inc. [References: 30] Number of References 30

Keywords:

Kornuta N, Bagley E, Nedopitanskaya N. 1996. Genotoxic effects of pesticides. *J Environ Pathol Toxicol Oncol* 15: 75-8.

Abstract: Epidemiologic data showed an increase in the number of cancer cases in persons involved in agricultural production using pesticides. According to IARC, more than 25% of pesticides are classified as oncogens. In recent years, the concept of malignant tumors developing after environmental contamination with chemicals has been accepted. Changes in genetic material are at the basis of this process because many environmental pollutants are chemical carcinogens and mutagens with the capacity of causing DNA damage. DNA damage was proposed as a useful parameter for assessing the genotoxic properties of environmental pollutants. The correlation between exposure to carcinogenic substance and the level of DNA damage is essential. Pesticides are highly biologically active chemicals. They may interact with DNA and damage its structure. Such interaction may be critical for the manifestation of carcinogenic properties of different chemicals. We report on the organotropic genotoxic effects of different chemical classes of pesticides (decis, cypermethrin, 2,4-D, polyram) studied by means of alkaline unwinding assay DNA.

Filkowski J, Besplug J, Burke P, Kovalchuk I, Kovalchuk O. 2003 Dec 9. Genotoxicity of 2,4-d and dicamba revealed by transgenic arabidopsis thaliana plants harboring recombination and point mutation markers. *Mutation Research-Genetic Toxicology & Environmental Mutagenesis* 542:23-32.

Abstract: The phenoxy herbicides 2,4-D and dicamba are released daily into the environment in large amount. The mechanisms of genotoxicity and mutagenicity of these herbicides are poorly understood, and the available genotoxicity data is controversial. There is a cogent need for a novel genotoxicity monitoring system that could provide both reliable information at the molecular level, and complement existing systems. We employed the transgenic *Arabidopsis thaliana* 'point mutation' and 'recombination' plants to monitor the genetic effects of the herbicides 2,4-D and dicamba. We found that both herbicides had a significant effect on the frequency of homologous recombination A --> G mutation. Neither herbicides affected the T --> G mutation frequency. Interestingly, these transgenic biomonitoring plants were able to detect the presence of phenoxy herbicides at concentrations that were lower than the guideline levels for Drinking Water Quality. The results of our studies

suggest that our transgenic system may be ideal for the evaluation of the genotoxicity of herbicide-contaminated water. Moreover, the unique ability of the plants to detect both double-strand breaks (homologous recombination) and point mutations provides tremendous potential in the study of molecular mechanisms of genotoxicity and mutagenicity of phenoxy herbicides. (C) 2003 Elsevier B.V. All rights reserved. [References: 40] Number of References 40

Keywords:

Garry VF, Tarone RE, Kirsch IR, Abdallah JM, Lombardi DP, Long LK, Burroughs BL, Barr DB, Kesner JS. 2001 May. Biomarker correlations of urinary 2,4-d levels in foresters: genomic instability and endocrine disruption. *Environ Health Perspect* 109:495-500.

Abstract: Forest pesticide applicators constitute a unique pesticide use group. Aerial, mechanical-ground, and focal weed control by application of herbicides, in particular chlorophenoxy herbicides, yield diverse exposure scenarios. In the present work, we analyzed aberrations in G-banded chromosomes, reproductive hormone levels, and polymerase chain reaction-based V(D)J rearrangement frequencies in applicators whose exposures were mostly limited to chlorophenoxy herbicides. Data from applicators where chlorophenoxy use was less frequent were also examined. The biomarker outcome data were compared to urinary levels of 2,4-dichlorophenoxyacetic acid (2,4-D) obtained at the time of maximum 2,4-D use. Further comparisons of outcome data were made to the total volume of herbicides applied during the entire pesticide-use season. Twenty-four applicators and 15 minimally exposed foresters (control) subjects were studied. Categorized by applicator method, men who used a hand-held, backpack sprayer in their applications showed the highest average level (453.6 ppb) of 2,4-D in urine. Serum luteinizing hormone (LH) values were correlated with urinary 2,4-D levels, but follicle-stimulating hormone and free and total testosterone were not. At the height of the application season; 6/7 backpack sprayers, 3/4 applicators who used multinozzle mechanical (boom) sprayers, 4/8 aerial applicators, and 2/5 skidder-radiarc (closed cab) applicators had two or more V(D)J region rearrangements per microgram of DNA. Only 5 of 15 minimally exposed (control) foresters had two or more rearrangements, and 3 of these 5 subjects demonstrated detectable levels of 2,4-D in the urine. Only 8/24 DNA samples obtained from the exposed group 10 months or more after their last chlorophenoxy use had two rearrangements per microgram of DNA, suggesting that the exposure-related effects observed were reversible and temporary. Although urinary 2,4-D levels were not correlated with chromosome aberration frequency, chromosome aberration frequencies were correlated with the total volume of herbicides applied, including products other than 2,4-D. In summary, herbicide applicators with high urinary levels of 2,4-D (backpack and boom spray applications) exhibited elevated LH levels. They also exhibited altered genomic stability as measured by V(D)J rearrangement frequency, which appears reversible months after peak exposure. Though highly detailed, the limited sample size warrants cautious interpretation of the data. [References: 28] Number of References 28

Keywords:

K. Atanassov 1992 'Effect of the herbicide Schpritsormit' (salt in 2,4-D) *Animal Science* 29:54-61. [When administered in rabbits' drinking water, the sodium salt of 2,4-D caused an increase in the number of chromosomes, brain cells with too many chromosomes and cells with multiple chromosome sets.] [ALSO LISTED IN 'POSITIVE RESULTS/BRAIN CANCERS' ABOVE]

The dimethyl amine salt of 2,4-D caused breaks in DNA molecules (genetic material) from human connective tissue. M. Clausen et al. 1990 'Comparison of the cytotoxicity and DNA-damaging properties of 2,4-D' *Arch. Toxicol.* 64:497-501.

Turkula TE, Jalal SM. 1985 May-Jun. Increased rates of sister chromatid exchanges induced by the herbicide 2,4-D. *J Hered* 76:213-4.

Abstract: The potential for genetic damage from widely used hormonal herbicides, such as 2,4-dichlorophenoxyacetic acid (2,4-D), continues to be of serious concern. The mutagenic effect as reflected by the rates of sister chromatid exchanges (SCE) was determined in cultured human lymphocytes. Data were based on the analysis of 50 cells for the control and each of the three treatments. A 50 micrograms/ml dosage caused a highly significant increase in SCE. Dosages of 100 and 250 micrograms/ml elevated the rate of SCE, but not significantly. Since 2,4-D biodegrades rapidly in soil and water, its continued use is not in serious question until safer compounds are available. However, the results of this study suggest that the danger of genetic damage from direct exposure to commercial samples of 2,4-D should not be ignored.

Madrigal-Bujaidar E, Hernandez-Ceruelos A, Chamorro G. 2001 Sep. Induction of sister chromatid exchanges by 2,4-dichlorophenoxyacetic acid in somatic and germ cells of mice exposed in vivo. *Food & Chemical Toxicology* 39:941-946.

Abstract: 2,4-dichlorophenoxyacetic acid (2,4-D) is one of the most widely used selective herbicides throughout the world; however, the studies that have been conducted to establish its genotoxic potential have given conflicting results. The aim of this investigation was to determine whether the herbicide increases the frequency of sister chromatid exchanges (SCEs) in bone marrow and spermatogonial cells of mice exposed in vivo. The experiment included an oral administration of 2,4-D to three groups of mice (50, 100 and 200 mg/kg), as well as to a control group of animals administered with distilled water, pH 10.5 and another group injected with cyclophosphamide (50 mg/kg). In somatic cells, the results showed a significant SCE increase with the two high doses tested, a response that was manifested in a dose-dependent manner. With regard to the mitotic index and the cell proliferation kinetics, there were no modifications exerted by 2,4-D; however, cyclophosphamide induced cytotoxic damage and a cell-cycle delay. With respect to the germ cells, the genotoxic results were similar to those described earlier; that is, there was a significant SCE increase induced by the two high 2,4-D doses tested and a higher genotoxic damage was observed in the animals treated with cyclophosphamide. Our investigation established that 2,4-D is a moderate genotoxicant in mice treated in vivo with high doses, and suggests a minor hazard for humans in the present

conditions of its use. (C) 2001 Elsevier Science Ltd. All rights reserved. [References: 42] Number of References 42
Keywords:

Korte C, Jalal SM. 1982 May-Jun. 2,4-D induced clastogenicity and elevated rates of sister chromatid exchanges in cultured human lymphocytes. *J Hered* 73:224-6.

Abstract: Potential for genetic damage in future generations from such widely used hormonal herbicide as 2,4-D (2,4-dichlorophenoxyacetic acid) is of serious concern. Yet the data, particularly on mammalian systems, continue to be inadequate and inconclusive. An attempt was made in this study to determine the clastogenic and mutagenic potential of 2,4-D in cultured lymphocytes. Chromosome damage though statistically insignificant occurred at dosages as low as 0.2 microgram/ml. Chromosome damage was increased at a statistically significant level whenever the concentration was 50 microgram/ml or higher. Mutagenicity, based on rates of increase in sister chromatid exchanges, was significant at 10 micrograms/ml of higher concentrations. Statistical testing was based on analysis of variance, Dunnett's multiple comparison tests and linear regressions. It seems imperative therefore to avoid indiscriminate use of 2,4-D, and to test the compound for long-range low-level exposures.

Arch Toxicol. 1989;63(3):203-8. Effects of commercial chlorophenolate, 2,3,7,8-TCDD, and pure phenoxyacetic acids on hepatic peroxisome proliferation, xenobiotic metabolism and sister chromatid exchange in the rat. Mustonen R, Elovaara E, Zitting A, Linnainmaa K, Vainio H. Institute of Occupational Health, Department of Industrial Hygiene and Toxicology, Helsinki, Finland.

The induction of hepatic peroxisome proliferation and drug metabolizing enzymes and of sister chromatid exchange (SCE) in lymphocytes was studied in male Han/Wistar rats after exposing them for 2 weeks to a commercial chlorophenolate formulation (Ky-5) (100 mg/kg/day), to 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD; 0.05-5 micrograms/kg/wk) and to the pure phenoxyacetic acids, 2,4-dichlorophenoxyacetic acid (2,4-D; 100 mg/kg/day) and 2-chloro-4-methylphenoxyacetic acid (MCPA; 100 mg/kg/day). The chlorophenolate formulation and pure 2,4-D and MCPA caused significant increases in the number of peroxisomes in liver cells, although the average size of peroxisomes was not affected, whereas the effect of even the highest dose of 2,3,7,8-TCDD remained small. This finding indicates that dioxin impurities do not account for the peroxisome proliferation induced by chlorophenolate. The relative weight of the liver increased significantly in rats treated with the chlorophenolate formulation and with 2,3,7,8-TCDD (5.0 and 0.5 micrograms/kg). The pattern of induction of xenobiotic metabolizing enzymes showed some differences between chlorophenolate treatment and 2,3,7,8-TCDD treatment. Furthermore, the effects of pure phenoxyacetic acids were different from that seen with chlorophenolate and 2,3,7,8-TCDD. The highest dose of 2,3,7,8-TCDD increased the frequency of SCE in circulating lymphocytes slightly, but significantly. PMID: 2764706 [PubMed - indexed for MEDLINE]

Mutagenesis. 1986 Jul;1(4):241-5. Effects of phenoxyacetic acids on the induction of chromosome aberrations in vitro and in vivo. Mustonen R, Kangas J, Vuojolahti P, Linnainmaa K. Institute of Occupational Health, Department of Industrial Hygiene and Toxicology, Helsinki, Finland.

The effects of phenoxyacetic acid herbicides were investigated on the induction of chromosome aberrations in human peripheral lymphocyte cultures in vitro and in lymphocytes of exposed workers in vivo. Pure 2,4-dichlorophenoxyacetic acid (2,4-D; 0.125, 0.150, 0.200 and 0.350 mM) did not increase the number of aberrations, whereas the commercial 2,4-D formulation (0.125, 0.250, 0.500, 1.000 and 1.250 mM, with respect to phenoxyacetic acid concentration) significantly increased the number of chromosome aberrations in vitro (without exogenous metabolic activation). The phenoxy acid levels in the breathing zone of the workers varied between 0.3 and 0.4 mg/m³, and the concentrations of phenoxyacetic acids in the urine of the workers after exposure varied from 0.000 to 0.055 mmol/l. There were no increases in chromosome aberrations in peripheral lymphocytes of the exposed subjects. PMID: 3331666 [PubMed - indexed for MEDLINE]

Mustonen R, Kangas J, Vuojolahti P, Linnainmaa K. 1986 Jul. Effects of phenoxyacetic acids on the induction of chromosome aberrations in vitro and in vivo. *Mutagenesis* 1:241-5.

Abstract: The effects of phenoxyacetic acid herbicides were investigated on the induction of chromosome aberrations in human peripheral lymphocyte cultures in vitro and in lymphocytes of exposed workers in vivo. Pure 2,4-dichlorophenoxyacetic acid (2,4-D; 0.125, 0.150, 0.200 and 0.350 mM) did not increase the number of aberrations, whereas the commercial 2,4-D formulation (0.125, 0.250, 0.500, 1.000 and 1.250 mM, with respect to phenoxyacetic acid concentration) significantly increased the number of chromosome aberrations in vitro (without exogenous metabolic activation). The phenoxy acid levels in the breathing zone of the workers varied between 0.3 and 0.4 mg/m³, and the concentrations of phenoxyacetic acids in the urine of the workers after exposure varied from 0.000 to 0.055 mmol/l. There were no increases in chromosome aberrations in peripheral lymphocytes of the exposed subjects.

Riabchenko NI, Fesenko EV, Antoshchina MM. 1995 Sep-Oct. [A cytogenetic analysis of the combined action of pesticides and irradiation on human lymphocytes]. *Radiats Biol Radioecol* 35:736-9.

Abstract: The efficiency of the combined action of pesticides and irradiation at the G(o) stage was studied in cultured human lymphocytes. Carbophos (malathion) increased the yield of chromosome and chromatid fragments in irradiated lymphocytes. Herbicide 2,4-D (dichlorophenoxyacetic acid) raised lymphocyte radiosensitivity by increasing the yield of chromosome type aberrations; the radiosensitizing effect of the herbicide decreased as its concentration increased.

Venkov P, Topashka-Ancheva M, Georgieva M, Alexieva V, Karanov E. 2000 Nov. Genotoxic effect of substituted phenoxyacetic acids. *Arch Toxicol* 74:560-566.

Abstract: The potential toxic and mutagenic action of 2,4-dichlorophenoxyacetic acid has been studied in different test systems, and the obtained results range from increased chromosomal damage to no effect at all. We

reexamined the effect of this herbicide by simultaneous using three tests based on yeast, transformed hematopoietic, and mouse bone marrow cells. The results obtained demonstrated that 2,4-dichlorophenoxyacetic acid: has cytotoxic and mutagenic effects. The positive response of yeast and transformed hematopoietic cells was verified in kinetics and dose-response experiments. The analysis of metaphase chromosomes indicated a statistically proved induction of breaks, deletions, and exchanges after the intraperitoneal administration of 2,4-dichlorophenoxyacetic acid in mice. The study of phenoxyacetic acid and its differently chlorinated derivatives showed that cytotoxicity and mutagenicity are induced by chlorine atoms at position 2 and/or 4 in the benzene ring. The mutagenic effect was abolished by introduction of a third chlorine atom at position 5. Thus 2,4,5-trichlorophenoxyacetic acid was found to have very weak, if any mutagenic effect; however, the herbicide preserved its toxic effect. [References: 25] Number of References 25

Keywords:

Pavlica M, Papes D, Nagy B. 1991 Jun. 2,4-Dichlorophenoxyacetic acid causes chromatin and chromosome abnormalities in plant cells and mutation in cultured mammalian cells. *Mutat Res* 263:77-81.
 Abstract: The cytotoxic and mutagenic effects of the synthetic auxin 2,4-dichlorophenoxyacetic acid (2,4-D) on shallot root tip cells and on V79 Chinese hamster fibroblast cells were examined and compared. In shallot root tips 2,4-D caused changes in mitotic activity, as well as changes in chromosome and chromatin structure, and also changes during the cell cycle. 2,4-D also showed mutagenic and cytotoxic effects on V79 cells in culture in concentrations higher than 10 micrograms/ml. The results in both systems (plant and mammalian cells) were in agreement showing mutagenic activity of 2,4-D in the concentration range higher than usually used in establishing plant tissue culture (greater than 5 micrograms/ml).

Zeljezic D, Garaj-Vrhovac V. 2004 Jul 15. Chromosomal aberrations, micronuclei and nuclear buds induced in human lymphocytes by 2,4-dichlorophenoxyacetic acid pesticide formulation. *Toxicology* 200:39-47.
 Abstract: Pesticides of worldwide application are used in agriculture in vast amounts each year, of which herbicides are the most prominent class. Phenoxyacetic herbicides constitute one of the largest groups of herbicides sold in the world. Among them, for many years 2,4-dichlorophenoxyacetic acid (2,4-D) has been the one most used. In this study we used Deherban A, a commercial formulation of 2,4-D to determine its possible genotoxic effect on human lymphocytes in vitro by chromosomal aberration analysis and micronucleus assay including the scoring of nuclear buds. Two different concentrations of pesticide formulation were used so that final concentrations of 2,4-D were 0.4 and 4 microg/ml, both in the presence and in the absence of the liver microsomal fraction as metabolic activator. Both concentrations of pesticide caused an increase in chromatid and chromosome breaks, number of micronuclei and number of nuclear buds. Presence of the S9 mix additionally elevated the number of chromatid breaks and micronuclei in treated lymphocytes.

RESULT NOT STATED/MUTAGENIC

Burroughs BL, Johnson CS, Garry VF. 1996. In vitro micronucleus response of commercial chlorophenoxy herbicides and adjuvants:1-5.
 Abstract: (Rough draft without graphs) Chlorophenoxy herbicides, particularly 2,4-D have been epidemiologically associated with excess Non Hodgkins Lymphoma in some studies while not in others (1,2,3,4). In vivo and in vitro studies in animals or in cultured cells of chemically pure chlorophenoxy herbicide do not suggest that these herbicides are notably genotoxic (1 ibid., 5,6,7,8). On the other hand, adjuvants sometimes used in conjunction with these herbicides as spreading and sticking agents have not to our knowledge been examined for genotoxic potential. To test the hypothesis that contaminants in these herbicides or adjuvants might have genotoxic potential, commercial grade chlorophenoxy herbicides, other herbicides and adjuvants were studied. Chemicals used in these in vitro studies were obtained from forest pesticides applicators who use these products in their work. This report is part of a larger laboratory based human population study of forest pesticide applicators.
 Keywords:

Tuschl H, Schwab CE. 2004 Aug. Flow cytometric methods used as screening tests for basal toxicity of chemicals. *Toxicology in Vitro* 18:483-491.
 Abstract: Aim of the present study was to evaluate the suitability of flow cytometry to test in vitro effects of toxicants. Flow cytometry offers the possibility to study several parameters simultaneously, e.g. cell cycle modulation, apoptosis and necrosis within the same cell culture. The effects of six compounds (acetaminophen = AAP, isoniazid = INH, digoxin, malathion, paraquat and 2,4-dichlorophenoxy acetic acid = 2,4-D) on cell cycle were investigated in HepG2 cells and the induction of apoptosis/necrosis was analyzed by a spectrum of flow cytometric assays in HepG2, AAH-1 and YAC-1 cells. Early indicators of apoptosis-loss of mitochondrial membrane polarization-as well as later events of the apoptotic process-annexin V binding and DNA fragmentation-were studied. The phases of the cell cycle and the occurrence of a sub-G0 peak of apoptotic cells were determined with propidium iodide staining. The present investigation demonstrated good correlations between results obtained by flow cytometric analyses and the IC50 data of the MEIC (= Multicenter Evaluation of In Vitro Cytotoxicity) study. Regarding the short time required for the tests, the possibility of investigating several parameters of cytotoxicity simultaneously and the ease of performance, flow cytometric analyses are well suited for the pre-screening for toxic effects of chemicals. (C) 2004 Elsevier Ltd. All rights reserved. [References: 22] Number of References 22Keywords:

Linnainmaa K. 1984. The effects of hypolipidemic peroxisome proliferators on the induction of sister chromatid exchanges. *Basic Life Sci* 29 Pt B:965-74.

AMBIGUOUS RESULT/MUTAGENIC

Linnainmaa K. 1984 Jun. Induction of sister chromatid exchanges by the peroxisome proliferators 2,4-D, MCPA, and clofibrate in vivo and in vitro. *Carcinogenesis* 5:703-7.

Abstract: Phenoxy acid herbicides 2,4-dichlorophenoxyacetic acid (2,4-D) and 4-chloro-2-methylphenoxyacetic acid (MCPA) have been found to induce proliferation of peroxisomes in the liver cells of rodents in the same manner as the hypolipidemic drug clofibrate. Both phenoxy acid herbicides and clofibrate (ethyl-alpha-p-chlorophenoxyisobutyrate) are suspected carcinogens. The present study reports the effect of these agents on the induction of sister chromatid exchange (SCE) in the blood lymphocytes of exposed rats (100 mg/kg with 2,4-D and MCPA, 200 mg/kg with clofibrate for 2 weeks in one intragastric dose/day), in the bone marrow cells of exposed Chinese hamsters (100 mg/kg, treatments as above), and in Chinese hamster ovary (CHO) cells in vitro (10(-5), 10(-4), and 10(-3) M, for 1 h). In the experiments in vitro, the effects of purified 2,4-D and MCPA phenoxy acids were studied, in addition to those of the commercial herbicide formulations and clofibrate. No increase of SCE frequency was observed in the blood lymphocytes of the exposed rats in comparison with the controls. In the bone marrow cells of the exposed Chinese hamsters, a slight increase of SCE was found in the group treated with MCPA but not in the groups treated with 2,4-D or clofibrate. A slight increase in the number of SCEs was characteristic of all the treated CHO cell cultures, both with and without a rat liver microsomal activation system (S9 mix). No clear dose-related effects, however, could be discerned with any of the compounds, and no differences in the SCE induction were observed between the commercial herbicide products and the purified phenoxy acetic acids. The present results support the data which indicate that 2,4-D, MCPA, and clofibrate do not act as direct DNA-damaging agents.

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NEGATIVE RESULTS/MUTAGENIC

Charles JM, Cunny HC, Wilson RD, Bus JS, Lawlor TE, Cifone MA, Fellows M, Gollapudi B. 1999 Jul 21. Ames assays and unscheduled dna synthesis assays on 2,4-dichlorophenoxyacetic acid and its derivatives. *Mutation Research-Genetic Toxicology & Environmental Mutagenesis* 444: 207-216.

Abstract: 2,4-Dichlorophenoxyacetic acid and several of its derivatives (collectively known as 2,4-D) are herbicides used to control a wide variety of broadleaf and woody plants. The genetic toxicity in vitro of 2,4-D and seven of its salts and esters were examined by employing gene mutation in bacteria (Ames test) and induction of DNA damage and repair in rat hepatocytes. In addition, an in vivo unscheduled DNA synthesis (UDS) assay was performed on 2,4-D. There were no indications of genotoxic potential for 2,4-D acid, or any of its derivatives, in these assays. These results are consistent with the reported lack of carcinogenic potential for 2,4-D in both mice and rats. (C) 1999 Elsevier Science B.V. All rights reserved. [References: 21] Number of References 21

Keywords:

Gollapudi BB, Charles JM, Linscombe VA, Day SJ, Bus JS. 1999 Jul 21. Evaluation of the genotoxicity of 2,4-dichlorophenoxyacetic acid and its derivatives in mammalian cell cultures. *Mutation Research-Genetic Toxicology & Environmental Mutagenesis* 444:217-225.

Abstract: 2,4-Dichlorophenoxyacetic acid and its derivatives (collectively known as 2,4-D) are herbicides used to control a wide variety of broadleaf and woody plants. The genetic toxicity of an ester (2,4-D 2-butoxyethylester) and two salts (2,4-D isopropylamine and 2,4-D triisopropanolamine) was investigated in cultured mammalian cells. The end points used were the induction of chromosomal aberrations in primary cultures of rat lymphocytes and forward mutations at the HGPRT locus of Chinese hamster ovary cells. There was no evidence of genotoxicity for the test materials in the experimental systems used. These results were consistent with the general lack of genotoxic potential for 2,4-D in a number of other test systems. (C) 1999 Elsevier Science B.V. All rights reserved. [References: 11] Number of References 11

Keywords:

Charles JM, Cunny HC, Wilson RD, Ivett JL, Murli H, Bus JS, Gollapudi B. 1999 Jul 21. In vivo micronucleus assays on 2,4-dichlorophenoxyacetic acid and its derivatives. *Mutation Research-Genetic Toxicology & Environmental Mutagenesis* 444:227-234.

Abstract: The potential for 2,4-D and seven of its salts and esters to induce cytogenetic abnormalities in mammalian cells in vivo was investigated in the mouse bone marrow micronucleus test. All the test materials were administered to male and female mice by oral gavage and the frequencies of micronucleated polychromatic erythrocytes (MN-PCE) in the bone marrow were determined at intervals of 24, 48 and 72 h following dosing. There were no significant increases in the incidence of MN-PCE in the treated mice at any of the bone marrow sampling times. These results are consistent with the reported lack of in vitro genetic toxicity for these materials in various in vitro genotoxicity assays as well as the absence of carcinogenic potential for 2,4-D in both mice and rats. (C) 1999 Elsevier Science B.V. All rights reserved. [References: 23] Number of References 23

Keywords:

Linnainmaa K. 1983. Sister chromatid exchanges among workers occupationally exposed to phenoxy acid herbicides 2,4-D and MCPA. *Teratog Carcinog Mutagen* 3:269-79.

Abstract: The induction of sister chromatid exchanges (SCEs) was studied in the peripheral lymphocytes of workers spraying foliage in forestry with phenoxy acid herbicides 2,4-dichlorophenoxyacetic acid (2,4-D) and 2-methyl-4-chlorophenoxyacetic acid (MCPA) or their mixtures. In order to follow possible exposure-related changes in the frequencies of SCEs, three successive blood samples were taken from 50 male sprayers during the spraying season of July-October, 1981. In addition, 15 control subjects not working with herbicides were included in the

study. The actual exposure levels of the exposed subjects were estimated by measuring the concentrations of 2,4-D and MCPA in the urine of the sprayers. Enough cells for the SCE analysis were obtained from 35 herbicide workers and 15 control subjects. The concentrations of 2,4-D and MCPA in the urine samples after exposure varied from 0.00 to 10.99 mg/l. No significant differences in the frequencies of SCEs were observed in samples taken before, during, or after the exposure. Furthermore, the means of SCEs in a nonexposed control group of 15 subjects fell in the same range as those of the exposed subjects. A difference in the means of SCEs was observed between nonsmokers and smokers, smokers having significantly higher mean values than nonsmokers. The results of the present study add support to the earlier data indicating that 2,4-D and MCPA do not act as direct DNA-damaging agents.

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OTHER CANCER MECHANISMS

Mechanistic are almost always experimental (prospective, controlled variables) studies. In this sub-category too the positive results overwhelmingly outweigh the negative results. It is thus notable that all published studies of 2,4-D's mechanism of carcinogenicity overwhelmingly and robustly find that 2,4-D plays several pro-carcinogenic roles. It is notable, as we stated above, that the immune system is a target 2,4-D, because both the epidemiologic and the mechanistic literature strongly support 2,4-D causing immune cancers. These results stress the evaluation of the experimental animal studies that you rely on in classifying 2,4-D as having insufficient evidence of carcinogenicity; and the main question that naturally arises is what is the quality of your evidence. In short, how many of the studies that you are relying on are published in independent journals? Please respond directly.

