Risky Business: Invasive species management on National Forests

A review and summary of needed changes in current plans, policies and programs

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Abstract

Invasive species management on public lands is a complex issue which is currently being approached in a variety of ways. Recent efforts to eradicate weeds on National Forests have been costly and sometimes ineffective. Controversy has erupted over the use of herbicides and their potential for harm to health and the environment. This study critically examines the basis of current plans, policies and programs for managing invasive species on federal public lands, along with a presentation of alternative solutions.

To successfully control invasive species, sound policies must be in place, which require clearly stated, measurable goals and objectives based on an understanding of the biology and ecology of invading species. In responding to invasions on public lands, managers need to shift their approach from short-term reduction efforts to flexible approaches that treat the causes of invasions rather than the symptoms, while placing more emphasis on prevention and monitoring.

Introduction and Background

Plant invasions remain one of the most serious threats to the long-term maintenance of regional biodiversity (Johnson et al., 1994; Clary and Medin, 1990). In the United States, non-native species are suspected of being the highest cause after habitat loss for the listing of all threatened and endangered species (Flather et al., 1994; Wilcove et al., 1998).

Used in this report, invasive species refer to those plant species which are rapidly increasing in an ecosystem without controls on their population growth. The generic term “weeds” is used more loosely for any “undesirable” plants, or “unwanted” vegetation. Invasive plant species may also be referred to here as “noxious weeds” in the legal sense, as species designated for control. The terms “non-indigenous”, “exotic”, or “alien” plants are also used occasionally for species originating outside the area of invasion.

Noxious weeds are spreading on BLM lands at over 2,300 acres per day and on all western public lands at approximately 4,600 acres per day (BLM, 1996). As of 1997, throughout the Pacific Northwest, over 860 exotic plant species have invaded arid and semi-arid lands (Hann et al., 1997). Despite efforts by federal, state, and local activities to combat the spread of invading species, weed epidemics on federal lands continue at alarming rates. Land management agencies are failing to control biological invasions (Bureau of Land Management, 1996) and actions taken by federal management agencies have been ineffective, inappropriate, and lacking in accountability.

Studies in 1940 showed that severe costs, degradation and even destruction of resources have resulted from policies of both non-action and inappropriate action (Cottam and Stewart, 1940). Sixty years later, we continue to deal with the same consequences on increasingly larger areas with invading species. A synopsis of recent conflicts over the management of invasive species on National Forests in the Pacific Northwest is provided in Table 1, below.

Table 1. History of U.S. Forest Service policy with regard to noxious weeds. (Source: Journal of Pesticide Reform. 1992. Beyond Herbicide Wars: Trees, Weeds, and the U.S. Forest Service in the Pacific Northwest. Vol. 12, No. 2 (A publication of Northwest Citizens for Alternatives to Pesticides).

March 1984	Northwest Citizens Against Pesticides, Oregon Environmental Council, and Portland Audubon Society win a sweeping legal victory (*NCAP v. Block*) that stops all herbicide programs on federal forestlands (Region 6 Forest Service and Bureau of Land Management) in Oregon and Washington. Judge James Burns retains jurisdiction in the case, meaning he must approve any EIS written to comply with the law. Soon thereafter, the Forest Service voluntarily curtails all aerial herbicide spraying nationwide on its forestlands.

June 1986	Forest Service decides to ignore its inadequate 1981 Environmental Impact Statement (EIS) and rewrite its entire policy. Over the next 2½ years, many groups and citizens provided extensive input to the development of the new forest vegetation management policy.
December 1988	Northwest Regional Forester James Torrence signs the Record of Decision for the Final EIS, Managing Competing and Unwanted Vegetation. This program sets the vegetation management policy in Oregon and Washington; all site-specific programs proposed in the Northwest will tier to this regional policy. Any proposed action in Region 6 that has the potential for vegetation management activity must comply with the new EIS after this date, including all timber sales.
January 1989	Forest Service petitions the court to lift the spray injunction. The petition is opposed by NCAP. Judge Burns orders the parties (plus Coast Range resident Paul Merrell) to attempt a mediated settlement. Unresolved issues focus on implementation procedures and specific points of fact that were never addressed in the final EIS.
May 1989	All parties to the suit sign a mediated agreement that specifies steps the Forest Service will take in implementing the regional policy. The Forest Service agrees to produce a regional guide for implementing the EIS within six months that includes profiles on 13 herbicides. The court-imposed spray injunction is lifted. Nine other parties file administrative appeals challenging the Regional Forester's decision to adopt the programmatic EIS. The agency issues its own administrative stay on all herbicide use pending agency review of the appeals.
February 1990	Forest Service issues its "Guide to Conducting Vegetation Management Projects in the Pacific Northwest Region", a document required by the mediated agreement.
June 1990	Forest Service dismisses all administrative appeals and lifts its administrative stay on herbicide use.
January 1992	Forest Service issues the first herbicide profile for glyphosate, clearing the way for its use in northwest forests. Thirteen profiles are required by the mediated agreement.

Many of the problems wrought by invasive plant species are a symptom of a larger problem of poor health of the land, brought about by excessive soil disturbance, overgrazing and excessive roads (Belsky and Gelbard, 2000). Models of the spread of invading species resemble that of infectious diseases. For an ecosystem, invading species are the equivalent of disease agents (Mack et al., 2000; Vale, 1982; Hengeveld, 1989; Grime, 1977). Consideration of disease etiology has strong implications for invasive species management, particularly in addressing causes and prevention.

To be effective, policies should be based on an understanding of the biology and ecology of invading species and must place higher priorities on prevention of new introductions and stopping the further spread of invaders (Campbell, 1993). Policies should account for the causes of plant invasions and should take a hard look at curtailing nonessential activities that contribute to invasions.

Successful invasive species management programs must function effectively without compromising the health of soil, water and native species. Policies must be based on sound science and programs must adhere to policy guidelines. Planning documents should provide reasoned analyses of environmental costs and benefits. In the absence of a distinct program aimed at preventing noxious weed spread, inappropriate management may increase the spread of noxious weeds (O'Brien, 1997).

Accountability continues to plague federal land management. The General Accounting Office (2000) recently cited the lack of clearly stated goals and objectives as a significant obstacle for the Forest Service:

> In addition, the Congress could help to expedite the Forest Service becoming more accountable for its performance by requiring the Agency to replace 13 years of promises and false starts with a strategy that includes clear goals and objectives, firm deadlines, and measurable indicators of progress.

Without clearly defined and mandatory objectives to force accountability, federal land managers have no means to assess the effectiveness or appropriateness of the actions they take. When policies provide sufficient direction for programs to operate under, assurances must be given that policy guidelines and regulations will be followed.

This study critically examines the basis of current policies, plans and programs for managing invasive species, along with a presentation of viable alternatives. Policy-makers should consider the formulation of a set of rules to guide invasive species management based on some of these principles.

Discussion topics are divided into chapters and sections in the main document, followed by operating principles and recommended solutions at the end of each section. Throughout the main document, case examples are taken from current programs to illustrate specific points.

Organization of this document

This document provides the background and rationale for recommended changes and improved implementation of objectives, policies and programs dealing with the management of invasive species. Topics are described in detail along with illustrative case examples. Emphasis is placed on describing the effects of herbicides on lands administered by the Forest Service, although in many instances, discussions also apply to pesticides in general and other land ownerships.

In the terminology used here, "invasive species" refer to those species, which are rapidly increasing in an ecosystem without controls on their growth and spread. When invasive species originate from outside the area of invasion, they may also be termed non-indigenous, exotic, or alien. When referring to legally regulated invasive plant species, the term "n*oxious weeds*" is used. The use of the term "*weeds*" or "*weedy species*" is interpreted loosely to refer to a situation where any unwanted plants may occur, e.g., as used in common parlance, "*a plant growing where it is not wanted*".

This document is divided into sections for convenience. Chapter 1, on policies, deals primarily with national and regional plans and policies, and how they interact with programs at all levels. Chapter 2, on disclosure, pertains to required program and project documentation, with particular emphasis on Forest-level projects. Chapter 3, on effects, details specific disclosure and analysis requirements for human and environmental impacts. Chapter 4, on monitoring, deals with accountability and the collection and reporting of information on project outcomes and effects. Chapter 5, on prevention, gives more details of the particular requirements of prevention management approaches. Chapter 6, on education and research, contains a brief discussion of opportunities to improve the future of invasive species management.

Chapter 1. Policies: Policies and plans must be linked to performance measures.

This section provides a discussion of national and regional policies, plans and programs that deal with invasive species. Most of these policies originate at the national level and serve to guide programs through all levels of federal agencies. Federal policies and plans derive from a number of Acts, agencies, and authorities pertaining to invasive species (Invasive Species Council, 2000, Appendix 2). The combination results in a hodge-podge of policies, some of which are only incidentally concerned with invasive species. An urgent need for change in Forest Service policies was stated by Jim Wells of the General Accounting Office (GAO) (2000), during hearings before the House of Representatives on June 29, 2000:

> Comparing the actions that the Forest Service has taken to improve its financial management and reporting with its lack of progress in becoming more accountable for its performance illustrates the low priority that the agency has assigned to providing the Congress and the public with a better understanding of its performance . . .
>
> To provide the Congress and the public with a better understanding of what it accomplishes with appropriated funds, the Forest Service will need to make performance accountability a priority within the agency.

Section A. Policies and plans need clearly defined goals and objectives linked to performance measures.

A large number of international treaties and statutes guide policy for the control of invasive species. Beginning with the Lacey Act in 1900, these statutes were enacted primarily to address specific problem areas, rather than affording a generalized approach to controlling invasions. This system of policies has created a polyglot of different approaches to invasive species problems, gaps in legal authority and potential contradictions in control measures, resulting in programs that are inefficient and ineffective at slowing plant invasions in the United States.

Under Executive Order 13112, February 3, 1999, the importance of goals and objectives in directing invasive species policies was strongly stated:

> Within 18 months after issuance of this order, the Council shall prepare and issue the first edition of a National Invasive Species Management Plan (Management Plan), which shall detail and recommend performance-oriented goals and objectives and specific measures of success for Federal agency efforts concerning invasive species.

Current land management policies, which operate under land protection plans, are subject to many constraints, such as funding. Plans are meant to follow a consistent approach and be available for public review. However, accountability is often skipped. The National Park Service (NPS), the Bureau Of Land Management (BLM) and U.S. Forest Service (Forest Service) are the largest federal land management agencies with responsibilities for protecting public lands from plant invasions. These agencies operate under different sets of regulations and performance standards.

With respect to the Forest Service, the National Forest System Land and Resource Management Planning, 47 FR 43037, Sept. 30, 1982, defines *goal* (in the terms of *project goals*) as:

> A concise statement that describes a desired condition to be achieved sometime in the future. It is normally expressed in broad, general terms and is timeless in that it has no specific date by which it is to be completed. Goal statements form the principal basis from which objectives are developed.

When a project has the potential to cause environmental or public harm, such as the spread of invasive species or use of herbicides, procedural requirements help to insure that documents and the Agencies themselves take this into account. Such projects are typically reviewed through a planning document that discloses the impacts and specifies mitigation measures, subject to judicial recourse if public interests are not met.

For instance, procedural requirements are specified in the National Environmental Policy Act (NEPA), which establishes policy, sets goals (Section 101), and provides means (Section 102) for carrying out policies. Action-forcing provisions insure that federal agencies comply with the procedures and achieve the goals of the Act and achieve the substantive requirements of Section 101. NEPA procedures require that environmental information is available to public officials and citizens before decisions are made and before actions are taken. NEPA directs that federal agencies shall to the fullest extent possible,

> Implement procedures to make the NEPA process more useful to decision-makers and the public . . .

Planning on National Forests is guided by the National Forest System Land and Resource Management Planning (LRMP) regulations (Forest Service, 1999b), which in the latest set of proposed revisions state,

> The set of documents that comprise the land and resource management plan must clearly display the goals, objectives, standards, guidelines, and other decisions made at different geographic and temporal scales that apply to the plan area. . .
>
> . . . goals, objectives, standards, or guidelines in special area plans be incorporated into the land and resource management plans as plan decisions.

In essence, there is to be a clear set of directions established, which drive the management decisions of the agencies. Disclosure requirements, such as those in NEPA, provide a means of assessing whether decisions conform with policy direction at all levels.

Despite such readily available guidance provided by NEPA and the National Forest Management Act (NMFA), there is no specific intent to guide invasive species policies. Consequently, projects on public lands lack the specific and consistent guidance and authority necessary for effective programs.

The GAO (1997b) answered Congressional requests for information on the underlying causes of inefficiency and ineffectiveness in the decision-making process used by the Forest Service in carrying out its mission by stating that, “agreement does not exist on the agency’s long-term strategic goals”. Essentially, there is a lack of consistency within the agency regarding its own mission surrounding public land management. The same problem also exists with regard to its long-term strategic goals for invasive species management.

This lack of consistency has been recognized regionally in the Proposed Decision for the Interior Columbia Basin Ecosystem Management Project (ICBEMP, 2000), which states,

> Uncoordinated efforts throughout the project area have been ineffective against noxious weeds. Noxious weed strategy (ies) need to be consistently implemented project-area wide to reduce the negative impacts of noxious weeds. This objective (B-O11) hinges on a project-area-wide integrated weed management strategy being developed….

Despite clear articulation of the problem, the ICBEMP document falls short of providing specific guidance for the development of the IWM strategy that it calls for.

This failure to provide a coordinated, consistent strategy for managing invasive species permeates all levels of the Forest Service (FS) and Bureau of Land Management (BLM), although the National Park Service has made notable attempts to develop innovative plans. Planning documents lack goals specific to invasive species that would guide the choice of actions toward successful outcomes. Lacking policy direction, program goals are more often described in terms of resource outputs with mitigation prescribed as an after-thought for the control of invasive species. Without clearly defined goals, performance measures, which would be linked to proposed actions, cannot be determined. Performance measures are important because they account for thresholds beyond which proposed actions are unacceptable and must be changed or restricted.

For example, the goals for controlling new invaders might be eradication; for established invaders in Wilderness areas it might be prevention; and for large infestations of established invaders it might be containment, quarantine, or tolerance of a quantity determined by a damage threshold. Each situation should have objectives, methods, and performance measures specific to the goals for the lands involved. Such goals and objectives should relate back to the agency's long-term strategy for stewardship of public lands, and should be disclosed as part of NEPA documentation.

However, existing Forest Plans were only written with loosely defined goals couched in general descriptions of "desired future conditions". These do not provide quantifiable criteria for the presence or management of invasive species. The end result is that Forest Service implementation of programs to control invasive species has resulted in the indiscriminate spraying of herbicides across large landscapes without any measures of program success or fiscal accountability. To date, performance is measured only by acres treated, with no accounting of the effectiveness of the measures or impacts of treatments on other resources.

Invasive species management continues to lag behind other areas of National Forest management in measured performance of programs and project effectiveness. Part of the blame lies with Forest Plans and projects that were written without clear goals, or with ill-defined goals, e.g., "the '*implied*' future condition is to have an absence of any new invader" (Okanogan NF, 1999, p.5).

Unfortunately, the primary goals of Forest Service land management plans operate under the oftentimes conflicting principles of multiple use and sustained yield, which requires managers to provide high levels of six "renewable" resources. The fact that project implementation under the multiple use doctrine guiding Forest Service actions may conflict with regulations under the NFMA or NEPA has been successfully applied in the courts to halt unsound projects. However, ultimately it will be up to the Forest Service to improve its public accountability.

> Almost 3 years later, the Chief of the Forest Service observed that the change in culture had not occurred. In his February 16, 2000, testimony he stated that to restore the agency's credibility with the Congress and the American people, the Forest Service must change its culture, recognizing that it cannot be an effective resource manager if it is not first accountable for taxpayer money and for its own actions on the landscape (GAO, 2000).

To date, there is no single set of goals and objectives which guide Forest Service management of invasive species. In the Forest Service, goals seem to be an afterthought to funding. According to the General Accounting Office (2000):

> To become more accountable for its performance, the Forest Service will need to link its budget and organizational structures as well as its budget allocation criteria, forest plans, and performance measures to its strategic goals, objectives, and strategies. However, the agency is still years away from completing these linkages.

In response to Congressional prodding through the Government Performance and Results Act of 1993 (referred to as the Results Act), the Forest Service Strategic Plan was revised beginning in fiscal year 2000 to address the problems with invasive species. This new plan states some admirable goals and objectives for invasive species, albeit somewhat grudgingly couched in the language of *forest health.*

> Increase the amount of forests and rangelands restored or maintained to a healthy condition with reduced risk and damage from fires, insects and diseases, and invasive species . . . Prevent the spread of invasive species . . . Measure trends in acres at extreme risk from fire, insects, diseases, and invasive species . . . Implement an invasive species detection and monitoring program.

Goals and objectives reflect the political concerns of the time they were enacted. Furthermore, the Forest Service expertise is largely vested in timber management and fire control. Existing invasive species programs in the Forest Service are piggybacked onto existing programs such as timber or range management, and as a consequence they lack a sound decision-making framework. These ad hoc programs skew the legitimacy of goals for invasive species management and sever the links between national policies and performance measures. Goals lack accountable budget targets, rendering some decisions irrational.

Successful management of invasive species is dependent on rational approaches, long-term planning and commitment such as that embodied in Integrated Weed Management (IWM), e.g., Hoglund (1991),

> IWM is a decision-making process, which selects, integrates and implements weed control based on predicted ecological, sociological and economic consequences.

This National Park Service Strategic Plan for 2000-2005 covers all of the National Park Service lands, reflecting its mission to preserve resources and serve the public. All goals are shaped by this mission statement. The Park Service (August, 1996) *Strategic Plan for Managing Invasive Nonnative Plants*, includes strategies for invasive species and also identifies targets within that strategy,

> *Strategy:* Prevent invasion.
> *Target:* Modify National Park Service policy and guidelines to include nonnative plant management issues, as needed.
>
> *Strategy:* Manage invasive non-native plants.
> *Target:* Reduce populations of invasive nonnative plants through an integrated pest management program that incorporates chemical, biological, cultural, and physical (mechanical) operations.

It is important to note that policy objectives should be formulated in terms of control, not blind treatment. The National Park Service states its service-wide goals as measurable outcomes (results), embedding the performance measure into each long-term goal and stating its annual goals in the same way, to show clear and direct relationships between long-term goals and annual goals. Annual goals are simply one-year increments of the long-term goals. For example, the long-term goal for Exotic Species states that by September 30, 2005, exotic (nonnative) vegetation on 6.5% of target acres of parkland is contained (167,000 of 2,656,000 acres). The annual goal for 2001 parallels that long-term goal: By September 30, 2001, exotic vegetation on 1.3% of targeted parkland is contained (33,000 of 2,656,000 acres). The Park Service bases its goals and targets on the appropriations that can reasonably be expected. Goals are directly related to budget requests on a goal-by-goal basis.

Case example: Boulder Creek on the Okanogan NF in Washington

Federal land management agencies have recently prepared a large number of weed control projects, e.g., the Okanogan NF Integrated Weed Management Environmental Assessment (EA) (1997, 1999). These documents do not originate from a set of overall planning goals for managing invasive species. Instead, they are ad hoc measures appended to existing range, timber or other programs (Forest Service, 1988; Mediated Agreement, 1989; Forest Service, 1992) and applied piecemeal by local authorities.

In lieu of appropriate project goals for invasive species management, the Okanogan NF EA cited the *desired future condition* and *historic range of variability* given in the Forest Plans, which are otherwise lacking in the mention of invasive species. Nonetheless the EA claimed that the desired future condition had contained within it an "*implied*" goal which was an, "absence of any new invader noxious weed species" (p. 5). On this basis, the EA then proceeded to build a case for selecting an alternative (p. 6).

> . . . the desired future condition is vegetation with structural diversity . . . wildlife needs would be met by maintaining vegetation within the historic range of variability. . . .

The alternatives proposed different control "*strategies*", which in reality were merely *tactics*. The differences between the alternatives did not involve a choice between a variety of treatments, but merely whether or not to use herbicides. In actuality, no substantive non-chemical measures were described or undertaken, except for some weed pulling by convict crews (a measure not described in the original document).

The document contains considerable detail aimed at demonstrating that all measures except chemical treatments would be ineffective or harmful. Offhand and anecdotal statements were frequently given without citation, e.g., non-chemical methods would allow toxic species to persist; and public health risks from chemical treatments would be remote and limited to dermal contact. The EA presented a biased analysis in which the two rejected alternatives without chemical treatments were made to appear frivolous and harmful to the environment, while the chosen alternative was contrasted favorably by overstating the expected outcome and minimizing or omitting any mention of associated untoward effects (p. 107):

> This [chemical] alternative would improve water quality by controlling noxious weed populations contributing to sedimentation . . . This alternative would improve fish habitat by improving the sediment indicator . . .

The treatment involved spraying non-selective herbicides along 34 roadside areas, each covering many miles. Most of the vegetation along these roads was predominantly native or beneficial non-native vegetation and many miles of roadsides with no weeds at all were also treated. The result was that many miles of roads were unnecessarily denuded or defoliated.

The projected benefits of the control program were not borne out by actual outcomes; e.g., the herbicides actually damaged beneficial native vegetation and denuded roadsides and streambanks, causing increased erosion. But, from the flawed analysis given in the EA, the chemically oriented alternative was made to appear to be the safest and most effective. Despite public sentiment against the project, a large Congressional appropriation given without constraints to this Forest appears to have been the hidden agenda that guided approval of the flawed EA.

In examination of this and similar Forest Service projects, an obvious flaw is the failure to clearly state goals and objectives required prior to making a decision. Had destruction of miles of native vegetation been a project goal, then the project could have been deemed successful.

It is true that some weed infestations were temporarily reduced in this operation, but non-target vegetation was reduced even more; spray trajectories left resistant weeds unharmed while reaching far beyond the roadsides into native communities. Long-term goals did not indicate whether re-infestation from soil seed banks and migration (Lajeunesse, 1997) would be within the range of effective control given the extremely large amount of areas treated and high budget costs of the 1997 program ($300,000, which did not cover monitoring expenses). Thus, there is little assurance that the so-called goal,“absence of any new invader noxious weed species”, is realistic.

Solutions

- Formulate policies and plans with clearly defined goals and objectives.
- Incorporate performance measures into policies and plans.
- Formulate policies based on rational approaches and sound biological principles that are not constrained by management infrastructure.
- Formulate policies specific to invasive species management.
- Formulate policies that manage invasive species over long terms.
- Formulate policy objectives in terms of control, not treatment.
- Formulate policies based on a statement of general governing principles for invasive species management that recognizes their pervasive effects and the great deal of harm that has come from inappropriate measures.

Plans need a sound, consistent framework for making decisions.

Efforts to successfully control plant invasions do not always follow a consistent or rational approach; these efforts are most likely to fail (Hobbs and Humphries, 1994).

Testifying before the U.S. House of Representatives on the Forest Service’s approach to making decisions, Barry T. Hill, Associate Director, Energy, Resources, and Science Issues, Resources, Community, and Economic Development Division, GAO (1997) stated:

> Our report on the Forest Service’s decision-making identifies an organizational culture of indifference toward accountability. The agency’s historically decentralized management and recently increased flexibility in fiscal decision-making have not been accompanied by sufficient accountability for expenditures and performance. As a result, inefficiency and waste have cost taxpayers hundreds of millions of dollars, and opportunities for both ecological and economic gains have been lost through indecision and delay. Past efforts by the Forest Service to change its behavior have not been successful. Decision-making within the agency is broken and in need of repair.

The GAO also recommended specific recommendations for improving Forest Service decision-making (GAO, 1997b):

> GAO recommends that the Chair of the Council on Environmental Quality change the Council’s regulations for implementing the National Environmental Policy Act to require, rather than merely allow, federal agencies to tier plans and projects to broader-scoped studies.

It is useful to use National Park Service planning efforts as a yardstick for agency progress in developing plans for invasive species control. Hiebert and Stubbendieck (1993) explained the need for an analytical decision-making approach to invasive species management, which was aimed primarily at the National Park Service, but which applies equally well to other land management agencies:

> Several sound reasons exist for using an analytical approach as the basis of prioritizing exotic species. One of the basic reasons for using a decision analysis process is to get scientists involved in the decision-making process. . . .
>
> . . . If an analytical approach was not employed, decisions would most likely be based on the opinion of an individual or a group of individuals or decisions would be based on precedent. Granted, many field ecologists have a good idea of which exotic species are impacting natural ecosystem processes or impacting species composition. However, decisions based on judgment alone are rarely based on defined criteria, do not usually document the reasoning processes, and give no assurance that the full array of significant factors was considered. Such decisions may suffer from personal biases and political whims. Decisions are hard to defend if challenged, and proposals for funding are hard to justify. Decisions based on precedent may be easier to defend but are not responsive to the variation in exotic species or natural system interactions over space and time. Thus, priorities set for managing exotic species based on precedent may not reflect current ecological and economic realities.

First and foremost should be a recognition that invasive species are as much a *symptom*, as they are a *cause* of poor forest health. The failure to address invasions from such a holistic viewpoint contributes to declining ecosystem integrity by perpetuating the very conditions that lead to invasions in the first place, e.g., ground disturbances, or spreading seeds through the consequences of management.

The failure to address the underlying causes of plant invasions results from the reluctance of the Forest Service to approach problems in a rational, analytical manner which links goals to expected outcomes. In many plant invasions, effective, inexpensive control measures have been ignored (Mack et al., 2000), resulting in invasions which cost thousands of times more to control (Pimentel, 1999), even to the point of irretrievable loss of resources (Turner et al., 1994; Van Wilgen and Richardson, 1985; Clarke et al., 1984). Unless the ecological causes of the plant invasions are addressed and understood within a framework for making decisions, weed control projects are doomed to fail.

Faced with public opposition and lacking sound guidance, project planners may cobble inappropriate measures from other programs with conflicting goals. One promising approach to invasive species management that, unfortunately, has been widely misinterpreted and misapplied, is Integrated Weed Management (IWM). IWM can afford managers with a wide variety of options (Wooten, 1999), but as applied by the Forest Service and other government agencies, it is more often used as a thinly veiled rationale for the overzealous use of herbicides.

The emerging paradigm of ecosystem management is beginning to take hold among land management agencies (Noss, 1999; Wooten, 1999; Appendix A). If land management agencies truly want to stem the tide of invasive species, then management programs going to have to look at the big picture afforded by ecosystem management. A recent paper by the Ecological Society of America suggests the importance of considering ecosystems (Mack et al., 2000).

> Control of biotic invasions is most effective when it employs a long-term, ecosystem-wide strategy rather than a tactical approach focused on battling individual invaders. Prevention of invasions is much less costly than post-entry control.

Invasive species plans and policies could benefit greatly by using principles of ecosystem management. For instance, National Park Service managers are directed to manage not only for individual species, but to maintain all the components and processes of naturally evolving park ecosystems (Hiebert and Stubbendieck, 1993). The requirements of ecosystem management vary. However, there are a number of consistent factors, which can be noted. Ecosystem management has pitfalls if attention to time and distance scales is not accounted for. Mistakes carry the burden of an entropy cost (see Appendix A).

Ecosystem management considers the following components (Noss, 1999; Appendix A):

1) Long-term sustainability.
2) Clear, operational goals.
3) Sound ecological models and understanding.
4) Understanding of complexity and interconnectedness.
5) Recognition of the dynamic character of ecosystems.
6) Attention to context and scale.
7) Consideration of humans as ecosystem components.
8) Adaptability and accountability.

Humanity can no longer pretend that land management can exist without considering ecosystem processes, many of which are of inestimable value to our way of life. According to Daily et al. (1999), "Based on available scientific evidence, we are certain that ecosystem services are essential to civilization."

Policies and plans should rely on objectives to control invasive species based on a rational decision-making framework, which can reasonably attain stated goals without significant negative impacts. Such a framework could be based on principles of **true** Integrated Pest Management, and its plant counterpart, Integrated Weed Management, or IWM (Wooten, 1999b; Appendix A):

> True IPM is an interdisciplinary system of techniques for controlling invasive plants that is both **practical** and **environmentally sensitive**.

Components of a true IPM program should include (Appendix A):
- monitoring
- integration of multiple objectives
- integrated strategies
- periodic re-evaluation

A wide variety of pest control options is considered in true IPM with preference for:
- Practicality -programs should be effective and cost-efficient.
- Environmental sensitivity -programs should reduce environmental risks.

When combined with ecosystem management, IWM can be used as a powerful tool to accomplish the goals and objectives of invasive species management (Wooten, 1999; Appendix A). A wealth of alternatives to chemical controls exist (Wooten, 1999c). To wage a successful campaign against plant invasions, plans and decisions need to be in place. A decision hierarchy must be capable of responding to emergency risks from actual or potential infestation problems. Such a hierarchy should flow smoothly from National goals, policies, plans, programs and specific project objectives. Management procedures need to anticipate the need for flexibility by incorporating the ability to make decisions based on expected outcomes, and when necessary, to adjust those procedures. The implementation of IWM is dependent on specific land use goals that manage ecosystems, not just administrative boundaries. Its use requires more than just proclamations, but should include detailed descriptions of how goals will be accomplished within ecosystems.

Another important part of invasive species management is coordination with other public and private entities.

The Land and Resource Management Plan, 47 FR 43037, Sept. 30, 1982, § 219.9 (a)(7), requires that,

> The regional guide shall contain a description of measures to achieve

> coordination of National Forest System, State and Private Forestry, and Research programs.

The need for coordinated activities is reiterated in terms of invasive species by the General Accounting Office (2000):

> Moreover, the agency has no plan to better link its research division and state and private programs (see fig. 1) to the national forests to identify and address stewardship issues--such as wildfires, insects and diseases, and noxious weeds--that do not recognize the forests' administrative boundaries.

Currently, the individual Forests and have incompatible goals with their regional offices. Regional goal statements include far more documented impacts, such as health protection measures, drift regulations and applicator certification, that do not get translated into Forest EAs. For example, the Forests are dependent on state certified applicators who are generally unaware of new Regional regulations.

Regional and federal offices maintain large databases which are unavailable on the Forests, but which contain important technical references, EPA hazard memos, EPA environmental effects database, EPA health effects database, and other documents that only get incorporated by reference into EAs. In addition to being a violation of the public trust, the lack of information makes it difficult to mount a rapid response to new invaders using the best available science.

Case example: Boulder Creek on the Okanogan NF in Washington

The lack of coordination between different government entities is evidenced on the Okanogan NF by the signing of a Biological Evaluation (Molesworth, 1999) for herbicide use which proposed using label violation as a method of protecting threatened and endangered fish species, in the same paragraph with a statement assuring label adherence:

> Surfactants, are often more toxic than the herbicide and will not be used within the riparian buffers...The EA specifies that herbicide label specifications will be followed and specifies that weather and soil conditions that will be met before herbicides are used.

When asked why this occurred, the applicator pinned the blame squarely on Forest Service directions. Although this resulted in a Notice of Correction from the Washington Department of Agriculture (Washington State Department of Agriculture. 2000. Case File 051C-99), the implementation involved other transgressions.

The Okanogan NF also attempted to protect aquatic species without considering the limitations inherent in control programs. The Integrated Weed Management Environmental Assessment (EA) (1997) specified buffers to protect aquatic species:

> The mitigation measures for herbicide use include 100' buffer widths along steelhead, bull trout, spring chinook, and westslope cutthroat habitat where no picloram will be applied and require that a Forest Service inspector work with the contractor at all times. Within this buffer and within 50' of all other streams glyphosate will be hand applied.

Yet, the treatments were obviously applied within riparian areas using a sprayer, as weeds were consistently missed while prominent native vegetation along the water was killed or damaged (Photo 4, p. 3). The National Marine Fisheries Service (NMFS) was contacted, and came to observe the site, however their investigation was never concluded.

Had the operation used hand application in riparian areas as specified, less herbicide would have been used, and this would have been evident from a much reduced application area and avoidance of non-targeted native plants. However a site visit and photographs taken after the application clearly show the width of the swath was wider and more even and continuous than would have resulted from hand application (Wooten, 1999d). Areas practically devoid of any vegetation were treated along with the rest of a five-mile stretch of road (Photo 4, p. 3). The treatment affected native plants far more than weeds, sometimes missing weeds completely, while spraying over them onto native plants on the streambanks below the road as far as 30 feet beyond the road (Photo 4, p. 3; Wooten, 1999d). The Forest Service claimed that a Forest representative was on hand during the treatment, but if so, then they must have allowed the contractor to preferentially treat native plants from a truck in violation of the EA.

If the agency cannot be relied upon to coordinate its activities with other agencies and with its own different branches, then there is little reason for the public to approve the use of dangerous chemicals by these same people.

Case example: Wenatchee NF in Washington

The Wenatchee NF Environmental Assessment (EA) for noxious weeds (1998) states as its legal direction the Federal Noxious Weed Act of 1974 that, "establishes and adequately funds an undesirable plants management program through the agency's budgetary process."

Unfortunately, agency programs cited in the EA are not linked to policy goals, but instead to regional guides for project implementation (Forest Service, 1988; Forest Service, 1992), which constrain plans to the analysis of various *tactics* for vegetation control without an overarching approach toward achieving federal goals, budgets, coordination, or long-term environmental sustainability.

The EA then goes on to design an entire Forest program within the EA, in excess of the scope of implementation and budgetary authority cited as direction. However admirable, the stated purpose and need do not follow the line of authority from policies to plans to programs to decisions. Instead, the EA concludes that an Integrated Weed Management program (IWM) should be implemented on the District, without really following the regional guidelines for following an IWM program.

IWM was defined by the Forest Service (1988) as a five-step process: (1) conduct a site analysis; (2) select a strategy; (3) design the project; (4) take action; and (5) monitor. It is arguable that this definition of IWM is incomplete. There is no consistent procedure to get from step 1 to step 2, and lacking such authority, the Forest Service inevitably concludes that herbicides will be the chosen "strategy", then concocts a project design to implement this "strategy".

Unfortunately, the flaw in this reasoning has resulted in the Wenatchee NF being unable to implement basic weed control measures because the so-called "IWM program" relied too much on herbicide treatments, which exceeded the program budget.

Case example: Wenatchee NF in Washington

Lacking a sound program for managing invasive species, the National Forests are floundering in a sea of weeds. Liz Tanke, botanist and Chelan Field Representative for the Northwest Ecosystem Alliance, documented the following cases of inappropriate management on the Wenatchee NF:

> In Swakane Canyon, Dalmatian toadflax occurs in multiple large populations, diffuse knapweed occurs along roads and Canada thistle occurs in riparian areas, much of this in bighorn sheep habitat and mule deer winter range on both state and NF land. Toadflax and

knapweed are in places where vehicles will pick up the seeds during the fall hunting season and during spring greenup, when deer and sheep will pick up seeds. At least two signboards are available to post notices about weeds, but neither are used to warn the public of the weed infestations.

On the Mad River, diffuse knapweed is thick at Pine Flat and Camp 9 trailheads, and is spreading into the Entiat Roadless Area and Chiwawa LSR along the trail. Canada and bull thistle, oxeye daisy, yellow sweetclover and a few patches of whitetop have also been observed along the trail. Volunteers have been pulling the knapweed and as many other weeds as possible for at least four consecutive years, but some of the thistles along the trail and the knapweed at the trailheads need a more concentrated effort. Volunteers have been told not to publicize this activity because it is not legal; there is no NEPA document to cover it. Yet the Forest Service has known about the volunteer effort for several years and despite requests, has not helped make the work legal. Trail crews busy with trail clearing ride their motorbikes past the weeds. When asked, they have admitted that they have not received training in noxious weed management.

On Echo Ridge on the north shore of Lake Chelan, Dalmatian toadflax is spreading within the off-road area where mountain bikers and cross-country skiers use multiple loop trails. Infestations are thick along several miles of approach road and along one edge of parking area. Nothing was done about the weeds in 1999. The road and parking area were mowed once this year which helped reduce the height of weeds, but trails were mowed after weeds went to seed. Toadflax plants growing over roadcuts are going to seed. A large signboard at the trailhead does not have weed information. Volunteers offering to lead weed-pulling outings with bikers and skiers have not gotten replies from the Forest Service offices.

Solutions

- Formulate plans and policies that incorporate a sound decision-making framework.
- Formulate plans and policies based on the *processes* of invasions.
- Prioritize long-term ecosystem sustainability as a prime goal of management.
- Formulate plans and policies using principles of *ecosystem management* (Appendix A).
- Principles of ecosystem management should include:
  1) Long-term sustainability.
  2) Clear, operational goals.
  3) Sound ecological models and understanding.
  4) Understanding of complexity and interconnectedness.
  5) Recognition of the dynamic character of ecosystems.
  6) Attention to context and scale.
  7) Consideration of humans as ecosystem components.
  8) Adaptability and accountability.
- Formulate plans and policies using principles of *true* Integrated Weed Management (Appendix A). Components of an IWM program should include:
  - monitoring
  - integration of multiple objectives
  - integrated strategies
  - periodic re-evaluation
- A wide variety of pest control options should be considered in IWM with preference for:
  - Practicality - programs should be effective and cost-efficient.
  - Environmental sensitivity - programs should reduce environmental risks.

- Formulate plans and policies to manage invasive species using principles of Integrated Weed Management within a framework of ecosystem management (IWM-EM, Appendix A). The application of IWM-EM includes the following principles:
  1) Maintenance of long-term ecosystem sustainability should be the prime goal.
  2) Planning needs to address the causes of biological invasions.
  3) Program budgets need to be based on performance evaluations and monitoring.
  4) Planning and implementation needs to be site-specific.
  5) Planning and implementation needs to be species-specific.
  6) Planning and implementation need to address prevention.
- Formulate plans and policies based on an analytical approach.
- Use adaptive management (Appendix A).
- Improve coordination among different agencies.
- Improve coordination among agencies and units.
- Improve coordination between agencies and units.

Programs need to treat the causes of invasions, not the symptoms, if they are to succeed.

The National Environmental Protection Act (40 CFR § 1508.20) requires that impacts be lessened through:

(a) Avoiding the impact altogether by not taking a certain action or parts of an action.
(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.

Land managers must address the problems that are the root causes of plant invasions. Such problems are diverse, but they result in the type of resource degradation that predisposes and reinforces the ability of plants to invade ecosystems, which then leads to further impacts, resulting in an inescapable whirlpool of environmental effects, as illustrated in the diagram below (Figure 1).

It rarely occurs that the causes of weed spread are attended to. Instead, land managers mitigate and treat the consequences of invasive species spread, not the impact. In essence, they continue to focus on the symptoms.

By treating only the symptoms of poor ecosystem health, land managers insure that programs will fail to control invasive species. In fact, such maintenance measures lack acknowledgment of
the causes of plant invasions and therefore will never be a viable means to eradicate the source of infection. What it does do, however, is reinforce the agency's dependence on herbicides.

The invasion of non-native plant species has resulted in a spate of recent decisions that attempt to justify a perceived need for the use of chemicals to manage impacts. Unfortunately the effects of the treatment are sometimes worse than what triggered them (e.g., the presence of weeds). When added to the prior effects, the result is a dilemma requiring perpetual management to maintain ecosystems from total collapse. These so-called "maintenance strategies" (Forest Service, 1988) are condoned and even encouraged by management schemes intended to insure funding, but which lack long-term sustainability.

In order to comply with regulations in the NEPA to limit negative environmental impacts, land managers must begin to eliminate and reduce the causes of invasive species spread. Planning documents that blame impacts on invasive species, and then subsequently fail to acknowledge the causes of those invasions, only contribute to increased degradation (BLM Weed Team):

> Weeds often start in sites where ecosystem processes are disrupted such as trailheads, trails, wildlife bedgrounds, overgrazed areas, and campgrounds.

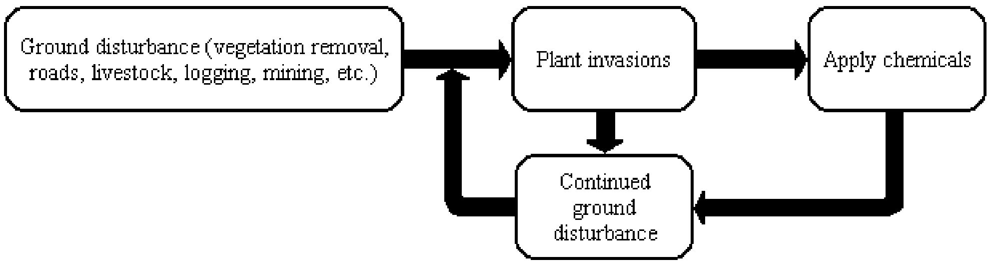

Figure 1. The cycle of plant invasions perpetuated by continued disturbances.

Planning documents that cite the impacts of weeds as a need for aggressive control measures further violate NEPA and mislead the public. By treating only the symptoms of resource degradation, managers insure that symptomatic control programs will fail to protect resources. In failing to look at the big picture of invasive species as part of ecosystems, program managers have abdicated their responsibility to avoid detrimental environmental effects of projects. Belsky and Gelbard (2000) found that,

> Most of the current recommendations in management plans for stopping non-indigenous plant invasions on public lands in the West focus on preventing landscape-level introductions of weed seeds by washing vehicles and using weed-free livestock feed. Although useful, these strategies are similar to rearranging the deck chairs on the Titanic.

Plant invasions are themselves a symptom of poor ecosystem health and poor stewardship of public lands.

For instance, overgrazing has been shown to degrade soils through compaction, reductions in soil decomposers, and lowered soil hydrologic conductivity; all of which appear to favor weedy species over native bunchgrasses (Belsky, 1995). Weed invasions are reinforced by a positive-feedback system involving selective grazing, trampling disturbances, destruction of microbiotic crusts and loss of native species (O'Brien et al., unpublished). Conversely, relatively healthy native shrub-steppe lands which still retain native species, such as the U.S. Department of Energy's Hanford Site in eastern Washington and a semi-isolated plateau known as *The Island* in central Oregon, are also relatively free of non-indigenous plant species, except along roads (Belsky and Gelbard, 2000). Roadless lands on National Forests and other ownerships also act as strongholds for native communities (Almack et al., 1993).

Without any mandate to seek long-term solutions to problems of invasive species, managers have concocted an array of complex bureaucratic procedures to appear efficient while providing short-term fixes to ameliorate the problem. The Forest Service is well aware of this, as shown by a letter from a private seed supplier that was circulated on the Forest Service computers (Dalpiaz, 1994):

> I think that the idea that native plant material is more expensive than exotic materials is a very big fallacy. . . . What will work best in the long run for overall ecosystem health will always be cheaper in the long run from a management standpoint. Eurasian Wheatgrasses and Smooth

Brome might be quick, cheap 'visual management' solutions in the short run, but just because they green up an area quickly doesn't mean it's fixed.

Case example: Okanogan NF

The Forest Service continues to plead for public recognition of the impacts caused by the invasion of non-native plant species (ICBEMP, 2000):

> Cheatgrass and other exotic plant infestations have simplified species composition, reduced biodiversity, changed species interactions and forage availability, and reduced the system's ability to buffer against change or act as wildlife strongholds in the face of long-term environmental variation.

Yet cheatgrass is not even classed as a noxious weed in most states and is legally allowed in so-called "100% noxious weed-free" seed mixtures which are specified for project use by the Okanogan NF.

The "Respect the River" program was initiated to restore degraded salmon habitat along the Chewuch River. Implementation involved liberal applications of "native" seed mixtures on a number of disturbed recreational sites. Because the sites were hardened campsites with extremely poor soil quality, the chances of successful restoration was not high, and many of the initial plantings failed, except for a single species of grass which managed to survive—cheatgrass.

Cheatgrass is one of the most destructive invasive species in the Inter-mountain West (Monsen, 1994; Mack, 1986), yet some states don't even classify it as a noxious weed. Although the Washington State Department of Agriculture certifies weed-free seed, it does not require the Forest Service to examine the certification or even require a certification. Regulations to certify seed are inconsistent from one state to the next, and allow any potential new weed species to be present in a mix, so long as they are not classified as Noxious in the receiving state.

The problem is that the *causes* of degradation—loss of resources due to spreading populations of invasive species—are not being attended to. Instead, the "Respect the River" program treated the symptoms of the problem—unhappy campers. Because our existing framework for controlling invasive species is based on a "noxious weed" list that is primarily designed to protect agricultural enterprises, ecosystem restoration efforts are failing and in some cases causing more harm than good.

Case example: Boulder Creek on the Okanogan NF in Washington

Because of the rugged terrain on the Okanogan NF, many roads on the Methow District are located along streams and rivers where they have become festering sores in the fragile glacial soils. The Forest acknowledges that, "We know that some road fills in the Boulder watershed have little to no vegetation on them and have surface erosion occurring at rates higher than we would like." (O'Neal, 2000).

To cope with the problem of eroding road banks, the Okanogan NF often uses non-native forage grass plantings to meet road vegetation guidelines. However, the problem of road bank erosion may be worsened by the use of forage grasses, not only because these are aggressive and invasive in their own right, but also because high-protein grasses attract deer and free-ranging livestock to sites where they grow. The result is that the cycle of Fig. 1 is perpetuated: soil disturbance leading to invasive species, leading to more soil disturbance, ad infinitum. The cause of the problem which should be addressed is the cycle of disturbance. But, the Forest is treating the symptom—lack of roadside vegetation—through an inappropriate treatment strategy of planting more invasive species.

The result is that native shrub-dominated communities have been replaced by orchard grass, Kentucky bluegrass, timothy and intermediate and crested wheat. Roadsides have been converted into linear pastures (Photo 1, p. 3), and the increased trampling disturbance provides a seedbed for new weed seeds hitch-hiking along with livestock and cars; trampling and driving helps scarify the seed-coats and cover the seeds with soil; and the ruts and hoof prints provide a convenient microniche to hold water during early development of the weeds.

These artificial ecosystems are self-reinforcing cycles of destruction, which can only be controlled by breaking the disturbance cycle, and restoring a self-sustaining vegetative community. Existing programs such as treating these sites with herbicides as the Okanogan NF did in 1999, contribute to further loss of beneficial native communities, and greater soil loss, while wasting valuable public funds. Weeds on the Okanogan NF are a symptom of poor forest health brought on by years of roading, logging and livestock grazing, but until these causes are addressed, symptomatic treatments will continue to fail.

Solutions

- Develop programs that acknowledge and treat the causes of invasions, rather than the symptoms.
- Include explicit acknowledgment of the causes of species invasions in program directions.
- Incorporate plans for invasive species control that include long-term, comprehensive strategies.
- Plans need strong direction to cease the use of unsound management practices which contribute to plant invasions.
- Planning goals should stay within the scope of the project, and avoid unattainable goal statements that use absolutes, e.g., “absence of” and “complete eradication”, which properly belong in vision and policy direction.
- Funds should be allocated and projects prioritized well in advance of anticipated spending, and over multiple-year time frames.

Section B. Projects and plans must incorporate measurable standards and guidelines.

The recently created National Invasive Species Council (2000) has made a strong recommendation for creation of standards and management framework for invasive species:

> In 1997, 500 scientists and resource managers wrote to the Vice President and requested action on invasive species. . . . The team prepared a review of the issue with recommendations, foremost among them that an executive order be issued providing standards and a framework for continuing action. On February 3, 1999, President Clinton issued Executive Order 13112 on Invasive Species . . .

During scoping from the National Invasive Species Council Research, Information Sharing, Documentation and Monitoring Working Group (2000), the importance of developing standards was addressed:

> Information sharing and documentation issues address the fact that our efforts related to invasive species have been hampered by the fragmented state of information systems addressing invasive species. A major challenge identified was to develop standards and protocols that shared core information (species names, locations, collections, effective practices, experts, etc.) needed for synthetic national assessments that can be reported in a cost-effective and transparent way,

> while still maintaining local control and responsibility for the fundamental data.

Standards and guidelines should be reasonable and should be implemented consistently across all National Forest lands. Decisions are being issued with statements that certain actions will occur, such as monitoring, reseeding, etc., when in fact such objectives have no means of accomplishment.

At a minimum, standards and guidelines should include damage and action thresholds for management and control of invasive species. The use of thresholds is a tenet of Integrated Pest Management, which uses pesticides only within predetermined action and damage thresholds (Quarles, 1999; Hoglund et al., 1991; Lanier, date unknown).

Damage thresholds refer to limits on the amount of impacts to humans and the environment that will be tolerated. Damage thresholds are determined by the amount of change that occurs in the environment or in humans as a result of a natural or management-induced process. The Forest Service uses a very narrow definition of damage threshold, limited only to the damage caused by invasive species (Okanogan NF 1997, 1999). Damage caused by the Forest Service is excluded from planning documents. Damage thresholds for chemical impacts are not presented in Forest Service planning documents because they are a constraint on the status quo. By forcing managers to limit their actions within acceptable limits, setting damage thresholds for control measures has the potential to upset the free rein which managers have had in the past in accomplishing targets regardless of the consequences.

Action thresholds are determined in relation to damage thresholds (Hoglund et al., 1991). Action thresholds set the minimum allowable quantity of an invasive species beyond which control measures will be undertaken. The use of action thresholds is dependent on both the management goals for an area as well as the calculated threat from each invading species. For instance, aggressive rhizomatous grasses might be highly tolerated in pastures and given a high action threshold; whereas in tree plantations, the action threshold might be lower and in Wilderness areas it might be zero, or not tolerated.

In conjunction with the development of action thresholds, which would determine when control or preventive actions were mandated, a national list of potential and known invasive species for which damage thresholds would apply needs to be compiled, along with the rationale for a species inclusion, and the action threshold it would receive for treatment. The Invasive Species Council (2000, Section 4) described the creation of such a list within a few years:

> Invasive species must be detected and identified before they become widespread. No comprehensive national system is in place for detecting and responding to incipient invasions. Key elements needed in such a system are accessing current scientific and management information; facilitating identification . . .

After years of neglect and inefficient spending on ineffective programs, the revised Forest Service Strategic Plan (Forest Service, 1999) performance measures for invasive species for the year 2006 is still nebulous,

> Acres infested with targeted invasive species remain unchanged or are diminished.

In contrast, the National Park Service has spent considerable amount of time and energy analyzing the management factors for various weeds (Hiebert and Stubbendieck, 1993), which the Forest Service would do well to heed:

> Managers must not only be concerned with the level of impact that an exotic can cause but must also consider the impact of removing the species. Removal can often disturb areas that are easily colonized

by the same or other exotic species (Westman, 1990).

Case example: Boulder Creek on the Okanogan NF in Washington

The Okanogan NF Environmental Assessment on noxious weeds (1997) proposed treating half of 10,000 weed infested acres with herbicides.

The public was concerned about the deleterious effects from using these herbicides, and said so in numerous letters, e.g., under issues contributed by the public (p. 15), “herbicides could damage or kill non-target species, even if used according to label instructions.” Forest Service reviews of the herbicide glyphosate (Syracuse Environmental Research Associates, 1996) indicate that it can be toxic, e.g., “herbicide treatments have the potential to be lethal to fish, amphibians, and aquatic invertebrates if the concentration of the application exceeds the tolerance of the organism and becomes toxic.”

Since herbicides are acknowledged to be toxic to a wide variety of organisms, the appropriate action would have been for the EA to analyze the extent of these risks through reference to the available literature, and then to establish threshold concentrations that would be measured during implementation to mitigate the harm that would occur as a result of using chemicals in the environment.

However, instead of analyzing the risks posed by applying toxic chemicals on over 5,000 acres, the EA brushed off these concerns, and cited a single out-of-date reference (Norris et al., 1991) to demonstrate that proposed chemicals will have low risks, in contradiction of the statements made about toxicity.

The EA did not include an analysis of the likely effects from herbicides, stating that this information was purportedly incorporated by reference to regional and national analyses, such as those performed during registration of a pesticide by the Environmental Protection Agency. Unfortunately, these references are generally unavailable to the decision-maker, the District staff, and the public at large.

The EA did not provide damage thresholds for chemical effects as required in the Competing Vegetation EIS, FEIS and ROD (Forest Service, 1988), but nonetheless stated that the herbicide applications would meet the Aquatic Conservation Strategy Objectives of PACFISH (Forest Service and BLM, 1995) and INFISH (Forest Service, 1995) and the impact on fish from herbicides would be “little”.

With no damage thresholds to measure effects, the assumption that impacts will be “little” is without justification. The EA goes on to print misleading and ridiculous claims for benefits, stating that,

> Native plant species would dominate existing population centers. This would improve and maintain wildlife habitat. Slight possibility of damage to non-targeted animal species from chemicals.

Building on this flawed analysis, a subsequent two-page Biological Evaluation was prepared and found there would be “no effect” on listed fish. The EA and BE are not posing reasonable alternatives, they are building a case for herbicide use. But based on the flimsy evidence given, the entire process can be seen as nothing but a house of cards. Clearly the “no effect” determination of the BE occurred without substantial review, and the actual, likely consequences were never described in the document.

In fact, the actual likely consequences that went undocumented included: (1) use of the wrong herbicide (picloram, not glyphosate) in riparian areas as documented in Forest Service memoranda and photographs (Bennett, 1999: Figure 6, and statement); (2) a killed or damaged swath of primarily native vegetation 3-10 feet wide along roadsides; and (3) increased streambank erosion due to removal of beneficial native plant cover (Wooten, 1999d).

The risks of ground-based herbicide applications exceeding damage thresholds to nontarget species was not presented. The lack of standards and guidelines meant that environmental impacts went undocumented. Reliable information that was available was ignored, resulting in a biased decision. Ultimately, the environment was degraded more by the cure than the cause, however the lack of standards and guidelines for protecting the environment insured that the public and decision-makers would never know the true extent of the damage.

Solutions

- Projects and plans must incorporate measurable standards and guidelines.
- Projects and planning standards and guidelines should be reasonable.
- Projects and plans should require the establishment of standards and guidelines for the measurement of action thresholds before approval.
- Projects and plans should require the establishment of standards and guidelines for the measurement of damage thresholds before approval.
- Projects and plans should be based on site-specific standards that consider the biology and causes of species invasions as well as the characteristics of the invaded ecosystem.
- Project funding should be contingent on measurement of action and damage thresholds over the course of the project.
- Compile a national list of potential and known invasive species for which action thresholds should apply, along with the rationale for each species' inclusion, and the priority it will receive for control or preventive actions.

Section C. Programs must be held accountable to budgets.

The goals and objectives of programs and projects should specify a timeline and budget for project accomplishment. Program budgets need to consider long-term funding limitations before deciding on an implementation plan. The current U.S. budget of $251 million for prevention of alien species invasions is estimated to be one-quarter of one percent of the yearly U.S. damage costs from all invasive species (National Invasive Species Council Risk Analysis and Prevention Working Group, 2000).

Existing budgets for invasive species are run as ad hoc extensions of grazing or timber departments which lack a comprehensive framework for handling species invasions (Okanogan NF, 1999). According to the General Accounting Office (2000):

> . . . the Forest Service continues to develop its annual budgets and to allocate most appropriated funds to its field offices primarily on the basis of its nine National Forest System programs. (See fig. 1.) These programs are not linked to the Forest Service's strategic goals, objectives, or strategies or to the way that work is routinely accomplished on the national forests.

Once funding is obtained, there is little incentive to follow through with plans. Existing budgetary policies within the Forest Service are lax and they act as a disincentive to cost-effective programs by basing future budget allocations on past spending, without a hard look at how funds were spent.

Case example: Budgets considerations

According to information received under a March, 2000 FOIA request from Kettle Range Conservation Group to the Region 6 Forest Service, the Okanogan NF received $300,000 for managing invasive species in 1999, which was used to apply herbicides over approximately 5,956 acres. But despite the large sum of money allocated by Congress, the Okanogan NF stated that three times this amount, or $1 million, would be necessary to control just one third of the existing weed population (Okanogan NF, 1997, p. 91). Funding on just the first year was completely exhausted before completing required monitoring specified in the EA, however, another appropriation of $300,000 was granted to the Okanogan in 2000.