POSITIVE RESULTS/OTHER CANCER MECHANISMS

Blakley BR, Gagnon JM, Rousseaux CG. 1992 Aug. The effect of a commercial 2,4-D formulation on chemical- and viral-induced tumor production in mice. *J Appl Toxicol* 12:245-9.

Abstract: Male CD-1 mice were exposed to a commercial formulation of 2,4-dichlorophenoxyacetic acid (2,4-D), the amine derivative, in the drinking water at concentrations ranging from 0 to 0.163% of the formulated product, equivalent to approximately 0-50 mg kg⁻¹ day⁻¹ 2,4-D content. The effect of 2,4-D on urethan-induced pulmonary adenoma formation was evaluated following a 105-day exposure. Urethan-induced sleeping times observed following an i.p. injection of urethan (1.5 mg g⁻¹) after 3 weeks of 2,4-D exposure were not altered by 2,4-D, indicating that 2,4-D did not influence urethan elimination. Pulmonary adenoma production, which was evaluated 84 days after urethan injection, was enhanced by 2,4-D exposure but had no effect on tumor size. The effect of 2,4-D on the incidence of spontaneous murine lymphocytic leukemia was evaluated during the 365-day treatment period. Mortality associated with the leukemia virus was not altered by 2,4-D treatment. Exposure to this commercial 2,4-D product at moderately high levels of exposure may modify the development or expression of certain tumors in CD-1 mice. The mechanism of the co-carcinogenic or tumor-promoting activity associated with 2,4-D exposure remains to be determined.

Figgs LW, Holland NT, Rothmann N, Zahm SH, Tarone RE, Hill R, Vogt RF, Smith MT, Boysen CD, Holmes FF, VanDyck K, Blair A. 2000 Apr. Increased lymphocyte replicative index following 2,4-dichlorophenoxyacetic acid herbicide exposure. *Cancer Causes Control* 11:373-80.

Abstract: OBJECTIVE: Evaluate peripheral blood lymphocyte proliferation (replicative index:RI) and micronuclei frequency (MF) among 2,4-D herbicide applicators. METHODS: Twelve applicators spraying only 2,4-D provided a blood and urine specimen upon enrollment, several urine samples during the spraying season, and a blood specimen at the study's end. Nine controls provided blood and urine specimens upon enrollment and at the study's end. Gas chromatography/tandem mass spectrometry determined urinary 2,4-D levels and standard in-vitro assays determined RI and MF scores. Applicator RI and MF were compared before and after spraying and with controls. RESULTS: Applicators contributed 45 urine specimens with concentrations ranging from 1.0 to 1700 (microg 2,4-D/g creatinine/L urine) that logarithmically (ln) increased as spraying time increased. Applicator RI increased after spraying ($p = 0.016$), independent of tobacco and alcohol use, and demonstrated a weak dose-response with increasing urinary 2,4-D levels ($p = 0.15$). Among 2,4-D applicators, pre-exposure complete blood counts and lymphocyte immunophenotypes were not significantly different from post-exposure measurements. CONCLUSION: Urinary 2,4-D concentration, an exposure biomarker, may be associated with lymphocyte replicative index, a cell proliferation biomarker.

[ALSO IN 'POSITIVE' RESULTS/MUTAGENIC]

Holland NT, Duramad P, Rothman N, Figgs LW, Blair A, Hubbard A, Smith MT. 2002 Nov 26. Micronucleus frequency and proliferation in human lymphocytes after exposure to herbicide 2,4-dichlorophenoxyacetic acid in vitro and in vivo. *Mutation Research-Genetic Toxicology & Environmental Mutagenesis* 521:165-178.

Abstract: Widespread use of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) and its association with non-Hodgkin's lymphoma (NHL) and other cancers has raised public concern. Here, micronucleus (MN) formation has been used as a biomarker of genotoxicity, and replicative and mitotic indices (MIs) as biomarkers of cell cycle kinetics in human lymphocytes. Cells were cultured either as whole blood or isolated lymphocytes and treated with pure or commercial forms of 2,4-D at doses between 0.001 and 1 mM for 48 h. Exposure to 2,4-D produced a minimal increase in MN in whole blood and even smaller one in isolated lymphocyte cultures. This induction took place only at levels approaching cytotoxicity and was accompanied by a significant inhibition of replicative index

(RI). At a low (0.005 mM) dose of commercial 2,4-D, a small, marginally significant increase in RI (12-15%) was found in two independent sets of experiments ($P = 0.052$). Additionally, we found that lymphocyte RI was more affected by commercial 2,4-D containing 9.4% of the chemically pure 2,4-D, than with an equal concentration of the latter suggesting that other ingredients present in the commercial pesticide may be responsible or may enhance the effect of 2,4-D. Mitotic index, however, did not show any significant change with either commercial or pure 2,4-D. The lymphocytes of 12 male applicators exposed solely to 2,4-D during a 3-month period had a significantly higher RI than the same group prior to exposure and than a control group ($P < 0.01$), in accordance with the *in vitro* finding of increased RI at low doses. (C) 2002 Elsevier Science B.V. All rights reserved. [References: 61] Number of References 61

Keywords: [ALSO IN 'MUTAGENIC/POSITIVE' RESULTS. **NOTE THE SUPER-LOW (5 PICOMOLE) DOSE EFFECT**]

Kaioumova D, Susal C, Opelz G. 2001 Jan. Induction of apoptosis in human lymphocytes by the herbicide 2,4-dichlorophenoxyacetic acid. *Hum Immunol* 62:64-74.

Abstract: Dimethylammonium salt of 2,4-dichlorophenoxyacetic acid (DMA-2,4-D) is a widely used herbicide that is considered moderately toxic. In the present study we found that DMA-2,4-D is able to cause apoptosis in peripheral blood lymphocytes of healthy individuals and Jurkat T cells. Apoptosis induced by DMA-2,4-D was dose and time dependent, independent of Fas, TNF receptor 1 or the aromatic hydrocarbon receptor, and involved disruption of the mitochondrial transmembrane potential and activation of caspase-9. ZVAD-FMK, a broad-spectrum inhibitor of caspases, blocked DMA-2,4-D-induced apoptosis completely. While an inhibitor of caspase-9, as well as caspase-9 and caspase-3 inhibitors in combination, strongly blocked DMA-2,4-D-induced apoptosis, an inhibitor of caspase-3 had a moderate inhibitory effect. Unlike Fas-mediated apoptosis, the initiator caspase, caspase-8, was not involved in DMA-2,4-D-induced apoptosis. Transfection of Jurkat cells with Bcl-2 prevented DMA-2,4-D-induced disruption of the mitochondrial transmembrane potential and led to a complete blockage of apoptosis. Our data indicate that DMA-2,4-D kills human lymphocytes by initiating apoptosis via a direct effect on mitochondria. The activation of caspases occurs downstream of mitochondrial damage, and the dysfunction of mitochondria appears to be sufficient for triggering all downstream events leading to apoptosis.

Lin N, Garry VF. 2000. *In vitro* studies of cellular and molecular developmental toxicity of adjuvants, herbicides, and fungicides commonly used in Red River Valley, Minnesota. *Journal of Toxicology & Environmental Health - Part A* 60:423-439.

Abstract: Recent epidemiologic studies showed increased frequency of birth defects in pesticide applicators and general population of the Red River Valley, Minnesota. These studies further indicated that this crop growing area used more chlorophenoxy herbicides and fungicides than elsewhere in Minnesota. Based on frequency of use and known biology, certain herbicides, pesticide additives, fungicides, and mycotoxins and suspect agents. To define whether these agents affect developmental endpoints *in vitro*, 16 selected agrochemicals were examined using the MCF-7 breast cancer cell line. In the flow cytometric assay, cell proliferation in this estrogen-responsive cell line indicates xenobiotic-mediated estrogenic effects. Cell viability, morphology, ploidy, and apoptosis were incorporated in this assay. Data showed that the adjuvants X-77 and Activate Plus induced significant cell proliferation at 0.1 and 1 $\mu\text{g/ml}$. The commercial-grade herbicide 2,4-D LV4 and 2,4-D amine induced cell proliferation at 1 and 10 $\mu\text{g/ml}$. The reagent-grade 2,4-D products failed to induce proliferation over the same concentration range, suggesting that other ingredients in the commercial products, presumably adjuvants, could be a factor in these results. The fungicides triphenyltin and mancozeb induced apoptosis at concentration of 4.1 $\mu\text{g/ml}$ (10⁻⁵ M). Data provide a mechanistic step to understanding human reproductive and developmental effects in populations exposed to these agrochemicals, and initiative to focusing limited resources for future use *in vivo* animal developmental toxicity studies.

Keywords:

Merillon JM, Filali M, Duperon P, Montagu M, Chenieux JC, Rideau M. 1995 Jul-1995 Aug 31. Effect of 2,4-dichlorophenoxyacetic acid and habituation on lipid and protein composition of microsomal membranes from periwinkle cell suspensions. *Plant Physiology & Biochemistry* 33:443-451.

Abstract: Investigations on biochemical changes associated with habituation in plant cells and tissues grown *in vitro* are still limited. In the present work, we have compared the lipid and protein composition of microsomal membranes prepared from two *Catharanthus roseus* cell lines: a 2,4-dichlorophenoxyacetic acid (2,4-D)-dependent line and a fully-habituated line selected from the former. In order to distinguish changes associated with habituation from those associated with 2,4-D treatment, each line was grown for one passage in medium with or without 2,4-D. The auxin provoked a lower amount of phospholipid, a higher free-sterol to phospholipid ratio, and a decreased fluidity in microsomal membranes, all parameters usually associated with cell senescence. On the other hand, habituation decreased the free sterol to phospholipid ratio, increased the oleic acid to linoleic acid ratio and the sitosterol to campesterol ratio. The fluidity of the membranes from habituated cells increased. Habituation, as well as treatment of the cells with 2,4-D, changed the polypeptide profiles of the microsomal membranes. The data lead to the conclusion that membranes are targets for biochemical changes associated with habituation. They also support the hypothesis that some similarities exist between habituated cells and animal tumour cells. [References: 38] Number of References 38

Keywords:

Ozaki K, Mahler JF, Haseman JK, Moomaw CR, Nicolette ML, Nyska A. 2001 Jul. Unique renal tubule changes induced in rats and mice by the peroxisome proliferators 2,4-dichlorophenoxyacetic acid (2,4-d) and wy-14643. *Toxicol Pathol* 29:440-450.

Abstract: Peroxisome proliferators are non-mutagenic carcinogens in the liver of rodents, acting both as initiators and promoters. The National Toxicology Program (NTP) conducted a study of several peroxisome proliferators (PPs), including Wyeth (WY)-14643 as a prototypical PP and 2,4-dichlorophenoxyacetic acid (2,4-D) as a weak

PP, in Sprague-Dawley rats, B6C3F1 mice, and Syrian hamsters. In the kidney, an unusual change was observed in the outer stripe of the outer medulla, especially in rats treated with 2,4-D or WY-14643. This change was characterized by foci of tubules that were partially or completely lined by basophilic epithelial cells with decreased cytoplasm and high nuclear density. Changes typical of chronic nephropathy such as interstitial fibrosis or basement membrane thickening were not associated with these foci. Results of immunohistochemical staining for catalase and cytochrome P-450 4A in the kidney indicated increased staining intensity in renal tubular epithelial cells primarily in the region where the affected tubules were observed; however, the altered cells were negative for both immunohistochemical markers. Ultrastructurally, affected cells had long brush borders typical of the P3 tubule segment. The most distinguishing ultrastructural change was a decreased amount of electronlucent cytoplasm that contained few differentiated organelles and, in particular, a prominent reduced volume and number of mitochondria; changes in peroxisomes were not apparent. In addition to the lesion in rats, mice treated with the highest dose of 2, 4-D, but not WY-14643, manifested similar renal tubular changes as seen by light microscopy. Neither chemical induced renal tubular lesions in hamsters. Hepatocellular changes characteristic of PPs were present in all 3 species treated with WY-14643, but not 2,4-D. These results indicate that the rat is the species most sensitive to the nephrotoxic effects of PPs and there is a site specificity to this toxicity related to areas of PP-related enzyme induction. Although 2, 4-D is considered a weak PP for the liver, it was the most effective at inducing renal lesions, indicating that the toxic potency of various PPs will depend on the target organ. [References: 38] Number of References 38

Keywords:

Palmeira CM, Moreno AJ, Madeira VMC. 1994 Jul. Interactions of herbicides 2,4-d and dinoseb with liver mitochondrial bioenergetics. *Toxicology & Applied Pharmacology* 127:50-57.

Abstract: The herbicides 2,4-D (2,4-dichlorophenoxyacetic acid) and dinoseb (2-sec-butyl-4,6-dinitrophenol), were tested in mitochondria because they are putative toxins to the organisms. To understand the toxic mechanisms involved, we have determined if mitochondrial bioenergetic functions are affected. Dinoseb partially inhibits uncoupled respiration, reflecting its limited interaction with the mitochondrial redox chain at the level of succinate dehydrogenase and cytochrome c reductase (complex III). Additionally, it increased the rate of state 4 oxygen consumption, stimulated ATPase activity, induced permeabilization of membrane mitochondria to H⁺, and depressed Delta Psi. These data characterize dinoseb as a classical proton uncoupler. The herbicide 2,4-D decreased Delta Psi as a function of concentration and the rate of repolarization was also progressively decreased. State 3 and uncoupled respiration were depressed by approximately the same extent (60%), ruling out interactions on phosphorylation assembly independent of the redox chain. The herbicide strongly inhibited succinate dehydrogenase and cytochrome c reductase (complex III), whereas cytochrome c oxidase was not affected. Additionally, 2,4-D also uncoupled mitochondria at concentrations 1000-fold higher than those required for a similar dinoseb effect. This study therefore suggests that dinoseb- and 2,4-D-induced cellular damage, as we have reported before, is putatively preceded by injury upon bioenergetic functions of mitochondria. (C) 1994 Academic Press, Inc. [References: 42] Number of References 42

Keywords:

Faustini A, Settini L, Pacifici R, Fano V, Zuccaro P, Forastiere F. 1996. Immunological changes among farmers exposed to phenoxy herbicides - Preliminary observations. *Occupational & Environmental Medicine* 53:583-585. Abstract: Objectives-To evaluate short term immunological changes after agricultural exposure to commercial formulations of chlorophenoxy herbicides. Methods-Blood samples were collected from 10 farmers within seven days before exposure, one to 12 days after exposure, and again 50 to 70 days after exposure. Whole blood was used to count lymphocyte subsets with monoclonal antibodies. Peripheral blood mononuclear (PBM) cells were used to measure natural killer (NK) cell activity and lymphocyte response to mitogenic stimulations. Values before exposure were used as reference. Results-in comparison with concentrations before exposure, a significant reduction was found one to 12 days after exposure in the following variables (P <0.05): circulating helper (CD4) and suppressor T cells (CD8), CD8 dim, cytotoxic T lymphocytes (CTL), natural killer cells (NK), and CD8 cells expressing the surface antigens HLA-DR (CD8-DR), and lymphoproliferative response to mitogen stimulations. All immunological values found 50-70 days after exposure were comparable with concentrations before exposure, but mitogenic proliferative responses of lymphocytes were still significantly decreased. Conclusions-According to our data agricultural exposure to commercial 2,4-dichlorophenoxyacetic acid (2,4-D) and 4-chloro-2-methylphenoxyacetic acid (MCPA) formulations may exert short term immunosuppressive effects. Further studies should clarify whether the immunological changes found may have health implications and can specifically contribute to cancer aetiology. Keywords:

[IMMUNE PARAMETERS INCREASED AFTER EXPOSURE, THEN DECREASED--A HINT OF CAUSATION:]

Tuschl H, Schwab C. 2003 Mar. Cytotoxic effects of the herbicide 2,4-dichlorophenoxyacetic acid in hepg2 cells. *Food & Chemical Toxicology* 41:385-393.

Abstract: 2,4-Dichlorophenoxyacetic acid (2,4-D) and its derivatives are herbicides widely used to control the growth of broadleaf and woody plants. Although 2,4-D is well known to be moderately toxic, little information is available on the mechanisms of its toxicity. Results on carcinogenicity, genotoxicity and mutagenicity are contradictory, but neurotoxic, immunosuppressive and hepatotoxic effects have been defined. The aim of the present study was to investigate the cytotoxic effects of 2,4-D on a human hepatoma cell line. HepG2 cells were treated with different concentrations of 2,4-D, and cell viability, induction of apoptosis/necrosis and cell cycle phases were determined. Apoptosis was detected in flow cytometric light scatter histograms, the annexin V assay, the determination of DNA strand breaks with the TUNEL assay and the occurrence of a sub G(0) peak after propidium iodide (PI) staining. The induction of apoptosis by 2,4-D was accompanied by a disruption of the mitochondrial membrane potential as verified by staining with the cationic JG-1 probe. In addition, 2,4-D affected the cell cycle in a concentration-dependent manner. Our investigation suggested that 2,4-D exerts its cytotoxic effects by the induction of apoptosis

via a direct effect on the mitochondrial membrane potential. (C) 2002 Elsevier Science Ltd. All rights reserved.

[References: 26] Number of References 26

Keywords:

Jenssen D, Renberg L. 1976 Aug. Distribution and cytogenetic test of 2,4-D and 2,4,5-T phenoxyacetic acids in mouse blood tissues. *Chem Biol Interact* 14:279-89.

Abstract: The phenoxyacetic acids 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), extensively used as herbicides, were tested for cytogenetic effects by means of induced micronuclei in erythrocytes of mouse bone marrow. Because of the high experimental resolution power this is a particularly suitable test system for the detection of weak chromosome breaking activity in mammals. The cytogenetic tests were supplemented with chemical analyses of the concentration the test substances reaching the target cells...

Schop RN, Hardy MH, Goldberg MT. 1990 Nov. Comparison of the activity of topically applied pesticides and the herbicide 2,4-D in two short-term in vivo assays of genotoxicity in the mouse. *Fundam Appl Toxicol* 15:666-75.

Abstract: Genotoxicity of eight topically applied compounds was determined using the bone marrow micronucleus (MN) test and hair follicle nuclear aberration (NA) assay in CD1 mice. Twenty-four hours after a single treatment, cyclophosphamide (CY), applied at doses corresponding to 1/4, 1/8, 1/16, and 1/32 of the published dermal LD50, and N-methyl-N-nitrosourea (MNU), applied at 1/4, 1/8, and 1/16 of the published dermal LD50, were found to increase the incidence of NA in a dose-dependent manner. The frequency of MN was significantly increased only at the highest dose of CY. Using the same protocol, six pesticides applied in dimethyl sulfoxide (DMSO) at doses of 1/8, 1/16, and 1/32 of the dermal LD50 were investigated. Aminocarb and chlordane induced a dose-dependent increase in the frequency of NA, while there was an observed increase in NA incidence at only the highest doses of dichlorvos (DDVP), 4,4'-DDT (DDT), and 2,4-dichlorophenoxyacetic acid (2,4-D). No effect was observed with fenitrothion on nuclear aberrations in hair follicles. Except for the highest dose of chlordane, none of the pesticides tested positive in the bone marrow micronucleus test. Serum cholinesterase levels were reduced to 70 +/- 4.7% of the DMSO control level with DDVP, 57 +/- 8.2% with aminocarb, and 60.3 +/- 4.8% with fenitrothion, indicating some systemic activity with these topically applied agents. The data suggest that aminocarb, chlordane, DDVP, DDT, and 2,4-D are genotoxic as determined by the NA assay and that this assay may be more useful in detecting topically applied genotoxic agents than the more often used bone marrow micronucleus test.

NEGATIVE RESULT/MECHANISMS/OTHER

Charles JM, Bond DM, Jeffries TK, Yano BL, Stott WT, Johnson KA, Cunny HC, Wilson RD, Bus JS. 1996 Oct. Chronic dietary toxicity/oncogenicity studies on 2,4-dichlorophenoxyacetic acid in rodents. *Fundam Appl Toxicol* 33:166-72.

Abstract: Forms of 2,4-dichlorophenoxyacetic acid (collectively known as 2,4-D) are herbicides used to control a wide variety of broadleaf and woody plants. Doses in the 2-year chronic/oncogenicity rat study were 0, 5, 75, and 150 mg/kg/day. The chronic toxicity paralleled subchronic findings, and a NOEL of 5 mg/kg/day was established. A slight increase in astrocytomas observed (in males only) at 45 mg/kg/day in a previously conducted chronic rat study was not confirmed in the present study at the high dose of 150 mg/kg/day. Doses in the 2-year mouse oncogenicity studies were 0, 5, 150, and 300 mg/kg/day for females and 0, 5, 62.5, and 125 mg/kg/day for males. No oncogenic effect was noted in the study. In summary, the findings of these studies indicate low chronic toxicity of 2,4-D and the lack of oncogenic response to 2,4-D following chronic dietary exposure of 2,4-D in the rat & mouse.

Knapp GW, Setzer RW, Fuscoe JC. 2003. Quantitation of aberrant interlocus t-cell receptor rearrangements in mouse thymocytes and the effect of the herbicide 2,4-dichlorophenoxyacetic acid. *Environmental & Molecular Mutagenesis* 42:37-43.

Abstract: Small studies in human populations have suggested a correlation between the frequency of errors in antigen receptor gene assembly and lymphoid malignancy risk. In particular, agricultural workers exposed to pesticides have both an increased risk for lymphoma and an increased frequency of errors in antigen receptor gene assembly. In order to further investigate the potential of such errors to serve as a mechanistically based biomarker of lymphoid cancer risk, we have developed a sensitive PCR assay for quantifying errors of V(D)J recombination in the thymocytes of mice. This assay measures interlocus rearrangements between two T-cell receptor loci, V-gamma and J-beta, located on chromosomes 13 and 6, respectively. The baseline frequency in four strains of mice was determined at several ages (2-8 weeks of age) and was found to be stable at similar to 1.5 X 10⁻⁵ per thymocyte. Strain AKR, which has a high susceptibility to T-cell lymphomas, did not show an elevated frequency of aberrant V(D)J events. We used this assay to examine the effects of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) on the frequency of these events. Female B63F1 mice, 27 days of age, were exposed to 2,4-D by gavage at doses of 0, 3, 10, 30, and 100 mg/kg/day for 4 successive days and sacrificed on day 5. Thymus DNA was isolated and examined for illegitimate V(D)J recombination-mediated gene rearrangements. In addition, pregnant mice were exposed to 2,4-D and thymocytes from the offspring examined at 2 weeks of age. No significant increase in aberrant V(D)J rearrangements was found, indicating that under these conditions 2,4-D does not appear to effect this important mechanism of carcinogenesis. [References: 40] Number of References 40

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MECHANISM/PEROXISOME PROLIFERATION

2,4-D is an undisputed peroxisome proliferator (PP), but PP's role in cancer in different species is the subject of a legitimate and vigorous scientific debate. Yet it is *not disputed* that PPs, and thus 2,4-D, are risk factors for cancer

in various vertebrate and other animal species, if not in humans.

POSITIVE RESULTS/MECHANISM/PEROX. PROLIF.

Ge R, Tao L, Kramer PM, Cunningham ML, Pereira MA. 2002. Effect of peroxisome proliferators on the methylation and protein level of the c-myc protooncogene in B6C3F1 mice liver. *J Biochem Mol Toxicol* 16:41-7.

Abstract: Peroxisome proliferators in general are nongenotoxic mouse liver carcinogens for which DNA hypomethylation and altered gene expression are proposed mechanisms. Therefore, the peroxisome proliferators 2,4-dichlorophenoxyacetic acid (2,4-D), dibutyl phthalate (DBP), gemfibrozil, and Wy-14,643 were evaluated for the ability to alter the methylation and expression of the c-myc protooncogene. Male B6C3F1 mice were administered for 6 days in their diet Wy-14,643 (5-500 ppm), 2,4-D (1,680 ppm), DBP (20,000 ppm), or gemfibrozil (8,000 ppm). All four peroxisome proliferators caused hypomethylation of the c-myc gene in the liver. Wy-14,643 appeared to be the most efficacious with a threshold between 10 and 50 ppm. The level of the c-myc protein was increased by Wy-14,643, but not the other peroxisome proliferators. When female B6C3F1 mice received a two-thirds partial hepatectomy and 16 h later were administered 50 mg/kg Wy-14,643 by gavage, hypomethylation of the gene occurred 24 h later. Hypomethylation was not found in mice that received Wy-14,643 following a sham operation. Hypomethylation of the c-myc gene within 24 h of administering Wy-14,643 after a partial hepatectomy but not after a sham operation supports the hypothesis that the peroxisome proliferators prevent methylation of hemimethylated sites formed by DNA replication.

Vainio H, Nickels J, Linnainmaa K. 1982 Mar. Phenoxy acid herbicides cause peroxisome proliferation in Chinese hamsters. *Scand J Work Environ Health* 8:70-3. Abstract: An increase in either the size or amount of peroxisomes was obtained in the liver cells of Chinese hamsters after the animals were exposed to the phenoxy herbicides 2,4-dichlorophenoxyacetic acid (2,4-D) or 4-chloro-2-methylphenoxyacetic acid (MCPA). At the dose level studied, 2,4-D was found to be more potent than MCPA in increasing the number of peroxisomes. A phenoxy acid derivative, clofibrate, one of the peroxisome proliferators known to possess carcinogenic properties in rodents, appeared to be still more potent in inducing peroxisome proliferation than either of the herbicides studied. Further investigations are warranted to clarify the significance of peroxisome proliferation to the toxicity of phenoxy herbicides.

Biochem Pharmacol. 1983 Sep 15;32(18):2775-9. Hypolipidemia and peroxisome proliferation induced by phenoxyacetic acid herbicides in rats. Vainio H, Linnainmaa K, Kahonen M, Nickels J, Hietanen E, Marniemi J, Peltonen P.

Male Wistar rats were treated daily by gavage with two phenoxy herbicides, 2,4-dichlorophenoxyacetic acid (2,4-D) (100-200 mg/kg body wt) and 4-chloro-2-methylphenoxyacetic acid (MCPA) (100-200 mg/kg body wt), and with the chemically different glyphosate N-phosphonomethyl glycine (300 mg/kg body wt) 5 days per week for 2 weeks. A hypolipidemic drug, clofibrate [ethyl-2-(4-chlorophenoxy)-2-methylpropionate], which is structurally related to phenoxy acids, was used as a positive control (200 mg/kg body wt). 2,4-D and MCPA had several effects similar to those of clofibrate: all three compounds induced proliferation of hepatic peroxisomes, decreased serum lipid levels, and increased hepatic carnitine acetyltransferase and catalase activities. 2,4-D and MCPA, but not clofibrate, decreased lipoprotein lipase activity in the adipose tissue to about a third of the control value but did not change the lipoprotein lipase activity in the heart muscle. The data suggest that these compounds cause hypolipidemia not by enhancing the storage of peripheral lipids in adipose tissue but by preferentially increasing lipid utilization in the liver. Glyphosate caused no peroxisome proliferation or hypolipidemia, suggesting that these effects are associated with the structural similarity between phenoxy acid herbicides and clofibrate. PMID: 6626247 [PubMed - indexed for MEDLINE]

Acta Pharmacol Toxicol (Copenh). 1983 Aug;53(2):103-12. Effects of phenoxyherbicides and glyphosate on the hepatic and intestinal biotransformation activities in the rat. Hietanen E, Linnainmaa K, Vainio H.