At the March 29th, 2000 meeting in Bend, Oregon, between the Forest Service and parties to the Mediated Agreement (1989), Wenatchee NF botanist, Terry Lillybridge, described procedures used to get more funding for noxious weed programs. It turned out that the Okanogan and Colville NFs got special allocations through lobbying efforts of the Okanogan County Weed Supervisor at the office of U.S. Senator Gorton. From this, it is apparent that the Forest Service is relying on under-the-table deals and pork barrel politics to secure funding, rather than proceed through its own internal processes.

Perhaps the federal funding process for managing invasive species needs to be changed. To undertake such a large program without assurances of budget accountability or long-term effectiveness is an irresponsible waste of taxpayer money. As described in the EA (p. 91), $300,000 is but a fraction of the $1.8 million that would be required to treat all the first-, second-, and third priority sites, and there is no guarantee that this experiment would work.

In fact, the following observations indicate that the project is failing to control weeds and protect public resources. Untreated populations continue to threaten the Forest, and new invaders have already returned to the treated sites (Wooten, 1999d). Native plant communities were the unintended targets of many treated sites. Spray applicators treated areas at their convenience, without Forest Service inspectors present to oversee their methods or postings of required public warnings (from a FOIA response of notes of Forest Service Contract Inspector Bauman, July 7, 2000). Herbicide labels were routinely violated in a number of ways: disregard for riparian buffers (Bennett, 1999); use of restricted herbicides on livestock forage (Wooten, 1999d); and through Forest Service instructions to applicators to violate labels and use of incorrect formulations.

Case example: GAO investigation into Forest Service performance

During hearings before the House of Representatives, an investigation by the Inspector General of the General Accounting Office (2000) described how a Forest Service worker reported spraying five acres of road with herbicide, instead of the 18 acres actually sprayed, because had the correct figure been reported, subsequent budgets would have been restricted to discounted prices obtained for that year’s purchase of herbicide (Hughes, 2000).

Solutions

- Hold programs accountable to budgets and secure funding before beginning significant actions.
- Identify required measures as line items in projected budgets.
- Suspend funding for programs that have not developed goals and objectives for invasive species management.

Section D. Policies, plans, and programs need adjustments based on periodic evaluations.

In testimony before the Subcommittee on Forests and Forest Health, Committee on Resources, House of Representatives, on June 29, 2000, the General Accounting Office (2000) reported,

> In addition, even though forest plans are intended to serve as a basis for developing future budget proposals, the Forest Service has not determined how or if the national forests will blend agency-wide objectives and strategies with local priorities in revising their plans. Moreover, instead of developing new performance measures and improving existing ones to better align them with its strategic goals and objectives and its on-the-ground projects and work activities, the agency is relying on old program-based performance measures.

Proposed new rule changes in the National Forest Management Act (Forest Service, 1999b) underscore the importance of adaptive management in relation to monitoring:

> In addition, as efforts continue to adopt the principle of adaptive management to guide natural resource stewardship, greater emphasis needs to be placed on evaluating resource conditions and monitoring trends over time. Consistent with the 1990 Critique as validated by the Committee of Scientists' report, the proposed rule emphasizes monitoring and evaluation so that management can be adapted as conditions change over time.

The Hearings over the Results Act brought these problems to the attention of the House of Representatives (Hill, 1997):

> Our report on the Forest Service's decision-making identifies problems in the agency's data and information systems dating back 17 years. These problems include (1) not adequately monitoring the effects of past management decisions to more accurately estimate the effects of similar future decisions and to modify decisions when new information is uncovered or when preexisting monitoring thresholds are crossed and (2) not maintaining comparable environmental and socioeconomic data that are useful and easily accessible. We and others have recommended steps that the Forest Service could take to improve its data and systems, but it has deferred action on these recommendations. . . .
>
> . . . In conclusion, Madam Chairman, the inefficiencies and ineffectiveness of the Forest Service's decision-making, combined with the agency's reluctance to change, give urgency to implementing the Results Act. The agency's plan should provide the starting point for establishing the measures and annual target levels to be used in assessing the Forest Service's progress toward achieving strategic goals. However, the draft plan's silence on the Forest Service's rationale for its strategic goals, its management approach, and the likely effects of its policy choices on multiple uses on the national forests has contributed to a stalemate on the agency's strategic goals which threatens successful implementation of this landmark legislation.

The National Forest Management Act (NFMA) requires that Forest Plans must contain "monitoring and evaluation requirements that will provide a basis for a periodic determination and evaluation of the effects of management practices" on forest resources. 36 CFR §

219.11(d). To effectively monitor the impacts of management actions, each Forest Supervisor is required to "obtain and keep current inventory data appropriate for planning and managing" forest resources (*ibid*. at § 219.12 (d)).

Field units operate within regional and national guidelines, which are in turn dependent on receiving meaningful feedback from the units.

There are strong indications that existing weed management programs are failing in many respects, however this information is not being relayed beyond individual Forests, which in some cases are not even performing required monitoring. Policy-makers should be provided with program evaluations in a timely fashion, so that plans can be adjusted when necessary.

Case example: Boulder Creek on the Okanogan NF in Washington

The Okanogan NF Environmental Assessment (EA) on noxious weeds (1997) was accompanied by a Biological Evaluation (BE) written two years after the 1997 EA and 3 years after a study provided for the Forest Service to review studies on the effects of the herbicide glyphosate (Syracuse Environmental Research Associates, 1996). In a March 3, 1999 letter from Janice McDougle to Forest Service Region 5, various reasons were given for denying a request to include an additional 78 citations to those in the review. These include the conclusion that based on a cursory review by the Forest Service Washington Office (McDougle, 1999), the new information,

> . . . would not alter anticipated impacts or consequences on aquatic organisms, water quality, plants and food, occupational exposure, drift, soil, and nontarget species from those previously disclosed. We suggest that the individuals submitting the list of references be asked to explain, in detail, why the studies referenced would significantly change or alter any of the consequences that the Forest Service has or will disclose to the public.

During appeals of the EAs for noxious weeds (Okanogan NF, 1999; Colville NF, 1998), the Regional Office went on record to deny requests to incorporate additional references to the toxicity of glyphosate made since the SERA was issued 5 years ago, stating,

> . . . the peer review process used by SERA [Syracuse Environmental Research Associates] for Forest Service pesticide risk assessments includes qualified scientific experts outside of the Forest Service. Their comments would already be incorporated into the final document you have retrieved.

Even if these assumptions were invalid, they should have been caught by monitoring. However, monitoring was not performed in most of the treated areas.

Following the implementation of the 1997 weed control program, photographs and surveys by independent investigators clearly show that the amount of nontarget vegetation killed was significant (Wooten, 1999d). Had the EA disclosed the likely effects, as it should have, a "no effect" determination might have been untenable. In that case, this disclosure *would* have altered the consequences, as the document could not implemented until consultation with lead agencies under the Endangered Species Act (ESA) occurred. This also would have altered the consequences in that oversight might have prevented the spraying of Tordon 22K© into at-risk streams and possibly would have prevented habitat degradation for threatened and endangered bull trout and salmon.

But the EA could not address the likely effects from herbicides because this information was not incorporated into regional and national analyses, which are generally unavailable on the Districts anyway.

The EA only briefly mentions effects from herbicides and then primarily under "Issues Contributed by the Public . . . herbicides could damage or kill non-target species, even if used according to label instructions . . ." (p. 15). The EA cites a single out-of-date reference (Norris et al., 1991) to justify the chosen alternative, despite numerous references in possession of the Forest Service (Syracuse Environmental Research Associates, 1996) showing a greater range of herbicide toxicity.

What should have occurred was to research the available literature and analyze whether the basis for the invasive species program was on a sound foundation. Instead, the EA makes projections based on invalid assumptions, e.g., "Formulations containing herbicides picloram or glyphosate would be applied with implementation of this alternative. Both chemicals are rapidly diluted and tend not to bioaccumulate." (p. 107). This is not an honest appraisal of available research, it is blatant rationalization. Only a single reference is cited, and that one is out of date. Furthermore the summarization lacks quantification ("*rapidly*" and "*tends*" leave much to the imagination).

The failure of the Okanogan NF to control invasive species lies largely with their lack of regard for following procedures. The Forest had numerous opportunities to question its motives and methods, but in each case blundered ahead without assurances that projects would be effective. Until the Forest Service is willing to change the way it does business, we will continue to see poor performance records.

Case example: Poor record keeping on Okanogan NF and Colville NF

The Okanogan and Colville National Forests applied herbicides over approximately 5,956 and 3,791 acres, respectively, in recent single years (Okanogan NF, 1997; Colville NF, 1998). A Freedom of Information Act Request (FOIA) was sent to the Regional Office by Kettle Range Conservation Group on March 14, 2000, requesting figures for the amount of acreage treated. The response took months for a reply to be received, which was a single page answer, stating the number of acres treated with herbicides as 810 acres for the Okanogan, and 1,777 acres for the Colville.

In trying to determine the reason for the large discrepancy with the Environmental Assessments, the Kettle Range Conservation Group sent another FOIA request for the number of treated acres to the Colville NF and received the following reply:

> This item . . . was not kept on Forest files and has just recently been mailed to us from the Regional Office.

It is interesting that the Colville NF says it did not have these required records because the information was supposedly at the Regional Forest, which supposedly came from the Colville NF in the first place. Unfortunately, the public will probably never know the amount of acres treated with herbicide on the Colville NF more accurately than between 1,777 and 3,791 acres.

The Okanogan NF responded to a FOIA request for the number of acres treated with chemicals in 1999 by sending an Accomplishment Report, but only from the Tonasket District, indicating that a total of 1,937 acres was treated. Again, the actual amount treated, which will probably never be known, was somewhere between 1,937 and 5,956 acres, however the Regional Office blithely went on record to say that only 810 acres were treated on the Okanogan NF. However important it might be, the need for adjustments to plans, programs and policies, cannot occur in a logical fashion until adequate record keeping occurs on the National Forests. In the meantime, poor record keeping serves to tell the public and policy-makers that everything is just fine.

Case example: The injunction in Region 6 Forest Service

In 1984, litigation over health and environmental damage on private lands caused by aerial herbicide spraying by the Forest Service and BLM resulted in a five-year injunction against using pesticides in Region 6. Following the injunction, the Forest Service did practically nothing to monitor or control invasive species on public lands, while allowing and even causing them to spread widely.

When interviewed by Audubon author Ted Williams (1997), University of Wyoming weed scientist Tom Whitson gave his rationale for the government's lapse of weed management as the inability of bureaucracies to cope with adversity:

> Why hire professional people and limit them to the point where they can't operate? . . . In government, progress is slow anyway; and when some of these groups start blocking it with a bunch of environmental-impact statements and lawsuits, it [all weed management] stops.

A more considerate explanation for the lack of invasive species management during this period might take note that when the existing program was excised from the timber budget, there was no weed management program at all left in its place.

Case example: Hell's Canyon Research Natural Area on the Wallowa-Whitman NF

Williams (1997) describes careless Forest Service reseeding efforts following the 1988 Tee Pee fire in Hell's Canyon, which resulted in a disastrous explosion of yellow star thistle (*Centaurea solstitialis*) in a Research Natural Area.

Despite the fact that the existing injunction against herbicide use in the Region was lifted the year after reseeding the burn, managers with failing programs found an excuse to blame the injunction rather than admit to their superiors that they were responsible for the infestation.

The initial control efforts were ineffective, despite costs of over $200,000 (Bob Williams, Wallowa Whitman NF, personal communication). However, detailed accounts of the reasons for the failure have since been destroyed (Forsgren, 2000), even though such information could be very informative. According to Williams (1997), "Managers knew they weren't going to eradicate yellow star-thistle . . ." The reasons for the failure of previous herbicide efforts are now concealed from the public and future managers who might otherwise make beneficial changes in the arena of invasive species management.

Lacking reports that would inform planners of the optimum course of action, hundreds of thousands of additional dollars have recently been allocated to annually treat 14 sites on 5,000 acres in Hell's Canyon, using aerial herbicide applications (Wallowa-Whitman NF et al., 1998). Although other methods are briefly mentioned, the proposal is clearly aimed at using herbicides first, and prevention last. Ironically, the government proposal fails to mention requirements to prioritize prevention and perform site-specific analysis and monitoring which were stipulated in the Mediated Agreement (1989) between the USDA and plaintiffs Northwest Coalition for Alternatives to Pesticides (O'Brien, 1989). In all these failed attempts to control invasive species, the common thread has been a lack of sound planning.

Solutions

- Policies and plans should be periodically adjusted, based on reported program evaluations.
- Programs should be required to prepare evaluations based on monitoring reports.

- Provide incentives to make programs effective, and penalize programs that do not accomplish goals and objectives for invasive species management, e.g., halt operations when weed control targets are not being met or when unacceptable environmental impacts are occurring.
- Require that yearly program evaluations be made available to the public and policy-makers in a timely fashion, so that plans can be adjusted when necessary.
- Field units should be required to complete yearly reports in conjunction with invasive species programs that will include the costs of program implementation and administration, ongoing monitoring results for the extent of weed infestations and summary tables of the amount of herbicides used (by formulation and application method). Reports should be filed promptly with the Regional offices.
- Require that evaluation reports include information sufficient to determine the extent of implementation, treatment effectiveness, and whether planning assumptions were correct.
- Fund annual monitoring reports for invasive species programs independently of programs.

Chapter 2. Disclosure: planning documents must be unbiased and fully disclose all impacts.

The preceding section provided the rationale for consistent and accountable policies, plans and programs for invasive species management, along with a means for evaluating their success or failure. This section discusses the disclosure requirements for planning documents in the context of invasive species management. Disclosure requirements provide valuable predictions and descriptions of the expected and likely effects of actions, which are critical to insure that policies and regulations are being followed. Case examples illustrate where disclosure requirements have not been adequately performed, with the result that projects may not have been carried out as intended and policy direction may not be met.

Section A. Planning documents must disclose all potential significant impacts, and provide detailed discussions and mitigation measures for all reasonably foreseeable impacts.

Invasive species management is a serious undertaking, with high potential for economic and resource losses and impacts. Such projects require prior disclosure of likely effects in order to insure that programs are effective, and remain within the limitations of policies and regulations. The National Environmental Policy Act (NEPA) is the guiding policy that provides for the descriptive documentation of a project through the development of an Environmental Impact Statement (EIS) or an Environmental Assessment (EA). These documents also provide the basis from which project inputs and outputs will be evaluated.

Pursuant to NEPA (§ 102 (2)(C)), every federal agency must prepare a complete detailed analysis of the environmental consequences and impacts of their proposed actions (see also 40 CFR § 1508.25, 1508.8, & 1508.9). The Council on Environmental Quality (CEQ) regulations clarifies what is meant by impacts (40 CFR § 1508.8):

> an “impact” or “effect” includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative.

Planning documents must provide an analysis of all potential significant adverse health and environmental effects, which includes chemical applications. CEQ regulations clarify the scope of alternatives presented (40 CFR § 1502.14):

> [Alternatives shall] rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated.

NEPA (40 CFR § 1508.9) provides that planning documents shall be concise, clear, and to the point, and shall be supported by evidence that agencies have made the necessary environmental analyses. NEPA also provides that planning documents will provide the means for project evaluations, (40 CFR § 1502.1 and 1502.2 (g)):

> An environmental impact statement is more than a disclosure document. It shall be used by Federal officials in conjunction with other relevant material to plan actions and make decisions.
>
> Environmental impact statements shall serve as the means of assessing the environmental impact of proposed agency actions, rather than justifying decisions already made.

Despite NEPA regulations, existing planning documents regarding invasive species management have not portrayed an accurate model of actual, expected impacts. Instead, planning documents are being used to rationalize predetermined decisions, while avoiding full disclosure. Weeds are vilified to the extent that chemical impacts appear acceptable in comparison, while strategies for preventing invasions are largely ignored and replaced by mitigation measures. The effect of such documents is to bias the choice of alternatives, because decision-makers must choose the alternative that appears to have the least impact. Without full disclosure of chemical impacts or prevention options, the choice of alternatives is prejudiced, policies are compromised, and projects are likely to fail.

Case example: Boulder Creek on the Okanogan NF in Washington

In the Okanogan NF Environmental Assessment for noxious weeds (1997), many required NEPA disclosures were never completed. Sensitive plant surveys were never performed in conjunction with the project, as required.

Herbicide label directions were not followed, resulting in a Notice of Correction from the Washington Department of Agriculture (2000). The Biological Evaluation accompanying the project (Molesworth, 1997) provided incorrect documentation to the National Marine Fisheries Service (NMFS) relating to likely effects of the project, biasing the determination of "no effect" on listed species.

Erosion increased into riparian areas following loss of native species from herbicide treatments (Photo 4, p. 3), and adding to the burden of sediment in the stream. A swath of killed and damaged native vegetation averaging 10 feet wide followed the road for five miles (Photo 2, p. 3), yet significant large infestations were left alongside the treated areas as a source of reinfestation.

The treatment was ineffective at killing weeds on many sites, and many of the weeds were able to go to seed. Livestock in the area browsed the seedlings of grasses planted to revegetate the roadside, leaving sites as poor as they were before. When forage became scarce in the fall, the livestock resorted to eating seeded plants of diffuse knapweed (*Centaurea diffusa*) and spotted knapweed (*Centaurea maculosa*) (Photo 1, p. 3).

Monitoring was practically nil. The response to a year 2000 FOIA by Kettle Range Conservation Group, was that no monitoring at all was done on the Methow District, which had about half of the treated acreage on the Forest. Following the treatment, several new exotic species were found along the road (common tansy, *Tanacetum vulgare*, and spotted knapweed), leading one to question whether the original baseline monitoring was incorrect, or whether the treatment opened up new ground for these new invaders.

Warning signs were never posted and some sensitive individuals were never contacted. When these problems were pointed out to the Forest Supervisor (Wooten, 2000), the response was (O'Neal, 2000):

> There is nothing in my staff's monitoring report that suggests to me that the project was not implemented as planned, and that the results of the project were what we had expected.

Solutions

- Planning documents must disclose all potential significant impacts.
- Planning documents must provide detailed discussions and mitigation measures for all reasonably foreseeable impacts.
- Planning documents should include a means for evaluating and reporting project expenditures and outcomes, to be used in determining project effectiveness and in adjusting plans and policies.

Planning documents must be site-specific.

Project decisions require site-specific compliance with the NEPA, which are appealable under 36 CFR 217. Requirements for site-specific analysis of noxious weed treatments is also included in the scope and requirements of the 1988 Region 6 FEIS for Managing Competing and Unwanted Vegetation (Forest Service, 1988), the Mediated Agreement (1989) and the subsequent Forest Service Guide to Conducting Vegetation Management Projects in the Pacific Northwest Region (Forest Service, 1992). These documents all give direction for site-specific risk assessment and risk analysis.

Many laws already have been enacted with site-specific requirements for management, e.g., the Clean Water Act, INFISH (Forest Service, 1995), PACFISH (Forest Service and BLM, 1995), and Best Management Practices (BMPs). To insure effectiveness, these measures have site-specific requirements (Mosley et al., 1998). With limited resources at their disposal, failure to prioritize treatments on a site-specific basis can result in wasting funds on lost causes while other controllable plant infestations get out of control.

Decisions based on Integrated Pest Management also require site-specific measures. True Integrated Weed Management begins with an honest, unbiased appraisal of the problem, including an examination of the reasons why invasive species are out of control, and it develops a solution based on the use of all available tools, which includes prevention, site-specificity, and adaptive management designed to respond to quantifiable, repeatable monitoring.

The importance for invasive species managers to take site-specific factors into account has been confirmed by biologists (Lonsdale, 1999; Woods, 1997; Hengeveld, 1989; Chicoine et al., 1988; Tyser and Worley, 1992; Weaver et al., 1989). Furthermore, species invasions are dependent on characteristics of both the invading species as well as the invaded ecosystem (Hobbs and Humphries, 1995; Randall, 1997). Thus, site- and species-specific measures should be incorporated into invasive species management.

Solutions

- Planning documents must include site-specific analyses of the effects of all proposed chemical treatments.
- Planning documents must include site-specific analyses of the response of invasive species to alternatives.
- Planning documents must include species-specific analyses of the response of invasive species to alternatives.

Planning documents must disclose potential impacts of proposed chemical applications, along with the impacts of other alternatives.

The National Forest Management Act (NFMA) specifies regulations designed to protect resources (36 CFR § 219.11(a-c)). These regulations prohibit the kinds of adverse environmental impacts caused by off-target denudation of vegetation being caused by herbicides, as specified in 36 CFR § 219.27(a):

Each management or multiple-use prescription must: 1) conserve soil and water resources and not allow significant or permanent impairment of the productivity of the land; 2) minimize serious or long-lasting hazards from flood, wind, wildfire, erosion, or other natural physical forces; 3) maintain diversity of plant and animal communities; 4) provide for adequate fish and wildlife habitat to maintain viable populations of

> native vertebrate species; and 5) maintain air quality at a level that is adequate for the protection and use of National Forest System resources and that meets or exceeds applicable Federal, State, and/or local air quality standards or regulations (*ibid.* at § 219.27(a)).

The National Environmental Policy Act (NEPA) requires that impacts be attended to, whether through elimination, avoidance, or reduction. The Council on Environmental Quality (CEQ) has promulgated regulations implementing NEPA which all federal agencies are required to follow. Again, these regulations specify that "environmental information" relevant to federal actions must be "available to public officials and citizens before decisions are made and before actions are taken." 40 CFR § 1500.1(b).

In the case of invasive species, impacts caused by the invasion of non-native plant species, while bad, often result in a perceived need to use aggressive chemical controls with even greater negative effects, for which the need for analysis is correspondingly greater.

Forest Service planning documents are deficient in that they conceal, rather than inform, the public and decision-makers of known hazards of chemicals. According to Kovach et al., (1992):

> Because of the EPA pesticide registration process, there is a wealth of toxicological and environmental impact data for most pesticides that are commonly used in agricultural systems. However, these data are not readily available or organized in a manner that is usable to the IPM practitioner.
>
> Extensive data are available on the environmental effects of specific pesticides, and the data used in this project were gathered from a variety of sources. The Extension Toxicology Network (EXTOXNET), a collaborative education project of the environmental toxicology and pesticide education departments of Cornell University, Michigan State University, Oregon State University, and the University of California, was the primary source used in developing the database (Hotchkiss et al., 1989). EXTOXNET conveys pesticide-related information on the health and environmental effects of approximately 100 pesticides.
>
> A second source of information used was CHEM-NEWS of CENET, the Cornell Cooperative Extension Network. CHEM-NEWS is a computer program maintained by the Pesticide Management and Education Program of Cornell University that contains approximately 310 US EPA - Pesticide Fact Sheets, describing health, ecological, and environmental effects of the pesticides that are required for the reregistration of these pesticides (Smith and Barnard, 1992).

Even when sufficient information is available to base an effects analysis upon, the Forest Service is unlikely to include any information that would contradict predetermined outcomes, such as a predetermined need to treat weeds with herbicides. In this way, even the most fundamental regulations regulating the use of poisons are ignored, such as the label directions required under 40 CFR § 152.

For instance, the labels for Tordon©, a restricted-use pesticide, contain information that it is hazardous to nontarget plants, both crop and noncrop, and that it is restricted from use on subirrigated soils. Existing planning documents rarely provide an analysis of the occurrence of such plants and soils, nor possible impacts from Tordon© applications on them. Instead, existing Forest Service documents have proposed broad-scale applications, combined with vague effects analyses so that herbicide treatments will be made to appear tightly controlled by numerous safeguards and the presence of qualified personnel. Furthermore, the broad hand waving and document padding that accompanies planning documents such as those of the Okanogan NF (1997, 1999), and Colville NF (1998) is a screen to hide the lack of required analyses of significant effects.

Nor can the Forest Service claim that methods for conducting impacts analyses are unavailable. The legal requirements to provide impacts analyses in planning documents can be accomplished with standardized methods of rating chemicals (Kovach et al., 1992):

> A rating system was developed for the environmental impact quotient of pesticides called the Environmental Impact Quotient (EIQ) model, where l = least toxic or least harmful, 5 = most toxic or harmful. Data included Mode of Action, Acute Dermal LD50 for Rabbits/Rats (m&/kg), Long-Term Health Effects, Plant Surface Residue Half-life, Soil Residue Half-life, Toxicity to Fish-96 hr LC50, Toxicity to Birds-8 day LC50, Toxicity to Bees, Toxicity to Beneficials, Groundwater and Runoff Potential . . .
>
> The impact of pesticides on terrestrial systems is determined by summing the toxicities of the chemicals to birds, bees, and beneficial arthropods. . . .. . . After the data on individual factors were collected, pesticides were grouped by classes (fungicides, insecticides/miticides, and herbicides), and calculations were conducted for each pesticide. When toxicological data were missing, the average for each environmental factor within a class was determined, and this average value was substituted for the missing values. Thus, missing data did not affect the relative ranking of a pesticide within a class. . . .

At the end of the process, Kovach was able to provide meaningful, quantified figures for the total impact of each alternative:

> *Traditional Pest Management Strategy* - Total Environmental Impact = 938
> *Integrated Pest Management (IPM) Strategy* - Total Environmental Impact = 167

The lack of impacts analyses in planning documents is due not to a lack of impacts, nor to a lack of standardized methods, but to a lack of integrity on the part of the Forest Service to provide honest, unbiased effects documentation. The logical solution is for Congress and the Regional and National offices to withhold funding for such duplicitous efforts and instigate oversight procedures for cases of obvious misconduct and dereliction of responsibility.

Herbicides used by the Forest Service should have completed registration profiles required by the EPA. Yet when EPA studies present equivocal results, the Forest Service consistently fails to disclose those effects in planning documents. Current documentation is unreliable or lacking for many of the potential effects of herbicide formulations. Newly emerging evidence points to a number of subtle, but pernicious effects on the environment from the carriers included in an herbicide’s formulation as “inert ingredients”.

Surfactants labeled as “inert” constituents of herbicide formulations are now believed to behave as endocrine-disrupting compounds in wildlife and humans. Cumulative effects of multiple chemicals used over time have rarely been analyzed. In addition, the identity of formulations containing “inert” ingredients has been kept as a trade secret from the public, in violation of NEPA disclosure requirements.

A 1996 ruling by District of Columbia Federal District Court found that pesticide manufacturers’ concealment of the identity of “inerts” as “trade secrets” was unsubstantiated (*NCAP et al. v. Browner*, 1996). In addressing the case brought by Northwest Coalition for

Alternatives to Pesticides (NCAP) and National Coalition Against the Misuse of Pesticides (NCAMP), the court opinion clarified that these chemicals are not exempt from the Freedom of Information Act.

In *NCAP et al. v. Browner,* the Court ruled that EPA must disclose secret ingredients in pesticides. The ruling protects the right of public access to secret chemicals in pesticides by requiring the EPA to provide information about the identity of so-called "inert" ingredients in pesticide products.

Unfortunately the ruling came too late to classify the risks of harm from hundreds of project plans based on incomplete testing of the environmental and health effects of only "active" ingredients. Since pesticide manufacturers were not required to reveal the identity of "inert" ingredients before 1996, the toxicity of formulations applied on the ground was generally not analyzed in documents prepared before that time. Pesticides also are generally not tested for synergistic or cumulative effects, are inadequately tested for neurotoxicity and immunotoxicity, and only recently have begun to be tested for their ability to disrupt the endocrine system.

The so-called "inert ingredients" revealed following this decision (*NCAP et al. v. Browner*), have been shown in some cases to be more toxic than the active ingredients. According to the EPA web site (www.epa.gov/opprd001/inerts), a chemical that is an active ingredient in one pesticide product may be considered an "inert" in another. The toxic nature of full herbicide formulations has not been adequately disclosed as required by NEPA. Instead, the disclosure of harmful effects from herbicides had to wait for citizens, such as this statement presented to the Forest Service by O'Brien (1997):

> The Region 6 herbicide information profile for picloram indicates that . . . 'No ingredient in any picloram formulations was categorized by EPA to have evidence or suggestion of toxic effects.' In fact, Region 6 doesn't know what is in Tordon K or Tordon 22K, but published its assurance of low concern on the fact that Tordon's inert ingredients are either on List 4 of inerts, which are generally recognized as safe, or on List 3, which [Forest Service] Region 6 characterized as being, 'low priority for health effects testing based on absence of data or chemical structures that would indicate toxic effects.'
>
> This is not true. But List 3 is the list of "Inerts of Unknown Toxicity". As Holly Knight, an intern at NCAP discovered, 1,981 pesticide inerts hide on List 3, including 264 pesticide active ingredients, some of which are known to be highly toxic, including naphthalene (which can cause brain damage, convulsions, and death in children), chlorothalonil (a probable carcinogen), and chloropicrin (a respiratory tract irritant that can cause asthma). Other inerts that are not active ingredients are likewise well known to be of toxicological concern.
>
> In other words, what you don't know about the constituents of Tordon K or 22K, or any other pesticide formulation could adversely affect your workers, wildlife, and humans who are exposed in water, air, or food to these chemicals.
>
> Even if you do know what you are spraying, you do not necessarily know how the different formulation components interact. For instance, you know that Roundup contains a surfactant in addition to the active ingredient, glyphosate. A surfactant enhances contact of the active ingredient with the plant's surface cells. Does it enhance uptake of glyphosate by cells in wildlife or the workers spraying it? Since chronic effects testing is not required for full

> formulations, you know little about the consequences of exposing wildlife or workers to the combination of glyphosate and a surfactant.

On January 12, 1998, NCAP issued a press release for the report, "Toxic Ingredients Hide as 'Inerts' in Pesticides" (available at www.pesticide.org/), which stated:

> Over 650 chemicals that have been identified as hazardous by federal, state, or international agencies are hiding behind the misleading word "inert" in pesticide products, according to a report released today by the Northwest Coalition for Alternatives to Pesticides. "Worst Kept Secrets: Toxic Inert Ingredients in Pesticides" documents the hazards of so-called "inert" ingredients, over 2,500 substances that are added to pesticides but are not named on product labels. Regulatory agencies have few requirements for toxicological or ecological effects testing of inerts. Despite this lack, the new report shows that over 25% of the chemicals used as "inerts" actually have been identified as hazardous.
>
> Inerts pose a wide variety of hazards, according to the new report. Almost 400 inert ingredients are now or have been used as the active, killing ingredient in pesticides. In addition, 209 are hazardous air or water pollutants, 21 have been classified as carcinogens, and 127 are occupational hazards. Many have been identified by more than one statute or agency. For example, the "inert" ingredient naphthalene is a pesticide active ingredient, a hazardous air pollutant under the Clean Air Act, and a priority pollutant under the Clean Water Act.
>
> 'Full possession of the facts is absolutely necessary,' says Holly Knight, of the Northwest Coalition for Alternatives to Pesticides (NCAP). 'These toxic chemicals cannot continue to hide. Our right to know the identity of these poisons must be honored.'

NCAP's report recommends that all pesticide ingredients be fully disclosed on product labels. In addition, all health and safety testing required for pesticides should use the complete pesticide product, including all so-called "inert" ingredients.

The decision to continue the use of herbicides without analyses of "inert" ingredients appears to be an arbitrary and capricious decision by the Forest Service. Now that herbicide formulations have been shown to contain toxic ingredients which formerly masqueraded as "inert", the use of planning documents which ignore those effects violates NEPA disclosure requirements. As described by NCAP's Grier (1994):

> Most safety tests for pesticides are made only on the active ingredient and not on the whole product. "inert" ingredients can be more toxic than the active ingredient and comprise up to 99% of a pesticide product. "inert" ingredients are any of over 2,300 substances that are added to pesticides but are not named on product labels. Despite their name, they are neither biologically, chemically, or toxicologically inert. According to the EPA web site (www.epa.gov/opprd001/inerts), a chemical that is an active ingredient in one pesticide product may be considered an "inert" in another. Furthermore, the toxicity of most of the "inert" ingredients allowed by the EPA in registered pesticides is unknown. So-called "inert" ingredients laws allow the application of toxic compounds such as kerosene, diesel fuel or fungicides

to be used as 98% of a mixtures application rate.

Planning documents are also required to analyze the impacts of cumulative and indirect effects. Cumulative effects can result from several causes: (1) ecosystem characteristics will change as a result of prior treatments, with some species becoming less frequent and others acquiring resistance to chemicals; (2) chemicals will accumulate over time in different parts of the environment; and (3) the combined effect of chemical combinations may be more potent than the sum of each chemical used individually (synergism).

The harmful effects of synergism documented in recent studies must be taken into account in planning documents. For instance, in acute toxicity tests of Rodeo©, with X-77 Spreader© per label recommendations, effects on salmonids can be seen between 120 to 290 ppm (Mitchell et al.,1987; Wan et al.,1989), with differences between species. Sublethal effects of glyphosate on fish include erratic swimming, labored breathing, altered feeding, migration and reproduction, and an increased likelihood of being eaten (Morgan et al.,1991; Liong et al.,1988). The acute toxicity of the formulation Roundup©, which uses added surfactants was studied on sockeye salmon, rainbow trout and coho salmon (Servizi et al.,1987). This study found that the combined effect of glyphosate and surfactants POEA and MON0818 were synergistic, e.g., their combined activities were,

> . . . more than additive and this raises doubt that the LC50s [concentration required to kill half of the test group] reported for Roundup© in reconstituted water are applicable to natural waters.

In fact, MON0818 surfactant was found to be much more toxic than glyphosate alone. Surfactants were found to result in up to a 400-fold greater toxicity to sockeye salmon fry than glyphosate alone (Monroe, 1988). Martinez and Brown (1991) found that in doses of 1.03g/kg, the surfactant POEA has serious pulmonary toxicity; when combined with the full formulation as Roundup©, it produced 100% death in rat subjects within 24 hours.

Bidwell and Gorrie (1995) showed that tadpoles, which respire with gills, were much more sensitive to the full formulation of Roundup© than adult frogs, and were considerably more sensitive to the formulation Roundup© 360 than to technical grade glyphosate. A possible mechanism of action involves surfactant damage to the gill membrane. LC50 values for adult frogs indicate there may be very little safety margin between concentrations they found in shallow water and lethal concentrations. In general, gilled species were found to be more susceptible to formulations with added surfactants, and existing animal models may not be applicable to specific situations (Rankin et al.,1982).

Case example: Appeal of the Okanogan NF Environmental Assessment (1997) for inadequate disclosure of effects

Risks from the herbicide picloram have resulted in recommendations from the EPA to withdraw its registration; however, neither the EPA recommendations nor the risks appear in Forest Service sanctioned specimen labels, (e.g., the specimen label for Tordon 22K© , revised 05-24-00). Neither are the risks disclosed in the Okanogan National Forest’s Environmental Assesments (EAa) on noxious weeds (1997, 1999, 2000).

Yet the risks of picloram harm to non-target plants is extremely high, as shown by the following EPA Ecological Effects Branch (EEB) recommendations to withdraw its registration (Abramovitch, date unknown):

> Due to the extreme phytotoxicity, its persistence under typical environmental conditions, and its extreme propensity to leach into groundwater in all soil types, the EEB is strongly recommending against the reregistration of all active ingredients of Picloram. This conclusion is based on the extreme exceedance of the acute levels of concern for non-endangered and endangered terrestrial plants. The risk quotients (RQ) are exceeded as follows for the various application methods. . . .
>
> . . . In 1989 EEB received incident data from a private citizen who cited 30 incident reports of plant damage resulting from surface runoff or leaching into groundwater. Based on these reports, EPA is requesting additional phytotoxicity data for potatoes and other sensitive crops including tobacco, soybeans, corn, pasture, watermelons, tomatoes, bell peppers, and hay. Further, there are sufficient data to state that picloram will likely cause serious adverse effects in nontarget terrestrial plants. These additional data are confirmatory and will support our risk assessment.

This call was repeated by the Chief of the EPA Ecological Effects Branch (Maciorowski, date unknown),

> Based on all available data EFGWB believes that picloram should not be reregistered because its use would pose unreasonable adverse effects to the environment. Because of picloram's mobility in all soil types and its persistence under normal ambient conditions, no practical use restriction can prevent it from contaminating the environment surrounding the target site.
>
> Picloram is among the most mobile of all currently registered pesticides. To date, picloram has been detected in ground water in 11 states including Iowa, Kansas, Maine, Minnesota, Montana, North Dakota, South Dakota, Texas, Virginia, Wisconsin, and Wyoming (Hoheisel et al.,1992; Williams et al., 1988). Concentrations in ground water range up to 49 ppb, which approaches 10 percent of the 500 ppb MCL [mean lethal concentration]. In addition, hexachlorobenzene is a contaminant of picloram production and is present in technical picloram at a maximum of 200 ppm and is a class B2 carcinogen with a MCL of 1 ppb.

Presently, picloram is registered as a restricted use pesticide and there are serious considerations that must be adhered to in its use, which were not included in Forest Service planning documents (Okanogan NF, 1997). These considerations appear to have been ignored in the use of using the herbicide near a high water table (Photo 4, p. 3) and in areas grazed by livestock (Photo 1, p. 3) where they may be later transferred to crop areas.

The lack of disclosure of picloram's negative effects to wildlife, plants and soils were brought to the attention of the Forest Service in a notice of appeal filed on October 10, 1997, by the Lands Council, Kettle Range Conservation Group, Methow Forest Watch and the Leavenworth Audubon Adopt-A-Forest:

> The FEIS, the Mediated Agreement (1989) and the Guide give direction for site-specific risk assessment/risk analysis, but that direction was not followed in the ONF EA. Herbicide profile information is not included in the EA. The USDA Forest Service rating of marginal adequacy for the quality of health effects testing for the proposed herbicides, picloram and glyphosate, is not included in the EA or discussed. Inert ingredients are not disclosed, when even the EA acknowledges that, "Technical grade glyphosate was less toxic (LC 50,140 mg/L), than Glyphosate formulations or the surfactant (LC50, 2 mg/L)

> (sic)". The significant 1996 amendment to the Federal Insecticide, Fungicide, and Rodenticide Act is not included or acknowledged as a reference (EA p.9).

In appealing the EA, the groups reminded the Forest Service that analyses must be available for public review. In defiance, the appeal was denied by the Regional Forester and the required analyses were never provided.

Case example: Boulder Creek on the Okanogan NF in Washington

The Environmental Assessment on noxious weeds (Okanogan NF, 1997) was accompanied by a Biological Evaluation (BE) (Molesworth, 1997) that determined, without substantial review, that there would be "no effect" from the chemical treatment of nearly 6,000 acres in the project.

No damage thresholds or risk analyses were presented for the herbicide applications. The EA presented biased effects analyses and failed in some cases to follow its own prescriptions, for instance in implementing treatments in violation of label directions. The EA failed to disclose important effects information provided by the Washington office (Syracuse Environmental Research Associates, 1996):

> The primary hazard to non-target terrestrial plants is from unintended direct deposition or spray drift. Unintended direct spray will result in exposure equivalent to the application rate. As discussed in the dose-response assessment for terrestrial plants (Section 4.3.3), such exposures are likely to result in adverse effects to a number of plant species. . . .
>
> . . . Direct deposition, either through unintentional direct spraying or spray drift does present a plausible hazard. If plants are accidentally sprayed at the application rates used by the Forest Service, they are likely to be damaged, particularly in the upper ranges of anticipated application rates. This kind of exposure may be regarded as an accidental scenario, which is relatively easy to control with proper management and application. The extent and duration of damage will depend on the time of application and plant species. . . .
>
> . . . (1992), this could damage some sensitive plant species. . . .
>
> . . . Glyphosate can reduce the emergence and weights of progeny seedlings on crops such as corn, soybeans, and Johnson grass (Jeffery et al., 1981). It is not clear whether this effect is caused by direct toxic action on the seeds or simply reduced vigor in the parent plant as the seeds develop. . . .
>
> . . . Gross signs of toxicity, which may not be apparent for 2–4 days in annuals or for more than 7 days in perennials, include wilting and yellowing of the vegetation, followed by browning, breakdown of plant tissue, and, ultimately, root decomposition. . . .
>
> . . . In addition to these laboratory bioassays, there are several field studies that have assessed the effects of glyphosate on terrestrial organisms (Appendix 2-2). . . In most cases, the effects noted were changes in population density that reflected changes in food availability or suitable habitat. . . .
>
> . . . Glyphosate residues or perhaps residues of adjuvants used with glyphosate have been shown to affect grazing preference in cattle (Jones and Forbes, 1984) but not sheep (Kisseberth et al., 1986).

Thus it came as no surprise when the application ended up causing significant off-target damage to native plants (Wooten, 1999d; Photo 2, p. 3), and in causing increased erosion and sedimentation in aquatic areas with listed fish species.

Case example: Boulder Creek on the Okanogan NF

The Okanogan National Forest Environmental Assessment (EA) on noxious weeds (1997) did not avail itself of the many references on documented effects of the herbicide glyphosate on ecosystems. Instead, the EA listed Folmar et al., (1979) and Newton et al., (1984) as their sole references. The Biological Evaluation (BE) (Molesworth, 1999) concluded that the herbicides would have "no effect" on listed species:

> Hand application of glyphosate within the buffers, the spill plan and mixing requirements, the small amount of herbicide near water at any given time, the rapid dilution of chemicals if they do enter the water all keep the potential effect to listed fish at a non-measurable level. Any herbicide that does enter the water should be an insignificant amount.

A more careful reading of the cited references might have resulted in a different conclusion, however no analyses were presented to indicate that the references were substantially considered.

In the 1984 report by Newton, glyphosate residues and metabolites were evaluated in a forest brush field on the Oregon coast range. Concentrations were higher and more persistent in sediment than in water. Early stream-bottom samples reflected concentrations found in the streamwater, but later samples showed that even the water concentrations occurring below the detection limit could contain enough glyphosate to contribute to adsorption by sediments. Of particular interest was the author's finding that residues (of glyphosate) in animals may remain detectable for several months. Concentrations in viscera were always higher than those in the remainder of the animal. Even though the EA and BE listed this as a reference, the lack of this information in the EA and BE indicate that it wasn't considered or read.

The findings of Newton should have been enough to garner a determination that the project "may affect" threatened or endangered species. In fish exposed to 2.0 mg/L of Roundup© (another glyphosate formulation) the fillets contained 80 mg/kg of glyphosate and the eggs contained 60 μg/kg. Roundup© is four times more toxic to rainbow trout fry and fingerlings than to larger fish. Significant increases in stream drift of midge larvae were observed after the 2.0 mg/L of Roundup© treatment. The toxicity of Roundup© to rainbow trout and bluegill increases with increasing temperature. Roundup© was about twice as toxic to rainbow trout at 17 degrees C than at 7 degrees C. It is also more toxic to bluegills at 27 degrees C than at 17 degrees C. Roundup© was more toxic to rainbow trout and bluegills at pH7.5 than at pH6.5. Technical glyphosate was less toxic to fish at a higher pH, but the surfactant appears to be more toxic at the higher pH. Solutions of Roundup© aged for up to 7 days in reconstituted water at 12 and 22 degrees C did not change in toxicity to midge larvae, rainbow trout, or bluegills. Applications of Roundup© to ditchbanks near aquatic ecosystems may be hazardous to resident fauna, particularly if the water temperatures are elevated or the pH exceeds 7.5. This is important because glyphosate causes water temperatures to increase for several years following treatment (Holtby and Baillie, 1987).

Since the publication of Newton in 1984, reports of the toxicity of glyphosate formulations on fish and wildlife have become more widespread in the scientific literature. The Forest Service was given ample information through publicly submitted scoping comments on the EA to avail themselves of this literature, yet they chose to ignore it and implement the project without full disclosure, in violation of National Environmental Policy Act (NEPA) procedures, and Endangered Species Act (ESA) consultation procedures.

Solutions

- Planning documents must disclose and analyze the full range of potential impacts.
- Planning documents must present the full range of potential outcomes, pro and con.
- Planning documents must disclose and analyze the full range of potential environmental effects of proposed chemical applications.
- Planning documents must disclose and analyze the full range of adverse effects on humans resulting from proposed chemical applications.
- Planning documents must be comprehensive; issues analyzed must address the full scope of project impacts; all known cumulative and indirect effects must be disclosed and analyzed.
- Planning documents must include a comprehensive list of citations referenced in effects analyses.

Decisions must not be biased toward the choice of a predetermined alternative.

The lack of integrity in some government decisions has been ascribed to the rigid military environment which governs conduct in some agencies (Hobbs and Huenneke, 1992):

> Staff in charge of data collection and interpretation have become so fearful of criticism that all negative connotations in their data are anticipated and counteracted prior to public release. This is unfortunate, in that the attachment of value judgments should follow, not precede data interpretation. The fault lies partly in our system, which assigns funding priority based on target attainment, and reinforces a military-like code of conduct to punish any case where the public complains. Managers need to be free to state facts as they are, and realize that; 'any disturbance and any management regime will be good for some species and bad for others.'

Addressing the Forest Service on their bias, O'Brien (1997) noted,

> . . . (i)t is intriguing to contemplate how the Forest Service would approach its management of the public's National Forests differently if the agency knew that it would no longer have herbicides available. The simple availability of herbicides is a siren song to continue noxious weed-favoring activities.

Biased decisions are blatantly evident to the public in recently prepared planning documents from the Forest Service (Okanogan NF, 1997, 1999; Colville NF, 1998; Wallowa-Whitman NF et al., 1998; Deschutes NF, 1998; Santa Fe NF, 2000). There is an unstated bias that favors the use of chemicals over other alternatives.

These documents used anecdotal comparisons of chemical and non-chemical treatments that often amounted to little more than conjecture. Data used for comparisons was often unsubstantiated. The range of alternatives presented was unreasonable, and the outcome was guaranteed by making exaggerated claims of environmental catastrophe resulting from non-chemical alternatives. In comparison, effects ascribed to chemical alternatives were minimized and inaccurate, if not completely ignored. Chosen actions were not based on rational evidence, and the public was misled into false beliefs about agency competency.

The buzzword in all these projects has been the claim that they are using "Integrated Weed Management". However, true Integrated Weed Management (IWM) begins with an honest, unbiased appraisal of the problem, including an examination of the reasons why invasive species are out of control, and then develops a solution based on the use of all available tools, which includes prevention, site-specificity, and adaptive management, in response to quantifiable, repeatable monitoring.

In contrast to the use of true IWM, the documents above are deficient in their analyses of undesirable effects of chemical treatments but spend an inordinate amount of time demonizing weeds in a way that appears to justify the benefits of short-term chemical treatments (resulting in the unstated need for long-term program funding for herbicide projects). The Okanogan NF (1997, 1999, 2000) readily listed the harmful environmental effects resulting from invasive species, including loss of native communities, loss of endangered species and loss of wildlife habitat. The remedies for these problems are obvious—removal of noxious weeds. Yet this solution is often complicated. The majority of weed populations are not pure infestations, and any non-specific measures will result in killing as much or more native species during the weed removal process.

Following short-term removal of weeds and off-target species, the result may be an environment of unstable denuded, soil, which is highly susceptible to re-infestation from the existing seed bank. The site may become too harsh for revegetation using native species, requiring that restoration be accomplished by encouraging rhizomatous species to take over, perhaps followed by reseeding with "beneficial" species such as timothy, orchard grass, Kentucky bluegrass, and Dutch clover. Yet these "beneficial" European species can be more invasive than the weeds replaced and are relished by livestock for their high protein content.

The result of such short-term treatment is that either the site gets worse, or it becomes converted into pasture, which rapidly becomes denuded again as livestock and wild ungulates are preferentially drawn to the palatable forage. In the process, soil quality worsens, and it becomes more disturbed and erosive—perfect conditions for initiating a new round of weed invasion, brought by seeds carried on livestock and wildlife. This cycle of ever-worsening invasion effects and stock-mediated reinfection has brought many acres of rangeland in the western states to a state of near or total ecological collapse (Belsky and Gelbard, 2000).

Prevention measures are rarely discussed in planning documents, an effort that tends to isolate chemical treatment as the "best alternative". Indeed, planning documents such as the weed treatment EA on the Okanogan NF (1997) summarized this biased viewpoint on p. 87 to be,

> Chemical treatments would provide a much increased long term noxious weed control success [*sic*].

Translated into terms that have meaning for program managers, this means that the need for chemicals (and project funding) will continue indefinitely. Programs must stop basing their actions on inappropriate goals (obtaining funding) and start basing their actions on goals that seek to effectively control invasive species, as summarized in Hobbs and Huenneke (1992):

> Nearly all systems are likely to be nonequilibrial in the future; we must be activists in determining which species to encourage and which to discourage. We cannot just manage passively, or for maximal diversity, but must be selective and tailor management to specific goals.

Case example: Untested assumptions and biased analyses

In justifying weed "treatments", the noxious weed Environmental Assessments (EA) from the Okanogan NF (1997, 1999) and Wenatchee NF (1998) cited Lacey et al. (1989) who demonstrated that surface runoff and sediment yield was higher in areas infested with spotted knapweed, *Centaurea maculosa*, than in areas occupied by native bunchgrasses. Although the study controls using bare ground did not account for bunchgrass basal area nor use repeatable metric measures for the independent variable of vegetation cover, the paper nonetheless was used to claim that soil erosion would be lower where weed treatment and successful revegetation (with forage grasses) occurred. (Okanogan NF, 1997, p. 94, 98, 103).

The EA then built upon this assumption by adding that the restoration seedings would effect restoration of the site, resulting in an "increase in native plant populations and grasses." In reality, the revegetation attempts failed in many instances, as corroborated by an independent photographic survey of the area (Photo 1, p. 3; Wooten, 1999d) as well as photographs taken by the Forest Service (Bennett, 1999). This could be due to several reasons: (1) because cattle grazing is nearly ubiquitous on the Forest and the young seedlings of European grasses were hungrily devoured (Photo 1, p. 3); or (2) because the seeds fell on unproductive soil and never germinated; or (3) because the seeds were never planted as stated.

The implication that native bunchgrass communities and soil stability would benefit from herbicide treatments was a naive assumption, and in fact the herbicides destroyed native species at a much higher rate than weeds were killed as documented in the photographs (Wooten, 1999d).

Case example: Use of research with untested assumptions

In dealing with the weed Dalmatian toadflax (*Linaria dalmatica*), the Wenatchee NF Environmental Assessment (EA) on noxious weeds (1998, p. 36, 47) concluded that mechanical treatments would be ineffective or would even stimulate weed growth, thus mandating that herbicides be used as a method of first choice. This conclusion was supported in the EA by a study by Harrod (1989).

However, in an independent, controlled study of the effectiveness of hand pulling Dalmatian toadflax, Jeffries (2000) found that hand pulling was very effective and resulted in a reduction of over 96% of toadflax plants with very little tendency to re-sprout from seed or root fragments. Furthermore, Jeffries found that many other methods were also effective against toadflax, including mowing, burning, and sheep grazing.

This demonstrates how the Forest Service uses research as a tool to skew projections, rather than as an unbiased estimate of likely results.

The Harrod study made a number of assumptions that should have been discussed in the EA. Harrod stated that toadflax was not palatable to livestock, however in contrast, Jeffries found that sheep seek it out. Harrod's study did not describe how hand pulling was accomplished; yet concluded that hand pulling was ineffective. In contrast, Jeffries notes that if the crown is removed, the plants cannot resprout in the time period observed by Harrod.

Case example: Failure to disclose information results in biased decision

In an appeal of the Environmental Assessment, Decision Notice, and FONSI for the 1999 Okanogan NF Integrated Noxious Weed Management Program, (Lands Council et al., 1999) the appellants noted that:

> The Purpose of the Integrated Weed Management (IWM) Project is to treat 15 sites that have noxious weeds, including riparian areas. The Okanogan NF attempted and failed to disclose why Alternative C was chosen over Alternative B. By selectively evaluating the two alternatives without a full analysis of treatment effectiveness, cost, and ability to maintain watershed integrity, the Forest has biased its Decision.

Appellants rightfully contended that the analyses in the EA were incomplete, since under Alternative C, herbicides would also kill substantial numbers of non-target species, whereas Alternative B would primarily only kill those species that were accidentally trampled or uprooted during treatment. The failure to compare the effects of these two alternatives fairly may have swayed the decision-maker to choose the alternative that was falsely portrayed to have less effects on native plants.

Case example: Boulder Creek on the Okanogan NF in Washington

Three alternatives were presented by the Okanogan NF EA on noxious weeds (1997): Alternative A was no-action, Alternative B was no chemicals, and Alternative C was to use chemicals on 50% of the infested areas. In efforts to make the predetermined alternative appear more favorable, the EA used a number of biased statements:

The EA claimed that, "areas that would be successfully treated would provide more native vegetation and thus be beneficial to wildlife." (p. 112). Yet the EA failed to mention that herbicides would denude the roadsides of native vegetation *as well*, during typical applications (Wooten, 1999d; Photos 2, 4, p. 3).

The EA is quick to point out the insidious nature of noxious weeds wherever possible, while ignoring the same effect when it is likely to happen from herbicide treatments, e.g., the following statement about aquatic habitat: "noxious weeds hinder the following objective: Maintain and restore the sediment regime under which aquatic ecosystems evolved." (p. 104). Thus, Alternative A (no treatment) was rejected because (p. 106),

> . . . this alternative would not meet the objectives of the Aquatic Conservation Strategy listed above because of the possibility of increased sedimentation and decreased water quality, and the threat to native riparian vegetation by noxious weeds.

The EA failed to mention that erosion and siltation would be greater, at least in the short term, in the chosen Alternative C, because the herbicides, being non-specific, would kill both weeds *and* native vegetation. This would result in increased erosion and siltation into aquatic areas over that in Alternative A, as a result of removing the protective cover and rooting along streambanks This is just what happened; the herbicide treatments killed far more native vegetation than weeds (Wooten, 1999d; Photo 4, p. 3), perhaps aided by pesticide resistance in the weed species (Photos 3, 4, p. 3).

Instead, Alternative C was chosen because (p. 107):

> . . . (t)his alternative would improve water quality by controlling noxious weed populations contributing to sedimentation. This alternative would improve fish habitat by improving the sediment indicator.

The EA was disingenuous when it attributed significant impacts (loss of vegetation) to a hypothetical scenario in Alternative A, while ignoring those same, well-documented and likely impacts in the chosen alternative, as borne out by actual results. When this was pointed out to the Forest Supervisor, the response was to brush off concerns (O'Neal, 2000) based on a single instance of "monitoring" from a staff report (Bennett, 1999) that was performed after the fall season (October 12) and too late to observe effects. Yet the Forest Supervisor is still convinced that,

> **There is nothing in my staff's monitoring report that suggests to me that the** project was not implemented as planned, and that the **results of the project were what we had expected** [*sic*; *emphasis ours . . . a subconscious slip of the pen?*].

The EA had little to do with fulfilling the NEPA. It was used as an effective tool for biasing the decision and hoodwinking the decision-maker, despite public skepticism from the evidence, and hard evidence to the contrary (Photos 2, 3, p. 3; Wooten, 1999d). As performed by the Okanogan NF, the "treatment" is the real threat to native plants and riparian habitats, as much or more than the noxious weeds.

True Integrated Weed Management (as opposed to the "IWM" used by the Okanogan NF) manages invasive species within a framework of ecosystem management. It begins with an honest, unbiased appraisal of the problem, including an examination of the reasons why invasive species are out of control, and develops a solution based on the use of all available tools, which includes prevention, site-specificity, and adaptive management, in response to quantifiable, repeatable monitoring. In contrast, the alternative chosen in the EA was based on inaccurate projections and incorrect environmental effects analyses.