The effects of phenoxyacid herbicides 2,4-D (2,4-dichlorophenoxyacetic acid) and MCPA (4-chloro-2-methylphenoxyacetic acid), clofibrate, and glyphosate on hepatic and intestinal drug metabolizing enzyme activities were studied in rats intragastrically exposed for 2 weeks. The hepatic ethoxycoumarin O-deethylase activity increased about 2-fold with MCPA. Both 2,4-D and MCPA increased the hepatic epoxide hydrolase activity and decreased the hepatic glutathione S-transferase activity. MCPA also increased the intestinal activities of ethoxycoumarin O-deethylase and epoxide hydrolase. Glyphosate decreased the hepatic level of cytochrome P-450 and monooxygenase activities and the intestinal activity of aryl hydrocarbon hydroxylase. Clofibrate decreased the hepatic activities of UDPglucuronosyltransferase with p-nitrophenol or methylumbelliferone as the substrate. Also 2,4-D decreased the hepatic activity of UDPglucuronosyltransferase with p-nitrophenol as the substrate. MCPA decreased the intestinal activities of UDPglucuronosyltransferase with either p-nitrophenol or methylumbelliferone as the substrate. The results indicate that phenoxyacetic acids, especially MCPA, may have potent effects on the metabolism of xenobiotics. Glyphosate, not chemically related to phenoxyacids, seems to inhibit monooxygenases. Whether these changes are related to the toxicity of these xenobiotics remains to be clarified in further experiments. PMID: 6624478 [PubMed - indexed for MEDLINE]

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NEGATIVE RESULTS/MECHANISM/PEROX. PROLIF.

Abdellatif AG, Preat V, Vamecq J, Nilsson R, Roberfroid M. 1990 Nov. Peroxisome proliferation and modulation of rat liver carcinogenesis by 2,4-dichlorophenoxyacetic acid, 2,4,5-trichlorophenoxyacetic acid, perfluorooctanoic acid and nafenopin. *Carcinogenesis* 11:1899-902. Abstract: Using an initiation-selection-promotion protocol for induction of liver tumors in Wistar rats, the modulating action of various peroxisome proliferators on neoplasia as well as on selected biochemical parameters was studied. After treatment with diethylnitrosamine (DEN), the

animals were subsequently subjected to a selection procedure involving feeding of 2-acetylaminofluorene (2-AAF), and in the middle of the 2-AAF treatment, a single necrogenic dose of carbon tetrachloride. Following a recovery period, the rats were fed a diet containing 0.1% nafenopin (NAF), 0.015% perfluorooctanoic acid (PFOA), 0.05% 2,4-dichlorophenoxyacetic acid (2,4-D), 0.05% 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) or 0.05% phenobarbital (PB) as a positive control. When the animals were killed, 7 months after initiation, the incidence of hepatocellular carcinoma was 83, 33 and 16% in the animals treated with NAF, PFOA or 2,4,5-T respectively. No cancers were observed in controls, or in the 2,4-D groups. In comparison with controls, NAF and PFOA caused a 60- and 24-fold increase in the peroxisomal beta-oxidation of fatty acids respectively, but only about a 2-fold increase in the catalase activity, 2,4-D and/or 2,4,5-T were much less active in this respect, giving approximately a doubling in the rate of fatty acid oxidation. The specific activity of D-amino acid and glycolate oxidases were significantly depressed, whereas the urate oxidase levels were apparently unaffected by the NAF and PFOA treatment. The results suggest that the selective induction of peroxisomal fatty acid oxidation is consistent with the hypothesis that imbalance between H₂O₂ overproduction and its destruction could play a role in the modulation of hepatocarcinogenesis by peroxisome proliferators.

Mikalsen SO, Ruyter B, Sanner T. 1990 Feb 1. Effects of hepatic peroxisome proliferators and 12-O-tetradecanoyl phorbol-13-acetate on catalase and other enzyme activities of embryonic cells in vitro. *Biochem Pharmacol* 39:527-35.

Abstract: The effects of the hepatic peroxisome proliferators (HPPs) clofibrate, di-(2-ethylhexyl)-phthalate (DEHP), mono-(2-ethylhexyl)phthalate (MEHP) and 2,4-dichlorophenoxy acetic acid (2,4-D) on the activities of some peroxisome-associated enzymes and marker enzymes for other organelles, have been studied in primary Syrian hamster embryo (SHE) cells and Wistar rat embryo (WRE) cells. The majority of the cells are fibroblast-like. 12-O-Tetradecanoyl phorbol-13-acetate (TPA) was included as it has been suggested that it may act as a peroxisome proliferator. The specific activities of catalase, fatty acyl-CoA oxidase (FAO) and peroxisomal beta-oxidation were approximately 100-fold lower in the embryonic cells than in rat hepatocytes. Other peroxisome-associated oxidases were not detected. The dihydroxyacetone-phosphate acyltransferase (DHAPAT) activity was comparable to that in rat liver. Marker enzymes for other organelles had specific activities comparable to rat hepatocytes. Catalase was shown by digitonin titration to be contained in a peroxisome-like compartment in both SHE and WRE cells. Clofibrate, DEHP and MEHP increased the catalase activity, which might suggest peroxisome proliferation. However, the findings that FAO and peroxisomal beta-oxidation did not increase or only very slightly, argue against peroxisome proliferation. 2,4-D and TPA induced no or only a very slight increase in the catalase activity.

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APPENDIX 2: THE ADDITIVE AND SYNERGISTIC TOXICITY OF HERBICIDE MIXTURES

The above twice-mentioned study of Trimec, a three-herbicide formulation (failed pregnancies in rats, at environmentally relevant doses).¹²⁵

Chlorophenoxy herbicides (dicamba, 2,4-D and MCPP, a similar mix to Trimec) along with formulation ingredients naphtha, naphthalene and nitroaniline (at concentrations below occupational limits) were drawn into a building's air intake; causing respiratory and neurologic acute effects, but with at least one permanent respiratory injury.¹²⁶

A herbicide formulation poses a greater risk to human fertility than indicated in trials of its separate ingredients. In a study of wheat, sugar beet and potato farm workers, birth defects were doubled among children of crop workers that were conceived during months when the pesticide 2,4-D was sprayed (recently confirmed and elaborated in a new study by this team). They note that in toxicity tests for its registration, pure 2,4-D was used, while workers actually handle a blend of 2,4-D and added ingredients.¹²⁷

Older women exposed to triazine herbicides and thiocarbamate insecticides had eight times the rate of spontaneous absorption as those exposed to triazines only.¹²⁸

Atrazine and alachlor herbicides together are acutely toxic to amphibian larvae.¹²⁹

Atrazine and possibly other pesticides synergize the infection of amphibian species such as frogs with the trematode worm. This parasite has been shown to be a direct cause of the frog limb deformities that are being observed so frequently in the field.¹³⁰ (atrazine itself may contribute to the amphibian decline, given its ability to disrupt their sexual development at environmental concentrations¹³¹). At environmentally relevant doses the immune system of frogs are severely depressed by the insecticides DDT, dieldrin and malathion--in the lab and in the field;¹³² thus theoretically these insecticides at least make frogs very vulnerable to the trematode parasite, which is usually observed in the evident epidemic of frog limb malformations.

N-NitrosAtrazine (N-NAt) increases chromosome breakage in-vitro at just 0.1 ng/ml (roughly, 0.1 ppb); whereas nitrates, nitrite or atrazine alone required concentrations 1,000 to 10,000 times higher to do so. Even when administered together they caused less chromosome damage than the N-NAt metabolite.¹³³

Atrazine and metachlor (only when dosed together) delay metamorphosis of tadpoles to frogs by 10 days, at concentrations found in farm run-off.¹³⁴

The same team recently tested a typical agricultural pesticide mix (the herbicides atrazine, metolachlor, alachlor, metylaxyl & one other, three insecticides and two fungicides). Alone they did not cause developmental abnormalities in frogs at 0.1 ppb (a low, env. relevant dose) but in creating a mix one by one (at the same doses), adverse effects appeared and amplified--

¹²⁵ Cavieres et al. 2002

¹²⁶ H. Zeliger Jan. 2003 'Toxic Effects of Chemical Mixtures' Arch Env Health:58:1:23-9 (see case #6).

¹²⁷ V. Garry et al. 1996 'Pesticide Applicators, Biocides and Birth Defects in Rural Minn.' Env. Health Perspectives 104:394-399. (Their **follow-up** study is Garry et al. 2002; below).

¹²⁸ Arbuckle et al. 2001 Env. Health Perspectives:109:851-7.

¹²⁹ Howe et al. 1998 'Effect of Chem. Synergy...' Env Toxicol Chem:17:519-525.

¹³⁰ J. Kiesecker 2002 'Synergism Between Trematode Infection and Pesticide Exposure, a Link to Amphibian Deformities in Nature' Proceeding Ntl. Academy of Science:99:9900-9904. **See also** A. Balustein & P. Johnson Feb 2003 'Explaining Frog Deformities' Sci. American, p. 60-5.

¹³¹ Hayes et al 2003.

¹³² M. Gilbertson et al. 2003 'Immunosuppression in the Northern Leopard Frog (*Rana pipiens*) Induced by Pesticide Exposure' Environ Toxicol & Chemistry:22:1:101-10.

¹³³ L. Meisner et al 1993 'In-Vitro Effects of N-Nitrosatrazine On Chromosome Breakage' Arch. Env. Contam. & Tox.:24:108-112.

¹³⁴ Hayes et al 2002; **as reported in** J. Raloff 2 Nov. 2002 'More Frog Trouble: herbicides may emasculate wild males' Science News.

basically in proportion with the number of added pesticides! The effects were slowed larval growth, development & metamorphosis; less immune response; and more production of stress hormones (which are known to slow growth).¹³⁵

A mix of 2,4-D, glyphosate and triclopyr herbicides was toxic to larvae at levels lower than recommended for field applications.¹³⁶

Picloram plus 2,4-D formulations (Tordon 202c) are a potent birth defect combination of a.i.¹³⁷

While neither of these two a.i. alone damages the gill cells of catfish, in one of these Tordon formulations they do, an outright proof of synergy.¹³⁸

A series of papers on similar formulation with the same two-a.i. (Tordon 75D) permanent testicular damage, often due to "inert" ingredients of the formulation, e.g. the detergents used; and severe depression of respiration in mitochondria for the mix but not the indiv. a.i., while a final study failed to elicit reproductive or teratogenic effects in the offspring of fathers dosed with Tordon 75D.¹³⁹

A separate confirmation of the above mitochondria respiration toxicity, except using picloram with 2,4-D, also shows shows an interaction with complex I of the respiratory chain, and a partial collapse of the proton motive force of the mitochondrial inner membrane without affecting its elasticity.¹⁴⁰ Early studies of this 'Agent White' mix looked at egg-hatching success;¹⁴¹ and a more recent study examined the acute aquatic toxicity of 2,4-D, triclopyr and glyphosate mixes.¹⁴²

Combinations of the herbicides alachlor, atrazine and picloram had various synergistic effects.¹⁴³

Various combinations of the herbicide atrazine, the insecticides aldicarb and carbamate, and nitrate (fertilizer) were synergistic at the concentrations they are typically found at in groundwater.¹⁴⁴

Atrazine + methyl-parathion + methoxychlor was marginally synergistic (more than additive). Atrazine in binary combinations with other organophosphates indicate more than additive toxicity

¹³⁵ T. Hayes et al. 2004, new data presented at symposium "Ecophysiology and Conservation: The Contribution of Endocrinology and Immunology" held during the Society for Integrative and Comparative Biology (SICB) meeting January 5-9, 2004, in New Orleans, Louisiana.

¹³⁶ Abdelghani et al. 1997 'Toxicol. Evaluation of Single & Chem. Mixtures..' *Env. Toxicol. & Water Quality*:12:237-43.

¹³⁷ P. Blakley et al. 1989--3 papers: *Teratology*:39:237-41 **and** 39:547-53; **and** *J. Tox. & Env. Health*:28:309-16.

¹³⁸ Gallagher & DiGuillo 1991 'Effects of 2,4-D and Picloram on Biotransformation, Peroxisomal...' *Toxicol. Letters*:57:65-72.

¹³⁹ D. Oakes et al. 2002 'Testicular changes induced by chronic exposure to the herbicide formulation, Tordon 75D ® (2,4-dichlorophenoxyacetic acid and picloram) in rats' *Reproductive Toxicology*:16 281-289; **and** D. Oakes & J. Pollak 2000 'The in vitro evaluation of the toxicities of three related herbicide formulations containing ester derivatives of 2,4,5-T and 2,4-D using sub-mitochondrial particles' *Toxicology* 151:1-9; **and** D. Oakes & J. Pollak 1999 'Effects of a herbicide formulation, Tordon 75D ® and its individual components on the oxidative functions of mitochondria' *Toxicology*:136, 41-52; **and** Oakes DJ, et al. 2002. A study of the potential for a herbicide formulation containing 2,4-d and picloram to cause male-mediated developmental toxicity in rats. *Toxicol Sci* 68:200-206.

¹⁴⁰ Pereira LF, Campello AP, Silveira O. 1994 Jan-1994 Feb 28. Effect of tordon 2,4-d 64/240 triethanolamine br on the energy metabolism of rat liver mitochondria. *J Appl Toxicol* 14:21-26.

¹⁴¹ Somers J et al. 1974 Jan. Effect of external application of pesticides to the fertile egg on hatching success and early chick performance. 1. Pre-incubation spraying with DDT and commercial mixtures of 2,4-D: picloram and 2,4-D: 2,4,5-T. *Bull Environ Contam Toxicol* 11:33-8. 2. Commercial-herbicide mixtures of 2,4-D with picloram or 2,4,5-T using the pheasant. *Bull Environ Contam Toxicol* 11:339-42.

¹⁴² Wan MT, Watts RG, Moul DJ. 1991 Sep. Acute toxicity to juvenile Pacific northwest salmonids of basacid blue NB755 and its mixture with formulated products of 2,4-D, glyphosate, and triclopyr. *Bull Environ Contam Toxicol* 47:471-8.

¹⁴³ Information Ventures Inc. 1999 'Review of the Literature in Herbicides...IV. Health Effects of Other Herbicides' avail. at <http://infoventures.com/e-hlth/>.

¹⁴⁴ W. Porter et al. 1999.

for all compounds except mevinophos.¹⁴⁵

Later exposures to any toxin are made more dangerous by 2,4-D's de-activation of detoxifying liver enzymes.¹⁴⁶ Organophosphate insecticides are degraded by the same enzyme in some plants & crops, thus the metabolism of either may be slowed by the other; causing damage. Some OPs, at least, are known to be taken up more thoroughly.¹⁴⁷

In protein deficient rats, the chlorinated herbicide diuron's acute toxicity was significantly enhanced, and their sperm production was halted; while normally fed rats were not affected.¹⁴⁸

The herbicide linuron and a mixture of 15 pesticides (mostly insecticides and fungicides) commonly found in the Italian diet act as additive promoters of existing cancers in test animals, implying a risk at current population-wide exposure levels.¹⁴⁹

Several studies have now definitively shown that pesticides, including herbicides, act in concert with the trematode parasites to cause the widely-observed deformities in amphibians. Tadpole vulnerability to u.v. in sunlight may also contribute.¹⁵⁰

When the estrogenicity of ten pesticides was added it was weaker than estradiol, the active form of estrogen, but in various combinations they had potent and synergistic estrogenicity.¹⁵¹

Two applicators were killed from the spill and inhalation of two of the herbicides mentioned for use in this FEIS, imazapyr and triclopyr--just 13 lbs. of the latter, an unstated amount of the former.¹⁵²

In the temporal and geographic vicinity of organophosphate insecticides, the unbelievably potent ALS inhibiting herbicides (the sulfonureas and the imidazalinones) are even more (synergistically) potent.¹⁵³

Various amounts of pesticides alone do not kill tadpoles, but when a single predator (separated from the tadpoles by a net) is added, they die. Six frog species are so affected with the insecticide carbaryl (Sevin); and the same result for "a common herbicide" is about to be published.¹⁵⁴

One research team has so far published at least **eight papers** studying the serious synergistic neurotoxicity of the herbicide paraquat with some fungicides (often used together in the real world), especially Parkinson's Disease.¹⁵⁵

12 of the 13 pesticide active ingredients significantly arrested very early mammalian development--a period that EPA's developmental test for pesticides fails to cover (typical!), even though the doses were at EPA's Reference Dose for the pesticide--a level 100 times (typically) lower than any adverse non-cancer effect is supposed to happen at! Similarly, five of six mixtures (three or four of the 13 in each, including a common lawn care herbicide mix and pre &

¹⁴⁵ Papelindstrom PA, Lydy MJ. 1997 Nov. Synergistic toxicity of atrazine and organophosphate insecticides contravenes the response addition mixture model. *Environmental Toxicology & Chemistry* 16:2415-2420.

¹⁴⁶ Rachel Carson 1962 'Silent Spring' Houghton Mifflin (Chapters 13-15).

¹⁴⁷ R. Hartzler 5/22/2000 'Interactions between ALS-herbicides & organophosphate insecticides' Integrated Crop Management is published by the Dpt. Entomology, Iowa State U. Ames, Iowa <http://www.ipm.iastate.edu/ipm/icm/2000/5-22-2000/interaction.html> (accessed early 2004).

¹⁴⁸ E. Boyd & V. Krupa 1970 'Protein Deficient Diet and Diuron Toxicity' *J. Food Chemistry*:18:1104-7.

¹⁴⁹ Pasquini R et al. Sep-1994 Oct 31. Assay of linuron and a pesticide mixture commonly found in the Italian diet, for promoting activity in rat liver carcinogenesis. *Pharmacology & Toxicology* 75:170-176.

¹⁵⁰ R. Blaustein, P. Johnson 'Explaining Frog Deformities' Feb. 2003 *Sci. American*, p. 60-5.

¹⁵¹ A. Soto et al. 1994 'The Pesticides Endosulfan, Toxaphene, and Dieldrin Have Estrogenic Effects on Human Estrogen-Sensitive Cells' *Environmental Health Perspectives*:102:380-383.

¹⁵² ATSDR 2002 'HSEES 1999-2000 Biennial Report', Atlanta GA (see Appen. C).

¹⁵³ R. Hartzler 2000.

¹⁵⁴ Rebecca Renner Apr 2004 'Double Distress: pesticide kills frogs only if predators are around' *Sci. American* p. 32 (referencing R. Relyea in the Dec. 2003 *Ecol. Applications*; and soon-to-be-published for the herbicide experiments).

¹⁵⁵ Deborah Cory-Slechta, U. Rochester, is the team leader--search PubMed on her name for the abstracts.

post-emergent herbicide mixes) significantly arrested development.¹⁵⁶

Immune B-cell populations are decreased after exposure to propanil, 2,4-D, or the mixture containing propanil and 2,4-D. Exposure to the mixture had greater toxic effects than the individual herbicides on bone marrow pre-B and IgM(+) B-cell populations.¹⁵⁷

Channel catfish exposed to a mixture of picloram and 2,4-D for 10 days displayed increased activities of hepatic ethoxyresorufin O-deethylase (EROD), decreased serum chloride concentrations and decreased liver/body weight ratios. These changes were not observed in fish exposed to either compound alone.¹⁵⁸

In a prospective, controlled study of applicator exposures (insecticides, fungicides, herbicides) only the herbicide group showed significant endocrinologic differences from controls. In vitro genotoxicity examination compared four different commercially available surfactant mixtures with 12 different commercial herbicide products, including six different chlorophenoxy herbicides. Only one herbicide yielded a significant dose-response curve. All four adjuvants showed positive dose-response effects [apparently only certain ranges of the dose curve were examined]. These preliminary data suggest that adjuvants are not inert but are toxicologically active components added to herbicide mixtures. Whether adjuvant toxicant effects are additive or are independent of herbicide effects is poorly understood.¹⁵⁹

The presence of single detergents and their mixtures increased promethrin herbicide effects by 10-13% on the testes invertebrates even in concentrations permitted in surface waters. The toxic effect of 2,4 D was potentiated by detergents in much higher concentrations, exceeding the permitted values.¹⁶⁰

Food deprivation tended to decrease the sensitivity of rats to the effects of either of two 2,4-D formulations. The spectrum of neurobehavioral effects varied with the ester isomers.¹⁶¹ Three formulations of 2,4-D were tested in rats for their ability to increase landing foot splay, a measure of ataxia. Results suggest that the 2,4-D-n-butyl ester metabolite n-butanol is responsible for the motor incoordination but not the depression of locomotor activity observed, demonstrating that different formulations of the same herbicide can produce differential behavioral effects.¹⁶²

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¹⁵⁶ Anne Greenlee et al. May 2004 'Low-Dose Agrochemicals and Lawn-Care Pesticides Induce Developmental Toxicity in Murine Preimplantation Implants' *Env. Health Perspectives*:112:6:703-9.

¹⁵⁷ de la Rosa P, Barnett JB, Schafer R. 2003 Dec 26. Loss of pre-b and igm(+) b cells in the bone marrow after exposure to a mixture of herbicides. *J Toxicol & Environmental Health* 66:2299-2313.

¹⁵⁸ Gallagher EP, Di Giulio RT. 1991 Jun. Effects of 2,4-dichlorophenoxyacetic acid and picloram on biotransformation, peroxisomal and serum enzyme activities in channel catfish (*Ictalurus punctatus*). *Toxicol Lett* 57:65-72.

¹⁵⁹ Garry VF et al. 1999. Herbicides and adjuvants: an evolving view. *Toxicology & Industrial Health* 15:159-167.

¹⁶⁰ Ranke-Rybicka B, Plachta J, Zycinski D. 1995. [Effect of water contamination with surface active substances and plant protecting agents on aquatic organisms]. *Rocz Panstw Zakl Hig* 46:175-81.

¹⁶¹ Schulze GE. 1987 Sep-Oct. Formulation and food deprivation affects 2,4-D neurobehavioral toxicity in rats. *Neurotoxicol Teratol* 9:363-7.

¹⁶² Schulze GE. 1988 Jan-Feb. 2,4-D-n-butyl ester (2,4-D ester) induced ataxia in rats: role for n-butanol formation. *Neurotoxicol Teratol* 10:81-4.

APPENDIX 3: FELSOT REPORT CRITIQUE

A herbicide risk report, by Dr. Alan Felsot,¹⁶³ was prepared under contract for Missoula County weed managers, who are heavy herbicide users.

This Felsot report contains not a single citation or other authority to support its claims. This is not surprising, considering that its herbicide risk review is an almost continual string of lies, omissions and distortions.

The Felsot report has a deliberate scheme. First, appear conservative (biased towards health and safety), by initially concluding that there is some excess risk, but only from the inhalation of pesticide drift. That allows Felsot to perform a detailed, credible exposure analysis of drift inhalation, which concludes his report by reporting that this single risk is negligible, almost nonexistent. Fine--for that single exposure pathway. But to so conclude Dr. Felsot first has to make the absurd claim that there is zero risk from dermal contact (there were no food exposure pathways for the uses of herbicides he evaluated); then he has to use data that is astoundingly biased towards the safety of herbicides and their contaminants.

It is worth emphasizing that Dr. Felsot's c.v. (his resume) lists hundreds of thousands of dollars of payments received from many of the pesticide manufacturers whose views on pesticide risk he ends up agreeing with--an important fact that went undisclosed in this report for Missoula County and its residents.¹⁶⁴ As often happens when distortions are propagated, neither do the several USFS Region 1 EIS' that approvingly cite his conclusions reveal this huge economic conflict of interests. The Missoula County parties who commissioned this report from Dr. Felsot--all heavy herbicide users--made sure the report's conclusions received thorough publicity from an unwitting mass media. Finally, Dr. Felsot's c.v. reveals his training is in entomology, not in toxicology, or even in botany.

Below are rebuttals those of Dr. Felsot's claims that were repeated in the LNF FEIS . They are *keyed to the page number in the Lolo FEIS* (which was incorporated by reference into this FEIS), but they were originally made by Dr. Felsot, and sometimes were copied verbatim by the LNF. Unlike Dr. Felsot's completely un-referenced claims, we either give a citation directly or refer the reader to a place in this paper where we have made the relevant citation to peer-reviewed, published science.

- (p. IV-11): Claim: As in the Felsot report, the five herbicides of the LNF FEIS have high (safe) acute lethality levels are given much emphasis. It is stated that consequences are unlikely , especially after dilution with water for the application.

Chronic and cumulative exposures are given little consideration, and acute lethality is the only effect considered in a section of the FEIS titled 'Herbicide Effects on Animal Health'.

- (p. IV-11 & 12): Claim: The herbicides evaluated are either excreted rapidly or metabolized and excreted.

See our discussion of exposure.

The metabolism of foreign compounds into more water soluble compounds (to pass into the urine for excretion) makes them highly reactive, damaging compounds, akin to free radicals.¹⁶⁵

- (p. IV-48 - 61, inclusive) Claim: These herbicides pose no significant risk to humans if used as proposed.

This is where the LNF FEIS' analysis of consequences relies almost entirely on the Felsot report, copying

¹⁶³ Allan Felsot, 2001 'Assessing the Safety of Herbicides for Vegetation Management in the Missoula Valley Region: a question & answer guide to human health issues' "Prepared on Behalf of Missoula Valley Weed Managers Missoula, MT"

¹⁶⁴ Discovered by Women's Voices for the Earth, Missoula MT; who also discovered he's not trained in botany.

¹⁶⁵ Klaasen (ed.) 2001.

in whole sections of it. The rebuttals are as follows:

-(p. IV-49) Claim: Reference Doses (RfDs--"safe" levels of exposures developed for chemicals) are conservative.

If so, why do RfDs assume that there can be no effect below the very high doses that are tested, when modern biology is often finding effects very low doses. Several other deadly faults of the RfD methodology are fully elucidated in our critique of quantitative risk assessment methodologies.

-(p. IV-49, 50) Claim: That dermal absorption is negligible for all chemicals on the market.

A staggeringly inept, even unheard of claim, or perhaps explained by Dr. Felsot's need to eliminate this route of exposure from this risk assessment. Though neither Dr. Felsot's or the LNF FEIS' evaluated herbicides are highly fat soluble, Dr. Felsot, when orally presenting his report, simply refused--repeatedly--to answer whether their *contaminants or other formulation ingredients* are fat soluble and therefore dermally absorbed. In critiquing chemical Q-RA, we have already shown (see chemical Q-RA Problem #5 above) that the obvious is accepted by all toxicologists--that fat-soluble chemicals generally permeate the mucus membranes and other barriers of the skin, lung and gut much more than water soluble chemicals.¹⁶⁶ In fact, we even showed that mixtures of both water and fat-soluble chemicals enhance the permeability of the water-soluble chemicals, to synergize their toxicity (being more reactive chemicals, they tend to have greater acute toxicity).¹⁶⁷ Critically, this circumstance is common in pesticide formulations--e.g. water soluble chlorophenoxy and chlorinated pyridine active ingredients formulated with fat-soluble adjuvants and solvents. This co-solvency effect also shows that Felsot's vaunted switch to less persistent (fat-soluble) herbicides in favor of more degradable (reactive, water-soluble) herbicides carries risks as well as benefits.

The dioxins in the chlorophenoxy herbicide 2,4-D, and the hexachlorobenzene (HCB) in the chlorinated pyridines such as picloram and clopyralid,¹⁶⁸ are in fact highly fat soluble and therefore dermally absorbed, also therefore bio-accumulative. EPA's re-registration of picloram finds that picloram's HCB would expose including dermally, backpack & low-pressure hand-wand sprayers beyond HCB's safe limit.¹⁶⁹ HCB is also at high levels in clopyralid; while the most potent dioxin (2,3,7,8-TCDD) is at low ppb levels in 2,4-D, but this is the most toxic molecule known, except perhaps for plutonium.