In the case of the Boulder Creek road slopes, the problem is not noxious weeds; it is erosion into the stream caused by the road and livestock being in too close to riparian habitats. The EA was not true IWM; the plan was biased, it didn't examine the causes of the problems, it avoided preventive measures, it did a poor job of incorporating monitoring into the management system, and it relied primarily on herbicide treatments rather than using all available tools. The EA overtly attempted to debunk any treatment other than herbicide and was driven by a biased motive to force the selection of a predetermined alternative.

The risks of ground-based herbicide applications exceeding damage thresholds to nontarget species was not presented. Effects analyses were biased, treatments analyzed were not the ones that occurred, and different herbicide formulations were used from ones specified in the EA. The EA provided unreliable information about the impacts of herbicide applications on the Okanogan NF.

In the zeal to obtain project funding on the Okanogan NF, the EA biased the discussion of impacts and failed to disclose the actual harm that would occur to aquatic habitat from increased erosion due to the off-target herbicide killing of valuable streambank vegetation. The Forest should consider performing a comprehensive restoration program designed to correct or prevent the damage caused by weeds, livestock, roads, and now herbicides on the National Forest. The EA wasted the allocated funds and should serve as an example of how **not** to manage invasive species.

Solutions

- Decisions must not be biased toward the choice of a predetermined alternative.
- Planning documents should analyze studies that offer different viewpoints.
- Project objectives should follow the goals of an effective system of invasive species management.
- Projects should follow a process of true Integrated Weed Management, which begins with an honest, unbiased appraisal of the problem, including an examination of the reasons why invasive species are out of control. Actions should be developed based on the use of all available tools, including prevention, site-specificity, monitoring and adaptive management.
- Invasive species management projects should incorporate the results of monitoring. Monitoring should include operational indices such as the ratio of increasers and decreasers used in range management.
- Ineffective programs should be replaced with comprehensive restoration programs that address and correct the causes of plant invasions, while preventing further damage caused by invasive species and inappropriate treatments.

Planning documents must be prepared by qualified personnel, and based on a thorough review of up-to-date scientific studies.

Recent Forest Service planning documents have relied on outdated procedures prepared by unqualified personnel. For instance, the Wenatchee NF prepared an 200-page

Environmental Assessment for noxious weed treatments (1998), in which a mere two paragraphs relating to the health impacts of herbicides concluded that there was, "little to no risk to human health as the result of proper application of these chemicals". None of the writers claimed medical or chemical expertise.

Forest Service personnel are discouraged from providing references that might contradict their agency's agenda to use herbicides without adequate review. The Washington Office of the Forest Service funded an extensive review of research on the effects of glyphosate (Syracuse Environmental Research Associates, 1996); however, individual Forests appear oblivious to this resource available within their agency and fail to cite it in planning documents proposing the use of the herbicide (Okanogan NF 1997, 1999; Colville NF, 1998; Wenatchee NF, 1998). A letter from the Washington Office (McDougle, 1999) makes it apparent that the Washington Office does not actually want Forests to have new information that implicates adverse effects from glyphosate, and in fact, that they blocked a request to provide an additional 78 references to glyphosate toxicity to humans and the environment.

On the Santa Fe NF (2000), agency personnel used a risk assessment procedure based on outdated studies from the 1980s in their noxious weed EA. If Forests are going to rely on outdated data, then it should be only because current data is unavailable. In any case, there needs to be a far greater margin of safety incorporated into actions. According to Tickner (1997):

> Given the limitations of science to address emerging environmental problems, such as endocrine disruption, there is a significant need for the development of new public policy approaches to anticipate and prevent harm to human health and the environment. The question of what society should do in the face of uncertainty regarding cause and effect relationships is necessarily a question of public policy, not science.
>
> Several policy analysts confronted with this problem have proposed a concept called the "precautionary principle" or the "precautionary approach" (Cameron and Abouchar, 1991; Dethlefsen, 1993). At the center of the precautionary principle is the concept of taking anticipatory action in the absence of complete proof of harm, particularly when there is scientific uncertainty about causal links (Jackson, 1993). The precautionary principle states that decision-makers should act in advance of scientific certainty to prevent harm to humans and the environment (O'Riordan and Jordan, 1995). It addresses many of the limitations of current decision-making methods, such as type II errors, problems of cumulative effects, and limitations of science. Precautionary approaches are goal oriented, lending themselves to technology innovation, pollution prevention, and facility planning.

In the above Forest Service examples, qualified experts in the fields of risk management, medicine, chemistry, or pesticide applications were not consulted, and available studies were either misinterpreted, misapplied or ignored. While Forest Service expertise can be helpful, a lack of qualifications does not excuse an agency from its legal responsibilities. Indeed. legal requirements, such as the National Environmental Policy Act, are frequently disregarded or ignored. In 1984, Judge James Burns found that the Region 6 Forest Service and Oregon BLM illegally relied on EPA registration when an independent environmental assessment is required (*NCAP v. Block*).

In recommending changes to the National Forest Management Act (NFMA), the Committee of Scientists (1999) recommended that the Forest Service should establish a science and technology advisory board with a primary goal of helping collaborative planning become a reality on the national forests and grasslands. This board would provide highly qualified and independent advice to the Forest Service to assure that the most current and complete scientific and technical knowledge is used as the basis of land and resource management.

Case example: Label violations

The Okanogan NF Environmental Assessment (EA) on noxious weeds (1997) proposed treatment of nearly 6,000 acres of weed infestations with herbicides. A Biological Evaluation (BE) (Molesworth, 1997) prepared for the EA concluded that in order to protect threatened and endangered anadromous fish, the herbicide formulation would have to be changed, in violation of label directions (Washington Department of Agriculture Case No. 0515C-99).

The label violation is by itself alarming. However, in trying to counter claims that the application's effectiveness had been compromised by violating the label directions, the Forest Service then disclosed that a second label violation had occurred, namely the use of a different pesticide than the one called for. Photographs provided by the Forest Service of riparian areas (Bennett, 1999) clearly state that Tordon 22K was used, in violation of riparian buffers set up in the EA.

As to the receipt of a Notice of Correction for not following label directions, the Forest Supervisor indicated that he did not consider this significant (O'Neal, 2000). The ready acceptance of label violations as a cost of doing business may very well be because it was actually the lesser of the second, more sinister crime—using picloram on riparian soils where it is not allowed—which was only uncovered later and is still under investigation by the Washington Department of Agriculture.

Solutions

- Planning documents should be prepared by qualified personnel.
- Planning documents that propose herbicide treatments should be reviewed by qualified medical and chemical experts.
- Planning documents must be based on a thorough, comprehensive review of up-to-date and peer-reviewed scientific studies.
- Planning documents should include references to peer-reviewed studies that provide a wide range of conclusions on potential effects.
- Risk assessments should be supplemented with precautionary principles that act in advance of scientific certainty to prevent harm to humans and the environment (Appendix A).
- The Forest Service should coordinate projects through a scientific advisory board that can offer qualified and independent advice about projects.

Section B. Projects must have goals that accomplish a stated need.

Projects which manage invasive species, must have a stated purpose and need, from which goals and objectives follow. Projects should also include benchmarks to validate whether the goals and objectives are effective in accomplishing the purpose of the project.

Despite large expenditures, invasive species are increasing beyond our means of control. The prospect of reversing this trend is not likely, even with vastly increased expenditures. Existing decisions are based on assumptions that actions will bring invasive species under control, when in fact, this hasn't happened. For the vast majority of cases, the chosen means have not justified the ends.

Because of the great deal of complexity and uncertainty that accompanies the fledgling "science" of invasive species management, it is imperative that managers err on the side of precaution, follow laws designed to protect human health and the environment and assure that decisions are made through an open public process.

As agencies gain experience in managing invasive species along with the conflict this generates in the affected public, a more solid foundation for choosing alternatives will develop. The Committee of Scientists (1999) defined the mechanism for assuring that the purpose and need for projects are being accomplished by the treatment methods used:

> Validation monitoring asks, are the basic assumptions about cause-and-effect relationships used to predict the outcomes of strategies and pathways of treatments valid?

The first step in a rational process should be to define the problem and then to clearly state the purpose and need for projects, which proposes to deal with that problem. Then, a set of goals for accomplishing that need should be stated along with a set of objectives, which accomplish those goals. Included among the objectives should be a measurable way of determining whether the goals are being met.

Presently the public interest is served at a minimum level by requiring Forests to follow NEPA procedural regulations. Until the agency becomes more accountable in reaching overall program goals, the public must rely on NEPA procedures and insist on rigid compliance with regulations. The next sections of this paper describe the need for these procedures in more detail.

Case example: Okanogan NF Weed Programs, 1997-2000.

The Okanogan NF Integrated Weed Management Environmental Assessment (EA) (2000) stated as its purpose to, "control or eliminate the existing noxious weed populations on the included sites." Essentially this same statement was included in the Okanogan NF's EAs for the 1997 and 1999 programs, which cost over $300,000. In the 2000 EA, the Okanogan NF program proposed to continue the program already begun, at the cost of $763,300 to control only 75% of the identified infestations over a five-year period.

It can safely be stated that the 1997 EA did not result in control or elimination of existing weed populations, except in a limited area of the Forest for a limited amount of time. Most of the sites treated under the 1997 EA were roadsides, because the majority of Okanogan NF weed infestations away from roads have never even been inventoried.

The purpose and need was a necessary statement which can be agreed upon by all concerned, but nonetheless complete elimination of weeds is unattainable under the methods given, except for very limited infestations of weeds, and then only until re-infestation occurs. Such a regular program for weed control is termed a *maintenance program*, and such programs are attainable only in limited circumstances. In addition, maintenance treatments typically need to be repeated every year until the seed bank is exhausted. An example of a successful maintenance program would be along railroads, where the railbed is kept in a continually sterile state though regular applications of herbicides.

The goals for invasive species management should follow from the stated purpose and need, followed in turn by objectives that can accomplish the goals. The Okanogan NF 2000 EA is a clear indication that the goals of the 1997 EA were never attained and should be revisited before proceeding further with costly approaches destined to fail. However, instead of documenting this failure through validation monitoring and adjusting the program through adaptive management, the Forest hardens its resolve to ignore all warnings and repeat its past mistakes.

Solutions

- Projects that manage invasive species must have a stated purpose and need from which goals and objectives of the project will follow.
- Projects should include benchmarks that can validate whether the objectives are accomplishing the purpose of the project.
- Projects should incorporate evaluation and reporting procedures that insure that program goals and implementation procedures conform to regional and national policies.

Action alternatives which propose herbicide use must demonstrate an overwhelming public need.

Herbicides are regulated under The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which is designed to regulate the use and safety of pesticide products within the United States. In 1972, amendments to FIFRA were passed that constituted a major restructuring of the Act to provide that the environmental harm resulting from the use of pesticides does not outweigh the benefits. Specific provisions of FIFRA require the evaluation of risks posed by pesticides.

Under FIFRA, the use of pesticides involves a weighing of both the harm as well as the benefits resulting from their use. In deciding to use herbicides, the Forest Service has a responsibility to provide risk analyses that weigh the costs and benefits of herbicides. Without a risk analysis or worst-case scenario, it is impossible to weigh the relative costs and benefits of using an herbicide.

The need for a risk-based approach was recently emphasized by the National Invasive Species Council Management and Restoration Working Group (2000):

> The effective management of invasive species depends upon several underlying capabilities: 1) the establishment of priorities based upon a science-based assessment of risks, . . .

It is unfortunate that the Forest Service does not adhere to established regulations because the combined effects of FIFRA and NEPA procedures could be a powerful tool for protecting the public and the environment. If followed, these procedures would force agency personnel to publicly reveal the potential and actual harm that their actions are causing, and thus change the system to one that benefits the public.

In their planning documents, the Forest Service frequently makes sweeping interpretations based on very limited readings of the literature without due consideration of assumptions made in those studies. Also lacking is any real attempt to find research studies which might conclude differently from the ones that give them their desired answer. The public is given the impression that herbicides are safe and are left believing that the government wouldn't let unsafe herbicides be used. Yet there are numerous situations in which the health and the environment can be harmed by pesticides that are beyond the control of the government (Diegelman in Campbell, 1998):

> Most people seriously overestimate the amount of protection given them by governments regarding pesticide safety. Congress found that 90% of the pesticides on the market lack even minimal required safety screening (American Defender Network, 1989). Of the 34 most used lawn pesticides, 33 have not been fully tested for human health hazards (Davidson, 1994). If any tests are done, they are performed by the

> chemical manufacturers, not the EPA. 'If a chemical company wanted to, they could start with a desired conclusion, and skew the data, and the EPA would never know', notes David Welch, an entomologist with the EPA's Office of Pesticide Programs. Welch did a random sampling of 15 pesticide files and found 13 without proper reviews (Sayan, 1991). One third of the most commonly used lawn pesticides were illegally registered for use. Despite the fact executives of Industrial Bio-Test labs were given jail terms for faking pesticides tests, the chemicals are still on the market (American Defender Network, 1989). Shortages in funding, personnel, and interference from business has slowed re-evaluation of these chemicals (General Accounting Office, 1993). Even when the EPA does refuse a pesticide registration, the manufacturer often files a lawsuit, which keeps the chemical on the market (Sayan, 1991).

An important scientific principle worth following is that when opinions differ, both sides get to see the other side's methodology. The practice of ignoring or concealing data that does not agree with the status quo is not only unscientific, but can lead to disastrous consequences, as explained in this story in the Bend Oregonian (Sunday, December 5, 1999):

> For decades, scientists had believed that people reacted the same way to toxic chemicals, regardless of their age. But as scientists began noticing learning disabilities in children, they suspected the old assumptions might be wrong.
>
> Then, in the 1970s, one major study after another proved children were in fact far more sensitive to lead than adults. Within a few years, scientists found they had dramatically underestimated the way lead hurts the developing brains of children.

The Forest Service has refused to consider more recent studies of supposedly "safe" glyphosate, which show it to have a death rate in humans of 10-20% during attempted suicides (Martinez and Brown, 1991). In contrast, Forest Service information on glyphosate poisonings only considers suicide attempts, not deaths (Syracuse Environmental Research Associates, 1996). The Forest Service studies have not kept pace with new information showing clear links between glyphosate and non-Hodgkin's lymphoma (NHL), such as a case-controlled study which linked NHL with exposure to pesticides including glyphosate (Hardell and Eriksson, 1999).

The justification for the use of pesticides with their proven impacts on public health simply hasn't been provided by the Forest Service. In the meantime, a new principle for protecting health and the environment has emerged as a potential tool—the precautionary principle. The precautionary principle states that when uncertainty exists about effects, potential harm should be avoided by avoiding the action. According to Rachel's Environment & Health Weekly (Montague, 1999c),

> Instead of asking how much damage or harm we will tolerate (which is the approach taken by risk assessment), the precautionary principle asks how to reduce or eliminate hazards, and it considers all possible means for achieving that goal, including scrapping the proposed activity. (Of course, alternatives to a hazardous activity must be scrutinized as carefully as the hazardous activity itself.)
>
> The precautionary principle shifts the burden of proof. Proponents of an activity should prove that their activity will not cause undue harm to human health or the ecosystem. Those who have the power and

resources to act to prevent harm have a responsibility to do so.

Case example: Okanogan NF Noxious Weed EA, 1997

Whereas Forest Service documents rarely provide risk assessments for herbicides, they are more likely to provide accounts of the risks associated with invasive species. Underlying the rationale for this is the assumption that weed control can only be accomplished with herbicides. The Okanogan NF noxious weed Environmental Assessment (EA) (1997) avoids consideration of any methods of weed control other than herbicides, and inexpensive releases of biological controls.

For instance, under the No-action Alternative, the EA warns against the likely hazards of weeds:

> This alternative [A] would not meet the objectives of the Aquatic Conservation Strategy listed above because of the possibility of increased sedimentation and decreased water quality, and the threat to native riparian vegetation by noxious weeds. [p. 106] . . . Alternative A, "may effect but is not likely to adversely effect" peregrine falcon, gray wolf, grizzly bear, northern spotted owl, and bald eagle. [p. 112]

In comparison, the use of non-chemical alternatives to control weeds is portrayed merely as ineffective:

> Weed species that are resistant to non-chemical control would continue to spread [p. 106] . . . Fish spawning and rearing habitat may be impacted slightly in the short-term due to ground disturbance caused by manual and mechanical treatments. . . . Water quality would continue to be slightly degraded by sediment from adjacent noxious weed populations. [p. 107]

Under the assumptions that **only** herbicides will control weeds, that they will **completely** control the weeds, that they will have **no effect** on native plants, and that they will have only **negligible** impacts to water quality, the EA then asserts the benefits of their pre-determined alternative:

> This alternative would improve water quality by controlling noxious weed populations contributing to sedimentation. This alternative would improve fish habitat by improving the sediment indicator. Formulations containing herbicides picloram or glyphosate would be applied with implementation of this alternative. Both chemicals are rapidly diluted and tend not to bioaccumulate. [p. 107]

This is not an honest appraisal of available research, it is blatant rationalization. The lone reference cited in support of their action is badly out of date. The analysis lacks quantification; instead it uses terms like "rapidly" and "tends". Unfortunately, the Forest Service continues to deny the public an objective risk assessment of the use of herbicides.

Case example: Inadequate worst case analysis leads to injunction.

In 1984, the Ninth Circuit Court of Appeals heard a case in which plaintiffs challenged the spraying of herbicides on Forest Service and BLM lands (*Save Our Ecosystems v. Clark*, and *Merrill v. Block*, 1984). The court ruled against the Forest Service and concluded that it could not simply rely on the EPA registration process for herbicides under FIFRA because that process is inadequate to address environmental concerns under NEPA. The Court concluded that the Forest Service must do research if no adequate data exists. This requirement follows from the requirement to do a worst case analysis.

The District Court had previously enjoined portions of the Forest Service spray program in *Merrill v. Block* and portions of the BLM program in *Save Our Ecosystems v. Clark*, but the injunctions were modified by the Ninth Circuit to enjoin **all** spraying in their respective regions until the agencies complied with NEPA. In the BLM case, subsequent to a prior requirement by the Ninth Circuit Court (*SOCATS v. Clark*, 1983), the BLM prepared a worst case analysis for its spray program on the Eugene District. But the District Court concluded that the worst case analysis was inadequate because it was brief and cursory and proceeded from the wrong assumption. The Court concluded that the worst result that could occur as a result of preceding in the face of uncertainty as to whether the herbicide could cause cancer, is that it does, in fact, cause cancer. That the agency considers it speculative or remote is not sufficient to justify failure to analyze the worst case.

In abdicating their responsibilities, the agencies have lost a large degree of public confidence.

Solutions

- Action alternatives which propose herbicide use must demonstrate an overwhelming public need.
- Planning documents must provide risk assessments for herbicides.
- Planning documents should provide risk assessments for invasive species.
- Planning documents should consider supplementing risk assessments with precautionary principles.

Herbicides should be considered only a last resort, after all other viable alternatives have been considered.

In 1989, a five-year injunction against herbicide spraying in the Pacific Northwest Region of the Forest Service was lifted. The injunction was originally instated because Forest Service herbicide spraying had harmed rural landowners without an adequate EIS (O’Brien, 1989). The injunction was lifted following preparation of a vegetation management EIS (Forest Service, 1988) and the signing of a Mediated Agreement (1989) between the USDA and plaintiffs. Among other things, the Mediated Agreement required that herbicides be used only as a last resort, prevention of plant invasions be given priority, analyses be site-specific, and monitoring be performed.

The avoidance of herbicides is more than a requirement—it is a basic tenet of integrated pest management, or IPM (Wooten, 1999b). According to Pimentel (1999),

> The basic premise of IPM centers on employing first biological and other non-chemical pest controls, with the use of chemical pesticides only as a last resort.

There are hundreds of viable alternatives available for vegetation management, which do not require chemicals (Parish, 1990; Quarles, 1999; Wooten, 1999c). Non-chemical alternatives are often more effective in the long term and almost always prove to be less damaging to the environment. When all reasonable alternatives are presented in planning documents, decisions can be made rationally. Unfortunately, the Forest Service has spurned the Mediated Agreement and proceeded heedless of the consequences based on seat-of-the pants decisions, which often fail to even consider viable alternatives or effective prevention measures (Okanogan NF, 1997, 1999, 2000; Colville NF, 1998; Santa Fe NF, 2000).

Instead, Forest Service decisions are being cloaked in the mantle of Integrated Pest Management. While IPM does consider the use of herbicides as a potential method for control of invasive species, it is more often used as a strategy to assist in the rational choice of effective control options that are the least damaging to the environment. Many Forest Service documents claim to use IPM yet fail to use a decision-making strategy or to demonstrate that chosen methods are effective and environmentally benign. Based on a survey of available definitions of IPM, Wooten (1999b) composed the following definition of true IPM:

True IPM is an interdisciplinary system of techniques for controlling invasive plants that is both **practical** and **environmentally sensitive**.

Case example: Alternatives to chemical control of invasive species.

A wide array of non-chemical alternatives is available for controlling invasive species (Wooten, 1999c). Physical methods include hot water or steam treatment (Waipuna International, Ltd. 1999, http://www.waipuna.com/). The town of Carrboro, North Carolina uses hot water to remove the waxy cuticle coating of plant leaves and stems on unwanted plants, causing rapid plant death.

Other physical methods may involve modification of the natural disturbance regime. Methods include controlled burning, flame weeding or flameless radiant energy (Prull, 2000). Commercially available radiant heat weed control equipment is available through the Swiss company Messerili Sessa, with inexpensive units beginning around $300. The principle of heat is to burst plant cells, causing loss of fluids and thermal denaturation.

Site modification methods include the amount and timing of shading (Elmore, 1993b) and mulching. Straw mulch 3.5 inches thick gave 98 percent control of yellow star-thistle, *Centaurea solstitialis*, (Dremann, 1996).

Chemical methods of plant control include using allelopathic chemicals (compounds that retard other plants from growing nearby). Some allelopathic chemicals are found in the weeds themselves, e.g., cnicin, a knapweed extract being tested under an EPA grant to the University of Colorado as a chemical agent to increase the effectiveness of biological control insects on knapweeds (*Centaurea* spp.) Another natural chemical is corn gluten meal, a byproduct of the corn milling process, which has been found to be more effective in garden weed inhibition than chemical herbicides (Consumer Reports, March 1999).

Modification of climatic and diurnal factors also have a strong influence on weeds. Wind entrainment through the use of barrier or “snow” fences has been successfully used to capture “tumbleweed” forms of weeds, preventing their spread, and allowing easier control by burning or plant removal (Roché, 1994).

Restoration grass seeding has been used to decrease leafy spurge (*Euphorbia esula*) by 67 percent in two years in Minnesota (Biesboer et al., 1994). Competitor enhancement can also help improve the chances for outcompeting weeds, for example by pruning desirable species, whether using a mechanical tool, or through selective grazing (Elmore, 1993). Range experience is needed in this technique however, because livestock can also benefit weeds (Photo 1, p. 3).

Prevention methods are perhaps the single most important tool for controlling the spread of invasive species. Prevention methods include prioritization of new invaders, use of signage to alert the public, and perhaps most importantly, constraints on soil disturbance and seed transport that avoid the most common entry routes for seeds: contaminated seeding mixtures, hay, mulch, topsoil, road gravel, nursery stock, and manure (Quarles, 1999; Olivarez, 1995).

Prevention opportunities are lost if attention is not given to adjacent infestations. Vehicle quarantines and vehicle washing should be part of regular operations. Prevention means taking a hard look at the cause, not the symptoms, of the spread of invaders. If the causes are eliminated, weed spread can often be eliminated, and eventually reversed. Causes that should be examined on public lands include soil disturbance processes such as logging, grazing, roading and mining.

Solutions

- Herbicides should be considered only a last resort after all other viable alternatives have been considered.
- Planning documents will present a range of non-chemical alternatives.
- Planning documents will provide an analysis of the long-term effectiveness and environmental costs of all alternatives.

Section C. All planning documents must address the impacts of invasive species and proposed control measures, whenever soil disturbances are planned or as a result of planned activities.

In order for decision-makers to allocate limited funds where they are most critically needed, it is imperative that land managers provide comprehensive effects documentation for *all* projects which affect invasive species, not just weed and vegetation management projects. Almost all projects can be expected to have an effect on the extent of invasive species including road construction and reconstruction, logging, livestock grazing, "forest health" restoration projects, and recreation (particularly motorized recreation).

Congress has provided the means to protect resources from declining through the National Forest Management Act (NFMA), which mandates the Forest Service to prepare and periodically review a comprehensive Renewable Resource Assessment, which,

> . . . must consider, among other things, the important . . . laws, regulations, and other factors expected to influence and affect significantly the use . . . and management of forest, range, and other associated lands [16 USC § 1601(4)]. . . . As part of the Assessment, an inventory of all National Forests and renewable resources must be maintained and kept current [16 USC § 1603]. . . . Public participation in the development of the Assessment is also required 16 USC § 1600 (3)].

If resource inventories are kept up to date as specified by NMFA, managers could at least make adjustments to their programs before plant invasions take over. Every project that involves groundbreaking disturbances is likely to cause invasive species to spread because it is universally acknowledged that a large percentage of weeds favor disturbances (Mooney and Godron, 1983). Like NMFA, NEPA requires federal agencies to keep records of resource inventories that would document the process of invasions.

> To effectuate NEPA's iterative decision-making process, all relevant information must be made available to the public to ensure that it plays a part in deciding which action an agency will implement [*Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989)].

The Council on Environmental Quality (CEQ) has promulgated regulations in 40 CFR § 1500.1(b) specifying that, "environmental information" relevant to federal actions must be "available to public officials and citizens before decisions are made and before actions are taken." These include "new and continuing activities, including projects and programs entirely or partly financed, assisted, conducted, regulated or approved by federal agencies" [40 CFR § 1508.18(a)].

But in all too many cases the Forest Service has attempted to satisfy these regulations through the use of documents such as the Integrated Weed Management Environmental Assessments of the Okanogan (1997, 1999) and Colville NFs (1998). Unfortunately, these documents have been self-serving, top-down treatment programs. Their methods have been primarily symptomatic in nature, they have failed to address individual projects that are causing weeds to spread and they have been based on inaccurate inventory information.

The Okanogan NF (1997, 1999, 2000) continues to use the same outdated inventory information collected by personnel driving along Forest roads and nowhere else. Rather than improving the quality of the inventory, the Forest Service continues to spend its funds on chemical treatment of roadsides using the "shotgun approach". This approach treats small areas of weeds alongside roads throughout the Forest while ignoring infestations away from roads, which later serve to re-infest treated areas.

Instead of acknowledging such shortfalls, the agency continues to issue direction as if the problems are being attended to (Forest Service, 1999):

> The environmental analysis for any project with the potential to introduce or spread noxious weeds must consider and analyze weed prevention strategies. . . . Issue clear direction with budget advice from Region to National Forests stating program areas responsible for ground disturbing activities are to build prevention costs into the project on the front end.

Unfortunately, this top-down instruction has yet to become implemented on National Forests, and as such is ineffective in anything but misleading the public. It is not enough to issue such proclamations; they must also be put to work. Project planning and decisions on public lands that involve soil disturbance activities should consider effects to existing and potential invasive species in the context of prevention and restoration. Yet weed management efforts remain largely focused on controlling the spread of weeds along roads rather than on preventing soil disturbing activities, which leave areas vulnerable to weed invasion (Belsky & Gelbard, 2000).

For instance, the Forest Service routinely approves funding priorities for activities such as grading, mowing, construction and closure of roads and trails, without consideration of the impacts of such activities on invasive species. Every year, the Forest proceeds to blindly follow the same plan it has in the past, despite research that has shown that secondary roads are a source of weed infestations (Roché and Roché Jr., 1988). Parendes and Jones (2000) found that non-native plant species occurred on high-use, low-use, and abandoned Forest roads. While the most frequently occurring species were clearly correlated with roads that received greater use, their research also showed that the legacy of exotic species on abandoned roads can persist for 40 years.