-(p. IV-51-52) Claim: The table of estimated doses (Table IV-16) lists safe doses without a time component, as if they were just safe concentrations.

Doses always include a the amount of time the concentration if given.

More critically, the table uses at least two false RfDs, and ones that state the risk as less than it is. First picloram--Dow's false RfD is three times too high than EPA's official RfD. Second, dicamba's listed RfD is 2.4 times higher than the one EPA set in 1983, to calculate allowable food pesticide residues (tolerances).¹⁷⁰ An RfDs must always be based on the lowest validated adverse effect dose that exists for any health effect. EPA's Integrated Risk Information System (IRIS) is considered a reliable source of independent and peer-reviewed RfD data. 2,4-D's IRIS RfD is the correct one. The IRIS does not yet contain clopyralid and imazapyr risk estimates, but clearly this table uses the wrong, less safe ones.

As to the couple of chronic effects that this table lists safe doses for, it is as false as the similar summary of chronic effects table for this BDNF FEIS,¹⁷¹ and as false as a similar table in the Felsot report. The risk claims in the accompanying LNF FEIS text are explicitly based on the table's claims. Though the LNF's table considers cancer risks, the surrounding text pretends that RfDs account for all risks (RfD are only used for non-cancer risk, as explained in our critique of quantitative risk assessment. Finally, the Felsot text surrounding the LNF's table chooses to put emphasize, as always, on the largely irrelevant acute doses of herbicides that kill 50% of test organisms rapidly; in order to draw attention away from our

¹⁶⁶ L. Alessio 1996.

¹⁶⁷ Zeliger 2003 and I. Witte et al. 1995.

¹⁶⁸ See our critique of pesticide registration.

¹⁶⁹ EPA/ORD 1996 (Picloram RED Factsheet).

¹⁷⁰ See our critique of the Information Ventures Inc. data

¹⁷¹ See our critique of that table in our section that critiques the Information Ventures Inc. data.

ubiquitous chronic exposures.

-(p. IV-52) Claim: Table IV-17 compares supposed chemical risks to far riskier and common activities of man, such as smoking and driving.

This is a tired table, having been employed in tens of thousands of risk assessments to date. Setting aside for a moment the huge bias in the table from chemical risk data gaps (such as ignoring cumulative chemical exposures and not testing effects, especially in developing organisms) and the fraudulent estimates of chemical safety (such as the picloram RfD), which make us question the table's chemical risk; let us take up this challenge that risk assessors are making to society. First, where are the benefits of chemical use, and to whom do they accrue (to a few private interests); and to whom do the risks accrue? Where are the benefits of vehicular mobility or of fire-fighting, etc., which somewhat discount many of these activities high risks? Second, why should society accept the assumption that life is a zero-sum game; that we have to choose which risks to bear? Why not reject many chemical risks as unnecessary (implementing, e.g., the prevention of weed seed germination and integrated weed management (which emphasizes prevention and data gathering), recognizing that pesticide use is very expensive and that all organisms are developing resistance to pesticides?

-(p. IV-54) Claim: Dr. Felsot claims that no chemical on the market is known to act synergistically with other chemicals or factors.

This claim conveniently de-emphasizes that safety testing assumes an unreal world where every person is exposed only to one chemical in their life. Testing every unique combination of the roughly 100,000 chemicals in commerce would require more test animals than there are stars in the known universe, it has been said. Instead, the biosphere and all its organisms are the natural multiple-exposure experiment that the chemical industry is carrying out without human informed consent, but an experiment whose results aren't being recorded. In direct contradiction to Dr. Felsot's claim, there are hundreds of peer-reviewed studies showing synergy (despite that there are no requirements to test for synergy), because the plaintiffs have a couple dozen of them (or descriptions of them). Also on this page the LNF uses Dr. Felsot's claim to exaggerate a conclusion of EPA about synergism that is directly quoted. Even if Dr. Felsot & the LNF were correct about synergistic effects not being a concern, that'd be a smoke screen to cover the fact that cumulative exposures to a chemical over one's life are an undeniable fact, as is the fact that risk assessment does not account for that huge risk (among many other failings)--see our critique of quantitative risk assessment.

-(p. IV-54 & 55) Claim: Herbicide impurities are not a significant risk.

Elsewhere (including directly above, in rebutting Dr. Felsot's claim of no dermal absorption) we have shown using independent peer-reviewed data the very large risks of highly toxic contaminants, such as hexachlorobenzene; the reactive, mutagenic nitrosamines; and the highly potent dioxins. It is worth refuting once again the common claim that 2,4-D does not contain the most potent dioxin, 2,3,7,8-TCDD (it does, at low but significant ppb levels¹⁷²).

-(p. IV-56 & 57) Claim: An attempt to dismiss hormone disruption as a concern.

This is amazing in light that this has been the most active area of toxicology for the past decade or so, with tens of thousands of papers published showing potent effects, often at low doses. In 1996 both FIFRA and the Safe Drinking Water Act were amended to require that pesticides and drinking water standards ensure hormone disruption is not a significant risk. Neither requirement has yet (six years on) been implemented for new pesticide registrations and drinking water standards, much less for existing ones. Yet the Felsot/LNF claim that these hormone disruption tests are assuring that all (not just hormonal) subtle effects are assessed! It's true that hormones are the classic example of subtle yet devastating effects (such as the sex steroid hormone mimics and sex reversal), but biology itself is made up of subtle effects, not all hormonal (more and more, molecular biology is called 'chemical signaling', which is generally studied at very sensitive concentrations of both biological molecules and contaminant molecules.

Critically, Dr. Felsot makes the inane claim that all known estrogen-disrupting chemicals (ignoring other

¹⁷² EPA/ORD 1998.

hormones) are far less potent than estradiol, the active form of estrogen. Not only are most of the man-made hormone disrupting chemicals far more persistent in the body than are natural hormones, the body does not know how to shut them off, as it does when carrying them in the blood with blood-binding receptors, or to hydroxylate hormones to make them active. So, while many man-made hormone disrupting molecules are less potent than the hormones that nature has optimized, others approach the potency of their natural analogs.¹⁷³

Last, Dr. Felsot uses here a classic semantics game of 'no evidence' vs. 'insufficient evidence as yet' that the chemical industry loves, to reverse the conclusions of a major study of the state of knowledge of low-dose hormone disrupting chemicals, by the National Research Council of the National Academy of Sciences. In truth, that study did not: "...conclude[] that current evidence does not support any adverse effects...on humans.", as Dr. Felsot writes. Rather, with the admirable and necessary conservativeness of the scientific method, the NAS/NRC concluded that while there is some human (and significant animal) evidence in this new field of study, that evidence is not yet sufficient to conclusively demonstrate whether or not humans are affected by hormone disrupting chemicals. Moreover, another recent prestigious review of the hormone disruption hypothesis, this time looking specifically at low level effects, found significant and varied evidence for low dose hormone disruption, though again conservatively insisting that the evidence in this new field is not yet sufficient to assign low-dose causation to hormone disrupting chemicals.¹⁷⁴ Given the serious implication of ultra low dose toxicity to health policy, that study--actually a peer-review itself--was rigorous, even analyzing much of the raw data of the studies it was reviewing.
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¹⁷³ F. VomSaal 2000; or Rajapaske et al. 2002.

¹⁷⁴ NTP 2001.

APPENDIX 4: GROWING RESISTANCE TO HERBICIDES

The GNF DEIS barely mention the large negative ecological impact of herbicide use--the inevitable, observed and continuing exponential growth in the resistance of weeds to herbicides. Evolution through selection pressures--such as herbicides--is omnipresent in the biosphere, but the more focused and intense it is (e.g. man's pest management with a single tool, say, herbicides), the greater the amount of natural selection that will adapt to this pressure (the survival of the fittest) to make that tool ineffective. Competing populations almost always achieve stability over time, in sometimes amazing ways.¹⁷⁵ The more rapid an organism's reproductive cycle (e.g. the approximately 10-20 minutes microbes take to reproduce) the faster it will develop resistance.

Available data shows that pesticide resistance is climbing exponentially across at least several of the basic kingdoms of life, even with an acknowledged lack of searching for cases of resistant species.¹⁷⁶ As to weeds, worldwide, at least 216 herbicide-resistant weed species were documented by 1999.¹⁷⁷ For example the herbicides of the picloram family, heavily relied on in this FEIS, are known to be resisted by some weeds.¹⁷⁸ At least one common western-United States weed family--spurge--has been proven to block picloram and 2,4-D herbicides from translocating to the root (where those herbicides kill the plant), explaining spurge's strong resistance to these herbicides.¹⁷⁹ Recently 4 to 5 more weed species have been added to the list of glyphosate-resistant weeds.¹⁸⁰ Monsanto's solution to this--recommending the application of other broad-spectrum herbicides such as 2,4-D--will only accelerate the growth of resistance, by greatly increasing selection pressure.

Monoculture rice fields were treated with sulfonylurea herbicide-based mixtures for 8 consecutive years. The resistant type of *M. vaginalis* showed high levels of cross-resistance to pyrazosulfuron-ethyl, bensulfuronmethyl, cyclosulfamuron, and flumetsulam, but not to imazaquin; and did not show multiple resistance to other herbicides having different modes of action, such as simazine, propanil, oxadiazon, butachlor, and 2,4-D. In vitro and in vivo ALS assay results showed that the resistance mechanism of *M. vaginalis* might be due to the altered acetolactate synthase.¹⁸¹

The diversity of 2,4-D-degradative plasmids in the microbial community of an agricultural soil was examined by complementation. By using agricultural soil that had been treated with 2,4-D for several years, transconjugants were obtained with both recipients, but not in the untreated control soil. The various transconjugants had plasmids with high degrees of homology to the *tfdA* gene. These results indicate that this soil microbial community submitted to selective pressure (application of 2,4-D) for several years maintained a diversity of self-transferable plasmids carrying diverse genes encoding 2,4-D degradation.¹⁸²

A recent study examined the role of auxin-binding protein (ABP) in auxin herbicide resistance. There were no differences in uptake, transport, and metabolism of auxinic herbicides between the Resistant (R) and Susceptible (S) biotypes of wild mustard weed. Based on that, and on studies on the role of auxin-enhanced ethene biosynthesis and calcium in mediating the auxinic herbicide resistance, they

¹⁷⁵ D. Pimentel 29 March 1968 'Population Regulation & Genetic Feedback' Science: 159:1432-7. This 35 year-old paper is an excellent introduction to the fascinating theory and observations of resistance, which Dr. Pimentel terms 'genetic feedback'.

¹⁷⁶ P. Weber May-June 1992 'A Place for Pesticides?' WorldWatch Institute:22-23.

¹⁷⁷ S. Barber 1999. 'Transgenic plants: field testing and commercialization including a consideration of novel herbicide resistant oilseed rape (*Brassica napust*)'; In: Lutman, P.J. 1999, Gene Flow and Agriculture: Relevance for Transgenic Crops. British Crop Protection Council. Farnham, Surrey, UK. 286 pp., pp. 311.

¹⁷⁸ E.g. Fuerst et al. 1996 'Physiological Characterization of Picloram Resistance in Yellow Starthistle' Pest. Biochem. Physiol. 56:149-161.

¹⁷⁹ Rodney Lym, Weed Science professor, N. Dakota State U., personal communication to Tony Tweedale, Sep. '01.

¹⁸⁰ Bob Hartzler 2003 'Are Roundup Ready Weeds in Your Future II' (extension weed management specialist, Dpt. of Agronomy, Iowa State U.) Avail at: <http://www.weeds.iastate.edu/mgmt/2003/glyresistance.shtml>

¹⁸¹ Hwang IT, Lee KH, Park SH, Lee BH, Hong KS, Han SS, Cho KY. 2001 Oct. Resistance to acetolactate synthase inhibitors in a biotype of *monochoria vaginalis* discovered in Korea. Pesticide Biochemistry & Physiology 71:69-76.

¹⁸² Top EM, Holben WE, Forney LJ. 1995 May. Characterization of diverse 2,4-dichlorophenoxyacetic acid-degradative plasmids isolated from soil by complementation. Applied & Environmental Microbiology 61:1691-1698.

hypothesized that resistance is due to an altered target site, possibly an auxin receptor. A small ABP gene family from both R and S types was characterized--amino acid changes were found in the ABP of the R biotype. The role of ABP in mediating auxinic herbicide resistance is still unknown.¹⁸³

There are more plant species resistant to ALS inhibiting herbicides (sulfonureas and imadazolinones) than any other family of herbicides, and more plant species are resistant to multiple ALS-inhibitors...despite these herbicides being much newer than almost all others.¹⁸⁴ This astounding fact is perhaps not suprising when you consider that ALS inhibitors are so toxic to all plants at extraordinarily low doses (inhibiting the enzyme the need to produce three amino acids) that plants face no choice other than to immediately die or show a genetic diference that means survival (and usually thriving survival as its genetic competition has been killed). In short this is a classic example of selection pressure at work, illustrating the inevitability of significant resistance.

The Weed Science Society of America confirms that known cases of herbicide resistance continue to climb exponentially, and they report that in Montana there are currently 9 reported types of resistant weeds. They say that local (Montana) weed scientists estimate that there are 6,640 sites and more than 617,100 acres infested with herbicide resistant weeds in Montana, which infest barley, cereals, cropland, railways, sugar beet, and wheat.¹⁸⁵ Herbicide resistance by weed species on public lands is under-reported, given the higher economic value of cropland promotes interest in resistance.

Such data corroborate what is possibly the best proof that pesticides aren't working: conventional (i.e. pesticide treated) crop losses have never decreased, even after decades of intensive pesticide applications (12% of crops are still lost to weeds, 13% to insects and 12% to disease).¹⁸⁶ This fundamental fact is supported by at least one controlled experiment that showed four corn pests (3 insects and smut--a fungus) increased only following application of the popular corn herbicide 2,4-D.¹⁸⁷ Agriculture-dominated economies such as Indonesia's; and those of several developed countries in Europe have reduced pesticide use by more than half, to date, with no detrimental economic effect¹⁸⁸ (and that's on average, i.e. some have already achieved greater reduction of pesticide use). Finally, herbicide use on the scale of public lands is expensive, even if we erroneously assume that they work in the long run. About the only known logical and efficacious use of herbicide is when an immediate and short-term effect is desired (such as to establish another vegetation species)--but even that can be problematic.¹⁸⁹ Some Roundup formulations induce the growth of dangerous and expensive plant molds such as fusarium (perhaps through a resistance mechanism), even at regular application rates (yet Monsanto is still pushing RoundUp Ready wheat, which it acknowledges will increase glyphosate use). This soil-organism effect may be due to the reduction of plowing that herbicides are used for; or due to an ingredient other than glyphosate, as different Roundup formulations have different effects.¹⁹⁰

In contrast to the direct-attack approach that pesticides represent, integrated pest management (IPM, or IWM in the case of weed pests) uses *both* pest prevention and a detailed knowledge of a pest's life cycle and environment to effectively manage the problem, with greatly reduced pesticide use. A holistic and preventative solution to any problem in nature is intrinsically more likely to succeed than is a narrow and reactionary one such as chemical attack. The prevention of the introduction of seeds is the universally acknowledged single effective answer to weed spread, so it is not logical to attempt other weed control methods before seeing if prevention is effective.

Yet this FEIS attempts the opposite. Road construction is the undisputed major vector for the

¹⁸³ Zheng HG, Hall JC. 2001 Mar-2001 Apr 30. Understanding auxinic herbicide resistance in wild mustard: physiological, biochemical, and molecular genetic approaches. *Weed Science* 49:276-281.

¹⁸⁴ Weed Science Soc. America 2003 'Herbicide Resistant Weeds Summary Table, avail at <http://weedsociety.org/summary/MOASsummary.asp> and A. Hashem & H.S. Dhammu 2002 'Cross-resistance to Imidazolinone Herbicides in Chlorsulfuron-Resistant R. Raphanistrum' *Pest. Mangmnt. Sci.*:58:917-9.

¹⁸⁵ I. Heap, The International Survey of Herbicide Resistant Weeds. Online. Internet. November 25 2002. Available at <http://www.weedsociety.com>

¹⁸⁶ Dr. David Pimental (Cornell U.), videotaped at Beyond Pesticides/NCAMP 2001 Conference, Boulder CO (available from BP/NCAMP).

¹⁸⁷ Pimental videotape (though also published in a scientific journal, the citation is unknown to us).

¹⁸⁸ Pimental videotape.

¹⁸⁹ See, e.g., our discussion of problem-causing residues of picloram-family herbicides in compost and in crop rotation, found at the end of our critique of pesticide registration.

¹⁹⁰ Adrian Ewins July 10 2003 'Scientists eye glyphosate-fusarium link' *The Producer*, Saskatoon Canada <http://www.producer.com/articles/20030703/production/20030703prod02.html> (the experiments were performed by USDA/ARS (at U. MO) and by Agriculture Canada's Swift Current research center at Saskatoon).

introduction of seeds into USFS lands, thus road construction and road use are natural focal points for weed prevention. In this FEIS only 160 of 16,000--or 1%--of the weed-infested acres planned to be managed every year will use alternatives to herbicides, most to be broadcast from the air.¹⁹¹ An integrated and varied management approach is inherently more challenging to weeds and their ability to evolve resistance. Spraying 99% of the acres seems, on the basis of evidence presented here, highly unlikely to succeed in controlling weeds before they become heavily established, which is the stated fundamental purpose of this FEIS' evaluated action.¹⁹²

It is worth questioning even the fundamental view of nature that we always take, here the ridiculously simplistic alleged distinction between weeds and native plants. For example, using a very large databases of plant species it was recently found that these alleged "weeds" are very much (three times) more likely to appear in the pharmacopoeia of highland Chiapas Mexico natives than would be predicted by the frequency of weed species there in general.¹⁹³ Obviously, disturbed, weedy areas are closer to humans than are many areas rich in native plants (such as the tropical forests around this human community), especially when you consider the short life-span of many pharmaceutical chemicals in plants. But the lead author adds:

"There is also good biochemical evidence that supports the hypothesis that plants in disturbed areas are likely to have more chemicals in them than for defense."¹⁹⁴

It is almost inevitable that such a strong preference ($p > 0.0001!$) to acquire drugs from weeds, not native plants, requires more of an explanation of convenience alone.

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¹⁹¹ FEIS Sec. 1.3, p. 1-3; and Table 2.4.2, p. 2-7.

¹⁹² FEIS pg. ROD-1.

¹⁹³ J. Stepp & D. Moerman 2001 'The Importance of Weeds in Ethnopharmacology' J. Ethnopharmacology:75:1:19-23.

¹⁹⁴ In a 15 March 2001 U. of GA Press Release.

APPENDIX 5: DRIFT (DISTANCE; HARM)

EXTENT OF DRIFT, ESPECIALLY FROM AERIAL APPLICATION:

[After the BDNF Weed FEIS I had expressed my concern to the EIS contact, Leaf Magnussen about aerial spraying, along with a study indicating the risk; she later left me a tel. message saying that the droplet sizes are 40 times larger than the study I had given her (re: Bt drift, below). Her response fails to respond to the following hard data:]

While it seems to be true, as the Regional Office claimed in their response to our BNF appeal, that aerial herbicide formulations are generally released at larger droplet sizes than are aerial insecticide formulations; the difference is small enough that there is significant overlap:

"Recommended droplet sizes for fungicides, insecticides and herbicides are 150-250, 200-300 and 250-400 microns, respectively."¹⁹⁵

Critically, it has been found that the peak ambient air concentration of 45% of agricultural pesticides is eight to 24 hours post-application; whereas most measurement of drift is made long before, leading to severe underestimates and inadequate mitigation of drift.¹⁹⁶

Ignoring that factor, it is documented that evaporation shrinks aerially released pesticide formulation drops as they descend, and that the vortexes of the aircraft break up drops; both factors that lead to greater drift than planned or modelled.¹⁹⁷ In addition, spraying during the no-wind condition of a temperature inversion will prevent much (the fine fraction) of an application from falling to the ground at all (due to the dense cool air being at the bottom), until solar mixing arrives and evaporates it to a further distance from the target.

The National Academy of Sciences says that from 5% to well over 60% of an aerial application will drift off-target, depending on weather conditions, notably wind and temperature inversions (where cold dense air near the ground retards pesticide molecules from falling to the ground, to be dispersed as the inversion breaks and the cold air warms & rises).¹⁹⁸ Typically, 1% of an application reaches the direct target pest (e.g., weed), while 40% leaves the general target area.¹⁹⁹ Another estimate is that less than 0.1% of pesticides ever reach their target pests.²⁰⁰ Also, it has been calculated that 20% of a pesticide application on surfaces volatilizes.²⁰¹ A 20 micron drop released just 10 feet off the ground will drift 1,056 feet in just a 3 mph breeze.²⁰² The fine spray typical of ultra-low volume application methods (median drop diameter <200 micrometers) increases off-target drift *ten-fold* over conventional nozzles producing median drop diameters around 300 um.²⁰³ A field experiment accounting for all the main variables for drift from **ground-applied** pesticides (wind, nozzle diameter and pattern, boom height, pressure and spray shielding) found that when nozzle diameter was decreased (to simulate more economical and swifter applications), but a shield was added to compensate for increased drift; drift nonetheless increased by 29%.²⁰⁴

So the obvious incentive to make significant cost savings on both product expense and expensive flight

¹⁹⁵ OH State U. Cooperative Extension Service 1992 'Reducing Spray Drift' Extension Bulletin #816; pg. 5.

¹⁹⁶ Pesticide Action Network N. America (PANNA) 2003 'Secondhand Pesticides: Airborne Pesticide Drift in Calif.' accessed June 2003 at: <http://panna.org/resources/documents/secondhandDriftAvail.dv.html> .

¹⁹⁷ Teschke et al. Jan. 2001 'Spatial & Temporal Distribution of Airborne Bacillus thuringiensis...' Env. Health Perspectives:109:47-52.

¹⁹⁸ Ntl. Academy of Sciences/National Research Council/Board on Agriculture/Committee on Long-Range Soil and Water Conservation 1993 'Soil & Water quality: an agenda for agriculture' Wash. DC: Ntl. Academy Press. p 323-4.

¹⁹⁹ U.S. Congress Office of Technology Assessment 1990 'Beneath the bottom line: agricultural approaches to reduce agricultural contamination of groundwater' Report No. OTA-4-418. Washington DC: U.S. Government Printing Office.

²⁰⁰ D. Pimentel April 1999. Speech at NCAMP/Beyond Pesticides annual conference, Boulder CO (Dr. Pimentel is a noted researcher on pesticide economics and resistance at Cornell Univ.).

²⁰¹ Dr. Alan Cessna, Env. Canada/Ntl. Water Research Institute Winter 2001 letter to the J. of Pesticide Reform.

²⁰² Ohio Cooperative Extension Services Bulletin # 816, on pesticide drift.

²⁰³ S. Bird et al 1996 'Off-Target Deposition of Pesticides From Agricultural Aerial Spray Application' J. Env. Quality:25:5:1095-1104.

²⁰⁴ T. Wolf. et al. 1993 Oct. 'Effect of protective shields on drift and deposition characteristics of field sprayers' Canadian J. Plant Science:73:1261-73.

or ground-vehicle time by covering the target area more quickly via a smaller nozzle diameter (smaller released drops) results in much greater drift. The EIS's fail to state what nozzle size & nozzle fan angle limits they will use, nor do they specify the drift reduction agents or their effectiveness. Nor may drift cards indicate drift if the vortex of the aircraft has sent the drift over the top of the drift cards. Nor may attempting to limit aerial spraying to periods of less than 6 mph winds prevent significant drift. All this is adequately shown by the studies cited here.

Even the industry Spray Drift Task Force's vaunted AgDrift model cannot be validated with field data when the distances to be calculated are not near, causing a *hundred-fold* under-prediction of drift at far distances when the release is from any helicopter scenario.²⁰⁵ This shocking underestimate of drift may be due to the persistence of helicopter vortexes, which have been calculated to influence airborne pesticides for over a minute; far beyond three hundred feet (a typical "conservative" buffer zone in aerial applications) in a typical 4.47 m/s wind. It may also be due to evaporation, which has been calculated in the same model to be a significant cause of drift²⁰⁶ (yet less volatile oily formulations lose this advantage by being lighter drops than aqueous formulations).

Of 16 studies on drift measurement found by one group, drift was detected no matter how far away they monitored, from 1.25 to 50 miles.²⁰⁷ **As to herbicides (refuting the RO's above claim):** 2,4-D drifted at least 50 miles from application, dicamba at least five to 10 miles, and paraquat at at least 20 miles.²⁰⁸ At least three more studies document significant 2,4-D (and triallate) drift beyond target areas.²⁰⁹ Rainwater concentrations of 2,4-D have exceeded allowable contaminant levels.²¹⁰

A liquid Bt insecticide formulation drifted over one kilometer. Released at 110-125 microns diameter, these drift droplets dispersed to 4-7 microns diameter. This study noted they could find no literature validating lack of drift.²¹¹ B.t.k. drift was documented up to 3,150 meters from a target spray area, concluding that "this biopesticide would likely drift farther than 3150 m under similar atmospheric and terrain conditions, given the level of detection observed at 3150 m." This study was done at wind speeds between 5.22 and 6.14 miles per hour.²¹² Even the USDA's statement on pesticide drift control, used by the USFS, calls for aerial spraying only below 5 mph winds (but ignoring inversion drift).

EFFECTS OF DRIFT AND VOLATIZATION:

Before describing the literature that conclusively proves very significant human, ecologic and economic adverse effects from the drift and volatilization of herbicides specifically, we wish to emphasize that few if any of these studies look for more than visible damage, which obviously is a small subset of the damage that poisons can cause. However, a reasonable number do look at chronic effects, which in the case of crops typically does not extend beyond one harvest.

Many instances of human chemical injury from drift have been documented, despite the uncontrolled nature of this type of exposure that makes it difficult to know what agent has made one acutely ill. California does attempt to keep records of pesticide injury; in 1991 they reported 20% of all pesticide injury reports were from over pesticide drift (350 drift injury reports, but pesticide injury overall was

²⁰⁵ S. Bird et al 2002 'Evaluation of the AgDisp Aerial Spray Algorithms in the AgDrift Model' Env. Toxicol. & Chem.:21:3:672-681.

²⁰⁶ M. Teske et al 2002 'AgDrift: A Model For Estimating Near-Field Spray Drift From Aerial Applications' Env. Toxicol. & Chem.:21:3:659-671

²⁰⁷ C. Cox Spring 1995 'Indiscriminately From the Skies' J. Pesticide Reform:15:1:2-7 (citations #33-38).

²⁰⁸ E. Robinson & L. Fox 1978 '2,4-D Herbicide in Central WA' J. of the Air Pollution Control Assoc.:28:10:1015-20; **and** P. Westra & H. Schwartz 1989 'Potential Herbicide Volatility & Drift Problems on Dry Beans' Service in Action, Colorado State U. Cooperative Extension; **and** C. Glantz et al. 1989 'An Assessment of the Meteorological Conditions Associated With Herbicide Drift...' Battelle Pacific NW Laboratories.

²⁰⁹ F. Larney et al. 1999 'Herbicide transport on wind-eroded sediment' J Environ Qual:28:1412-1421 **and** D. Renne 1979 'Experimental studies of 2,4-D herbicide drift characteristics' Agric Meteorol:20:7-24 and D. Waite et al. 2002. Environmental concentrations of agricultural herbicides: 2,4-D and triallate' J Environ Qual:31:129-144.

²¹⁰ USGS 1997 'Pesticides in the Atmosphere' Factsheet FS-152-95. Sacramento, CA:U.S. Geological Survey. Available: <http://ca.water.usgs.gov/pnsp/atmos> [accessed 15 March 2002].

²¹¹ Teschke et al. Jan. 2001.

²¹² W. Whaley 1998 'Canyon Drift and Dispersion of Bacillus thuringiensis and Its Effects on Select Nontarget Lepidopterans in Utah' Env. Entomology:27:3:539-548.

acknowledged to be under-reported).²¹³ More recently (1998-2000) drift accounted for 51% of injuries, possibly due in part to more & improved reporting to the system.²¹⁴ Obviously these are almost all acute injuries, only. Children living a over a quarter mile from an orchard using ground-level blowers to apply pesticides had these pesticide metabolites in their bodies at levels 50% greater than the controls.²¹⁵ California Air Resource Board monitoring as far as 500 feet from the target found levels of at least three pesticides that significantly exceeded their estimated safe doses; even though they failed to account for many health end-points and did not allow for the vulnerability of children by adding a 10-fold safety factor.²¹⁶ Other documentations of human injury from pesticide drift exist,²¹⁷ including from herbicides (2,4-D and paraquat, both applications resulting in severe chronic injury).²¹⁸ 165 poor persons were acutely poisoned (respiratory symptoms persisting at least 11 days after exposure, without health insurance, no further medical follow-up occurred) by the evaporation a quarter mile away of a soil fumigant; after it was injected 17-18" into soil, the soil was compacted, and weighted boards covered the 18 acres.²¹⁹

As to ecologic damage, another study of Bt drift found that aerial applications of B.t/k. killed butterflies and moth species almost two miles (3000 meters) from a target spray area, concluding that "[t]he potential negative impact of drift on other B.thuringiensis-sensitive nontarget lepidopteran species can be significant even when their larvae are a considerable distance from the release site."²²⁰

As to economic damage, the potent sulfonurea (SU) and related herbicides, though fairly new, have already caused tens of millions of dollars of documented damage to crops, from drift.²²¹ In fact, following early and persistent problems in eastern WA state of crop damage from the long-range use of SU and other herbicides,²²² EPA's pesticide environmental fate and effects scientists recommended that SU be banned!²²³ Low cholorsulfuron levels (1/100th the label application rate), but not the same low levels of the more traditional herbicides atrazine, glyphosate and 2,4-D; caused severe yield and growth inhibition in several taxonomically diverse crops, especially when applied at critical developmental stages.²²⁴ Similar damage occurred at even more tenuous simulated SU drift (down to 0.33% of label application rate of a thifensulfuron/tribenuron mixed formula).²²⁵

Economic damage from drift of traditional herbicides. According to various Extension Service reports, glyphosate, 2,4-D, dicamba, clopyralid and the ALS inhibitors (eg. the sulfon ureas) damage non-target

²¹³ California Environmental Protection Agency/Dpt. Pesticide Regulation/Worker Health and Safety Branch 1994. 'Pesticide Illness Surveillance Program: Summary Report. Health and Safety Report' HS-1692. Sacramento, CA.

²¹⁴ M. Reeves et al. 2003 'Greater Risks, Fewer Rights: U.S. Farmworkers & Pesticides' Int'l J. Occup. & env. Health:9:30-39

²¹⁵ R. Fenske et al. 2000 'Strategies for Assessing Children's Organophosphorous Pesticide Exposure in Agricultural Communities' J. Exposure Analysis & Env. Epidemiology:10:662-671.

²¹⁶ PANNA 2003.

²¹⁷ C. Cox Spring 1995 'Indiscriminately...' (citations #2-8, 50-51).

²¹⁸ C. Cox Spring 1995 'Indiscriminately...' (citations #4, 6 & 7).

²¹⁹ Centers for Disease Control & Prevention 20 Aug. 2004 'Brief Report: Illness Associated with Drift of Chloropicrin Soil Fumigant into a Residential Area--Kern County, CA, 2003' Morbidity & Mortality Weekly Rpt.:53(32):740-742 (<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5332a4.htm>).

²²⁰ J. Barry et al. 1993 'Predicting and Measuring Drift of Bacillus thuringiensis Sprays' Env. Toxicol. & Chemistry:12:1977-1989.

²²¹ Idaho Dpt. Agriculture 18 Jan.. 2002. Press release & publications 'Idaho State Department of Agriculture completes Oust investigation'; **also** M. Ferullo 2002 'Farmers sue DuPont, seek compensation from Interior for Alleged Herbicide Damage' Chem. Reg. Rep. 26:553; **also** S. Turner 1987 'Post-application movement of sulfometuron methyl from treated rights of way areas via wind (soil) erosion' Proc. Fourth Symposium on Environmental Concerns in Rights-of-Way Management. October 25-28, 1987. Indianapolis, Indiana; **also** Fletcher 1993 **and** Burns 1999.

²²² O'Neal G. 1989/ Apr 28. email re: The problem of undetectable residues of drifted herbicide causing non-target crop damage. [E-mail from Gary O'Neal, EPA Air & Toxics Division/Reg 10, to EPA's Anne Lindsay].

²²³ A. Maciorowski 1994 Mar 24 'Qualitative assesement of sulfonylurea herbicides' U.S. Environmental Protection Agency Memorandum .To: Evert Byington, chief science analysis and coordination branch environmental fate and effects division (EFED, EPA mail-drop 7507C).

²²⁴ J. Fletcher et al. 1996 'Potential impact of low levels of cholorsulfuron and other herbicides on growth and yield of nontarget plants' Environmental Toxicology & Chemistry:15:1189-96.

²²⁵ D Gealy et al. 1995 'Growth and yield of pea (*Pisum sativum* L.) and lentil (*Lens culinaris* L.) sprayed with low rates of sulfonylurea and phenoxy herbicides. Weed Science:43:640-47.

crops, including from drift, when applied at labelled rates.²²⁶ Endosulfan insecticide concentrations of 0.004 mg/L (4 ppb, if that's a concentration in water) severely damaged amphibian populations, 200 m away from an aerial application zone (at the allowed rate).²²⁷ Sub-lethal applications of 2,4-D and dicamba caused persistent crop loss in experiments.²²⁸ Garlon 4, the most volatile of the triclopyr formulations, is suspected to have volatilized on a hot, windy day after a June 2004 application at a California state park, then drifted onto two adjacent vineyard properties, killing up to \$500,000 worth of high-quality grapevines and olives.²²⁹ That's a lot of dead plants from an incident that did not involve drift at the time of application! In the 1990's a team published at least five papers in *Weed Technology* on their experiments of aerial application of several of the herbicides the USFS is using, consistently finding severe and season-long crop damage (including cherry trees) even at 1/100th the maximum label application rate (to simulate quite long drift). They consistently found that chlorsulfuron (a SU), 2,4-D and glyphosate caused the most crop damage (the other herbicides tested were bromoxynil, thifensulfuron and tiburon)²³⁰ Further confirming that it's the USFS' herbicides that do the most damage to non-target vegetation, another team found that glyphosate caused significant damage to seven crops, compared with only one species for MCPA and mecoprop, and asulam was the least toxic (they modeled that vaporization after glyphosate application should not cause that damage, implying that drift would).²³¹

²²⁶ J. VanDyk Last updated 7/12/1999 'Drift injury to corn & soybean' <http://www.ipm.iastate.edu/ipm/icm/1997/6-16-1997/driftinj.html> (accessed late 2003).

²²⁷ M. Berrill et al. 1998 'Toxicity of Endosulfan to Aquatic Stages of Anuran Amphibians' *Env. Toxicol. & Chem.*:17:9:1738-1744.

²²⁸ J. Gilreath et al. 2001 Jul. 'Crop injury from sublethal rates of herbicide. II. Cucumber. *Hortscience* 36:674-76 and '...III. Pepper', pp. 677-81.

²²⁹ Beyond Pesticides, 9 July 2004 'Vintners Blame Pesticides For Damage' *Daily News*, originally reported in *Wine Spectator*: <http://www.winespectator.com/Wine/Daily/News/0,1145,2528,00.html>).

²³⁰ Al-Khatib K, Mink GI, Reisenauer G, Parker R, Westberg H, Lamb B. 1993 'Development of a biologically-based system for detection and tracking of airborne herbicides' *Weed Technology*:7:404-10; and Alkhatib K, Parker R, Fuerst EP. 1992 'Alfalfa (*medicago-sativa*) response to simulated herbicide spray drift' *Weed Technology*:6:956-60; and Alkhatib K, Parker R, Fuerst EP. 1992 'Sweet cherry (*prunus-avium*) response to simulated drift from selected herbicides' *Weed Technology*:6:975-9; and Bhatti MA, Alkhatib K, Parker R. 1996 'Wine grape (*vitis vinifera*) response to repeated exposure of selected sulfonylurea herbicides and 2,4-d' *Weed Technology*:10:951-6; and Bhatti MA, Alkhatib K, Parker R. 1997 'Wine grape (*vitis vinifera*) response to fall exposure of simulated drift from selected herbicides' *Weed Technology*:11:532-6.

²³¹ V. Breeze et al. 1992 Dec. 'Use of a model and toxicity data to predict the risks to some wild plant species from drift of 4 herbicides' *Ann Appl Biol*:121:669-77.

APPENDIX 6: LOW-DOSE TOXICITY OF PESTICIDES

A single pesticide application may give exposed organisms the right amount of the poisons to cause a disease in the long term, even if it is not a persistent, bioaccumulative toxin (PBT). Society does not know if this is occurring, because we don't test that scenario. Despite the expense and difficulty of it, this question has intrigued many scientists, as detection methods have become uniformly sensitive enough. Results to date--though an infinitesimal sliver of the data needed to test all synthetic chemicals--are very unsettling, but not surprising given the delicacy of biologic homeostasis. Among many other examples that we are aware of, several **pesticide-specific** ones illustrate the potent response of biology confronted with low-dose (real-world) levels of toxic chemicals exogenous to it:

A concentration of just four to six or so *molecules* per cell of several potent estrogenic agents (such as some pesticides) in male rodent prostate cells triggers those cells to multiply inappropriately, but increasing the concentration a little shuts off that effect.²³¹ One likely mechanism for such a result is that too many hormones in a cell are known to turn off the production of the receptor molecule that activates them.²³¹ Uncontrolled cellular division is called hyperplasia, a necessary step for cancerous tumors. In fact, prostate cancer is epidemic in industrialized countries.²³¹

The carcinogenic, persistent fungicide and herbicide contaminant hexachlorobenzene (HCB, allowed at up to 200 ppm in picloram--the most popular herbicide on public lands); already associated with several human reproductive disorders; was shown to significantly speed sexual maturity of the prostate in male mice at a low environmentally relevant dose; yet it significantly retarded this development at doses just two to over 20 times higher. In vitro, it was confirmed that the low dose HCB stimulated action via the androgen hormone receptor while high dose

repressed it.²³¹

Trimec (a mixture of three related herbicides--2,4-D, mecoprop and dicamba, each planned for use in this FEIS--plus the other formulated ingredients) was added to the drinking water of gestating mother mice. The authors used EPA's reproductive effect test protocol for pesticide registration but added a lower dose--altogether the four doses spanned a 10,000-fold range. At several times of the year (because season affects sex hormone production in mothers, a variable), up to a 20% increase in failed pregnancies resulted; but as the dose increased, the effect lessened--at every dose level; and smoothly. Almost as alarming, the lowest dose (i.e. that which showed the greatest toxicity) of the 2,4-D within the mixture was seven times lower than the maximum EPA allows in drinking water. That dose was selected because it is equivalent to EPA's RfD--the supposedly "perfectly safe" dose--for 2,4-D.²³¹

The ubiquitous chemical bisPhenol-A (inter alia, an ingredient in some pesticide formulations), in the range of typical human exposure levels, causes exposed mice fetuses to gain excessive weight during life, a major risk factor for many deadly diseases. Moreover the effect was greatest at the lower doses tested.²³¹ Obesity rates are well-known to have exploded in recent decades in industrial countries, although it is obviously a multi-factorial syndrome. bPA is an estrogen so unsurprisingly it has many other toxic low-dose effects not exhibited at typical test doses (and two industry papers finding no low-dose toxicity are shown invalid²³¹)

It appears that the massive-use, highly water soluble herbicide atrazine, an established hormone disrupter, may cause stronger effects at actual exposure low doses than at the higher doses of toxicity testing. Developmental endocrinologist Tyrone Hayes (UC/Berkley) has shown, both in the lab and in actual field conditions, that developing male tadpoles in water with 0.1 ppb to less than 1.0 ppb concentration of atrazine became demasculized (including depressed testosterone) and hermaphroditic. The 0.1 ppb dose--a ubiquitous environmental concentration, i.e. even in areas where it is not used--is 30,000,000 times(!) lower than the result using the traditional protocol for amphibian reproductive toxicity. A 25 ppb concentration in the lab, or uncontaminated field frogs, did not elicit/show those effects.²³¹ Hayes believes atrazine may be inducing the production of the enzyme aromatase, used to produce the correct male and female sex hormone ratios, a key to sexual differentiation (all vertebrates begin female). His team repeated his two sets of experiments four times resulting in replicating results 51 times. Meanwhile scientists funded by Syngenta, the prime manufacturer of atrazine say they are unable to replicate this effect.²³¹ Despite these alarming results at up to 30 times below the allowable level of atrazine in drinking water (3 ppb), EPA just declined to change that required-to-be safe exposure level, and in re-registration imposed no significant restrictions on atrazine use.

In extensive experiments for both low-dose and synergy effects, rats dosed with the pesticide chlordecone and the solvent/cleaner carbon tetrachloride (significantly below acutely toxic levels) caused a 67-fold increase in liver toxicity, but not complete liver failure; while substituting phenobarbital for carbon tetrachloride in the mix caused complete liver failure, even though it caused half as much liver damage as the first mixture! Extensive experiments indicated that this and similar results are likely due to tissue repair programs being activated by tissue damage, but unpredictably.²³¹ They call this a 'two-threshold doses' model of toxicity and point out the serious challenge it poses to traditional Q-RA. We say such results lay waste to the linear dose/response assumption that toxicology relies so completely on!

In elegant experiments using mainly pesticides, it was shown that for activated signalling systems (such as a hormone docking with its receptor) there may be no dose threshold below which no effect occurs.²³¹

Various combinations of the herbicide atrazine, the insecticides aldicarb and carbamate, and nitrate (fertilizer) had synergistic effects...at the concentrations they're typically found in groundwater--below drinking water limits.²³¹

Atrazine is yet again shown to be toxic (the long-term survival of tadpoles) at a low, everyday-exposure dose (3 ppb--the current EPA drinking water limit); but this time the low dose was also more toxic than higher doses (30, 100 ppb--typical of pulses received by waters).²³¹

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In sum, the concerns stated during public comment are unalloyed by your responses; aerial spraying should be eliminated until it can be shown that significant drift does not occur.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
 REGION 8, MONTANA OFFICE
 FEDERAL BUILDING, 10 West 15th St., Suite 3200
 HELENA, MONTANA 59626

Ref: 8MO

August 19, 2004

Mr. William R. Queen
 Hebgen Lake Ranger District
 Gallatin National Forest
 P.O. Box 520
 West Yellowstone, MT 59758

USDA FOREST SERVICE Hebgen Lake Ranger District West Yellowstone, MT AUG 20 2004 Ranger: <u>B</u> All: _____ File: _____

Re: CEQ 040321; Gallatin National Forest Noxious and
 Invasive Weed Treatment Project Draft
 Environmental Impact Statement

Dear Mr. Queen:

The Environmental Protection Agency (EPA) Region VIII Montana Office has reviewed the Draft Environmental Impact Statement (DEIS) for the Gallatin National Forest Noxious and Invasive Weed Treatment Project. The EPA reviews EISs in accordance with its responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act. Section 309 of the Clean Air Act directs EPA to review and comment in writing on the environmental impacts of any major Federal agency action. The EPA's comments include a rating of the environmental impact of the proposed action and the adequacy of the NEPA document.

The EPA concurs with the need in the Gallatin National Forest for an expanded integrated weed management program to prevent the establishment and spread of noxious weeds. The EPA commends proposed efforts to address invasive weed infestations before weed problems become an epidemic. Noxious weeds are a great threat to biodiversity, and can out-compete native plants and produce a monoculture that has little or no plant species diversity or benefit to wildlife. Impacts to native plant communities are much reduced when control actions are taken at an early stage of invasion.

We support proposed integrated weed management methods in the preferred alternative, Alternative 1, and we recognize that aerial application of herbicides facilitates effective weed management where there are large areas of weed infestation across inaccessible terrain. We do consider it important, however, to ensure that adequate measures are incorporated into aerial applications to mitigate risks of adverse health and environmental effects (e.g., avoid drift of potentially toxic herbicides to aquatic areas or other sensitive areas).

3-1



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F-5

The environmental protection measures included in Table 2-11 appear to recognize the need to avoid drift of herbicides to non-target areas. EPA is pleased to see that consideration has been taken into ensuring the accuracy and safety of aerial pesticide applications, although we do have some suggestions for additional measures that may further mitigate potential environmental effects of proposed weed treatments. These suggestions are included in our more detailed comments (enclosed).

We support the proposal to have a strong monitoring and adaptive management program that includes monitoring of the density and rate of spread and effects of invasive plants on natural resources; effectiveness of herbicides and biological control agents; and the presence of herbicides in surface and ground water in high risk areas. It is important to have an adaptive management program that monitors treatment activities and effects, to document and assure effective weed treatment with minimal impacts on non-target species, and avoidance of other adverse environmental or public health effects. We encourage the Forest to track weed infestations, control actions, and effectiveness of control action in a Forest-level weed database 3-2

We are pleased that monitoring of water samples is included to detect the presence of herbicides from drift, leaching or runoff. Aquatic monitoring is an important element of an effective weed management program utilizing herbicides to validate that herbicide application protocols and environmental protection measures are effective in preventing herbicide transport to surface and ground waters. Such monitoring should increase public confidence that chemical contamination of surface waters does not occur. We do recommend that additional information be provided regarding monitoring for herbicides to validate effectiveness of environmental protection measures (see enclosure). The Forest may also want to consider monitoring for herbicide concentrations in soils, and soil microbiologic assays or assessments of soil fertility. 3-3

The DEIS states that watersheds having existing weed infestations in areas of "high" watershed vulnerability risk should have special mitigation measures designed into the current treatment plans to avoid water contamination. Seventeen of 108 watersheds have been identified with a potentially "high" risk. Salmonid habitat and fisheries is a major beneficial use in and downstream of the Gallatin National Forest, further evidencing the need to assure that mitigation measures are effective in preventing herbicide drift, leaching and/or runoff to streams. It would be helpful to public understanding to include more information regarding the special mitigation measures to avoid water contamination in "high" risk areas. It is not clear what measures are proposed in such "high" risk areas above and beyond the environmental protection measures identified in Table 2-11. We also recommend that information be disclosed in the FEIS showing aquatic toxicity of the proposed herbicides for the fish species present in the areas to be treated. 3-4

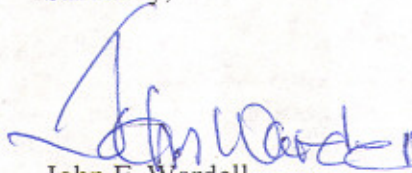
Our more detailed comments, questions, and concerns regarding the analysis, documentation, and/or potential environmental impacts of the Gallatin National Forest Noxious and Invasive Weed Treatment Project Project DEIS are enclosed for your review and consideration as you complete the Final Environmental Impact Statement (FEIS). Based on the procedures EPA uses to evaluate the adequacy of the information and the potential environmental impacts of the proposed action and alternatives in an EIS, the DEIS has been rated as Category

EC-2 (Environmental Concerns - Insufficient Information). A copy of EPA's rating criteria is attached.

The EPA concurs with the need for an expanded integrated weed management program to prevent the establishment and spread of noxious weeds, including some aerial application of herbicides. We note the need for adequate environmental protection measures to reduce potential for herbicide transport to surface and ground waters and to protect public health, and have suggestions for additional measures to further mitigate potential environmental effects of proposed weed treatments. The EPA also believes additional information regarding herbicide monitoring and aquatic toxicity is needed.

The EPA appreciates the opportunity to review and comment on the DEIS. If we may provide further explanation of our concerns please contact Mr. Steve Potts of my staff in Helena at (406) 457-5022 or in Missoula at 406-329-3313.

Sincerely,



John F. Wardell
Director
Montana Office

Enclosure

cc: Larry Svoboda/Julia Johnson, EPA, 8EPR-N, Denver
Donna Rise, Montana Dept. of Agriculture, Helena
Carole Mackin, MDEQ, Helena

U.S. Environmental Protection Agency Rating System for Draft Environmental Impact Statements

Definitions and Follow-Up Action*

Environmental Impact of the Action

LO - - Lack of Objections: The Environmental Protection Agency (EPA) review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC - - Environmental Concerns: The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce these impacts.

EO - - Environmental Objections: The EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no-action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU - - Environmentally Unsatisfactory: The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

Adequacy of the Impact Statement

Category 1 - - Adequate: EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis of data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2 - - Insufficient Information: The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses or discussion should be included in the final EIS.

Category 3 - - Inadequate: EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the National Environmental Policy Act and or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

* From EPA Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment, February, 1987.

EPA Comments on Gallatin National Forest Noxious and Invasive Weed Treatment Project Draft Environmental Impact Statement

BRIEF PROJECT OVERVIEW:

The Gallatin National Forest has prepared this DEIS to evaluate a proposal to expand its current integrated invasive weed control program to include treatments on approximately 13,260 acres. The purpose and need is to prevent and reduce the loss of native plant communities associated with the spread of weeds. The principal weeds to be treated are Dalmatian toadflax, cheatgrass, Canada thistle, houndstongue, spotted knapweed, musk thistle, yellow toadflax, oxeye daisy, leafy spurge, and common tansy, although other weeds may also be treated.

Alternative 1, the proposed action, would use an Integrated Weed Management approach involving cultural, biological management, ground and aerially applied herbicide, education and prevention, and incidental mechanical treatments on approximately 13,260 acres, including 10,600 acres of noxious weeds, 1,995 acres of invasive plants, and 665 acres of tall larkspur control. Ground application of herbicides would occur on 5,179 acres; aerial application of herbicides on 255 acres; biological control on 4,985 acres; 41 acres of weed pulling; 2,135 acres of cultural treatments (selective grazing or reseeding); and 665 acres of larkspur control through herbicide, fertilizer, mineral supplement, sheep grazing, and supplementing native biological controls. Herbicides available for control include picloram (Tordon, Grazon, Access, Pathway), clopyralid (Tringer, Curtail, Transline, Redeem), chlorsulfuron (Telar), metsulfuron methyl (Escort, Ally), 2,4-D (HiDep, Weedar64, Weed RHAP, Amine4, Aqua-Kleen), imazapyr (Plateau), dicamba (Vanquish or Banvel), glyphosate (Roundup, Rodeo, Accord, Glyphomate), Hexazinone (Velpar, Pronone 10G), Sulfometuron methyl (Oust, Triclopyr (Garlon, Redeem, Remedy). Implementation would occur over a 5 to 15 year period. Acres to be treated each year would be dependent on funding and a priority rating system. Alternative 1 is the preferred alternative.

Alternative 2 involves weed control without use of herbicides. Under Alternative 2, 130 acres of hand pulling; 2,017 acres of cultural treatments; 7,622 acres with biological control agents; and 665 acres of tall larkspur control would occur. Under this alternative 2,826 acres would not be treated because there is either not an approved biological control program, lack of resources for hand pulling or the plants spread via roots and extensive soil disturbance to attack the roots is not acceptable.

Alternative 3 is the no action alternative involving no change from current weed management, which means no additional herbicide treatment outside areas identified in the 1987 Gallatin National Forest Noxious Weed Control EIS or a 1992 East Dam Spotted Knapweed Infestation EA. Alternative 3 would treat spotted knapweed and leafy spurge on 346 acres with 2,4-D and picloram, 281 acres using mechanical and cultural treatments; and 535 acres with biological treatments. Approximately 11,433 acres would not be treated because they were not covered in previous environmental analysis.

Alternative 4 is the same as Alternative 1 except that the aerial treatment sites would not be treated. Ground application of herbicides would occur on 5,179 acres; biological control on 5,086 acres; 41 acres of weed pulling; and 2,135 acres of cultural treatments.

COMMENTS:

1. Thank you for including many informative tables and figures in the DEIS to clearly present the weed management problem and the proposals to address the problem (e.g., listing of acreages of more prevalent invasive plants, page S-1; Table 2-13 showing Decision Tree for new weed locations, pages 2-13, S-6; Table 2-1 showing the weed management priority rating system, pages 2-5, S-9; Table 2-3 with proposed treatments for all alternatives, pages 2-6, S-9; Tables 2-4 and 2-5 showing herbicides to be used and herbicide application rates and timing, pages 2-7, 2-8; Table 2-13 summarizing trade-offs and potential impacts between alternatives, pages 2-22, S-11; Table 1-1 comparing weed management methods, pages 1-12, 2-22; Table 2-9 showing relative costs of treatment types by alternative, page 2-15; Table 2-11 showing environmental protection measures, page 2-18; Table 2-12 showing picloram treatments in sensitive watersheds, page 2-21; Figures 2-1 through 2-30 with maps showing proposed treatment areas). These tables and figures provide useful information that improves project understanding, and facilitates review and evaluation of proposed Gallatin National Forest weed management activities.
2. The EPA commends proposed efforts to address invasive weed infestations in the Gallatin National Forest before weed problems become an epidemic. We concur with the need to expand the Gallatin National Forest integrated weed management program to prevent the establishment and spread of noxious weeds. Noxious weeds are a great threat to biodiversity, and can out-compete native plants and produce a monoculture that has little or no plant species diversity or benefit to wildlife. Noxious weeds tend to gain a foothold where there is disturbance in the ecosystem. Impacts to native plant communities are much reduced when control actions are taken at an early stage of invasion.

We support proposed integrated weed management methods in the preferred alternative, Alternative 1, and we recognize that aerial application of herbicides facilitates effective weed management where there are large areas of weed infestation across inaccessible terrain. We do consider it important, however, to ensure that adequate measures are incorporated into aerial applications to mitigate risks of adverse health and environmental effects (e.g., avoid drift of potentially toxic herbicides to aquatic areas or other sensitive areas).

The environmental protection measures included in Table 2-11 (page 2-18) appear to recognize the need to avoid drift of herbicides to non-target areas. EPA is pleased to see that consideration has been taken into ensuring the accuracy and safety of aerial pesticide applications, although we do have some suggestions for additional measures that may

further mitigate potential environmental effects of proposed weed treatments. These include:

- 1) operators should calibrate spray equipment at regular intervals to ensure proper rates of herbicide application;
- 2) field inspectors who will be present during all aerial applications, should be trained and equipped with the appropriate personal protective equipment according to the label;
- 3) a more selective herbicide (clopyralid) should be considered for use in conifer associated communities to reduce impacts on non-target vegetation;
- 4) the 300 foot streamside buffer should specify application of the buffer to wetlands as well as streams;
- 5) aquatic areas and buffer zones should be delineated and reviewed with the pilot prior to aerial application;
- 6) only treatment methods that target individual noxious weed plants should be done in riparian and wetland areas (depending on the targeted weed species, manual control or hand pulling may be one of the best options for weed control within riparian/wetland areas or close to water). We also note that the herbicide application technique of hand or manual wipe-on (especially applicable for contact systemic herbicides such as glyphosate) is not mentioned as an option to control individual plants up to the existing water level adjacent to streams or sensitive aquatic sites.