Beyond the mere fact that roads provide an extreme amount of soil disturbance in which weeds flourish, they also provide access to relatively undisturbed areas, acting as a conduit for weed spread into more remote areas. Studies show that exotic weeds don't remain along roads. When road surveys for noxious weeds are extended to 50 meters, the invasive species are still present 70-100% of the time (Gelbard, unpublished). In Montana, it was found that exotic weeds spread outward from roadsides by invading adjacent relatively undisturbed communities (Forcella and Harvey, 1983). Within the interior Columbia Basin, cheatgrass (*Bromus tectorum*) originating on roadways has successfully invaded shrublands, ponderosa pine forests, and pinyon-juniper woodlands (Monsen, 1994).

The Forest Service has displayed a lack of regard for any acknowledgment that their primary activities of logging and associated roading could be responsible for weed invasions. It is a widely held view that logging provides the type of open, disturbed habitats favorable for weed establishment and research confirms this to be true. Both spotted and diffuse knapweed prefer open, disturbed habitats including roads and over-shaded areas (Watson and Renney, 1974). Yet Environmental Assessments written for timber sales rarely include more than cursory analyses of the effects of these projects on invasive species. Instead of addressing the issue squarely where it begins, logging projects often marginalize invasive species threats as "public concerns" that never see the light of day, and to date, timber budgets have not shouldered their fair share of the management of invasive species.

The Interior Columbia Basin Ecosystem Management Project objective to prevent invasions by reducing disturbance activities would be a good idea if only it applied to the majority of cases where logging occurs—in timber sales (ICBEMP, 2000, p. 30):

> Because weeds are not adapted well to shade, consider retaining shade along roads by minimizing removal of trees and other roadside vegetation during construction, reconstruction, and maintenance, particularly on south aspects.

The intent is to try and get the public to accept the plan by deferring action that would affect industry concerns while pacifying environmental concerns through piecemeal approaches to weed prevention.

Management plans on federal lands also need a thorough analysis of the relationship between livestock grazing and weed invasions (Belsky & Gelbard, 2000). It is possible that current infestations of some non-native plants are a result of livestock grazing, not an independent threat (*ibid*.). In Washington State, 84% of yellow star-thistle (*Centaurea solstitialis*) and 80% of diffuse knapweed (*Centaurea diffusa*) populations are found on lands predominantly used for livestock grazing (Roché and Roché Jr., 1988). Preferential grazing of native plant species over non-native species by cattle and sheep, combined with impacts from livestock to soil disturbance, microbiotic crusts, mycorrhizae, nutrients, and fire cycles, will likely keep these communities open to weed invasion and prevent natural community recovery (Belsky & Gelbard, 2000).

While the ICBEMP did not propose any substantial changes that would alter the current direction of management from its increasing reliance on chemicals, they did acknowledge that prevention efforts should be prioritized and they implied that a relationship between livestock and plant invasions should be considered by range conservation managers (ICBEMP, 2000):

> If livestock grazing management is a factor in causing an area to function 'at risk', then that area shall be a high priority to initiate changes to livestock grazing management [p. 27]. . . . Consider using grazing management practices where feasible . . . to reduce the spread of targeted undesirable plants [p. 31].

Lacking comprehensive input from specialists trained in invasive species biology, Forest Service actions will continue to contribute to the spread of invasive species. It is important that all Forest Service decisions address the responsibility for managing invasive species and take an interdisciplinary approach to project planning and implementation.

Case example: Great Basin restoration

A near-total collapse of the native sagebrush-steppe ecosystem in the Great Basin has prompted the Bureau of Land Management (BLM) to request an unprecedented $40 million for recovery (Christensen, 2000). Yet the initiative failed to pass Congress, in part due to fears of Western politicians and ranchers that restoration could mean restrictions on livestock grazing. While this may be unfortunate for the BLM managers who are essentially being asked to forget about their plans for restoring the Great Basin, it is a sign that Congress considers expensive restoration activities as red herrings and management time might be better spent protecting intact ecosystems.

In the Great Basin, native sagebrush rangelands have been largely replaced by annual cheatgrass (*Bromus tectorum*), which burns hotter and more frequently (Mack, 1986). The Great Basin Bird Observatory breeding-bird atlas indicates that less than half the number of bird species are able to breed in the altered cheatgrass ecosystem (Christensen, 2000). Livestock forage is also reduced and desperate managers have resorted to "restoration" with alien species such as kochia (*Kochia scoparia*, a noxious weed in some states) and crested wheatgrass (*Agropyron cristatum*) to try and outcompete the cheatgrass. In the Great Basin, the BLM spends $70 an acre to counter weeds that cause devastating wildfires, but also pays an additional $71 an acre to put out fires, and another $64 per acre for rehabilitation following fires (Wolfson, 2000). In 2000, the BLM requested $17 million to begin the Great Basin Restoration Initiative on 500,000 acres of rangeland.

In denying the initiative, Congress was willing to write off 500,000 acres of Great Basin rangeland and save the taxpayers $40 million on an investment with unknown return potential. Given the available data, the inevitable conclusion is that the current agricultural system in the Great Basin is unsustainable in the long run. Addressing global desertification, Verstraete and Schwartz (1991) offer a glimmer of hope:

> . . . it is not difficult to see that this situation cannot be sustained for much longer. The time is for action, not panic, and the scientific community has a definite role to play.

Case example: Hell's Canyon Research Natural Area on the Wallowa Whitman NF.

Following the 1988 TeePee fire in Hell's Canyon Research Natural Area, the Forest Service failed to check if restoration seed mixtures were free of invasive species. They weren't. Because of this error, yellow star-thistle (*Centaurea solstitialis*) contaminating the seed mix resulted in over $200,000 in ongoing control costs by the mid-1990s (Bob Williams, Wallowa Whitman NF, personal communication).

Due to the haste with which wildfires are often fought and "restored", written guidelines for wildfire fighting and restoration that could have prevented this are often unavailable or ignored. Revision of the guidelines came about several years later in a Wallowa-Whitman Forest Plan Amendment (Richmond, 1992), which unfortunately was too late to correct the infestation.

A year 2000 FOIA request to the Wallowa-Whitman NF from George Wooten for "plans and management actions related to reseeding efforts for restoration and recovery following the 1988 Tee Pee fire" was nonresponsive, as the records have destroyed (Forsgren, 2000). It is unfortunate that the Forest Service lost these records, as they could be invaluable to managers developing invasive species programs.

Solutions

- All planning documents must address the impacts of invasive species and proposed control measures, whenever soil disturbances are planned or are a result of planned activities.
- Prevention strategies must be built into all projects through their inception, planning and implementation.
- Planning for projects that involve soil disturbances should involve specialists trained in invasive species biology.

Section D. Decisions must be subject to public review and appeal.

In order to protect public interests in guarding against alien species invasions, the legal right to citizen appeals of government proposals must be preserved. There is little cause for assurances that decisions will be given in good faith, given the poor record to date given by the BLM and Forest Service for protection from invasive species.

Recent proposed changes to the National Forest Management Act (Forest Service, 1999b) preserve these rights:

> Under the proposed regulation any person would be allowed to object to a pending decision. The objection would be filed, in writing, within 30 days of public notice of the appropriate NEPA documentation. Unlike the current 217-regulation, the proposed objection process does not have a specific time limit for resolving objections. Instead, the responsible official would not be allowed to approve a plan amendment or revision under objection until a decision on the objection has been reached and documented in an appropriate decision document for the land and resource management plan. The proposed rule does not change the 36 CFR 215 appeal process for site-specific project decisions.

Rights of citizen appeal are protected under the National Forest Management Act (NFMA) Land and Resource Management Plans (LRMPs), required for each administrative unit of the National Forest System, which require periodic revision. The decision documents for LRMP approval, amendment and revision are subject to appeal under 36 CFR 217. Appeals of a Regional Forester's Record of Decision or Decision Notice are referred to the Chief's Office in Washington, D.C. where a subsequent disposition may render either a dismissal, and affirmation, or a reversal, in whole or in part.

Rights of public review and appeal are also guaranteed under the National Environmental Policy Act (NEPA, 36 CFR 217). As part of the Interior Appropriations Act of 1992 (106 Stat. 1419) Congress added requirements for notice and comment and an administrative appeal of projects implementing LRMPs. The project notice/comment and appeal process went into effect January 4, 1994 under 36 CFR 215.

In addition to these provisions for public review and appeal, the Record of Decision (ROD) for Managing Competing and Unwanted Vegetation (Forest Service, 1988) responded to a 1984 court injunction that prohibited all herbicide spraying until legal insufficiencies were satisfied. As a result of court-ordered mediation, additional requirements were added to the ROD in a Mediated Agreement (1989). Signers of the Mediated Agreement were granted the right to petition the court for relief if the Region failed to comply with its requirements.

Even with these safeguards, invasive species continue to make inroads onto public lands. The specter looming before us is that the agencies who have sat idly for so long will now react to Congressional prodding with hastily prepared, costly approaches which depend primarily on widespread use of broad-spectrum herbicides, with concomitant contamination of the environment, compromised human health and preordained failure to control invasive species.

In site-specific situations, once invasive species establish themselves as integral, albeit unwanted, parts of the natural environment, further control efforts may be wasteful spending, and in addition may require destruction of the underlying ecosystem. If agencies are not held accountable to protecting ecosystem resources, they may have little restraint in spending funds on futile eradication efforts.

There are some provisions to limit wasteful government spending when weed control becomes a lost cause. For instance, when it becomes apparent that control of a species is no longer possible, state noxious weed Control Boards can remove weeds from lists requiring mandatory controls, in essence, admitting defeat, but at the same time saving limited funds for use in controlling other species. For instance, in Washington state, bull thistle (*Cirsium vulgare*), and Canada thistle (*Cirsium arvense*) have become so ubiquitous that they have been relegated Class C status, meaning they no longer require mandatory control under the state noxious weed control laws. Regardless of their "status", Canada thistle used to be listed as the worst weed in the United State and still has the potential to aid in the loss of western rangelands (Colorado State University, 1999).

The determination to reclassify these weeds was made purely on economic grounds because control was perceived to be beyond the range of present budgets. However, such weeds should still be given consideration whenever ground disturbing activities are proposed in areas where known populations exist or are adjacent.

For some invasive species, a point may be reached where the costs of control outweigh the benefits of removal. This point occurred long ago for species like Kentucky bluegrass (*Poa pratensis*), Dutch clover (*Trifolium repens*) and common bentgrass (*Agrostis stolonifera*), which were originally valued additions to the pastures of early homesteaders. They were chosen for their value as forage components and their ability to dominate and thrive under a regime of heavy disturbance. These same traits caused these species to spread aggressively into native ecosystems (Almack et al., 1993) where they have choked out native species.

Solutions

- Decisions must remain subject to appeal.
- Decision documents must be subject to public review and comment.
- Decisions must be subject to peer review and legislative oversight.
- Managers need to provide a documented review process for issues that involve controversy.

Chapter 3. Adverse impacts

Section A. Adverse impacts of chemicals on human health must be quantified and eliminated.

The Council on Environmental Quality (CEQ) regulations (40 CFR § 1508.14) state that decisions will analyze effects on the "human environment", which is defined to include "the natural and physical environment and the relationship of people with that environment." NEPA (§ 1500.2(f)) states that,

> Federal agencies shall to the fullest extent possible…avoid or minimize any possible adverse effects of their actions upon the quality of the human environment.

Despite such direction, National Forests have radically increased their use, and hence reliance, of herbicides over the last several years in projects that cover thousands of acres of public lands (Okanogan NF, 1997; Colville NF, 1998). In the 5-year period from 1994 to 1999, the Forest Service's use of herbicides on National Forests in Washington and Oregon increased by 1600% (personal communication, Gary Smith, Region 6 Forest Service Noxious Weed Coordinator, December 4, 2000). Yet projects involving the use of herbicides were and continue to be designed and analyzed without due consideration for actual incidents acute poisonings (Wooten, 2000c), known adverse health effects or for the health and safety of vulnerable groups of society (McCampbell, 2000; Voorhees, 1999). The Forest Service continues to disregard their fundamental legal requirements to protect human health and safety.

Vulnerable populations include children, the developing fetus, the elderly, the ill and immunocompromised, and those with asthma, allergies, and other medical conditions. Herbicides pose significant public health risks, particularly for cancer, infertility, miscarriage, birth defects, and effects on the brain and nervous system (Pesticide Education Center, date unknown).

Furthermore, the presence of herbicides discriminates against people disabled with multiple chemical sensitivities by restricting their accessibility to public lands, in violation of the Americans with Disabilities Act (42 USC § 1201 et seq.).

Some of the potential and likely effects, which have been omitted from Forest Service planning documents are briefly described in this section. NEPA (§ 1508.8) specifies that the effects analyzed must address the following:

> (a) Direct effects, which are caused by the action and occur at the same time and place.
>
> (b) Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.
>
> Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.
>
> Effects and impacts as used in these regulations are synonymous. Effects includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial.

The amount of details to be described about detrimental health effects are given in the NEPA (§ 1508.27):

> ‘Significantly’ as used in NEPA requires considerations of both context and intensity:
>
> (a) Context. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.
>
> (b) Intensity. This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating intensity: (1) Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial. (2) The degree to which the proposed action affects public health or safety.

The Forest Service has evaded their responsibility to analyze detrimental human health effects by claiming that such analyses are already available under the Environmental Protection Agency (EPA) analyses included with pesticide registrations. Even so, the Forest Service is still bound to refer to those analyses and apply mitigation for known effects as necessary. However, EPA registration data for herbicides is far from complete and Forest Service Districts that prepare project-planning documents have little technical experience that would allow them to access this technical information or to necessarily understand it.

Actually, according to NEPA (§ 1504.1 (c)), it is the EPA that should review Forest Service actions:

> Under Section 102(2)(C) of the [NEPA] Act other Federal agencies may make similar reviews of environmental impact statements, including judgments on the acceptability of anticipated environmental impacts. These reviews must be made available to the President, the Council and the public.

Exposure risks. Exposure risks refer to the amount of a chemical taken up by a body through various routes such as ingestion, inhalation, or dermal absorption. False and misleading claims about the safety of pesticides, lack of government disclosure, and flaws in the federal registration process all raise serious concerns about increased exposure to environmental chemicals when there is lack of information on their reproductive and endocrinological effects, synergy, bioaccumulation and continual low-dose exposure.

Forest Service documents have made claims that exposure risks from herbicides are very low because they primarily occur via dermal routes and that preferred pesticides have low skin permeability. These shallow arguments pale under scrutiny as explained by the Pesticide Action Network (Puvaneswary, 1999):

> Scientific principles, particularly toxicokinetics, must apply. The exposed person will be subjected to risks of adverse effects, known or unknown. Even if the chemical has low vapor pressure, appreciable inhalation exposure can occur since micro-droplets can form and particulates can be carried by movement of air. Oral intake can also occur through contaminated food or water. The fact that glyphosate is a systemic herbicide and persists in the environment for a

> relatively long period of time (as long as 3 years in soil) makes it likely to enter the body through residues (contamination) in food and water. Residues are unlikely to be removed from plant tissues and use of glyphosate in animal feed can result in residues in animal food products such as meat, milk and eggs. Residues are stable to up to one year in plant materials and water and up to two years in animal products in storage.

Clement and Colborn (1992) examined the issue of increased exposure to pesticides, herbicides and fungicides, and the difficulties encountered in measuring exposure rates for women, children, and embryos in vivo, in contrast to typical standards based on adult males. Exposures include routes from both active as well as so-called "inert" ingredients, through food, water, rainwater, snow, household dust, yard soil, and indoor air. The timing of exposures exerts a profound teratologic effect on embryos.

Differences in diet can cause increased susceptibility to pesticide effects. Children with vitamin A deficiencies are more susceptible to the effects of DDT, hydrocarbon carcinogens and polychlorinated biphenyls (Mekdeci, date unknown). The fact remains that there is great uncertainty regarding the public's exposure, both in terms of risk and frequency, to herbicides used on National Forests. Without such information, it is highly questionable as to whether agencies should continue with the practice of prescribing such chemicals on public lands.

Inhalation exposures. Effects through inhalation of volatile herbicides, spray mists and semi-combusted by-products formed during controlled fires are not addressed in most government documents because research on inhalation exposure routes is seldom provided in pesticide registrations. Nonetheless, this is a method of human exposure which can occur and needs to be addressed.

The herbicide dicamba is highly volatile. Its use in one area can damage crops or native plants another area by vapor migration. Thus, it can be expected to exhibit adverse effects on people and wildlife removed from the application. When applying volatile organic compounds during hot days in narrow valleys, their concentration can build up to very high amounts where airflow is constrained, for instance in narrow valleys, or under tree canopies. This may expose a large number of people to high concentrations of chemicals. For herbicides, which contain hydrocarbon carriers, the volume of volatile ingredients released from the carriers may be much higher than that of the herbicide alone.

In the case of a fire involving previously treated areas, extremely large numbers of the public could be exposed to herbicide-contaminated smoke fumes.

Vulnerable groups. Although the adverse effects of herbicides and their associated surfactants and carriers are profound, the Forest Service prefers to characterize these risks as minimal (Okanogan NF, 1997, p. 127):

> It is unlikely that any members of the general public would receive sufficient exposure to develop any adverse effects from the treatment.

This statement indicates that concerns about health risks from herbicides were dismissed from consideration. Such statements are irresponsible and insulting to those who are subsequently harmed by or concerned about harm by the chemicals used. In addition to contributing to a biased decision, the statement is also a denial of human diversity. Even beyond the obviously vulnerable groups of children, fetuses, the elderly, those with impaired nervous, respiratory or immune systems, and sensitive individuals, chemicals can impact the health and well-being of even "the general public", for example during periods of stress or within predisposed cross-sections of the public.

For instance, the New Mexico Department of Health determined in a 1997 random survey of the general public that 16% of New Mexicans report being sensitive to everyday chemicals like pesticides. Among women and Native Americans the prevalence is 21% and 27%, respectively (Voorhees, 1999).

Unfounded statements, like the one given by the Forest Service above, should not be the basis for a lack of analysis of health hazards. People are commonly made sick by low levels of the pesticides described in this report. In 1998, approximately 50 residents of Tierra Amarilla, New Mexico became ill after a farmer in the center of town sprayed his field with a combination of 2,4-D and Roundup©, at a level that was falsely assumed to be safe. It has been found that the general population of agricultural regions has a higher incidence of birth defects than elsewhere (Garry et al., 1996).

The average citizen is at risk from ambient pesticides. To claim otherwise, or to conceal such evidence from environmental effects documents, is illegal and a direct violation of the NEPA.

It is a fallacy to present herbicide exposures as unlikely. Pesticide poisonings are underreported, according to Ann McCampbell, Chair, Multiple Chemical Sensitivities Task Force of New Mexico:

> Most physicians are not sufficiently trained in recognizing pesticide poisonings and hence many cases are misdiagnosed as the flu or some other ailment. Long term effects from pesticide exposures, such as peripheral neuropathy following organophosphate exposures, are also not usually connected with the earlier exposure. Individuals often do not make the connection themselves. The end result is that there is a vast underestimate of the number of pesticide poisonings each year which contributes to a false reassurance about their safety.

Although the increased risks associated with certain public groups is generally ignored in Forest Service documentation, in some instances the Forest Service has provided for special protection for applicators and its own personnel. The acknowledgment of enhanced risk in certain segments of society is a first step toward better recognition of actual health hazards. A Minnesota study indicated an association between paternal employment as a pesticide applicator and a variety of birth defects in offspring, including abnormalities of the lungs, heart, musculoskeletal system, and urogenital system.

Forest Service planning documents often make claims that there is a low likelihood that chemically sensitive people will actually be exposed to herbicides during project implementation, but as noted above, this group of vulnerable people actually represent a significant portion of the population. In addition, their likelihood of exposure is higher than in the general public, according to Ann McCampbell, Chair of the Multiple Chemical Sensitivities Task Force of New Mexico (2000):

> In addition, chemically sensitive people frequently seek refuge in the National Forests, sometimes camping for months to years, because they are one of the few remaining refuges from our ever increasingly polluted world. Thus the chances that chemically sensitive people will be exposed to forest herbicides is many orders of magnitude greater than estimated in this report. Another factor that needs to be considered when deciding whether to use herbicides is that it can be a violation of the Americans with Disabilities Act when the presence of herbicides makes forest facilities inaccessible to people disabled with multiple chemical sensitivities. . . .
>
> When exposed to pesticides, chemically sensitive people can become extremely ill and may suffer severe relapses for months. Some

> reactions are life threatening. Symptoms can include, but are not limited to, headache, nausea, diarrhea, vomiting, aphasia, trouble thinking and concentrating, weakness, incoordination, numbness and tingling, fatigue, difficulty breathing, irregular heartbeat, seizures, and joint and muscle pain. In addition, many people report that they developed chemical sensitivities after a pesticide exposure, such as after a home, office, or school treatment or exposure to aerially or ground sprayed agricultural pesticides.

The Forest Service has no basis to claim that the general public is unlikely to be unaffected because most studies on human susceptibility to toxic substances are performed on average, healthy, adult males, which do not account for effects on underweight or overweight persons, women, children or different races. Yet, the magnitude of effects on humans can vary by 2 to 3 orders of magnitude (Santa Fe NF, 2000, p. III-E-42).

Children. In 1989, the National Cancer Institute reported that children develop leukemia six times more often when pesticides are used around their homes (American Defender Network, 1989). The American Journal of Epidemiology found that more children with brain tumors and other cancers had been exposed to insecticides than children without (*ibid*.).

The increased use of pesticides and herbicides in industrial countries may be an important contributing factor to the 50% rise in non-Hodgkin's lymphoma (NHL) over the past ten years in the American population. Studies of farmers who once used these pesticides found alarmingly high numbers of NHL, particularly in those who didn't wear protective clothing. This latest finding also proves the theory that most danger from pesticides comes through dermal absorption, not ingestion (Zahm, 1992).

Teratogenic effects. Teratogenic effects refer to birth defects resulting from gene mutations acquired during fetal exposures. Numerous birth defects, particularly limb-reduction defects, have been associated with pesticide exposures in human studies (Restrepo et al., 1990; Schwartz and LoGerfo, 1988; Lin et al., 1994). Exposure of the fetus to pesticides more than doubles the risk of stillbirth due to congenital anomalies (Pastore, 1997).

According to the Executive Director of the Association of Birth Defect Children (Mekdeci, date unknown):

> An analysis of current research on immunotoxins also suggests that prenatal exposure to xenobiotics can result in a fourth type of adverse outcome—teratogenesis. New research in developmental immunotoxicology is exploring the possibility that one teratogenic outcome of prenatal exposure to immunotoxins may be impairment of the developing fetal immune system [National Toxicology Program, 1988]. Children born with dysfunctional immune systems are at increased risk of allergies, chronic infections, autoimmune disease, learning problems and/or childhood cancer.

Fat-soluble pesticides accumulate over time in our bodies, then are released at potentially toxic levels when illness or stress results in our fat reserves being metabolized. A large portion of a woman's lifetime exposure to such pesticides is released in the breast milk for her firstborn child (International Joint Commission on the Great Lakes, 1990).

As a result of chemical exposures, reproductive sterility has resulted in human females, reduced sperm counts in human males (Sharpe and Skakkebaek, 1993) and birth defects have occurred in children (Kurzel and Cetrulo, 1981; Wilson, 1977). A California study reported a statistically significant increase in limb-reduction deformities in the children of mothers who lived in areas of high pesticide exposure. (Schwartz, 1988). Two large chemical companies paid an out-of-court settlement to the family of a child born without any arms or legs after the mother was exposed to pesticides while working in the grape fields during pregnancy. (Moses, 1988)

The critical need for further research on the teratogenic effects of pesticides is underscored by Betty Mekdeci, Executive Director, Association of Birth Defect Children (date unknown):

> The prenatal and neonatal periods are characterized by immunoincompetence. Any toxic interference with the delicately balanced immune system during this period may have major consequences, much more so than in the adult. (Shoham, 1986) Current research confirms that many immunotoxic agents also have teratogenic potential. One possible teratogenic outcome from prenatal exposure to immunotoxins may be impairment in the development of the immune system. This possible teratogenic outcome has not been addressed to any extent in current research nor has such an outcome been measured in any epidemiological studies of suspected immunotoxins to date. Since the consequences of immune incompetence include such serious outcomes as cancer, chronic illness, severe allergies and learning disabilities, it is critical that the new field of developmental immunotoxicology addresses these important issues as quickly as possible.

Cancer. According to Dr. Lynn Goldman of the U.S. EPA, over 100 pesticides in current use are probable or possible human carcinogens. (Goldman, 1998). One in every three Americans will develop cancer in their lifetime (Mekdeci, date unknown).

A University of Iowa study of golf course superintendents found abnormally high rates of death due to cancer of the brain, large intestine, and prostate (Davidson, 1994), while other experts are beginning to link golfers and non-golfers who live near fairways with these same problems (New York State Attorney General's Office, 1990).

A case-controlled study (404 cases and 741 controls) linked non-Hodgkin's lymphoma (NHL) with exposures to herbicides (Hardell and Eriksson, 1999). NHL is a cancer of the white blood cells, which is increasing rapidly in industrialized countries. In the U.S., NHL has the third highest increase in incidence rate at 3.3% per year (Harras et al., 1996, p. 17). The Hardell study observed a positive association between exposure to glyphosate and NHL, in which any chance error could be ruled out with reasonable confidence.

One of the herbicides linked to NHL in the Hardell study is glyphosate, sold by Monsanto under several trade formulations, including Roundup©. Roundup© has also been implicated in hairy cell leukemia (cancer of the blood-forming organs), a rare kind of NHL (Nordstrom et al., 1998). Animal studies have also shown that Roundup© causes gene mutations and chromosomal aberrations.

These studies contradicted previous evaluations conducted by the EPA and the World Health Organization (WHO) that suggested that glyphosate was not mutagenic or carcinogenic. The older investigations were inconclusive and limited to tests of only active ingredients on healthy individuals. In 1995 in the UK, glyphosate was the most frequently reported cause of complaints and incidents from pesticide exposures recorded by the Health and Safety Executive, according to the National (UK) Poisons Centre, which also reported an increase of glyphosate poisonings that year in Malaysia. Monsanto sells over 200 tons of glyphosate each year (Puvaneswary, 1999).

Numerous epidemiologic investigations have also linked the phenoxyacetic acid herbicides

2,4-D with non-Hodgkin's lymphoma (Hardell et al., 1981; Persson et al., 1989; Hoar et al., 1986; Zahm et al., 1990) and with soft-tissue sarcomas in Sweden (Lynge, 1985). Studies by the National Cancer Society have discovered a link between NHL exposure to triazine herbicides like atrazine.

The Environmental Protection Agency (EPA) categorizes both picloram and atrazine as a "possible human carcinogen." Picloram is a preferred pesticide for Forest Service use. Atrazine is a long-lived herbicide found in much of the drinking water in the midwestern U.S. and is measurable in corn, milk, beef and other foods. In female rats, it causes tumors of the mammary glands, uterus, and ovaries.

Documented cases of pesticides in groundwater wells are suspect for the incidence of cancer clusters in many towns. In 1989, drinking water in at least 38 states was known to be contaminated (American Defender Network, 1989). After the herbicide Dacthal was applied to Long Island golf courses, it was detected in drinking water wells at levels twenty times the State's safety limits. The water also contained a dioxin that is a highly toxic by-product of Dacthal (New York State Attorney General's Office, 1990; Sayan, 1990). The New York State Attorney General sued the manufacturer in 1989 to investigate the contamination and develop a treatment program, since ground water is the main source of drinking water for Long Island. Twenty-two other pesticides have been found in the water so far. However, there is still no requirement or systematic program designed to test for drinking water contamination (American Defender Network, 1989).

Acute effects. Acute effects refer to physical symptoms which are experienced within a short time after a chemical exposure. Acute effects from herbicide exposures are almost completely ignored in Forest Service documents. The Washington Office of the Forest Service has information about acute effects, which is seldom presented in planning documents (Syracuse Environmental Research Associates, 1996):

As indicated in Appendix 1-1, the signs and symptoms of glyphosate or glyphosate/surfactant toxicity in humans generally include gastrointestinal effects (vomiting, abdominal pain, diarrhea), irritation, congestion, or other forms of damage to the respiratory tract, pulmonary edema, decreased urinary output sometimes accompanied by acute renal tubular necrosis, hypotension, metabolic acidosis, and electrolyte imbalances, probably secondary to the gastrointestinal and renal effects. In some cases, elevated temperatures have been noted (Tominack et al. 1991).

Changes in blood enzymes have been observed and attributed to hemolysis (Sawada et al. 1988).

In experimental mammals, signs of acute toxicity after oral or intraperitoneal dosing include increased respiratory rates, elevated rectal temperature, and in some instances asphyxia convulsion. The primary pathological lesion is lung hyperemia (Bababunmi et al. 1978; Olorunsogo et al. 1977; Olorunsogo and Bababunmi, 1980). Hemolysis was not noted in sheep with an inherently low erythrocyte glucose-6-phosphate activity (Geiger and Calabrese, 1985).

The mechanism by which glyphosate exerts its acute toxic effects is not clear. As discussed below, the surfactant in Roundup may be a factor in some of the acute effects associated with exposure to this herbicide.

Based on a series of experiments using rat liver mitochondria exposed to the isopropanolamine salt of glyphosate without any surfactant (summarized in detail by U.S. EPA 1992a), glyphosate appears to be an

> uncoupler of oxidative phosphorylation (Bababunmi et al. 1979; Olorunsogo 1982; Olorunsogo and Bababunmi, 1980; Olorunsogo et al. 1977; Olorunsogo et al. 1979a,b).

Immune system effects. According to Betty Mekdeci, Executive Director of the Association of Birth Defect Children (date unknown),

> The most immediately noticeable immune reaction to pesticide exposure is an increase in allergic reactivity often including multiple chemical hypersensitivity. People whose immunity is suppressed by pesticides may also be unable to fight off viral infections or may experience a reactivation of one or more of the herpes viruses. Immunological studies reveal that pesticide-exposure can cause a decrease in the number of B and T cells. The ratio of T-4 to T-8 helper cells is often reversed similar to the immune abnormalities found in AIDS patients. (Legro, 1988)

Endocrine effects. Endocrine effects refer to the disruption of glandular systems (such as the pituitary, the pancreas, the adrenals, and the testes) which control maturation, development, growth, and regulation within the body through the release of natural chemical transmitters. Atrazine, one of the triazine herbicides frequently used for its resistance to breakdown, can disrupt ovarian function, cause mammary (breast) tumors in animals, and interferes with the binding of steroid hormones and the breakdown pathway of estrogen (Bradlow et al., 1995; Cooper et al., 1996; Danzo, 1997).

Behavioral effects. Pesticide exposures have been experimentally linked to decreased mental abilities and increased aggression among children (Guillette, 1998), as summarized by Montague (1999):

> Elizabeth A. Guillette and colleagues studied two groups of Yaqui Indian children living in the Yaqui Valley in northern Sonora, Mexico. One group of children lives in the lowlands dominated by pesticide-intensive agriculture (45 or more sprayings each year) and the other group lives in the nearby upland foothills where their parents make a living by ranching without the use of pesticides. The pesticide-exposed children had far less physical endurance in a test to see how long they could keep jumping up and down; they had inferior hand-eye coordination; and they could not draw a simple stick figure of a human being, which the upland children could readily do.

Synergistic effects. Synergistic effects refer to the combined action of two ore more chemicals that are greater than the sum of the effects of each chemical taken individually. The Forest Service relies on pesticide registrations for individual chemicals based on “acceptable risks” at levels “typically” used in applications. However, the combined effects of multiple chemicals can present much higher risks to the public. In a 5-year experiment using low levels of mixtures of pesticides in the drinking water of male mice, it was found that when combined, levels of chemicals similar to those found in U.S. groundwater have measurable detrimental effects on the nervous, immune and endocrine (hormone) systems (Porter, 1999). Effects found included lowered body weight, decreased immune responses and increased aggressive behavior. This research has a direct bearing on human safety and health because the nervous system, the immune system, and the endocrine (hormone) system are all closely related. If any one of the three systems is damaged or degraded, the other two may then also be adversely affected. The research team notes,

> Of particular significance in the collective work of Boyd and others, [1990] Porter and others, [1993, 1984] and our current study, is that thyroid hormone concentration change was consistently a response

due to mixtures, but not usually to individual chemicals.

The research team noted that proper levels of thyroid hormone are essential for brain development of humans prior to birth and other studies have shown that attention deficit, hyperactivity and/or aggressive behavior disorders in children are linked to levels of thyroid hormones.

Certain chemicals in the environment are estrogenic (Arnold et al.,1996). When studied singly they exhibit little effect on biological systems, however combinations of two or more weak estrogen-mimicking chemicals can be up to 1000 times as potent. This synergistic interaction of chemical mixtures with the estrogen receptor has profound environmental implications for the National Forests, whose managers generally haven't considered the synergistic or cumulative effects of herbicides that use surfactants to increase effectiveness.

Cumulative effects. Forest Service documents often present faulty assumptions that herbicides always degrade relatively rapidly and that treatments represent only a single spraying. This assumption is incorrect if one considers that downstream users add to the burden of treatments in an aquatic system and that many noxious weed sites on National Forest lands are "treated" more than just once.

Forest Service planning documents can hardly be expected to accurately portray the manifold routes of potential human exposure risks presented by herbicides. If they could, the public would probably not tolerate any further pollution by herbicides. Instead, the Forest Service tries to portray their use of agricultural chemicals as posing small risk due to rapid breakdown of the chemicals. In fact, research on the breakdown products of herbicide products is scant and toxicological effects analyses are seldom performed on the breakdown products. The assumption that the half-life of pesticide disappearance is a measure of its safety may not be warranted.

Many herbicides are persistent in the soil. According to a Forest Service fact sheet, prometon has a half-life in the soil of up to 6 years and glyphosate has been found in crops harvested over a year after the latest application. Dicamba, triclopyr and picloram have been found in the soil 1, 2, and 3 years, respectively, after the last application. Thus, the commonly misstated assumption in Forest Service documents that herbicides are only used infrequently and do not persist in the environment is unfounded.

Many herbicides are resistant to breakdown, and when they do break down, the secondary byproducts can also have toxicity. For organochlorine pesticides, the chlorine-carbon bond resists breakdown by normal biochemical and physical processes and remains in the environment. Since the majority of organochlorines are foreign to nature, living organisms have developed few methods to detoxify them (Reinecke and Knackmuss, 1988; Nielsen 1990).

For instance, trichloroethane in groundwater may degrade to highly toxic vinyl chloride (Oldenhuis et al., 1989). There are a large number of unidentified organochlorine and other breakdown products accumulating in the environment. In the sediments of the Great Lakes, for example, some highly toxic organochlorines, such as chlorinated dioxins and dibenzofurans, have steadily increased from zero up to 3200 parts per trillion since the chlorine industry started production there in the late 1920s (Czuczwa and Hites, 1984, 1985).

"**Inert**" **ingredients**. "Inert" ingredients refer to the contents of a pesticide which are not directly involved in the killing of the intended pest, but which may be quite hazardous nonetheless. According to Knight and Cox (1998), over 2,500 substances in pesticides are not named on product labels. The report shows that over 25% of the chemicals used as "inerts" actually have been identified as hazardous.

Most effects studies are only performed on pesticide active ingredients, which comprise only a small fraction of pesticide products. The "inert" ingredients, which are only inert in a legal sense, can account for a significant portion of a pesticide's toxicity. In fact, these effects are the basis for manufacturer's claims of "trade secrets", which are used to try and block public access to formulation contents. Thus, the true toxicity of herbicide products proposed for use on National Forests is undetermined.

For example, in a presentation to the Forest Service, O'Brien (1997) described the lack of information by officials:

> A so-called "inert" ingredient in Banvel CST (active ingredient: dicamba), which is used in Region 6, is ethylene glycol, which has caused birth defects and a decrease in male fertility in laboratory animals. The decrease in male fertility was not reported in the Regional information profile on dicamba formulations, including the inert ingredient, ethylene glycol. Ethylene glycol appears to be an endocrine disruptor.
>
> Chemicals that differ widely in molecular structure are involved in endocrine disruption, such that any given component of an herbicide formulation may be an endocrine disruptor and you could not know that unless it has been tested for various mechanisms of endocrine disruption such as mimicking estrogen or blocking testosterone. Most herbicide formulations have not been tested for any mechanisms of endocrine disruption and likely will never be tested.

Pesticide registration. In response to an application to register a pesticide, the EPA is required to analyze studies on the pesticide and conduct risk analyses that can be used to set limits on pesticide concentrations that will provide an acceptable safety factor during its use. The intent is to produce a balance between risks and benefits, since it is acknowledged that risks are always present. Unfortunately, most studies are commissioned by the chemical manufacturers, which may not be impartial, using animal testing models, which may be inapplicable to humans. Other faults with the process are that it has a narrow focus that allow a number of significant effects to escape documentation, including cumulative effects, synergism, environmental fate in specific environments, phytotoxicity (potential harm to plants), and analysis of "inert" ingredients.

The re-registration of many older pesticides mandated by law in 1988 is still incomplete. For many pesticides, exposure risks are unknown. By 1999, the EPA had been unable to determine risk factors for 9,700 pesticides which had outdated registrations, and limits had still not been set for 60% of the 5,500 pesticides that are supposed to get priority attention (Eisler, 1999). The decision by Congress to require EPA to update the registrations came after it was learned that children have higher risk factors than those given in the old registrations.

In fact, recent evidence indicates the studies used in registrations are inadequate at portraying toxicological risks. A study by Porter et al. (1999) found that current methods used by the EPA and others for studying the toxic effects of low-levels of pesticides may be flawed. Speaking in a press release from the University of Wisconsin (Devitt, 1999), Porter stated,

> . . . Herbicides can have neurological impacts and hormonal impacts and immune impacts. . . . They are not the harmless chemicals they are sometimes portrayed to be. They can be every bit as biologically active as insecticides or fungicides. . . . Neurological, immune and endocrine tests for pesticides have been mandated by federal law for almost three years, but there has been no enforcement of these laws. . . . Toxicological testing so far has been extremely limited in scope and focused on mechanisms that require extensive mutations or cell damage to show any effects. They do not adequately assess the potential for

biological effects under real world exposure scenarios.

Pesticide profiles analyze health effects by extrapolating from animal experiments, which include tests of the LD50 (the dose that kills half the test animals) and the NOEL (no-observed-effect level/dose). These endpoints only indicate gross symptoms in test animals. Such gross measures do not give any indication of the effects on impairments of memory, learning, and other more subtle areas of functioning that would be significant to humans. It is inappropriate to conclude that there is “no effect” just because no effect is observed and there is still a great deal of uncertainty about which animal studies are applicable to humans, or even appropriate.

Cancer risks are calculated for chemicals for which the EPA had established a cancer potency value at the time of analysis. Thus, carcinogenic contaminants of “inert” ingredients are not considered in recent pesticide profiles. And, even if a chemical is carcinogenic, the EPA risk / benefit models allow for an acceptable amount of cancer effects in registered pesticides. Picloram was noted to be a possible human carcinogen by the EPA but was approved for use nonetheless.

The Forest Service health protection measures are based on information contained in pesticide registration profiles stored at the Supervisor’s office. However, registration profiles made with the above assumptions may be inapplicable in specific circumstances.

Health risks described in Forest Service documents (Syracuse Environmental Associates, 1996) rapidly become outdated as new research becomes available. The Forest Service uses such documents as a shield against having to address new research, by claiming that new information can only be analyzed during periodic reviews, which occur infrequently. At that time, the Forest Service may very well switch preferences to another herbicide which has less information available on its harmful effects, and start the misinformation process over again.

Case example: Okanogan NF Integrated Weed Management Environmental Assessment (EA) (1997, 1999)

The Okanogan NF Integrated Weed Management EA for 1997 received many comments from the public asking for documentation and analysis of the risks of herbicides to human health and safety, yet all of these concerns for safety were lumped into a single issue on p. 15-16:

> Noxious weed populations can degrade recreational experiences by decreasing the desirability of campsites, replacing native plant populations in developed and dispersed areas and changing the scenery. Herbicide contact could pose risks to human health through skin exposure, inhalation, or ingestion. Some noxious weeds also pose risks to human health.

The marginalization of human health as mere “issues” rather than actual hazards suggests that there was never any intention of questioning the safety or use of herbicides, except in a very limited fashion, and this is borne out in the analysis section.

Two years later the Okanogan NF prepared a second EA (1999) and through another public comment process, the issues identified through public comments were exactly the same.

Why are the issues of public health ignored? According to the rationalization given in the EA (Okanogan NF, 1997, p. 17), public comments were addressed in a “higher level document”. In other words, concerns about human health and safety were not considered in the EA. By its limited scope, the agency effectively avoids having to consider issues that it doesn't want to.

The purpose of an EA is to assess a problem, propose and evaluate alternatives and select the most effective remedy, which should be the least harmful to the environment. In this case, the alternative to use herbicides had been selected prior to doing an analysis. The EA was only used to justify a predetermined decision rather than truly explore alternatives.

Case example: McFarland Creek spraying of sensitive individuals results in acute effects

In 1999, McFarland Creek on the Okanogan National Forest was sprayed repeatedly by County Weed trucks under a "Coordinated Weed Management Area" agreement. The trucks used herbicide mixtures and procedures that would have been illegal for the Forest Service to use, and they treated areas without posting signs or notifying either the Forest Service or the public. The event is described from a personal experience (Wooten, 2000c):

> In the summer of 1999, the entire McFarland Creek watershed, an area of about 15 square miles, was sprayed with pesticide along most of the roads. The intense summer heat raised a cloud of petrochemical vapor, which settled in the valley bottom for several weeks. During the 5-10 days that I worked in the watershed, I experienced several bloody noses, constant headaches and occasional dizziness. These symptoms began immediately after being passed by a County spray truck bound for National Forest Land (cover illustration of this paper) and whenever I worked in the sprayed area. The symptoms were partially relieved by leaving the sprayed area and working the higher ridges a mile or more from the sprayed roads. At that time, in response to another herbicide incident, I requested that the Okanogan National Forest notify me when and where they would be using herbicides, as I was a contractor working in the treated areas. However, the Forest never notified me until the fall of 2000.
>
> I am registered as a sensitive individual in Washington, which means that agencies must try to contact me when using herbicides in my area. During scoping for the Okanogan National Forest Environmental Assessment (EA) for spraying noxious weeds (1997), public comments were submitted reminding the Forest Service that the herbicides might harm sensitive individuals, or even casual visitors to the Forest. However, mitigation measures to protect human health were not incorporated by the EA in these subsequent applications. It is worth noting that the magnitude of this problem involves approximately 50 other sites treated this same way.
>
> The EA written in 1997 specified that the Forest Service would use the herbicides Tordon (picloram) and glyphosate, but the effects I experienced were more akin to acute effects that would be expected from volatile hydrocarbons, rather than the systemic reactions I would expect from herbicides. The onset of symptoms began immediately upon detection of a strong hydrocarbon vapor smell, and were made worse because there was nowhere in the watershed where the smell could be avoided. The smell alone was overwhelming, and made any work in the area an unpleasant experience.

From a FOIA response of notes of Forest Service Contract Inspector, Bauman, taken in McFarland Creek on July 7, 2000, it was apparent that the Forest Service was also unaware of when this spraying occurred, so of course, no warning signs could have been posted in time to warn anyone. The EA stated that special precautions would be necessary for Forest workers, yet these were hollow claims.

Solutions

- In implementing invasive species control projects, the Forest Service must follow NEPA mitigation measures given in 40 CFR Parts 1508.20 that include:
  (a) Avoiding the impact altogether by not taking a certain action or parts of an action.

(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
(e) Compensating for the impact by replacing or providing substitute resources or environments.

- Planning documents should provide an analysis of exposure routes, including inhalation, that would result from the use of herbicide applications, and determine safety thresholds for allowable application rates. Where thresholds would be exceeded, treatments with inhalable dusts or volatile compounds should be curtailed.
- Planning documents should provide an analysis of vulnerable groups, including children, fetuses, the elderly, those with impaired nervous, respiratory or immune systems, sensitive individuals, and fertile men and women planning to have children, that have higher exposure risks from the use of herbicide applications. If the possibility of harm to these groups exceeds EPA risk quotients, then such herbicide applications should be curtailed.
- Planning documents should provide an analysis of the potential effects of proposed herbicide applications on incidence rates for human cancer, acute effects, immune system effects, endocrine system effects or behavioral effects. Planning documents should provide descriptions of proposed mitigation measures to compensate for Forest Service-caused increases in incidences of these adverse effects. If the possibility of increased harm from these adverse effects exceeds EPA risk quotients, then such herbicide applications should be curtailed.
- Planning documents should provide an analysis of the synergistic and cumulative effects of proposed herbicide applications on the human environment. If the possibility of increased harm from these adverse effects exceeds EPA risk quotients, or if the effects are essentially unknown, then such herbicide applications should be curtailed.
- Planning documents should provide an analysis of the effects of “inert” ingredients on human health and safety. If the possibility of increased harm from exceeds EPA risk quotients, or if the effects are essentially unknown, then the use of such “inert” ingredients should be curtailed.
- Planning documents should provide an analysis of the negative human effects of herbicide applications that may be volatized during forest fires.
- Herbicide applications should be avoided in areas where controlled burns are expected to occur. Firefighters fighting wildfires should be provided with warnings when working in areas that have been recently treated with herbicides.
- The Forest Service must track reported and confirmed adverse human effects on an incidents tracking form.
- The Forest Service appeals process must be retained to protect citizens’ rights to have a safe and healthy environment. No sufficiency language should be allowed that insulates the Forest Service from the appeals process or the responsibility to protect human health and safety.

Section B. Adverse impacts of chemicals on the environment must be quantified and eliminated.

The NEPA regulations (40 CFR § 1500-1508) are specific about limiting negative environmental impacts. In fact, Section 1500.2(f) states,

> Federal agencies shall to the fullest extent possible…(u)se all practicable means, consistent with the requirements of the Act and other essential considerations of national policy, to restore and enhance the quality of the human environment and avoid or minimize any possible adverse effects of their actions upon the quality of the human environment.

In attempting to minimize "any possible adverse effects", mitigation is implied, which is defined in NEPA (§ 1508.20) as:

> (a) Avoiding the impact altogether by not taking a certain action or parts of an action.
> (b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
> (c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
> (d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
> (e) Compensating for the impact by replacing or providing substitute resources or environments.

The use of herbicides is both unwarranted and illegal if their impacts on the environment are not disclosed. This Section of the NEPA presents details of potential and likely impacts, many of which have been intentionally excluded from Forest Service planning documents.

One such impact from the use of herbicides, is the removal of desirable native plant species as an unintended consequence of the lack of host-specificity by herbicides. The harm this causes to biological diversity and ecosystem integrity is seldom disclosed publicly, in disregard for the Code of Federal Regulations (36 CFR 219 § 27 (G)), which state that management prescriptions,

> where appropriate and to the extent practicable, shall preserve and enhance the diversity of plant and animal communities, including endemics and desirable naturalized plant and animal species, so that it is at least as great as that which would be expected in a natural forest and the diversity of tree species similar to that existing in the planning area. Reductions in diversity of plant and animal species from that which would be expected in a natural forest, or from that similar to the existing diversity in the planning area, may be prescribed only where needed to meet overall multiple-use objectives. Planned site conversion shall be justified by an analysis showing biological, economic, social, and environmental design consequences, and the relation of such conversions to the process of natural change.

Rather than provide actual data, the Forest Service prefers to characterize herbicides they intend to use in vague, general terms that underexaggerate any undesirable effects and make them appear benign, e.g., Okanogan NF (1997):

> Picloram is relatively toxic to invertebrates. However, the medium lethal concentrations of (LC50s) picloram are one or two orders of magnitude less toxic to aquatic organisms than most insecticides and would probably have little impact on food resources of fish (Driver, 1991).

Such simplification of the known and potential effects from herbicides that are used on public lands greatly misrepresents the information that agencies are required to disclose to the public and decision-maker prior to undertaking such actions. Perhaps even more importantly, such simplification also misrepresents the effects of herbicides which agencies, such as the Forest Service, are required to "avoid or minimize", according to NEPA.

Below, is a brief summary of some of the information that currently exists on the effects of herbicides and invasive species on the environment. This type information should be more readily recognized and included in planning documents and decisions. Where information is lacking, land managers should use extreme caution in assigning such situations as low risk.

Soils. Evidence is readily available to show that soils can be impacted both by invasive species as well as herbicide treatments. Research in shrub-steppe habitats showed that invasive species, which are usually non-mycorrhizal, disrupted succession by native plant species, 99% of which were mycorrhizae-dependent (Wicklow-Howard, 1994). The authors suggested that long-term impacts to mycorrhizae may result from invasive species because without host plants to support the mycorrhizae, the fungal propagules may not be able to survive.

Available research indicates that herbicides alter soil ecosystems through direct effects on soil microflora, such as plant pathogens, antagonists, or mycorrhizae, resulting in increased or decreased incidence of plant disease (Levesque and Rahe, 1992). This study also found that herbicides predispose pathogens to fungicide susceptibility, e.g., they act as synergists. Persistence of herbicides through soil and humus binding is unaccounted for in most quantitative measurements of toxicity used to determine safe exposure levels (Bordeleau and Bartha, 1971) and the possibility exists that they may be released at unexpected times in the future (Pramer and Bartha, 1980).

Herbicides can lead to alteration of soil microclimate (Evans and Young, 1984) by causing destruction of beneficial macro- and microorganisms in the soil, including earthworms, fungi and bacteria (Pimentel, 1992). Soil organisms are vital to the proper functioning of soil ecosystems and their loss leads to nutrient deficiencies. Earthworms and soil microorganisms break down organic matter and make nitrogen and other nutrients accessible to plants, yet earthworms are vulnerable to pesticides (Bugg, 1994).

The negative effects of herbicides on the living components of soils initiates a pernicious cycle of decline in forest health and a wide range of deleterious effects. The loss of soil microflora as a result of using herbicides has led to the conversion of productive forestland to unforested openings (Perry and Amaranthus, 1994; Amaranthus and Perry, 1987; Perry, 1984). Herbicides kill a broad range of non-target vegetation, which can lead to altered ecosystems, beginning with raised site temperatures as a result of loss of cover (Holtby and Baillie, 1987). The effect of vegetation removal on test plots resulted in increased sediment yields of 216% and 126% on bunchgrass and knapweed sites respectively (Lacey et al., 1989).

The soil crust and vegetative cover is important for increased soil stability, water infiltration, and soil fertility (Harper and Marble 1988; Johansen, 1993; Belnap and Gardner, 1993) and reduces the susceptibility of the soil to wind and water erosion (Iverson et al. 1981; Wilshire and Nakata, 1976). Increased erosion can result in a decline in water quality due to an increase in sediment and dissolved matter (Miller, 1970). In addition, a reduction in soil water content influences soil biota activity, nitrogen cycle dynamics (Torbert and Wood, 1992), vascular plant vigor and reproduction (Crawford 1979; Skujins, 1984), and decomposition rates of soil organic matter (West, 1981). Changes in uptake and cycling of soil nutrients have resulted from elimination of cryptobiotic crusts, which accompany species changes resulting from soil disturbance (Bolton et al., 1993; Anderson et al., 1982; Kleiner and Harper, 1972).

Belnap (1995) found that concentrations of nitrogen and macronutrients in annual, biennial, and perennial plants were significantly higher when grown on undisturbed crusted surfaces than on trampled areas. The disruption of nutrient cycles and availability can adversely impact vegetation productivity and abundance and ultimately the ecology of an area. She found that disturbed arid soils at her study site in Utah had lowered nitrogen and carbon inputs and slower decomposition of soil organic matter, resulting in lower nutrient levels in vascular plants. Additional time, ranging from 35 to 250 years is required for the recovery of cyanobacterial biomass, lichen cover, and moss cover, respectively (Belnap, 1993). As a consequence of the fragility, sensitivity, and slow recovery of desert soils, these areas are particularly susceptible to desertification (Belnap, 1995).

Reeves et al. (1979) documented a negative correlation between disturbance and mycorrhizal fungi in their study of a western Colorado sage assemblage. Reductions in survival and growth of *Pinus lambertiana* (sugar pine) seedlings were correlated with reductions in the formation of beneficial ectomycorrhizal fungi following seeding of the non-mycorrhizal grass *Lolium multiflorum* (annual, or Italian rye) (Amaranthus and Perry, 1994).

Aquatic resources. Forest Service documents often claim that herbicide impacts on water quality will be negligible, yet they consistently fail to substantiate these claims. Even when statistics are given that show a potential for lowered water quality from chemical applications, documents quickly dismiss such possibilities as insignificant. A careful interpretation of potential effects would reveal that not only ecosystems, but human industries, agriculture, and society at large suffer each time water quality is diminished by chemicals used in herbicides applications.

The Forest Service uses herbicides, such as picloram and the sulfonylureas, which have extremely high phytotoxicity and high potential for leaching and drift. Unless the herbicide breaks down before reaching groundwater, it will contribute to the rising levels of chemical mixtures already found in downstream groundwater. In recommending against the registration eligibility of picloram, the EPA had this to say about the likelihood of its effects (Abramovitch, date unknown):

> The use pattern of picloram is highly specialized, but it is almost certain to eventually reach ground water in areas where it persists in the overlying soil. In submitted terrestrial field and forestry studies, picloram exhibited calculated half-lives of up to 278 days and was detected up to the limits of sampling depth (up to 1.8m). Even under the most constrained soil conditions in the submitted field studies (e.g., 1/2 the maximum application rate, high soil organic matter, minimum rainfall) the compound moves through the soil profile to the deepest sampling depth. In addition, in soils of low permeability, picloram residues may be transported by dissolved run-off during rainfall events and potentially reach non-target vegetation.

In 1989, drinking water in at least 38 states was found to be contaminated. (American Defender Network, 1989). Such conditions could potentially be made worse by herbicide applications on National Forest lands. The herbicide Dacthal, a chemical similar to the picloram which the Forest Service uses, was applied to Long Island golf courses after which it was detected in drinking water wells at levels twenty times the State’s safety limits.

The EPA eligibility registration of picloram continues:

> Furthermore, incident data indicate that 15,880 pounds of fish died from symptoms of chemical poisoning at a fish hatchery in Sheridan, Montana on July 21, 1989. Picloram (Tordon 22K) was detected at the scene and

> the chemical had been sprayed one-quarter mile upstream from the fish hatchery by Montana State highway personnel. Rain on the day of the fish kill had washed Picloram into the hatcheries water source. Although the LC50 data indicates that the risk does not exceed the LOC [EPA determined levels of concern], the latest EPA paradigm states that an incident itself is sufficient to exceed the LOC for acute risk.

The Forest Service has this to say about the risk of picloram to fish (Okanogan NF, 1997, p. 108):

> In areas adjacent to identified fish populations, buffer areas as described above [hand wicking and hand spraying within 50 feet of visible water] would be used to minimize impacts to fisheries.