3-5

We thank you for including a 300 foot buffer for aerial applications around streams and for including other measures to reduce risk of herbicide drift to sensitive areas. Herbicide drift into streams and wetlands could adversely affect aquatic life and wetland functions such as food chain support and habitat for wetland species. We believe a 300 feet buffer provides an adequate safety zone to reduce risk of drift and runoff of potentially toxic herbicides to streams and wetlands during aerial applications. A adequate buffer zone is particularly important for streams with valuable or sensitive fisheries resources (e.g., westslope or yellowstone cutthroat trout) or where there are downstream public water supplies.

3-6

We are also appreciative of the other proposed measures to minimize risk of herbicide drift to sensitive areas (e.g., all areas to be aerially sprayed be flagged and marked with GPS; maintain constant communications between helicopter and ground observers; wind monitoring; use drift cards, dyes, drift reduction agents, spray nozzles that produce larger droplets, etc.); and for the description of monitoring plans to detect herbicide drift during aerial applications (page 2-17).

We support monitoring and use of spray detection cards and modification of application methodology based on monitoring results. The discussion of herbicide drift (pages 3-50, 3-51) and analysis of herbicide drift (beginning on page 4-71) is informative and facilitates public understanding of the factors that influence drift of herbicides. We are pleased that proposed buffers and drift reduction measures should likely result in no

significant offsite drift, and that herbicide spray drift from aerial treatments would not significantly affect the health of the general public or adversely affect water quality (page 4-74).

3-7 We are pleased that Forest wildlife biologists would review and coordinate spray projects with the District/Forest Weed Coordinator to identify raptor nesting areas, grizzly bear core habitat, wolf territories, or other critical wildlife areas that may be affected by weed control activities to ensure appropriate mitigation. We suggest that the Weed Coordinator also review and coordinate projects with fisheries biologists and botanists assure that sensitive fisheries and plants are protected. We are pleased that the proposed environmental protection measures include surveys for sensitive plants prior to application of herbicides, and note surveys should be conducted by qualified surveyors prior to aerial applications and at all previously unsprayed sites so that rare plant species viability and population may be protected where such plants are found in areas with weed infestations.

3-8 Also, for your information we are attaching a copy of the environmental protection measures included in the final EIS for the Bitterroot Noxious Weed Treatment Project which included additional measures and in some cases more detailed clarifications regarding such measures. We suggest these measures be reviewed to see if additional measures may also be appropriate for the Gallatin Invasive and Noxious Weed Control Project,

3-9 3. It is stated in Chapter 2 that the preferred alternative, Alternative 1, includes 255 acres of aerial herbicide treatments and 5, 179 of ground herbicide applications (page 2-4, Table 2-3), yet it is stated in Chapter 4 (page 4-74) that Alternative 1 proposes to treat 459 acres aerially and 5,390 acres with herbicides. This discrepancy should be corrected.

4. Table 2-7 (page 2-14) shows aerial application of herbicide has the lowest monetary cost by far (\$40 per acre) in comparison to a \$100 acres cost for ground applications of herbicide and \$400 per acre for hand pulling of weeds, \$150 per acres of biological control and \$250 per acre for cultural controls (grazing, burning, planting). Table 2-10 (page 2-15) shows that a fiscally realistic portrayal of the Forest weeds program, given the limited budgets historically available for weed management on the Gallatin National Forest, would consist primarily of ground application of herbicides along with some biological control and a very minimal amount of manual control (hand pulling). No aerial applications of herbicide are shown in Table 2-10. The DEIS states that aerial treatment is not considered a priority for the \$300,000 currently being budgeted.

3-10 It is not clear to us why with very limited funding the most cost-effective method of weed treatment (aerial application of herbicide) is not included in the fiscally realistic portrayal of the Forest weeds program. Some further discussion is needed to more clearly explain the lack of inclusion of aerial treatments in a fiscally limited weed management program.

It would seem that the most cost-effective weed treatment method would be a bigger part of a weed management program with limited funding.

5. EPA is pleased to see Integrated Weed Management as a cornerstone for the Gallatin National Forest weed management program. Monitoring is an integral part of Integrated Weed Management. We support the intent stated in the DEIS to have a strong monitoring and adaptive management program (page 2-17) that includes monitoring of the density and rate of spread and effects of invasive plants on natural resources; effectiveness of herbicides and biological control agents; and the presence of herbicides in surface and ground water in high risk areas. It is important to have an adaptive management program with monitoring of treatment activities and effects. This is necessary to document and assure effective weed treatment with minimal impacts on non-target species, and avoidance of other adverse environmental or public health effects. We encourage the Forest to track weed infestations, control actions, and effectiveness of control action in a Forest-level weed database. Additionally, it would be helpful to disclose where the long term herbicide test plots and biological control plots, described on page 2-17, will be located. 3-11

6. An Integrated Weed Management program should also strive to identify the reason(s) why noxious and invasive weeds are present. We, therefore, suggest adding a discussion on the probable causes of noxious and invasive weed establishments within the Gallatin National Forest (i.e. logging practices, grazing practices, recreational activities, erosion, etc.). By describing why weeds have become a problem, the Gallatin National Forest may be better able to apply strategies to mitigate root causes. 3-12

7. We support proposed monitoring of water samples where there is reason to suspect that herbicides may have entered surface or ground waters, and collection of water samples after the first substantial rain to detect the presence of herbicides from leaching or runoff (page 2-17). The Forest may also want to consider groundwater monitoring in selected wells in close proximity to application sites. 3-13

We believe aquatic monitoring is an important element of an effective weed management program utilizing herbicides, and should be an integral part of the management decision. Monitoring is needed to validate that herbicide application protocols and environmental protection measures are effective in preventing herbicide transport to surface and ground waters, and avoiding impacts to wildlife and non-target plant communities.

We believe the health of downstream domestic, agricultural and recreational water users and of the aquatic ecosystem should dictate some level of aquatics monitoring to document and verify that aqueous transport of herbicides, particularly picloram, which is highly mobile and toxic, does not occur. Such monitoring will also verify that mitigation measures were effective in avoiding herbicide drift to streams, and may increase public confidence that chemical contamination of surface waters did not occur. 3-13

In regard to aquatic monitoring, we generally recommend that sensitive streams adjacent to or nearby aerial herbicide treatment areas be monitored to validate that herbicide transport to aquatic areas does not occur, particularly monitoring for picloram and clopyralid, since these herbicides are highly soluble and mobile, and relatively persistent and toxic (i.e., select a stream with a high potential for herbicide drift for monitoring or high nearby treatment acreage, and if no herbicide is identified in this stream, you can better validate and extrapolate that mitigation measures were effective in preventing herbicide drift to other aquatic areas with lower intensity of treatments).

3-13

It would be appropriate to focus such monitoring on waters in the 17 "high" risk watersheds shown in Table 4-10 (page 4-21) where some risk for exceeding the "safe" herbicide concentrations exists. Monitoring in the Hyalite and Bozeman Creek municipal watersheds may be helpful to document that water contamination does not occur in the municipal watershed.

3-13

The monitoring program should display sampling locations relative to area of herbicide treatment, parameters to be monitored, methodologies to be used, frequency, pattern and number of samples to be collected, etc.,. We are also enclosing information regarding a rapid bioassay technique that may be of assistance in detecting herbicides in water (see attached). We also note that bioassay techniques using aquatic species sensitive to the herbicides to be used are available for detecting aquatic impacts from herbicide applications (e.g., stoneflies, cutthroat trout). EPA has prepared a toxicity testing manual entitled, "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms", EPA/600/4-90/027, September 1991. Toxicity testing procedures are described in this manual, including procedures using rainbow and brook trout. If you have questions regarding toxicity testing procedures we encourage you to contact Mr. Glenn Rodriguez at our EPA Denver Office at (303) 312-6832.

3-13

The aquatic monitoring program should be more completely described in the FEIS, perhaps in an Appendix, to assure that project effects on water quality (i.e., chemical and biological impacts) and public health will be detected, and to allow the adequacy of the monitoring program to be evaluated.

8. The Forest may also want to consider monitoring for herbicide concentrations in soils, and soil microbiologic assays or assessments of soil fertility. Weed infestations are often able to out compete native vegetation in soils where overgrazing, fire, or other disturbance has depleted soil fertility levels. It may be useful to analyze for soil fertility parameters (pH, Ca, Mg, K, P, organic matter, % N). If soil fertility is low, it may be helpful to apply slow release fertilizers to initiate competitive growth of native vegetation.

3-14

9. It is not clear why larkspur control on some of the 665 acres with larkspur is not included in Alternative 2, albeit without herbicide use. Could larkspur control be a part of an Alternative 2 weed management program without use of herbicides, but with use of fertilizer, mineral supplement, sheep grazing, and supplementing native biological controls? 3-15

10. As a general practice, EPA suggests prioritizing perimeter weed infestations such as around trailheads and roadsides before treating interior weed infestations. 3-16

11. Table 2-5 (page 2-8) showing herbicide application rates and timing is helpful for evaluating effects of herbicide applications. This table shows that picloram (Tordon) may be applied at rates of 1 quart/acre in the fall to control leafy spurge. Picloram is a mobile, toxic, and persistent herbicide. Would applications of less than 1 quart/acre of picloram effectively control leafy spurge? 3-17

Table 2-5 also shows applications of some persistent herbicides such as picloram more than once per year. Would it be appropriate to limit picloram and other more persistent applications to once per year to reduce potential for accumulation in soil? Potential for persistent herbicides to accumulate in soil in harmful amounts would be reduced if most sites are treated only once per year (twice being the limit). Trade-offs between effective weed control and effects on soil productivity and leaching concerns may need to be considered. A second treatment application if needed should only occur after 30 days (or according to label directions). 3-17

For your information, Dow AgroSciences, the manufacturer of Tordon 22K, has recently developed supplemental labeling for Tordon 22K for areas west of the Mississippi River. They have directions for wick or carpet roller applications. Tordon 22K herbicide can be applied using wick or carpet roller equipment where drift presents a hazard to susceptible crops, surface waters, and other sensitive areas. One part Tordon 22K is mixed with 2 parts water to prepare a 33% solution. The wick method of application is more labor intensive but very effective at targeting particular noxious weeds adjacent to surface waters, wetlands, or protected plants. 3-17

12. Most picloram products, including Tordon 22K, are Restricted Use Pesticides (RUPs) requiring pesticide applicator certification to purchase and apply. Please provide a detailed description on how U.S. Forest Service employees will be certified throughout the duration of the project. If commercial applicators will be contracted for RUP applications, we recommend checking to make sure their MT commercial RUP license is current. Please contact Montana Dept. of Agriculture at (406) 444-5400 for more information. Also, please note that registration for Access, picloram active ingredient, is cancelled and Table 2-4 should be updated. 3-18

13. Thank you for providing a clear and comprehensive discussion of weeds, native plants and rare plants in Chapter 3 (pages 3-3 to 3-13). It is very helpful to have information on magnitude and occurrence of weed infestations as well as native plant communities and rare plants on the Forest.

3-19

We note that Table 3-5 (page 3-9) showing acres on the Gallatin at risk to invasive weeds seems to show that leafy spurge, spotted knapweed, Dalmatian toadflax, Dyers woad, and Sulfur cinquefoil present the highest risks (i.e., highest acreages of weed infestations). The listing of more prevalent weeds on page 1 of the DEIS Summary, however, lists the most prevalent weeds as Dalmatian toadflax, cheatgrass, Canada thistle, houndstongue and spotted knapweed. There appears to be somewhat of an inconsistency between these two listings in regard to the most prevalent weed species presenting the greatest risks.

3-20

14. Since, spotted knapweed is one of the more prevalent noxious weed species in the project area, we note that spotted knapweed is non-rhizomatous and should be relatively easy to control with lower rates of the most selective low toxicity herbicides.

3-21

15. The DEIS outlines mechanical removal or hand-pulling of weeds that do not contain extensive root systems. It may be helpful to add a list of those weed species which *can* be effectively hand-pulled (i.e. those without large tap roots and spreading rhizomatous root systems).

3-22

16. Sites selected for application of biological control agents should be protected from other management actions that could negatively influence the biocontrol agent. These sites can also function as collection points for redistribution of established biocontrols to other sites.

3-23

17. It would be helpful if information regarding the presence of sensitive features in weed treatment areas were tabulated for each treatment area (e.g., rare or sensitive plants, aquatic areas, T&E species, downstream public water supplies, etc.). Are the Hyalite Creek and Bozeman Creek watersheds the only watersheds in the Forest with proposed weed treatments that provide public water supplies (page 3-24)? Are there any other sensitive waters near herbicide treatment areas, including potable, agricultural, and recreational uses of surface and ground water immediately downstream or downgradient from proposed herbicide application areas? Will all possible precautions be taken to avoid contamination of potable water supplies with weed control chemicals?

18. Thank you for providing Relative Aquifer Vulnerability Evaluation (RAVE) hazard assessment information including Tables 4-6 through 4-9 (beginning on page 4-13) and Figures 1 and 2 in Appendix E showing RAVE risk classes and watershed vulnerability evaluations. We are pleased that almost all of the Gallatin Forest falls in the "low to moderate" risk class, although there are "hot spots" in each Ranger District where special mitigation measures should be considered to avoid water contamination (page 4-19).

The DEIS states that watersheds having existing weed infestations in "high" risk areas should have special mitigation measures designed into the current treatment plans. It would appear helpful to have a list of the areas with existing weed infestations in "high" risk areas so that planning could be initiated to develop the appropriate special mitigation measures that may be needed to treat weeds in such areas, and to assure that the special mitigation measures in "high" risk areas are not overlooked. It would also be helpful to public understanding to include more information on the special mitigation measures intended to avoid water contamination in "high" risk areas. It is not clear what measures are proposed in such areas above and beyond the environmental protection measures identified in Table 2-11.

3-24

Sensitive fisheries (e.g., westslope cutthroat, yellowstone cutthroat, western toad, and northern leopard frog waters) are identified in many Gallatin Forest streams in Tables 3-11 (age 3-19), and it is stated that a major beneficial use in and downstream of the Gallatin National Forest is salmonid habitat (page 3-23). This demonstrates the need to assure that mitigation measures are effective in preventing herbicide drift, leaching and/or runoff to fishery streams. Adequate precautions or mitigation measures must be taken to avoid drift of herbicide to sensitive fishery waters during ground or aerial applications. If any of the "high" risk areas for herbicide leaching or transport involve streams with sensitive fisheries it would further support the need for development of special mitigation measures to minimize risk of herbicide transport to such waters.

3-25

19. Thank you for including Table 3-9 (page 3-16) showing Montana Water Quality Human Health Standards for herbicides, and Table 3-14 (page 3-34) with mammalian and avian toxicity of herbicides proposed for use on the forest. It should be noted that while the Water Quality Standards do not identify numerical criteria for aquatic life protection for the herbicides proposed for use, it should be recognized that the research and data requirements necessary to establish numerical aquatic life water quality criteria are very rigorous, and there are many chemicals in use which are toxic, but for which numerical aquatic life criteria have not been established. The Montana Water Quality Standards include a general narrative standard requiring surface waters to *be free from substances that create concentrations which are toxic or harmful to aquatic life.*

We recommend that information be disclosed in the FEIS showing aquatic toxicity of the proposed herbicides for the fish species present in the areas to be treated. It would also be helpful if relative toxicity of proposed herbicides to fish and aquatic life were identified. The National Pesticide Telecommunication Network (NPTN) website at <http://npic.orst.edu/tech.htm> which operates under a cooperative agreement with EPA and Oregon State University and has a wealth of information on toxicity, mobility, environmental fate on pesticides that may be helpful (phone number 800-858-7378). Information from this website on some of the herbicides proposed for use includes:

3-26

Picloram: Picloram has a very high pesticide movement rating; a soil half-life of 90 days; water solubility of 200,000 mg/l (salt form) and a sorption coefficient of 16 soil Koc. Picloram is slightly to moderately toxic to fish and aquatic invertebrates. The reported 96-hour LC50 values for picloram are 3.5 mg/l in cutthroat trout, 19.3 mg/L in rainbow trout, 14.5 mg/L in bluegill sunfish, and 55 mg/L in fathead minnow. The 48-hour LC50 in *Daphnia* is 50 mg/L, indicating moderate toxicity. Most salts are of similar or lesser toxicity, but the isooctyl ester may be highly toxic. The reported 96-hour LC50 for the isooctyl ester in rainbow trout is 4 mg/L, and in channel catfish is 1.4 mg/L. Other LC50 values in aquatic invertebrates ranged from 10 to 68 mg/L. Picloram is not expected to accumulate appreciably in aquatic organisms; the measured bioconcentration factor in bluegill sunfish was less than 0.54.

"Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates: Summaries of Toxicity Tests Conducted at Columbia National Fisheries Research Laboratory, 1965-78. U.S. Dept. of the Interior, Fish and Wildlife Service, Resource Publication 137, Washington, D.C., 1980, lists the picloram 96-h LC50 for cutthroat trout as follows:

- 1) Picloram technical grade material, 90 - 100%; Stage or wt.(g) 0.4; Temp. (C) 12; 96-hr LC50, 95% CI: 4.8 mg/l, 3.8-6.2 mg/l;
- 2) Picloram - potassium salt, 24.9%; Stage or wt.(g) 0.9; Temp.(C) 10; 96-h LC50, 95% CI: 1.5 mg/l, 0.8-3.0 mg/l;

2,4-D: 2,4-D has a moderate pesticide movement rating; a soil half-life of 10 days; water solubility of 890 mg/l and a sorption coefficient of 20 soil Koc. 2,4-D is slightly to highly toxic to fish depending upon the formulation used. The LC50 ranges between 1.0 to 100 mg/l depending upon the formulation used. The LC50 value for the compound is 18 mg/L in the fathead minnow, 7.5 to 17 mg/L in the bluegill sunfish, and 2 to 14 mg/L in the rainbow trout. No studies were available on the toxicity of the compound to freshwater or marine invertebrates.

"Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates: Summaries of Toxicity Tests Conducted at Columbia National Fisheries Research Laboratory, 1965-78. U.S. Dept. of the Interior, Fish and Wildlife Service, Resource Publication 137, Washington, D.C., 1980, lists the 2,4-D 96-h LC50 for cutthroat trout as follows:

- 1) 2,4-Dichlorophenoxyacetic acid, granular 100%; Stage or wt.(g) 0.3; Temp. (C) 10; 96-h LC50, 95% CI: 64 mg/l, 57-72 mg/l;
- 2) Butyl ester of 2,4-D liquid, 98.4%; Stage or wt.(g) 0.8; Temp. (C) 10; 96-h LC50, 95% CI: 0.9mg/l, 0.7-1.0 mg/l;
- 3) Propylene glycol butyl ether ester of 2,4-D, liquid 100%; Stage or wt.(g) 1.0; Temp.(C) 10; 96-h LC50, 95% CI: 1.0 mg/l, 0.9-1.2 mg/l;

Clopyralid: Clopyralid has a very high pesticide movement rating; a soil half-life of 40 days; water solubility of 300,000 mg/l and a sorption coefficient of 6 soil Koc. Reported 96-hour LC50 Rainbow trout 103.5 mg/l/Conditions of bioassay not specified/ LC50

Bluegill sunfish 125.4 mg/l/96 hr /Conditions of bioassay not specified.

Dicamba: Dicamba has a very high pesticide movement rating; a soil half-life of 14 days; water solubility of 400,000 mg/l and a sorption coefficient of 2 soil Koc. Dicamba is of low toxicity to fish. The LC50 (96-hour) for technical dicamba is 135 mg/L in rainbow trout and bluegill sunfish, greater than 100 mg/L in grass shrimp, and greater than 180 mg/L in fiddler crab and sheepshead minnow. The LC50 (48-hour) for dicamba is 35 mg/L in rainbow trout, 40 mg/L in bluegill, 465 mg/L in carp, and 110 mg/L in *Daphnia magna*, a small freshwater crustacean.

Metsulfuron-methyl: Metsulfuron-methyl has a high pesticide movement rating; a soil half-life of 30 days; water solubility of 9500 mg/l and a sorption coefficient of 35 soil Koc. The chemical has very low toxicity to aquatic organisms. 96-hour LC50 values are greater than 150 mg/l in rainbow trout and bluegill. Forty-eight hour toxicity tests with the freshwater invertebrate *Daphnia magna* resulted in a LC50 of greater than 150 mg/l (40). A 21-day life-cycle test with *Daphnia magna* also exhibited very low toxicity. The NOEL for survival and reproduction was >150 mg/l.

We also suggest that the FEIS disclose other general characteristics and effects of the proposed herbicides for use in this project. See attached as examples, tables from the Helena National Forest DEIS Noxious Weed Treatment Project providing information on general characteristics and effects of herbicides. Although we recommend that a table showing *General Characteristics of Herbicides to be Used* should show the chemical properties of different chemical forms (salt vs. acid) of herbicides, since properties vary with chemical formulation. For example, the solubility of the *acid* form of picloram (430 mg/L) is much lower than the *salt* form of picloram (200,000 mg/L). The more soluble salt form of picloram is most often used. Similarly, the salt form of clopyralid has a solubility of 300,000 mg/L, which is considerably greater than the acid form solubility of 1,000 mg/L.

It is important to know that picloram and clopyralid are toxic and mobile herbicides with a high potential for leachability, and thus, a high potential to be transported to surface and ground waters. They do not readily adsorb to soils, do not photo degrade, and do not volatilize. Picloram can persist and be transported in water systems for long periods. Clopyralid is closely related structurally to picloram (3, 6, Dichloropicolinic acid). The Montana Dept. Agriculture (MDA) has found picloram and clopyralid in ground water in the Fairfield Bench area northwest of Great Falls where there are sandy clay soils. Clopyralid levels in ground water have been in the part per billion levels, below those considered a risk for human health.

Clopyralid and picloram can easily leach to ground water. Clopyralid has a water solubility of approximately 300,000 ppm, a relatively low adsorption coefficient, and a moderate half life (approximately 40 days). There is potential for leaching to ground

water in areas with highly permeable, sandy gravelly soil with high or perched ground water tables. Depth to ground water or seasonal variation of ground water depth and soil permeability and other soil characteristics that can influence leaching should be discussed. Soil permeability and ground water depth information may be helpful to have before spraying to assure minimal risk of leaching of herbicides to ground water.

The Montana Department of Agriculture recommends that pesticide/herbicide applicators establish soil depth criteria with sufficient depth to ground water to mitigate the potential for the movement of leachable herbicides such as picloram or clopyralid to ground water (Donna Rise, MDA, phone 444-5400). Six feet of soil may be adequate if the soils are less permeable (e.g., clay) and may provide adequate time for picloram and clopyralid to degrade. Six feet of soil, however, will not be adequate if the soils are sandy, gravelly or have cobbly, stony, or other permeable structural characteristics. The Ground Water Information Center at the Montana Bureau of Mines & Geology in Butte, MT (406-496-4153) may have well log information for estimation of ground water levels in treatment areas.

For your information, a few years ago Tordon (picloram) application by a County Weed District in Wyoming (in accordance with herbicide label restrictions) resulted in transport of picloram through ground water a distance of several miles. Subsequent pumping of downstream ground water for household use resulted in the death of garden and household plants, evidencing the continuing presence of picloram in ground water.

20. The DEIS states that picloram is used as a surrogate for all herbicides to assess risks to aquatic species (page 3-21), and that a "safe" concentration level synonymous with the maximum allowable toxicant concentration (MATC) equaling 0.075 ppm has been chosen (MATC derived by taking 1/20 of the 1.5 ppm 96 hour LC-50 for cutthroat trout). Risk assessment techniques were used to estimate the maximum amount of herbicides that can be used within any watershed (6th order HUC) within any year using flow duration curves and watershed size. Appendix D includes a table showing the maximum amount of herbicides that can be used within any watershed.

3-28 The DEIS indicates that the analysis shows herbicide applications in all but a few 6th code HUCs on the Forest should remain well below the "safe" concentrations and pose little risk to fisheries (page 4-22). Table 4-10 (page 4-21) shows 17 of 108 watershed where some risk for exceeding the "safe" concentrations in surface waters exists, however, by following the restrictions on the maximum amount of herbicides that can be used within any watershed (6th order HUC) within any year (Table 4-10) the DEIS states that instream concentrations should remain below 0.12 ppm (picloram) and negative impacts to sensitive or MIS aquatic species should not occur. This analysis appears reasonable, however, as stated in the DEIS (page 4-22) it will be very important that safety and mitigation measures identified in the EIS are used during project implementation.

21. We note that the environmental protection measures in Table 2-11 (page 2-20) state that no ester formulations of herbicides will be used due to fish toxicity concerns, however, the table in Appendix D showing the maximum amount of herbicides that can be used within any watershed includes identification of the maximum amount of 2,4-D ester to be used in each watershed. There would appear to be no need to specify this if no ester formulations are to be used. 3-29
22. Thank you for identifying streams on Gallatin Forest that are 303(d) listed with water quality impairments (Gallatin River, Taylor Fork, East Boulder River, and Clarks Fork of the Yellowstone, and Squaw, Cache, Mill, Watkins, Fisher Creeks, page 3-17). Stream segments designated as "water quality impaired" and/or "threatened" listed on the States 303(d) list need development of a Total Maximum Daily Load (TMDL).

A TMDL: Identifies the maximum load of a pollutant (e.g., sediment, nutrient, metal) a waterbody is able to assimilate and fully support its designated uses; allocates portions of the maximum load to all sources; identifies the necessary controls that may be implemented voluntarily or through regulatory means; and describes a monitoring plan and associated corrective feedback loop to insure that uses are fully supported; Or can also be viewed as, the total amount of pollutant that a water body may receive from all sources without exceeding WQS; or as a reduction in pollutant loading that results in meeting WQS.

Montana's approach is to include TMDLs as one component of comprehensive Water Quality Restoration Plans. TMDLs/Water Quality Restoration Plans contain eight principal components:

1. Watershed characterization (hydrology, climate, vegetation, land use, ownership, etc.)
2. Description of impairments and applicable water quality standards.
3. Pollutant source assessment and estimate of existing pollutant loads.
4. Water quality goals/restoration targets.
5. Load allocations (i.e., TMDLs).
6. Restoration strategy
7. Monitoring Strategy
8. Public involvement (30 day public comment period, informational meetings, etc.)

The load allocations and targets established by TMDLs/WQRPs inform land managers how much sediment, nutrient or other pollutant discharge may be too much (i.e., prevent support of beneficial uses). We note that sometimes significant sources of pollutant loading occur in unlisted tributaries, and TMDLs must account for all sources of pollution, hence the need to identify and address sources throughout the watershed, including unlisted waters. A WQRP provides a means to track the health of a stream over 3-30

time. If a WQRP has not restored beneficial uses within five years, the Montana DEQ conducts an assessment to determine if:

- * the implementation of new and improved best management practices is necessary;
- * water quality is improving but more time is needed to comply with WQS; or
- * revisions to the plan will be necessary to meet WQS.

Pending completion of a TMDL in Montana, new and expanded nonpoint source activities may commence and continue, provided those activities are conducted in accordance with "reasonable soil, land and water conservation practices" (MCA 75-5-703). The Administrative Rules of Montana (17.30.602) define these as "methods, measures, or practices that protect present and reasonably anticipated beneficial uses." The EPA believes land management activities carried out in the watershed of 303(d) listed streams should not further degrade impaired streams, and should be consistent with TMDLs and associated WQRPs.

The Montana Dept. of Environmental Quality (MDEQ) is under a Court Ordered schedule to prepare TMDLs. This schedule includes the following for the TMDL planning areas in the Gallatin N.F. area:

Cooke City TMDL Planning Area done 2002
 Upper Madison TMDL Planning Area due 2004
 Boulder Big Timber TMDL Planning Area due 2005
 Upper Gallatin TMDL Planning Area due 2005
 Shields TMDL Planning Area due 2005
 Paradise TMDL Planning Area due 2005
 Yellowstone Sweet Grass TMDL Planning Area due 2006
 East Gallatin TMDL Planning Area due 2007
 Lower Gallatin TMDL Planning Area due 2007

3-30 Each TMDL planing area may include several impaired watersheds that have specific TMDL preparation needs. Although none of the 303(d) listed waters identify herbicides as a cause for impairment, we recommend that the Gallatin N.F. contact the Planning, Prevention, and Assistance Division of the MDEQ (i.e., Carole Mackin, Federal Consistency Coordinator at 444-7425 in Helena, MT) to ensure that TMDL requirements are adequately addressed with the proposed Gallatin Noxious and Invasive Weed Control Project. For your information, we believe that with proper use of herbicides and environmental protection measures, significant adverse effects to surface water quality, including water bodies on the 303(d) list, should not occur.

23. Thank you for including the Appendix A discussion of BMPs for Weed Control. It is helpful to identify such measures since the most cost-effective way to manage and control weeds is avoid new infestations and spread of weeds at the earliest stages. Early

recognition and control of new infestations is encouraged to stop the spread of the infestation and avoid wider future use of herbicides.

EPA is pleased to see the establishment of native grasses listed as a long-term goal in the DEIS (page 2-16). However, we would like to see this important proactive aspect of weed management performed on more acreage, if at all possible. We suggest revegetation (reseeding with native grass mix) of sites where vegetation density is low enough to allow for reinfestation or introduction of other noxious weeds, or erosion. The goal of the seeding program should be to establish the sustainability of the area. Where no native, rapid cover seed source exists, we generally recommend using a grass mixture that does not include aggressive grasses such as smooth brome, thereby allowing native species to eventually prevail, however, we acknowledge that it may be necessary to seed with a non-native aggressive grass, such as smooth brome, to reduce the competitiveness of downy brome (cheatgrass) where no native alternatives exist (page 2-16). Mr. Phil Johnson, Botanist, Montana Dept. of Transportation, in Helena at 406-444-7657, may be able to provide guidance on revegetation with native grasses. Measures we often recommend at the project level for preventing spread from source areas to uninfested areas include:

- ▶ Ensure that equipment tracks and tires are cleaned prior to transportation to an uninfested site.
- ▶ Focus control efforts at trail heads and transportation corridors to prevent tracking of seed into uninfested areas.
- ▶ Attempt to control the spread from one watershed to another to reduce water as a transport vector.
- ▶ If a localized infestation exists and control is not a viable option, consider rerouting trails/roads around the infestation to reduce available vectors for spread.
- ▶ Establish an education program for industrial and recreational users and encourage voluntary assistance in both prevention and control activities.
- ▶ Reseed disturbed sites as soon as possible following disturbance.

Noxious weeds can be spread by vehicles. The Forest Service may want to consider some restrictions on vehicles to reduce potential for reinfestation of the area by noxious weeds after treatment. Also, if sufficient vegetation is killed during ground disturbing activities (e.g., by prescribed burning) it may warrant revegetation efforts. Forest wide programmatic direction should also assure that the effects of burning on the potential stimulation of noxious weeds be evaluated during site-specific project level analysis. Prescribed fire has the potential to stimulate weed growth (e.g., Dalmatian toadflax or leafy spurge), and can destroy insects planted for biological weed control. Burning followed by application of appropriate herbicides can provide effective weed control. We suggest that such considerations be evaluated for during development of direction and plans for prescribed burning.

3-31 We also note that hay can be a source of noxious weed seed. Hay/straw is used as mulch to slow erosion and encourage seed germination, and used to feed horses in hunting and recreation camps, and as wildlife feed during harsh winters. The Federal Noxious Weed Act of 1974 prohibits the interstate transport of noxious weeds or weed parts, such as seed. Cattle that are released on grazing allotments or horses used on public lands can transport undigested weed seed and spread it in their manure. Montana has a weed free certification program for hay, and certified weed free hay should be required in permits or projects. We are pleased that weed free feed is used on all Forests in Montana. Another option for preventing the introduction of noxious weeds is to require cattle and horses, especially those coming from areas with noxious weeds, to be penned and fed weed free hay for several days prior to being released on public lands.

24. Thank you for providing Appendix B – Procedures for Mixing, Loading, and Disposal of Herbicides; Spill Plan in the DEIS for the Gallatin National Forest. As stated in Table 2-11, we agree that all herbicide applicators should be familiar with and carry a copy of Appendix B.

- 3-32 25. We note that Noxious Weed Control projects on other National Forests have often included in appendices Aerial Spray Recommendations and Mitigation Measures (e.g., Bitterroot, Lolo). We believe such guidance and/or protocol for aerial spraying is useful in demonstrating to the public that all possible efforts will be made to avoid drift of herbicides to sensitive areas during aerial applications. We suggest that such information be included in an appendix to the FEIS. We are enclosing a copy of the Aerial Spray Recommendations and Mitigation Measures Appendix from the Lolo National Forest Big Game Winter Range and Burned Area Weed Management EIS as an example.

3-32 For your information, we are also enclosing a copy of an Aquatic Resources Implementation Monitoring Form for Aerial Treatment of Noxious Weeds with Herbicides that was used in the Bitterroot Noxious Weed Treatment Project. This implementation monitoring is intended to help direct and document attention on the need to take actions to avoid drift and transport of herbicides to surface waters.

- 3-33 26. Thank you for including discussion and analysis of human health effects associated with proposed weed treatments (beginning on page 4-61). For improved public understanding and disclosure we recommend that the herbicide specimen labels, material safety data sheets (MSDS sheets) be included in FEIS Appendices.

- 3-34 27. Please be aware that certain pest control activities described in the DEIS may fall under EPA's Worker Protection Standard (WPS) if, (1) the U.S. Forest Service is the "employer" in control of the "operation" and the operation involves or is related to commercial production of timber or timber products, (2) the U.S. Forest Service is using WPS-labeled pesticides, and (3) the pesticide applications in question are related to the production of timber/timber products and they are not covered by one of the applicable

exceptions or exemptions. If you have any questions regarding WPS or its applicability please contact either David Rise in the Helena EPA office at (406) 457-5012 or Jaslyn Dobrahner in the Denver EPA office at (303) 312-6252.

28. The DEIS discusses effects to threatened and endangered wildlife (Grizzly Bear, Gray Wolf, Canada Lynx, and Bald Eagle, pages 3-25 – 3-28). However, Appendix F indicates that the Biological Assessment (BA) will be prepared for the selected alternative which will be selected after comments from the DEIS are received and reviewed. We believe the draft and final EIS should include the Biological Assessment, and the final EIS should include the associated FWS Biological Opinion or formal concurrence for the following reasons:

3-36

- (1) NEPA requires public involvement and full disclosure of all issues upon which a decision is to be made;
- (2) The CEQ Regulations for Implementing the Procedural Provisions of NEPA strongly encourage the integration of NEPA requirements with other environmental review and consultation requirements so that all such procedures run concurrently rather than consecutively (40 CFR 1500.2(c) and 1502.25); and
- (3) The Endangered Species Act (ESA) consultation process can result in the identification of reasonable and prudent alternatives to preclude jeopardy, and mandated reasonable and prudent measures to reduce incidental take. These can affect project implementation.

Since the Biological Assessment and EIS must evaluate the potential impacts on listed species, they can jointly assist in analyzing the effectiveness of alternatives and mitigation measures. EPA recommends that the final EIS and Record of Decision not be completed prior to the completion of ESA consultation. If the consultation process is treated as a separate process, the Agencies risk USFWS identification of additional significant impacts, new mitigation measures, or changes to the preferred alternative. If these changes have not been evaluated in the final EIS, a supplement to the EIS would be warranted.

3-36

We also note that the DEIS discussing threatened/endangered terrestrial wildlife species does not mention threatened/endangered plants, fish, or insects. If no other endangered or threatened species exist within or downstream of Gallatin National Forest Boundaries, EPA suggests including a sentence stating this. Otherwise, a review of the risks to all endangered/threatened species must be provided. For example, Ute Ladies-Tresses may exist in Gallatin County, but not within Forest boundaries.

3-36

From Bitterroot N.F. Noxious Weed Treatment Project EIS

Aquatic Resources Implementation Monitoring Form for Aerial Treatment of Noxious Weeds with Herbicides

Project Name _____ Date ____/____/____

Herbicide Applied _____ Drainage _____

Monitoring Crew _____

Start Time _____ End Time _____

Range of wind speeds and direction:

Time	Wind speed	Direction

(Attach map noting treatment area, buffers, drift card and water sample location)

SAMPLING DESIGN	Yes	No	
Are there aquatic "sensitive areas" in the project area?			
If so, were they flagged for avoidance?			
Buffer used _____ ft (see mitigation measures for minimum buffer widths)			
Were drift cards set along the perimeter of the treatment area?			
Were drift cards set inside the buffer?			Spacing _____
Were drift cards set inside the treatment area?			
Water samples taken before and following aerial application? ¹			GPS Location N W
RESULTS			
Did drift cards set along the perimeter of the treatment area detect any herbicide?			Amount _____
Did drift cards set inside the buffer detect any herbicide?			Amount _____
Did drift cards set inside the treatment area detect any herbicide?			Amount _____
How far was spraying equipment from surface water, wetlands or other aquatic sensitive areas?			

¹ Water samples would be collected before spraying and immediately after spraying. Laboratory analysis, by an independent lab, would test these water samples for herbicides whenever there is reason to suspect that herbicide may have entered the stream during the spraying operation (such as herbicides detected on drift cards, or if a spill occurred). Water samples would also be collected after the first substantial rain to detect herbicides that could possibly enter surface water through leaching or runoff. These water samples will be collected from the closest fish-bearing streams immediately downstream of the treatment area. This form does not track the post-rain samples.

Droplet deposition will be monitored using white plastic (Kromekote) spray cards positioned along the perimeter of the treatment area and inside the buffer around the sensitive areas (streams, wetlands). The herbicide will be lightly dyed with food coloring to produce a distinctive droplet stain when drops of herbicide contact the cards. The number of droplets on each card will be counted in the field immediately after spraying. Reexamination of the cards will occur in the office and the samples will be converted to a estimate of the application rate.

The first three aerial herbicide applications of each field season will be monitored. If all buffers and monitoring is implemented, and no drift into buffers is observed, monitoring will be reduced to monitoring drift at one of every three sites.

Table F-3: Spray Conditions—FSCBG Model Inputs for Bell 47 Soloy

Release Height	10 and 25 feet above ground
Operating Speed	50 mph
Formulation	Tordon/Picloram
Application Rate	2 gal/acre
Swath Width	45 feet
Temperature	70 deg. F.
Relative Humidity	60%
Wind Speed	6mph
Nozzle Vertical Distance	-8.07 feet
Nozzle Type and Orientation	D8 Jet/45 degrees
Number of Nozzles	16
Rotor Diameter	37.17 feet
Nozzles	Evenly spaced over 100% of the boom
Wind Directions	Crosswind, 45 degrees and 85 degrees (where the direction of a north wind is 0 degrees)

The entire modeling report is on file at the Lolo NF. Modeling runs clearly demonstrate that:

- Most of the spray is deposited in the treatment block regardless of wind direction
- Direction of off-target deposition can be managed by monitoring the winds and conducting spray operations under conditions that will carry the spray away from the sensitive areas and into the spray block.
- Even when spraying under a crosswind and directions of 45 and 85 degrees, there would be essentially no deposition in the sensitive areas with a buffer of 300 feet. However, there would be no applications in these crosswind situations.

TABLE 2-27
Environmental Protection Measures

Buffers	Alternatives
Ground application of herbicides will not occur within 25 feet of sensitive plants	B, E
Ground application of herbicides will not occur within 25 feet of culturally sensitive resources.	B, E
Ground-based spot applications of herbicides would be authorized for use to within 15 feet of surface water. Herbicides approved for streamside applications (2,4-D, glyphosate and triclopyr) would be used near live water or in areas with shallow water tables.	A, B, E
Herbicides approved for streamside applications would be used within 15 feet of live water or in areas with shallow water tables.	A, B, E
Aircraft will avoid known active raptor nests by 0.25 mile between March 15 and August 31	A, E
Aircraft will avoid peregrine eyries by 1 mile.	A, E
The Forest botanist will be consulted when aerial spraying occurs near sensitive plants. Plants that are susceptible to the herbicide in use will be covered with a tarp	E
Aerial application of herbicides will not occur within 100 feet of a dry intermittent stream unless monitoring of drift card data indicates a small buffer is appropriate (Intermittent streams have a definable channel and bed throughout their length).	E
Aerial application of herbicides will not occur within 300 feet of live water until drift card monitoring shows what buffer width is adequate to keep herbicides out of streams. In no case will aerial application of herbicides occur within 150 feet of live water.	E
Aerial application of herbicides would not be performed within 100 feet of live water or within 50 feet of sensitive resources or special status plants.	A
General	Alternatives
Weed treatments would only be applied where weed populations actually exist. None of the alternatives propose blanket treatment of areas where no weeds are present.	A, B, C, E
All invasive weed treatments would be in accordance with local, state, and federal regulations.	A, B, C, E
Equipment used in off-road operations for Forest management activities would be properly cleaned prior to entering Forest land.	A, B, C, E
Areas with bare soil and areas proposed for cultural treatment would be monitored to assess need for revegetation.	A, B, C, E
Certified weed-free seed would be required for revegetation. Revegetation would be considered for any site within the treatment area with soil disturbance or vegetative density low enough to allow re-infestation or introduction of other invasive weeds and/or to control erosion.	A, B, C, E
Revegetation seed mixes would be designed on a site-specific basis to consider objectives and conditions at each potential revegetation site. Native species would be used in some seed mixes as appropriate. All plant species used on the Forest would comply with Region One USFS policy regarding source and type of plant materials used in seeding projects.	A, B, C, E
The Forest would convene an interdisciplinary team annually to evaluate the program of work prior to implementation of the Project. The team would consist of appropriate specialists for the respective resource(s).	A, B, C, E
New invaders, as identified by local and state agencies, within and adjacent to the treatment sites would be given high priority for treatment.	A, B, C, E
Grazing may be deferred after weed treatment by working with permittees to adjust their annual operations plan as needed based on site-specific conditions.	B, E
Biological Agents	Alternatives
Biological agents would not be released until screened for host specificity and approved by the USDA Animal Plant Health Inspection Service.	A, B, C, E
Notification	Alternatives
Traffic control and signing during weed-treatment operations would be used as necessary to ensure safety of workers and the public.	A, B, C, E
Signs regarding herbicide use would be placed at access points to treatment areas prior to initiating treatment. Signs would list herbicides to be used, effective dates, and name and phone number of Forest contact.	A, B, E
The public would be notified of herbicide use by using a combination of news releases, and maintaining a current telephone hot line and web page during the application season. Colored dye would be used with all herbicide applications.	B, E
Sensitive Plants	Alternatives
Weed treatments would be coordinated with the Forest botanist. Site-specific treatment prescriptions (e.g., covering with tarps or applications of herbicide in the fall) would be followed for infestations within or adjacent to known special status plant populations as directed by the Forest Botanist.	A, B, E
Water Quality	Alternatives
Land types in treatment areas identified as having a high water table would be field-checked; treatment methods would be modified based on ground conditions (see map in project file).	B, E
In buffers, weed treatment would be by individual plants (e.g., hand-pulling, hand-spray, wipe-on, or carpet roller).	B, E
Mixing and loading of tanks will occur 300 feet from live water where possible. In no case will it occur closer than 150 feet of live water.	A, B, E
Fish	Alternatives
Forest fisheries biologist would review and coordinate spray projects with the District/Forest weed coordinator to map and identify buffers, methods of application, and necessary herbicide restrictions.	A, B, E

Wildlife	Alternatives
Forest wildlife biologist would review and coordinate spray projects with the District/Forest weed coordinator to map and identify buffers, methods of application, and necessary herbicide restrictions which may be pertinent to the respective project.	A, B, E
Areas with known active raptor nests, including northern goshawk, red-tailed hawk, peregrine falcon, prairie falcon, golden eagle, Boreal owl, Great Gray owl, and flammulated owl, would be avoided.	A, B, E
Herbicide applications between May 1 and June 15 would be coordinated with the Forest wildlife biologist to ensure that potential big horn sheep and elk calving areas are protected from excessive disturbance.	B, E
Heritage Resources	Alternatives
Weed treatments would be coordinated with the Forest heritage resource specialist to protect heritage resources such as traditional plant gathering areas, pictographs, and wooden structures.	A, B, C, E
Herbicide Use	Alternatives
The state-certified applicator would obtain a current weather forecast for the treatment area prior to applying herbicides. Weather conditions will be monitored so that applications comply with label recommendations for wind, temperature, and humidity.	A, B, E
Application of 2,4-D will be limited to areas where picloram and clopyralid are restricted by label because of sandy soils or relatively high water tables.	B, E
No more than one application of picloram would occur on a given area in a calendar year to reduce potential for accumulation in soil, except as needed to pick up skips.	A, B, E
Equipment used for transportation, storage, or application of herbicides would be maintained in leak-proof condition.	A, B, E
Herbicides would be used in accordance with federal label instructions and restrictions.	A, B, E
Where woody vegetation is the dominant cover, herbicide treatments would be designed to minimize damage to non-target species such as woody vegetation.	B, E
Ground-spray application of herbicides would occur only when the wind speed is less than 10 mph and blowing away from sensitive areas.	B, E
A pre-operations briefing would be required and documented to brief spray personnel on the location of sensitive resources (streams, lakes, wetlands, sensitive plants) and to review operational details.	B, E
Total treatment with herbicide under this EIS will be about 5,000 acres annually.	B, E
No spraying would be performed if precipitation is occurring or imminent.	A, B, E
No spraying would occur if air turbulence is sufficient to affect normal spray pattern.	A, B, E
No spray if snow or ice covers target foliage.	A, B, E
Herbicides would not be applied directly into streams, springs, rivers, ponds, lakes, or wetlands. Mixing and loading operations would occur in areas where accidental spills would not contaminate a stream or body of water before being contained.	A, B, E
Applicators would have an Herbicide Emergency Spill Response Plan (Appendix B) on-site during treatments. The plan would identify methods to report and clean up accidental spills. An emergency response spill kit containing clean-up equipment and materials would also be required on-site (or within spraying vehicles).	A, B, E
Sample areas would be monitored before and after treatment to determine effectiveness of treatments on target species.	A, B, E
Herbicide applications would be coordinated with adjacent landowners and individual range permittees in each project area as applicable.	A, B, E
Herbicides would be handled in accordance with the spill plan.	A, B, E
Application of herbicides would be performed by or directly supervised by a state-certified applicator.	A, B, E
Spray equipment would be calibrated prior to seasonal start-up and periodically throughout the season.	A, B, E
Herbicides would generally be applied one time per year; two times at least 30 days apart would be the maximum application.	B, E
Aerial Spray	Alternatives
Information and experience gained from each aerial treatment would be used to improve methodology for future applications. This adaptive approach would improve effectiveness and reduce impacts of future projects.	A, E
Adjacent landowners and affected permittees would be notified by letter at least 24 hours in advance of planned aerial herbicide treatments.	A, E
On-site wind monitoring devices (e.g., smoke bombs) would be deployed prior to aerial applications of herbicides.	A, E
Aerial application of herbicides would be performed when wind speeds are less than 6 mph and blowing away from sensitive areas.	A, E
Aerial herbicide application would be approximately 1,000 acres the first year and about 3,000 acres annually thereafter.	E
Buffers would be adjusted based on monitoring results. Drift cards will be analyzed, and if drift analysis indicates that the buffers are overly conservative, they would be reduced.	E
Aerial spray would not occur in advance of a predicted inversion.	E
Weather conditions would be monitored on-site (temperature, humidity, wind speed/direction), and spot forecasts would be reviewed for adverse weather conditions before aerial spraying occurs.	E
Areas to be aerial sprayed would be marked so that the boundaries and buffers are visible from the air.	E
Aircraft used for aerial spraying would use a global positioning system.	E
Drift reduction agents and nozzles that create large droplets would be used for aerial spraying.	E
Temporary area and road closures would be used to ensure public safety during aerial spray operations.	E

Monitoring

A strong monitoring program would be incorporated as part of the adaptive management approach. Monitoring is the collection of data to determine effectiveness of management actions in meeting prescribed objectives. Monitoring would focus on the: 1) density and rate of spread of invasive exotic plant species and the effect these aggressive plants have on natural resources, 2) effect of herbicides on noxious weeds and desirable vegetation, 3) effectiveness of biological control agents, 4) effect of cultural weed management activities, and 5) effects of herbicides on surface water quality. An *Aquatic Resources Implementation Monitoring Form* has been developed by the Forest and is included in **Appendix A**.

Citizen Monitoring: Under Alternatives B, C, and E, a citizen monitoring team would be established and invited to participate in monitoring weed treatment projects. They would be asked to review project implementation and monitoring data.

Drift Detection: Under Alternatives A and E, the first three aerial herbicide applications of each field season adjacent to sensitive resources (streams, lakes, wetlands, sensitive plants) would be monitored to determine the amount and distribution of spray drift. Spray detection cards (Kromekote) would be placed along the perimeter of the treatment area and inside the buffer around sensitive areas. The herbicide would be dyed with food coloring to produce a distinctive droplet stain when drops of herbicide contact the cards. The cards would be visually examined immediately after spraying. Reexamination of the cards would occur by an independent lab and the samples would be converted to an estimate of the drift quantity. The drift monitoring form will be used to document monitoring results on each spray block. Under Alternative E, the results of drift card and water quality monitoring would be used to adjust buffer widths on future aerial spray blocks.

Water Quality: Under Alternatives B and E, the Project hydrologist or fish biologist would review the annual program of work and select sensitive water resources (streams, lakes, wetlands) to

monitor. Water samples would be collected before spraying and immediately after spraying. Laboratory analysis, by an independent lab, would test these water samples for herbicides whenever there is reason to suspect that herbicide may have entered the stream during the spraying operation (such as herbicides detected on drift cards, or if a spill occurred). Water samples would also be collected after the first substantial rain to detect herbicides that could possibly enter surface water through leaching or runoff. These water samples will be collected from the closest fish-bearing streams immediately downstream of the treatment area.

Vegetation: Under Alternatives B, C, and E, vegetation plots would be established prior to treatment in a representative sample of all treatment methods to determine species composition, frequency, and cover. The plots would be remeasured at one, three, and five years after treatment.

Sensitive Plants: In Alternatives B and E, sensitive plant populations would be inventoried prior to weed treatment and a follow-up inventory would be conducted post-treatment to identify and document non-target damage. Monitoring plots may be established to coincide with vegetation monitoring. The combination of inventory results and drift card data would be used to adjust buffer widths on sensitive plant populations.

Heritage Resources: In Alternatives B and E, vegetation resources with cultural significance (peeled trees, cultural plant collection areas) would be inventoried prior to weed treatment and a follow-up inventory would be conducted post-treatment to identify and document non-target damage. The combination of inventory results and drift card data would be used to adjust buffer widths on heritage plant populations.

Soils: Under Alternatives B and E, vegetation would be used to gauge soil condition. The project soil scientist would use the vegetation plot data, visual observation, and photo points to evaluate changes in soil productivity and erosion on selected treatment blocks.

Evaluation: Under all alternatives, the noxious weed treatment program would be evaluated and results made public.

Appendix F—Aerial Spray Recommendations and Mitigation Measures

The treatment block should be marked with flagging to mark the block corners or clearly described and reviewed with applicator. It would be desirable to have a GPS system on board to record helicopter swaths, position, and boom on and off times and location.

In canyon areas, winds should follow the typical diurnal pattern of upslope during the day and down slope during the night. Canyon winds are those that move up or down the canyon; slope winds are those that move up or down the slope. These diurnal winds result from heating and cooling of the surface. Clear skies with solar radiation reaching the surface during the day cause up canyon and upslope winds. Cooling that occurs after sunset generates upslope or drainage winds. Given that waterways/riparian areas are often located in the bottom of canyon areas, it is essential to avoid drift down canyon and downslope. Down canyon and downslope winds will likely occur on clear days following daytime hours. To prevent spray from drifting down canyon/downslope, winds should be up canyon and upslope. This can be attained by taking the following steps:

- Spray in the morning when up canyon and upslope winds are well established and blowing up canyon. The specific time will need to be determined by real-time weather monitoring.
- Maintain boom pressure at less than 40psi.
- Monitor spray pressure during flight, since changes in pressure can change the application rates and may change the drop size.
- Check nozzles and review calibration with pilot.
- Begin the first swath 300 feet from any sensitive area.
- Mark boundaries so they are clearly understood by the pilot.
- Monitor treatment boundaries next to sensitive areas with spray deposit cards to detect any possible drift.
- Monitor and record weather in the area. The weather should be monitored in real time for operational control and to help with the post-spray analysis.
- Conduct Forest Service Cramer-Barry-Grim (FSCBG) or AgDRIFT computer models to evaluate drift potential and to develop operational and drift mitigation measures.

FSCBG Spray Dispersion Model Predictions

FSCBG model predictions were conducted by Pat Skyler, FPM Pesticide Application Group, Davis, CA to assist in developing aerial spray strategies for proposed herbicide

Appendix F

applications to control noxious weeds on the Lolo National Forest. The predictions can be used to do the following:

- Plan operational methodologies.
- Determine size of buffer strips to prevent or minimize sensitive area contamination
- Decide under which wind and other atmospheric conditions to conduct aerial spraying

Three commonly used aircrafts in Western Montana are the: Bell 47 Soloy, Bell 206BIII, and Hiller 12E. Table F-1, 2, and 3 lists the FSCBG model inputs.

Table F-1: Spray Conditions—FSCBG Model Inputs for Hiller 12E

Release Height	10 and 25 feet above ground
Operating Speed	40 mph
Formulation	Tordon/Picloram
Application Rate	2 gal/acre
Swath Width	40 feet
Temperature	70 deg. F.
Relative Humidity	60%
Wind Speed	6mph
Nozzle Vertical Distance	-8.70 feet
Nozzle Type and Orientation	CP/0 degrees
Number of Nozzles	29
Rotor Diameter	35.43 feet
Nozzles	Evenly spaced over 100% of the boom
Wind Directions	Crosswind, 45 degrees and 85 degrees (where the direction of a north wind is 0 degrees)

Table F-2: Spray Conditions—FSCBG Model Inputs for Bell 206BIII

Release Height	10 and 25 feet above ground
Operating Speed	80 mph
Formulation	Tordon/Picloram
Application Rate	2 gal/acre
Swath Width	45 feet
Temperature	70 deg. F.
Relative Humidity	60%
Wind Speed	6mph
Nozzle Vertical Distance	-9.01 feet
Nozzle Type and Orientation	TeeJet D4-46/0 degrees
Number of Nozzles	35
Rotor Diameter	33.37 feet
Nozzles	Evenly spaced over 100% of the boom
Wind Directions	Crosswind, 45 degrees and 85 degrees (where the direction of a north wind is 0 degrees)

TABLE 4-5
Effects of Each of the 12 Herbicides and Phase Surfactant

Herbicide	Carcinogen (Cancer)	Teratogen (Birth Defects)	Mutagen (Genetic Damage)	Reproductive Inhibitor	Skin Irritant	Eye Irritant	Bio-Accumulate	Toxicity To Birds	Toxicity To Bees	Toxicity To Mammals	Target Plants
Picloram	No	No	No	No	Mild	Moderate	No	Almost non-toxic	Relatively non-toxic	Low	Broadleaf plants, brush, conifers and broadleaf trees
2,4-D	Not tumor causing; kidney damage at low doses	No	No	No	Mild to Moderate	Corrosive	No	Non to moderate based on form	Relatively non-toxic	Moderate	Broadleaf weeds, grasses and other monocots, woody plants, aquatic weeds, and non-flowering plants
Dicamba	No	No	No	Little to No	Mild	Corrosive	No	Non-toxic	Non-toxic	Slight	Broadleaf weeds, brush and vines
Metsulfuron methyl	No	No	No	No	Moderate	Moderate	No	Non-toxic	Non-toxic	Non-toxic	Brush and woody plants, annual and perennial broadleaf weeds, and annual grassy weeds
Glyphosate	Not enough information to determine	No	No	No	Mild	Mild to Moderate	No	Non-toxic	Non-toxic	Non-toxic	Grasses, herbaceous plants, brush, some broadleaf trees and shrubs, and some conifers.
Hexazinone	No	No	No	No	Mild	Corrosive	No	Non-toxic	Relatively non-toxic	Non-toxic	Broadleaf weeds, grasses, and woody plants
Sulfometuron methyl	No	No	No	Observed at maternally toxic doses	Mild	Moderate	No	Slight	No Info Available	Slight	Grasses and broadleaf weeds
Triclopyr	No	No	Not enough information to determine	No	Mild to Moderate	Mild to Moderate	No	Very Low	Non-toxic	Slight	Woody plants and broadleaf weeds
Clopyralid methyl	No	No	No	No	Mild	Moderate	No	Low	Non-toxic	Low	Brush and weed species, broadleaf plants, thistle
Chlorsulfuron	No	No	No	No	Mild	Moderate	No	Non-toxic	Non-toxic	Non-toxic	Broadleaf weeds and some annual grass weeds
Imazapic	No	No	No	No	Non-irritating	Non-irritating	No	Non-toxic	Non-toxic	Non-toxic	Annual and perennial broadleaves and grasses
Phase (Surfactant)	Not listed by NTP, IARP, or ACGIH	Unknown	Unknown	Unknown	Yes, from MSDS	Yes, from MSDS	Unknown	Unknown	Unknown	Specific levels unknown	Used as an additive/surfactant in herbicide formulations
Imazapyr	Not enough information to determine	No	No	Not enough information to determine	Moderate	Moderate	No	Non-toxic	Low	Non-toxic	Grass and broadleaved weeds, brush, vines, many deciduous trees

exposed to glyphosate, and possibly other herbicides, would cause a slight decrease in soil water infiltration and nutrient cycling until the earthworm population recovers. Overall, herbicide applications would increase soil quality by controlling weeds and minimizing the negative effects of weeds (Lacey et al., 1989; Olson (a), 1999; Olson and Kelsey, 1997). **Table 4-3** lists solubility potential for mobility and half-life of herbicides proposed for use.

Application Method

Aerial application of herbicide (in Alternative A only) would not have impacts on soils beyond the effects of the herbicide. The use of motorized vehicles for ground application of herbicides would result in a minor amount of soil compaction and erosion if vehicles were used in off-road areas for follow-up application on aerial units.

Biocontrol

Biological control agents are not expected to have any negative effect on soil quality since these herbivorous insects have a high degree of host specificity and would not be expected to target beneficial, native vegetation. Biological control agents would provide the benefit of weed control without the potential for changes to soil biota communities.

Grazing

High-intensity, short-duration grazing would occur on approximately 1,356 acres and would

cause a degree of soil compaction that is proportional to the intensity and duration of grazing.

Handpulling

Incidental handpulling of weeds would result in minor soil disturbance where weeds are pulled. This would be outweighed by the benefit of removing the weeds as spread to other areas would be reduced and desirable vegetation would have the chance to reestablish, thereby protecting the soil against erosion.

ALTERNATIVE A

This Alternative would provide control of weed infestations in previously untreated, difficult to access areas. Effective treatment of weeds would reduce the negative impacts of weeds on soil quality (Lacey et al. 1989; Olson (a) 1999; Olson and Kelsey 1997). Herbicide use would have minor and short-term negative impacts on soil productivity. Aerial application would have no ground disturbing effect. Ground application, grazing, and handpulling would have minor soil disturbing or compacting effects. These effects would not be considered detrimental soil disturbance, as they would occur on relatively small areas that would subsequently support desirable plant species. Minor, short-term negative effects would be greatly outweighed by beneficial, long-term improvements in soil quality and productivity.

TABLE 4-3
General Characteristics of Herbicides to be Used

Herbicide	Solubility (ppm)	Potential For Mobility	Half Life (Days)
Chlorsulfuron	300 (pH 5), 7,000 (pH 7)	High (increases with pH)	30 to 120
Clopyralid methyl	1,000	High	15 to 287
Dicamba	500,000 ~~4,500~~	High	7 to 42
Glyphosate	12,000 to 900,000	Low	3 days - several years
Hexazinone	33,000	High in soil, low in leaf litter	30 to 180
Imazapic	2,200	Moderate (increases with pH)	31 to 233
Imazapyr	11,272	Moderate to high	Several months
Metsulfuron methyl	1,750 (pH 5.4), 9,500 (pH 7)	High (increases with pH)	14 to 180
Picloram	430	High (increases with pH)	20 to 300
Sulfometuron methyl	10 (pH 5), 300 (pH 7)	Low (increases with pH)	30
2, 4-D	890 to 800,000	High	30 or less
Triclopyr	23 to 2,100,000	Moderate	30 to 46

Draft EIS

A Rapid Bioassay for the Detection of Photosynthesis Inhibitors in Water

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A modified leaf disc buoyancy procedure for the detection of photosynthesis-inhibiting residues in water is described. The modifications proposed, mainly the presence of sodium hydrogen carbonate in the infiltration solution, increased the sensitivity of the method and reduced the time required. The substituted urea and 1,3,5-triazine herbicides diuron, linuron, monuron, atrazine, ametryn and atraton were detected below $0.7 \text{ mg litre}^{-1}$ using cucumber (*Cucumis sativus* L., cv. 'Dalia') leaf discs. A concentration as low as $0.09 \text{ mg diuron litre}^{-1}$ could be detected. Although bean (*Phaseolus vulgaris* L., cv. 'Bulgarian') leaf tissue was less sensitive in this bioassay than cucumber, $0.3 \text{ mg diuron litre}^{-1}$ could still be detected. The test, being very rapid (less than 30 min per determination) and relatively sensitive, could be used for the detection of photosynthesis inhibitors in recycled water used for irrigation.

1. Introduction

The use of waste water for irrigation in arid and semi-arid regions is an attractive disposal technique from both the economic and ecological points of view. Treating effluents to a high quality standard is usually costly and requires advanced technology; therefore waste water which has undergone varying levels of treatment is frequently used for irrigation. Residual organic compounds not removed by conventional sewage treatments could be phytotoxic to crops. Some of these chemicals are photosynthesis inhibitors. Assessment of the phytotoxicity of a complex, ill-defined solution can be done only by biological tests.

The bioassay techniques commonly used for the detection of photosynthesis inhibitors in a medium are based on the response of plants grown in the medium. The main drawbacks of many such tests are that they are time-consuming and non-specific and often include the destruction of the test plants. Specific bioassay techniques for photosynthesis inhibitors which have been developed include the use of green algae,¹ the inhibition of specific reactions of isolated chloroplasts,² the measurement of leaf chlorophyll fluorescence,³ and the leaf-disc buoyancy method.^{4,5} As the last technique is simple, rapid, and does not require sophisticated equipment, its adaptation for the detection of photosynthesis inhibitors in recycled water was considered.

The leaf disc buoyancy (LDB) procedures for the detection of photosynthesis inhibitors are based on the ability of photosynthesising leaf discs to float, apparently because of the high oxygen concentration in the leaf tissues. Blocking photosynthesis, either by lack of light, or by the presence of a photosynthesis inhibitor, stops oxygen production and induces disc sinking. The first LDB procedure developed, worked with cotyledon leaf discs only, and required 12-24 h per test.

A later modification of this procedure used infiltration of the leaf discs by the test solutions under vacuum until buoyancy was lost. The sunken discs were exposed to light in a similar medium to that used for infiltration, to which sodium hydrogen carbonate had been added, and the time taken for the discs to float was determined.⁶ This procedure, which worked with true leaves, was used for the identification of triazine-resistant and -susceptible weeds.

The purpose of the present work was to adapt the basic LDB test, as modified by Hensley,⁶ for the rapid detection of photosynthesis inhibitors in recycled water, using cultivated plants as the test species.

2. Experimental methods

Cucumber plants (*Cucumis sativus* L., cv. 'Dalia') were grown in a greenhouse in continuously aerated half-strength Hoagland solution. Bean plants (*Phaseolus vulgaris* L., cv. 'Bulgarian') were also grown in aerated Hoagland solution in a growth chamber at $25 (\pm 1)^{\circ}\text{C}$ and $50 (\pm 5)\%$ relative humidity. A light intensity of 18000 lux ($350 \mu\text{E m}^{-2} \text{ s}^{-1}$) at the plant tops was provided by fluorescent lamps for 13 h per day. Deionised water was added regularly to the culture solutions to replace losses due to transpiration.

Chromatographically pure ($>99\%$) standards of the herbicides diuron, linuron, monuron, atrazine, ametryn and atraton were used in all studies. The recycled water samples were secondary treated effluents of domestic origin from two municipal treatment plants (Qiryat Shmona and Hertzliya) and from an oxidation pond near Nazareth (Tel-Adashim). The characteristics of these effluents, which were used for crop irrigation, were within the limits of conventionally treated secondary effluents [suspended solids $20\text{--}40 \text{ mg litre}^{-1}$, biological oxygen demand (BOD) $15\text{--}35 \text{ mg litre}^{-1}$, chemical oxygen demand (COD) $30\text{--}70 \text{ mg litre}^{-1}$, ammonia-N $15\text{--}35 \text{ mg litre}^{-1}$, phosphorus-P $6\text{--}12 \text{ mg litre}^{-1}$]. In addition, a raw sewage sample (suspended solids 299, BOD 384, COD $599 \text{ mg litre}^{-1}$) from Hertzliya was tested.

Discs (9 mm diam.) were cut from fully expanded, young leaves of both species and transferred to 0.01-M potassium phosphate buffer, pH 7.5, containing 0.1-M sodium hydrogen carbonate, or to the same solution containing a variable concentration of herbicide, or to the sewage effluent samples, containing 0.1-M sodium hydrogen carbonate. Cucumber plants were 6 weeks old and bean plants were 3 weeks old when the leaves were harvested for the experiments. Leaves of the same age and taken from the same position on the plants (second fully expanded leaf) were used in all experiments. The discs were infiltrated under vacuum (25 mmHg) for 5 min (sinking time) in 250-ml Erlenmeyer flasks containing the above solutions. The flask contents were then transferred to 100-ml beakers and kept in the dark for 5 min. The beakers were then exposed to a light source provided by a Philips HPLR, 250-W lamp ($350 \mu\text{E m}^{-2} \text{ s}^{-1}$).

All the treatments were replicated at least four times, each replicate consisting of 20 discs. Each experimental set included a control treatment to which no photosynthesis inhibitor was added. The time required for all the discs to float to the surface of the medium was recorded, and the results were expressed as the ratio between the refloating time in the test solutions and that in the control for each set; this ratio is the retardation index (RI). The higher the RI, the stronger was the inhibition of photosynthesis. Means of all the data were used for calculation of the RI.

3. Results

Leaf discs of both bean and cucumber that were infiltrated under vacuum with 0.01-M potassium phosphate buffer, in the presence of sodium hydrogen carbonate, sank in a few minutes, but resurfaced upon exposure to light. Preliminary experiments showed that the time required for the refloating of bean discs varied within narrow limits (3–7 min), and was affected by the experimental conditions (Table 1). Increasing the infiltration time above 5 min seemed to reduce the time required for resurfacing while the increased time in darkness delayed the refloating of the discs. The time in darkness did not appear to affect the refloating time at a concentration of 12.5-mM sodium hydrogen carbonate (Table 1). The same trend was observed with cucumber leaf discs.

As a preliminary experiment (data not presented) had shown that the immediate transfer of the infiltrated discs to light resulted in a very fast resurfacing, it was necessary to increase the contact time with the herbicides by keeping the samples in darkness. A tendency for an increased refloating time after a longer period in darkness was observed, mainly at the higher concentration of sodium hydrogen carbonate.

Table 1. The relationship between the infiltration time, the dark period, and the refloating time for bean discs

Infiltration time (min)	Time in darkness (min)	Refloating time* (min)	
		100-mM HCO_3^-	12.5-mM HCO_3^-
5	5	3.68 (± 0.10)	5.60 (± 0.22)
	10	3.82 (± 0.15)	6.50 (± 0.25)
	15	5.15 (± 0.22)	6.66 (± 0.25)
10	5	3.90 (± 0.10)	5.43 (± 0.20)
	10	4.25 (± 0.20)	5.96 (± 0.15)
	15	5.03 (± 0.15)	5.46 (± 0.17)
15	5	3.33 (± 0.30)	5.03 (± 0.15)
	10	3.48 (± 0.15)	5.61 (± 0.20)
	15	4.43 (± 0.18)	5.51 (± 0.20)

*Data are the means of four replications with 20 discs per replication.

The need for the hydrogen carbonate ion in the incubation medium was tested over the concentration range of 0–100 mM (Figure 1). In order to ensure that sufficient hydrogen carbonate would be present in the leaf discs at the time of light exposure, and to prevent the anticipated lag period before maximal photosynthesis rate was reached, the hydrogen carbonate must also be present during the infiltration period. With discs of bean leaves, a very strong inhibition of the rate of photosynthesis was observed over the range of 0–12.5-mM sodium hydrogen carbonate; at concentrations higher than 25 mM, the maximal rate was obtained. Although cucumber leaf discs responded well in the presence of 100-mM sodium hydrogen carbonate, a very strong photosynthesis inhibition was observed at 50 mM. Therefore, in order to obtain uniform experimental results, 100-mM sodium hydrogen carbonate was used in all the experiments.

The inhibitory effects of three herbicides from the substituted-urea group on the leaf disc photosynthesis are shown in Table 2. While linuron and monuron behaved in a similar manner,

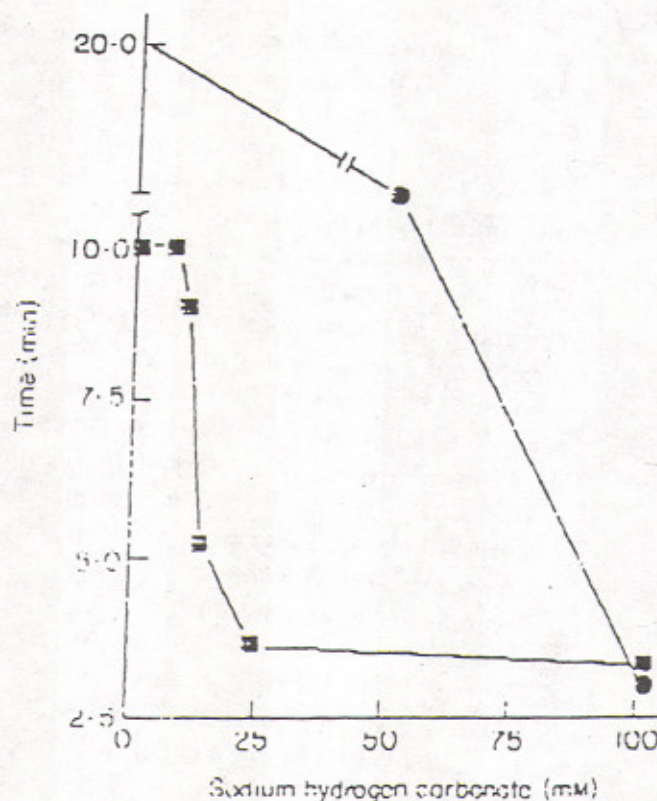


Figure 1. The effect of the sodium hydrogen carbonate concentration in the incubation solution on the refloating time of: (■) bean leaf discs, (●) cucumber leaf discs. Both the infiltration time and the time in darkness were 5 min.

Table 2. The effect of substituted urea herbicides on the retardation index (RI) of cucumber and bean leaf discs

Herbicide	Herbicide concentration (mg litre ⁻¹)	Retardation index*	
		Cucumber leaf discs	Bean leaf discs
Diuron	0.09	1.22 (± 0.02)	NI
	0.30	1.28 (± 0.08)	1.03 (± 0.12)
	0.50	1.70 (± 0.10)	1.06 (± 0.14)
	0.70	3.18 (± 0.28)	1.05 (± 0.02)
	1.00	4.08 (± 0.23)	2.09 (± 0.18)
	1.50	—	2.55 (± 0.08)
Linuron	0.40	NI	NI
	0.50	1.27 (± 0.08)	NI
	0.70	2.22 (± 0.20)	NI
	1.00	3.27 (± 0.17)	1.55 (± 0.20)
	1.50	—	2.55 (± 0.08)
Monuron	0.50	NI	NI
	0.70	1.16 (± 0.06)	NI
	1.00	2.27 (± 0.18)	NI
	1.50	3.25 (± 0.15)	1.19 (± 0.17)
	2.00	—	2.55 (± 0.07)

*Retardation index = (refloating time in medium + herbicide) / (refloating time in medium without herbicide).

NI—no inhibition (RI < 1).

diuron showed a much stronger inhibition, as demonstrated by the higher RI values. Diuron concentration as low as 0.09 mg litre⁻¹ reduced the LDB of cucumber by 22%, while for bean leaf discs at least 0.3 mg litre⁻¹ was needed for even a slight inhibition. Generally, the sensitivity of cucumber was much greater than that of bean. At a concentration of 0.7 mg diuron litre⁻¹, the refloating time was increased more than three-fold with cucumber, while only 65% increase was observed with bean leaf discs. Linuron and monuron inhibited the photosynthesis of cucumber leaf discs only at concentrations of 0.5 mg litre⁻¹ or greater, while with beans the minimum concentration needed to produce an effect was 1 mg litre⁻¹.

Herbicides from the 1,3,5-triazine group were also treated for their inhibitory effect on the LDB of cucumber and bean leaf discs. The results (Table 3) showed that at the lowest concentrations tested, atraton and ametryn inhibited the photosynthesis of cucumber discs, while atrazine had no effect. As with the substituted urea herbicides 0.7 mg litre⁻¹ was the minimum concentration required to cause severe inhibition (RI more than 2) of the photosynthesis of cucumber leaf discs. Bean leaf discs were less sensitive to 1,3,5-triazines than cucumber, the minimum concentrations affecting photosynthesis being 0.7 mg litre⁻¹ for atraton, and 1 mg litre⁻¹ for atrazine or ametryn. Using bean leaf discs, the minimum concentration necessary to induce severe inhibition was 1.5 mg litre⁻¹ for all the 1,3,5-triazine herbicides tested.

Several experiments were carried out using discs cut from leaves of cucumber plants grown in a growth chamber under the conditions described for the growth of the bean plants. These discs seemed to be less sensitive to photosynthesis inhibitors than those cut from plants grown in the greenhouse (data not presented). This difference was reflected more in the magnitude of the response than in the minimum herbicide concentration required for inhibition.

Table 3. The effect of 1,3,5 triazine herbicides on the retardation index (RI) of cucumber and bean leaf discs

Herbicide	Herbicide concentration (mg litre ⁻¹)	Retardation index*	
		Cucumber leaf discs	Bean leaf discs
Atrazine	0.5	NI	NI
	0.7	2.41 (± 0.28)	NI
	1.0	2.50 (± 0.21)	1.07 (± 0.02)
	1.5	—	2.03 (± 0.13)
	—	—	—
Ametryn	0.3	1.29 (± 0.05)	NI
	0.5	1.48 (± 0.04)	NI
	0.7	2.82 (± 0.15)	—
	1.0	4.16 (± 0.32)	1.73 (± 0.11)
	1.5	—	2.59 (± 0.25)
Atraton	0.3	1.20 (± 0.03)	NI
	0.5	1.54 (± 0.04)	NI
	0.7	3.17 (± 0.41)	1.10 (± 0.10)
	1.0	3.32 (± 0.51)	1.09 (± 0.06)
	1.5	—	2.40 (± 0.16)

*Retardation index = (refloating time in medium + herbicide) / (refloating time in medium without herbicide).

NI = no inhibition (RI ≥ 1).

Table 4. The effect of wastewater on the refloating time of cucumber leaf discs

Sample	Refloating time (min)	
	No inhibitor added	Diuron added (1 mg litre ⁻¹)
Buffer solution	2.32 (± 0.03)	>10
Tap water	2.42 (± 0.18)	>10
Treated effluent (Tel-Aviv)	2.15 (± 0.09)	>10
Treated effluent (Oiryat Shimonai)	2.53 (± 0.05)	>10
Treated effluent (Hertzliya pond A)	2.45 (± 0.11)	>10
Treated effluent (Hertzliya pond B)	2.50 (± 0.05)	>10
Raw waste water (Hertzliya)	2.47 (± 0.50)	>10

The suitability of the modified LDB test for the detection of photosynthesis inhibitors in recycled water was also tested. Secondary treated sewage effluents used for irrigation did not affect the refloating time of cucumber leaf discs (Table 4). However, the raw sewage sample tested caused severe photosynthesis inhibition (RI 3.22). In order to determine whether the soluble and suspended components of the sewage effluents interfered with the determination of the presence of photosynthesis inhibitors by the LDB technique, the effluent samples were fortified with 1 mg diuron litre⁻¹. The results obtained (Table 4) show that the sensitivity of cucumber leaf discs to diuron present in sewage effluent samples was similar to that in tap water or buffer solution.

4. Discussion

The present work was aimed to adapt the LDB technique for the detection of photosynthesis inhibiting compounds in recycled water that was to be used for irrigation. Such a procedure must be fast and versatile, sensitive to different known photosynthesis inhibitors, work with cultivated plants, and in experimental conditions close to natural ones. This required several alterations of the existing technique. One of them is the presence of sodium hydrogen carbonate in the infiltration solution, in addition to the medium used for exposure to light. The role of the sodium hydrogen carbonate is to provide carbon dioxide for the photosynthesis process. Carbon dioxide is lost during the infiltration of leaf discs under vacuum, thus delaying the start of photosynthesis after exposure to light. Infiltrating the leaf discs with solutions containing sodium hydrogen carbonate eliminates the lag period caused by the loss of carbon dioxide, so that photosynthesis can start immediately after exposure to light. Consequently, the experimental time decreased; only 3–7 min were needed for all the sunken discs to refloat, following exposure to light in check solutions.

The dark period, the additional step introduced in the experimental procedure between infiltration and exposure to light, delays photosynthesis (an increase of this period from 5 to 15 min increased the refloating time by 30–40%). Hence the most convenient refloating time in check solutions, can be chosen at will. In the present procedure, the experimental dark period was 10 min.

In order to mimic the normal growth conditions of plants, the experiments were carried out at high light intensities, similar to natural light. For the same reason, true leaf tissue from cultivated plants was used in this procedure. The sensitivity of the method was checked for six herbicides, which are known photosynthesis inhibitors. The use of cucumber leaf discs allowed for the detection of each of these herbicides in concentrations of 0.7 mg litre⁻¹.

As expected, the sewage effluents tested, which were successfully used for irrigation, did not inhibit photosynthesis in cucumber leaf discs. Moreover, an added photosynthesis inhibitor was detected by the LDB test without interference from the suspended and soluble components of the effluents (Table 4), thus indicating that this simple and rapid test should be suitable for these conditions.

Acknowledgements

The authors are grateful to Dr Z. Plaut for valuable suggestions and to A. Sela and Rosa Kalmar from the Water Purification Plant, Hertzliya, which provided water samples and analyses.

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United States Department of the Interior

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August 25, 2004

ER 04/519

William R. Queen, District Ranger
ATTN: Susan LaMont
Hebgen Lake Ranger District
USDA Forest Service
PO Box 520
West Yellowstone, Montana 59758

Dear Mr. Queen:

The Department of the Interior (Department) has reviewed the Draft Environmental Impact Statement (DEIS) for the Noxious and Invasive Weed Treatment Project, Gallatin National Forest (Forest) and provides the following comments.

General Comments

We appreciate the Forest's efforts to control noxious and invasive weeds as they often out-compete native vegetation leading to habitat degradation and fragmentation, thereby adversely affecting wildlife. Our concerns related to the proposed project focus primarily on possible effects to species listed under the Endangered Species Act from application of the herbicide.

We recommend that herbicides that have the potential to cause severe dermal irritation, especially eye injury, not be applied aurally. In particular, we are concerned about adverse effects of such exposure to migratory birds, grizzly bears, lynx, and wolves.

We recommend also more detail to the effects of application to Canada lynx. The document notes under Affected Environment, page 3-27, that approximately 9 percent or 1000 acres of known weed infestation occurs in subalpine fir type forests typical of lynx habitat. Most of the infestations occur in clearcuts that are not considered suitable to meet lynx resource needs. Although the clearcuts themselves are not considered suitable, early successional areas can provide a food resource for lynx at their edges in the form of snow shoe hare and other small mammals. Within the clearings, broad treatment and removal of tree seedlings, saplings, low-lying shrubs, especially when treated on a regular basis by mechanical or chemical means, could delay the development of suitable habitat. We recommend that the infestations within areas considered potential lynx habitat be surveyed by a resource specialist and a weed control

4-1

4-2

F-4

treatment selected to retain as many woody plants as possible. The retention of shrub and tree components is covered in the Canada Lynx Conservation Assessment and Strategy (Ruediger et al., 2000) under standards for livestock grazing (page 7-11) and guidelines for timber management (page 7-6).

Specific Comments

4-3 **Summary S-6, Flow Chart.** Moving from Weed Location, "No," to Threatened, Endangered or Sensitive species present, "Yes," the Forest should replace "mitigation" with "further action." If adverse effects are likely, consultation with the Service will be necessary.

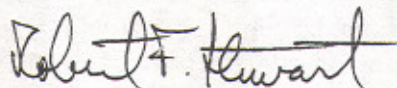
4-4 **Page 4-26.** We recommend avoiding introduction of sheep or goats in grizzly bear areas, especially outside of Management Situation 1 habitat, where conflicts are not necessarily resolved in favor of the grizzly bear. If the use of livestock cannot be avoided, however, then the measures proposed in the DEIS would minimize the possibility of grizzly bear depredation of weed-control livestock.

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4-6 **Page 4-35.** The Montana Bald Eagle Management Plan guidelines for Zone III include use of pesticides in a manner which poses no hazard to eagles. We recommend that aerial or broad cast herbicide spray locations be prohibited within the 2.5 miles of an active bald eagle nest where there are likely eagle foraging areas. This would minimize the possibility of adverse effects due to the "uncertainty regarding toxicity of some herbicides and inert ingredients" as well as minimizing aerial drift and unexpected direct exposure.

Thank you for the opportunity to review this DEIS. If you have any questions regarding this letter, please contact Beth Dickerson, at the U.S. Fish and Wildlife Service Montana Field Office, at (406) 449-5225, extension 223.

Sincerely,



Robert F. Stewart
Regional Environmental Officer

Reference

Ruediger, B., J. Claar, S. Gniadek, B. Holt, L. Lewis, S. Mighton, B. Naney, G. Patton, T. Rinaldi, J. Trick, A. Vandehey, F. Wahl, N. Warren, D. Wenger, and A. Williamson. 2000. Canada lynx conservation assessment and strategy. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Forest Service Publication #R1-00-53, Missoula, Montana. 142 pp.



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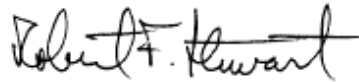
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