Rashin and Graber (1993) examined the use of pesticides on forested sites, in accordance with Best Management Practices (BMPs) established in the Washington Forest Practices Rules and Regulations. Pesticides examined included 2,4-D, triclopyr, glyphosate, imazapyr, metasystox-R, and chlorothalonil. Following their application, pesticides were detected in streams and runoff at all seven sites, with peak levels ranging from 0.02 to 7.55 mg/L. The majority of pesticide introduction to streams was attributed to off-target swath displacement and drift from spray areas near streams. The overall distribution of pesticide levels indicated that overspray occurred in small headwater streams because the applicator had incorrectly assessed them as not having surface flow. The BMPs were judged ineffective because water quality standards were exceeded, drift of herbicide spray into surface waters was not prevented and compliance with pesticide label restrictions regarding entry to surface waters and avoidance of off-target drift was questionable.

Despite evidence of changes in streamside habitats resulting from herbicides, the effects have been largely ignored by Forest Service managers (O'Brien, 1997):

> If stream or wetland temperature is raised upon the removal of vegetation, or if cover is lost upon which butterflies, nesting birds, or other wildlife depend, effects that are not even considered or tested for in the registration of herbicides may be caused. EPA states, for instance, that, 'a number of terrestrial and aquatic plant species are listed as being at jeopardy from the use of herbicides.' I would guess that none of the registration documents for any of those herbicides predicted or even discussed the demise of rare plants from the use of the herbicides.

Austin et al., (1991) found that glyphosate negatively affects the aquatic food chain through stimulation of eutrophication. Buhl and Faerber (1989) found that Roundup© caused an 89% decline in the numbers of the midge, *Chironomas riparius*, an important food resource in the food chain. Goldsborough and Brown (1988) found that the photosynthetic rates of algal communities in six forest ponds were affected by Roundup©, with an EC50 value (glyphosate level resulting in 50% inhibition of carbon fixation) between 8.9 and 89mg/L.

Increased evapotranspiration caused by invasive plants can lower water tables. (Kerpez and Smith, 1987; Horton, 1977). Herbicides applied to halt weed encroachment add to the severity of this effect by decreasing the amount of available shade and increasing solar exposure to the soil (Parendes and Jones, 2000).

The paucity of published research on the action of glyphosate on aquatic species composition, bioaccumulation and food chain relationships further recommends caution in the application of this herbicide, which unfortunately has gone unheeded by the management of National Forests.

Vegetation. Native plant loss occurs in at least three ways during invasive species management. First they may be competitively displaced by invasive species. Secondly, they may be killed outright by herbicides. Thirdly, they may be displaced by so-called beneficial seed mixtures applied to mitigate herbicides.

The loss of biological diversity attributed to invasive plants is well-documented (Randall, 1996; Rosentreter, 1994), and includes native plant displacement occurring through competitive exclusion (Harris, 1967). Other examples include interference by *Cirsium vulgare* (bull thistle) resulting in lowered growth rate and survival of *Pinus ponderosa* in forest plantations (Randall and Rejmánek, 1993). Displacement of native plants and reduced plant diversity resulted following entry of *Centaurea maculosa* (spotted knapweed) (Tyser and Key, 1988) and the displacement of native bunchgrasses by *Bromus tectorum* (cheatgrass) was noted following fire (Melgoza et al., 1990). *Bromus tectorum* (cheatgrass) dominance caused permanent increased frequency and severity of fires (Billings, 1983; Peters and Bunting, 1994).

Loss of species diversity occurred in timberline vegetation with exotic invasion by Kentucky bluegrass, *Poa pratensis*, and timothy, *Phleum pratense*, (Weaver et al., 1989). Destruction of nontarget plants resulted in lowered species richness and replacement by introduced species following 2,4-D treatment of native *Veratrum californicum* in an alpine plant community (Anderson and Thompson, 1993).

However bad the effects of invasive species are on ecosystems, in almost all cases, the effects of herbicides are often worse. When herbicides are used on a site, they may leave the area devoid of all vegetation, and ripe for future invasion. The loss of native plants from herbicides needs no explanation—it is an unavoidable impact whenever non-specific herbicides are chosen for treatment measures. However, the initial loss of species leads to further ecosystem disruption, which is seldom documented or taken into consideration. Planning documents produced by the Forest Service rarely analyze ecosystem effects to native vegetation, despite the fact that plants are primary producers in an ecosystem.

Following plant removal, soil temperatures and water retention may be negatively affected, and often severe disruptions to plant successional and nutrient cycling processes may occur as a result of destruction of important soil microflora (Evans and Young, 1984; Perry and Amaranthus, 1994; Amaranthus and Perry, 1987; Perry, 1984).

Results of herbicide applications include reduced plant cover and biomass, fewer and less vigorous plants (Jeffery et al., 1981), lowered plant diversity (Anderson and Thompson, 1993), increases in density of exotic species (Barber, 1999),

Food web disruption may be caused by elimination of important native primary producers by invasive plants (Orians and Solbrig, 1977; Marks and Bormann, 1972). Habitat itself is often altered. For example, habitat selection by birds is influenced by vegetation structure, diversity, composition, and habitat patchiness (James and Wamer, 1982; Rotenberry and Wiens, 1978), all of which are affected by changes in vegetation structure caused by herbicide applications.

The role of added surfactants is seldom accounted for in herbicide applications and effects. However, there is an extensive amount of literature on herbicides indicating that the addition of surfactants can greatly enhance their phytotoxicity (Green et al. 1992; Clay and Lawrie, 1988; Sherrick et al. 1986; Turner, 1985), which thus magnifies the effects on native vegetation. Glyphosate, as the formulation Roundup©, contains a polyethoxylated tallow amine surfactant at a level of 15% (150 g/L) and Roundup© Pro contains a phosphate ester neutralized polyethoxylated tallow amine surfactant at a level of 14.5%. Other formulations of glyphosate recommend the use of a surfactant to improve its efficacy.

As a broad spectrum herbicide, glyphosate has documented phytotoxicity to a wide array of organisms, including lichens (Brown, 1995), nitrogen-fixing bacteria (Tu, 1994; Carlisle et al., 1986; Moorman et al., 1992; Martensson, 1992) and beneficial mycorrhizal fungi (Estok et al., 1989; Chakravarty and Chatarpaul, 1990; Sidhu and Chakravarty, 1990; Chakravarty and Sidhu, 1987). These species are all integral components of the ecosystem, which are negatively affected by herbicides. The Carlisle study found that the rate of glyphosate degradation correlates with the soil respiration rate, an estimate of microbial activity. Glyphosate has been found to inhibit growth (at 50 ppm) of 59% of randomly selected soil bacterial, fungal, actinomycete, and yeast isolates; of nine herbicides tested, glyphosate was the second most toxic.

Picloram is another herbicide often touted as being of low toxicity, however its extremely high phytotoxicity, combined with its high potential to leach, have caused the EPA to recommend withdrawing its registration. Because of its broad applicability and persistence, picloram is a potent phytotoxic compound. Picloram is readily adsorbed by plant roots and is readily translocated throughout plants, where it remains intact and stable. The US Fish and Wildlife Service has determined that the compound picloram, because of its persistence, mobility and toxicity to plants, may pose a threat to endangered plant species. According to EPA's report, Reregistration Eligibility Decision (R.E.D.), "Picloram is nearly recalcitrant to all degradation processes."

Revegetation attempts following herbicide applications also often result in a loss of ecosystem integrity, unless restoration plant species are carefully chosen. The regular seeding of strongly competitive and aggressive alien species following National Forest management causes dramatic displacement of native vegetation (Ralphs and Busby, 1979). The use of inappropriate seed mixtures following wildland herbicide applications leads to further degradation as grazers respond to the changes. Food web disruption by maladaptive herbivores has been documented (Edwards and Gillman, 1987; Daubenmire, 1940). In the case of livestock use of reseeded wildlands, the result is conversion of native ecosystems to agricultural ones. This in turn leads to a cycle whereby livestock selectively graze beneficials, which leads again to weed invasions (Photo 1, p. 3). The inescapable conclusion is that increased livestock use is a result of the maladaptive restoration plantings, which then becomes a source of further spread of invasive species, the need for additional herbicides, and further seedings.

Fish and wildlife. Wildlife habitat reduction by invasive plants is frequently used to justify a "need" for herbicides (Bedunah, 1992), however wildlife may be directly affected by herbicides, or indirectly through changes in habitat. Habitat for native organisms may be reduced or eliminated by invasive plants (Nee and May, 1992; Brothers and Spingarn, 1992).

Herbicide application is implicated as one of the causes in the global decline of amphibian populations (Blaustein and Wake, 1995). A summary of amphibian effects from herbicides indicates that these species are a very sensitive indicator of environmental effects that should be included in any environmental monitoring scheme intended to mirror effects (Schuytema and Nebeker, 1996).

Surfactants in different commercial preparations of the herbicide glyphosate can result in 400-fold greater toxicity to sockeye salmon fry (Monroe, 1988). In a study of the effects of glyphosate on fish, Servizi et al. (1987) found that the combined effect of glyphosate and the surfactant POEA found in the commercial produce sold as Roundup© is more than additive, and some surfactants used alone are more toxic to fish than the pesticide. Martinez and Brown (1991) found that the surfactant POEA (in doses of 1.03g/kg) has serious pulmonary toxicity, but not quite as serious as the full formulation, Roundup©, which produced 100% death in rat subjects within 24 hours. Folmar (1979) found that Roundup© is four times more toxic to rainbow trout fry and fingerlings than to larger fish.

Glyphosate formulations are acutely toxic to fish (Servizi et al., 1987). Acute toxicities of

Rodeo©, with X-77 Spreader© per label recommendations, vary from 120 to 290 ppm (Mitchell et al., 1987), and can result in effects to pink, chum, coho, and chinook salmon (Wan et al., 1989). Sublethal effects of glyphosate on fish include erratic swimming, labored breathing, altered feeding, migration and reproduction and increased likelihood of being eaten (Morgan et al., 1991; Liong et al., 1988). Studies also show that salmonids may alter their migration patterns in response to avoidance of herbicides (Folmar, 1976).

Applications of glyphosate to ditchbanks near aquatic ecosystems may be hazardous to resident fauna if the water temperatures are elevated because glyphosate causes water temperatures to increase for several years following treatment (Holtby and Baillie, 1987).

A number of studies show detrimental effects from glyphosate on birds (Cox, 1991, 1995, 1995b). MacKinnon and Freedman (1993) examined the effects of glyphosate use on breeding birds and found densities of most common breeding species decreased significantly on all treatment plots.

A memorandum from Akiva Abramovitch, Ph.D., Chief of EPA Review Section #3, to Walter Waldrop, Product Manager #71, EPA Special Review and Registration Division, reminds the department of potential to fish that can occur, despite label precautions.

> The above table characterizes the Picloram acid as moderately toxic to freshwater fish with a LC50 of 5.5 mg/l (ppm) and slightly toxic to freshwater invertebrates (LC50 of 34.4 mg/l). Field runoff studies conducted with cutthroat trout concluded that concentrations as low as 290 eeg/l and 610 eeg/l will affect survival & growth of cutthroat trout. . . .
>
> . . . The preliminary aquatic risk assessment indicates that the Picloram TIPA and Potassium Salts are not likely to affect nontarget aquatic organisms from ground and aerial applications on an acute toxicity basis. However, for endangered species the Potassium salt is likely to adversely affect fish for ground applications. To complete the aquatic risk EEB will require the acute LC50s for a coldwater fish (rainbow trout), a warmwater fish (bluegill), a freshwater and marine invertebrate, and a marine oyster shell deposition study for the IOE, and a marine fish study for the Potassium and TIPA salts. . . .

Connor and McMillan (1990) compared moose forage resources on control and on herbicided cutovers. On control areas, available moose browse was four times greater, and utilized browse was 32 times greater, than in treated areas after one growing season post-spray. Winter moose presence was almost two times greater on untreated than treated areas after one growing season.

Fire. Invasive species can lead to increased fire frequency and severity (D'Antonio and Vitousek, 1992; Whisenant, 1990), such as in the case of cheatgrass (*Bromus tectorum*) (Young and Evans, 1978). Unfortunately, noxious weed managers have essentially given up controlling this pest, to the point where it is even an allowed contaminant in "native" seed mixtures.

Fires have become more common and extensive in pinyon-juniper woodlands and sagebrush ecosystems invaded by cheatgrass (Billings, 1994). Ponderosa pine forests have also shown an increase in incidence of fire following the invasion of cheatgrass (Monsen, 1994).

Cumulative, indirect and non-target effects. Cumulative effects are the incremental accumulation of effects over time and space that may not be significant individually, but which may be significant when added together. Much of our native fauna is threatened by the synergistic effects of synthetic compounds on living estrogenic activity. These estrogenic compounds are associated with many herbicides and pesticides (Fox, 1992).

According to O'Brien (1977):

> The removal of microbiotic crusts, depletion of mycorrhizal fungi, erosion, soil compaction, replacement of native vegetation or wildlife with exotic vegetation or wildlife, removal of old growth trees or riparian vegetation, isolation from floodplain functioning, and other stresses may be cumulative with herbicides on wildlife and vegetation. For instance, if livestock grazing has reduced riparian vegetation, and the stream temperature has been raised somewhat, will the toxicological effects of an herbicide be enhanced by the temperature increase?
>
> Again, the registration of the active ingredients of herbicide formulations do not, and cannot, take the cumulative impacts of site-specific stresses into account. The Forest Service is neither funded nor inclined toward detecting cumulative impacts when herbicides are used, and none of the herbicide information profiles consider these impacts.

The environmental fate of herbicides used on Forest Service lands is wrongly ascribed to be "insignificant" in Forest Service documents that do not consider that U.S. groundwater is already significantly contaminated with herbicides and other pesticides. In Washington alone, 6% of public wells were found to be contaminated with measurable herbicides and other pesticides (US Geological Survey, 1996)

National Forest disclosure documents have been remiss about documenting the detrimental effects of herbicide on non-target vegetation (Wenatchee NF, 1998; Okanogan NF, 1997). Herbicides not only destroy the target weed, but often reduce a number of non-target plant species as well. According to the Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida (Rao et al., 1998),

> In addition to the pesticide solubility and soil permeability it is important that the pesticide's toxicity to nontarget species be considered. Some of the pesticides listed in Tables 1 and 2 have severely restricted use due to acute toxicity or long half-life. An important purpose of the pesticide container's label is to instruct users to apply the pesticide safely and with minimum threat to nontarget species, both on and off the application site.

During a denied appeal of a plan to use herbicides, the Regional 6 NF Noxious Weed Coordinator in Portland assured appellants that analysis files available at the Washington Office disclosing the effects of glyphosate application were incorporated into the final documentation. Appellants claimed that the Forest Service had not documented indirect effects described in a national survey which led to permitting the use of the chosen herbicide (Syracuse Environmental Research Associates, Inc., 1999):

> Non-target plants could be damaged by unintentional application or drift. . . . The primary hazard to non-target terrestrial plants is from unintended direct deposition or spray drift. Unintended direct spray will result in exposure equivalent to the application rate. As discussed in the dose-response assessment for terrestrial plants (section 4.3.3), such exposures are likely to result in adverse effects to a number of plant species.

Nonetheless, an independent site visit and documenting photographic taken after the application (Wooten, 1999d) clearly show that the treatment primarily affected native plants. Noxious weeds alongside the road were missed completely while spraying over them onto native plants on streambanks as far as 30 feet beyond the road.

Herbicides may weaken native plants to the point where they are harmed. Pimentel (1999) notes that when herbicides did not kill non-target plants, plant pathogens increased in abundance up to 5-fold and attacks on plants increased up to 3-fold.

Indirect effects of herbicides include those effects that follow, like ripples, from the removal of both target and non-target vegetation (O'Brien, 1977). Transport of pesticides up food chains and concentration in lipid tissues of secondary consumers can result in exposures to fish 49,000 times higher than to target organisms (Reinert, 1967).

Many herbicides are resistant to breakdown, and when they do break down, the secondary byproducts can also have toxicity. For organochlorine pesticides, the chlorine-carbon bond resists breakdown by normal biochemical and physical processes and remains in the environment. Since the majority of organochlorines are foreign to nature, living organisms have developed few methods to detoxify them (Reinecke and Knackmuss, 1988; Nielsen, 1990).

So called "inert ingredients" are strongly implicated in the decline of Atlantic salmon. According to Montague (1999),

> A study published in May in Environmental Health Perspectives, a U.S. government science journal, makes the case that insecticides sprayed on forests in eastern Canada in the mid-1970s led to a dramatic decline in the population of Atlantic Salmon (45% reduction in small salmon, 77% reduction in large salmon) (Fairchild, 1999). Salmon are born in fresh water but after 2 or 3 years they undergo physical changes called "smoltification," after which they move downstream into salt water. Smoltification is controlled by hormones. Researchers believe the pesticide interfered with the hormones of the salmon, somehow disrupting smoltification, leading to the loss of large numbers of fish. The pesticide in question was called Matacil 1.8D. The "active ingredient" in Matacil 1.8D is aminocarb, which makes up about 25% of the insecticide by weight. The other 75% of Matacil 1.8D is an "inert ingredient" called 4-nonylphenol (4-NP for short). In laboratory tests, 4-NP is anything but inert. It is a powerful hormone disrupter. The authors of the study point out that many U.S. streams contain levels of hormone- disrupting chemicals comparable to the levels that they believe wiped out so many Atlantic salmon.

National Forests often exhibit weather patterns, which leads to serious drift problems. In the case of aerial applications, even under ideal weather conditions only approximately 25% of the herbicide reaches the target area, and it is estimated that less than 0.1% of pesticides ever reach their target pests, resulting in more than 99% of applied pesticides impacting the surrounding environment (Pimentel, 1999). Research has shown that less than one percent of the pesticides that are applied to crops actually reaches their target organism (Office of Technology Assessment, 1990, p. 104).

Finally, yet another unaccounted effect of herbicides is that they rarely solve the problem and require additional applications. Repeated chemical treatments can lead to acquiring herbicide resistance in weeds. Pesticide resistance has already been acquired by nearly 200 different species of plant pathogens and invasive plants, according to the National Research Council (1996, p.26). These studies indicate that the increase in pesticide-induced resistance suggests that dependence on pesticides as the dominant means of controlling pests is not a sustainable solution. The spiraling costs of treating resistant pests are estimated to account 10 percent of United States pesticide use (Pimentel, 1992).

Worldwide, there are over 216 herbicide-resistant weed species (Barber, 1999). Resistant species include flannel mullein (*Verbascum thapsus*), hoary white-top (*Cardaria draba*), Russian tumbleweed (*Salsola kali*) and diffuse knapweed (Photo 3). These super-plants are being inadvertently bred through the excessive and regular use of too many herbicides along our highways. This leads to increasingly rapid spread along roads, and ultimately, abandonment of hopes for control. In Washington State, the Noxious Weed Control Board has had to delist a number of species because they became ubiquitous.

Case example: TES plant surveys

The Forest Service Region 6 Forester has given direction to the Forests to protect threatened, endangered and sensitive (TES) species (FSM 2600). Plant survey guidelines for TES plant surveys insure that TES plants will be searched for prior to project implementation. In 1999 the Okanogan NF treated 5,956 acres with herbicides, under an Environmental Assessment (Okanogan NF, 1997) which claimed to have surveyed for sensitive plants prior to the project. Yet responses obtained through Freedom of Information Act (FOIA) requests by Kettle Range Conservation Group for these “surveys” revealed that this was not so. Many of the “surveys” were merely lists of plants for areas which were never visited; one of the “surveys” was a list of “cultural plant information” that listed edible plants (e.g., “Bailout”, 1998), some “surveys” were grazing allotment reviews or timber sale evaluations conducted at earlier dates, and several of the “surveys” were only performed through examining aerial photos, rather than actually sending a botanist to visit the site (e.g., “Cayuse”, 1993; “Redmill”, 1997). To conduct sensitive plant surveys using aerial photos in lieu of field surveys is a repudiation of the Regional Forester’s directive.

Any threatened or endangered plants existing on the sites would have been exterminated without the Forest Service or anyone else ever having known about it. In fact, valid TES plant surveys did find rare species in several of the treated areas, but these were not documented in the EA (e.g., TES surveys in McFarland Creek and Fawn Creek in 1998.

Case example: Herbicide persistence

The Forest Service Region 6 currently has two available herbicides for use in the Pacific Northwest, glyphosate and picloram. These were the first chosen following lifting of the five-year injunction against their use in the Region (NCAP et al. v. Clayton Yeutter, et al., 1989). Picloram, however, has an extremely high ratio of toxicity to effective concentration for plants, and it has been recommended by the EPA to have its registration rescinded (Abramovitch, undated).

‘Beware,’ warns noted Colorado State University fisheries biologist Dr. Harold Hagen, ‘anytime you spray Tordon [picloram] it’ll come back to haunt you. It may be eight or ten years, but it will come back.’

In July 29, 1989, a weed-killing crew near Sheridan, Wyoming applied Tordon 22K a quarter mile from Hagen’s fish hatchery. The day afterward rain carried the herbicide into the trout ponds and within hours, more than 8,000 pounds of trout were dead, eventually killing all 15,000 pounds of the hatchery’s fish, and leaving Hagen out of business. ‘What they did was destroy the best trout hatchery in the country,’ said Hagen of the incident.

‘I wouldn’t let that stuff within 50 miles of my place,’ says Lew Grant, owner of the Fort Collins, Colorado based Piedmont Farms, when asked about Tordon. ‘The Soil Conservation District came out and treated circular patches of Canadian thistle on our place with Tordon. For at least seven or eight years we grew corn and other crops on that land with no problems. Then, nine years later, we planted sugar beets on it. They came up just fine but then they started dying in these big circle areas. I called Great

Western Sugar, and they came out and analyzed them. They told me they were dying from Tordon. I couldn't believe it. After nine years, it [Tordon] was still in the soil.'

Case example: cumulative effects

O'Brien (1977) described how cumulative effects might be multiplied in an ecosystem:

> A field study of glufosinate, for instance, found that it reduced the number of fungi in forest soils by 20 percent. Plant disease-causing fungi were among those species least impacted, while Trichoderma species, considered beneficial because they parasitize disease-causing species, were among the most sensitive to glufosinate. The researchers noted that use of glufosinate has, "important microbiological consequences".
>
> While glufosinate is not an herbicide Region 6 is currently using, I mention this study for two reasons. The first is that a soil whose cover and rooting vegetation have been reduced by logging or livestock or heavy recreation use might already have compromised biological functioning. The use of an herbicide that further reduces biological functioning is a cumulative impact.
>
> The second is that this type of effect could be happening with the Region's current use of any of its herbicides, but the agency is not looking for cumulative impacts, and would most likely not know they were occurring.

Solutions

- Invasive species management projects must follow NEPA mitigation measures in 40 CFR § 1508.20, which require:
  - (a) Avoiding the impact altogether by not taking a certain action or parts of an action.
  - (b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
  - (c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
  - (d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
  - (e) Compensating for the impact by replacing or providing substitute resources or environments.
- Project plans should only consider alternatives that preserve and enhance the diversity of plant and animal communities, as required by 36 CFR 219 § 27 (G).
- Projects should only use herbicides as a last resort, and only after careful consideration of all impacts.
- Planning documents should provide an analysis of the effects of herbicide applications on soils, including soil macro- and micro- organisms, soil nutrients, soil productivity, persistence, and erosion effects. Applications should be avoided in situations where they will negatively impact healthy soils.
- Planning documents should provide an analysis of the effects of herbicide applications on aquatic habitats, including analyses for water quality, aquatic species, riparian vegetation, and persistence. Applications should be avoided in situations where they will negatively impact aquatic habitats and species.
- Planning documents should provide an analysis of the effects of using herbicide formulations on non-target native flora and fauna. Herbicide applications should be avoided in situations where they will predominantly impact native species.
- Planning documents should measure and analyze effects of herbicide formulations on suitable indicator species. Recommended classes of indicator species include amphibians, fish, algae, lichens, and select vascular plants.

- Planning documents should specify monitoring and mitigation measures to assure that adverse effects are being avoided and minimized and that damage thresholds are being adhered to.
- Herbicide applications should be avoided on wildlife forage, particularly where browsed frequently or where the habitat is used by threatened and endangered species.
- Planning documents should provide an analysis of the cumulative, indirect, and synergistic effects of the use of herbicide formulations on the environment.
- Planning documents should provide an analysis of the cumulative effects of repetitive treatments of herbicide formulations or other weed treatment activities on the environment, especially when other land management activities, such as livestock grazing, road construction and logging, inhibit the “success” of treatments.
- Planning documents should provide an analysis of the effects of herbicide formulations on areas that contain invasive species that disrupt the normal fire regime, e.g., cheat grass (*Bromus tectorum*).
- Planning documents should provide an analysis of increased herbicide resistance in association with herbicide treatments. Herbicide treatments should be avoided on herbicide-resistant species.

Section C. Stringent safety precautions for handling chemicals should be followed and applications should strictly adhere to established procedures.

In implementing vegetation management projects, all land management agencies must follow recognized safe chemical handling and spill procedures, accompanied by standardized documentation of accidents. In addition, safety precautions, established procedures and label directions must be strictly followed and chemical applications must comply with planning documents.

Chemical safety is regulated under the Occupational Safety and Health Administration (OSHA). The Forest Service is required to satisfied OSHA requirements (29 CFR 1910.1200(g)(8)) for maintaining Standard Material Safety Data Sheets:

> The employer shall maintain copies of the required Material Safety Data Sheets for each hazardous chemical in the workplace and shall ensure that they are readily accessible during each work shift to employees when they are in their work area(s).

Under 29 CFR 1910.1200(e), the Forest Service is required to:

(1) . . . develop, implement, and maintain at each workplace, a written hazard communication program which at least describes how the criteria specified in paragraphs (f), (g), and (h) of this section for labels and other forms of warning, material safety data sheets, and employee information and training will be met, and which also includes the following:

(1)(i) A list of the hazardous chemicals known to be present using an identity that is referenced on the appropriate material safety data sheet (the list may be compiled for the workplace as a whole or for individual work areas); and,

(1)(ii) The methods the employer will use to inform employees of the hazards of non-routine tasks (for example, the cleaning of reactor vessels), and the hazards associated with chemicals contained in unlabeled pipes in their work areas.

(2) Multi-employer workplaces. Employers who produce, use, or store hazardous chemicals at a workplace in such a way that the employees of other employer(s) may be exposed (for example, employees

of a construction contractor working on-site) shall additionally ensure that the hazard communication programs developed and implemented under this paragraph (e) include the following:

(2)(i) The methods the employer will use to provide the other employer(s) on-site access to material safety data sheets for each hazardous chemical the other employer(s)' employees may be exposed to while working . . .

. . . (h)(1) Employers shall provide employees with effective information and training on hazardous chemicals in their work area at the time of their initial assignment, and whenever a new physical or health hazard the employees have not previously been trained about is introduced into their work area. Information and training may be designed to cover categories of hazards (e.g., flammability, carcinogenicity) or specific chemicals. Chemical-specific information must always be available through labels and material safety data sheets.

Under 29 CFR 1910.1200(d)(3)(ii), the Forest Service is required to evaluate one of the following sources for chemical hazard evaluation: Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA); or, "Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment," American Conference of Governmental Industrial Hygienists (ACGIH) (latest edition).

Under 29 CFR 1910.1200(d)(4), the Forest Service is required to evaluate one of the following sources for establishing that a chemical is a carcinogen or potential carcinogen for hazard communication purposes: National Toxicology Program (NTP), "Annual Report on Carcinogens" (latest edition); International Agency for Research on Cancer (IARC) "Monographs" (latest editions); or 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration.

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), Section 12(a)2 states, "It shall be unlawful for any person to use any registered pesticide in a manner inconsistent with its labeling." The EPA has the authority to register, restrict, or prohibit the use of pesticides, while States may offer additional protection. Pesticide registration decisions balance the risks involved with the benefits, after consideration of the nature of the chemicals, their toxicity and their environmental fate. The Washington Pesticide Control Act (RCW 15.58.150(2)(c)) states, "It shall be unlawful for any person to use . . . any pesticide contrary to label directions."

Recent Forest Service planning documents have failed to refer to available EPA information or even acknowledge the role of the Forest Service in weighing the benefits and risks of applications. There appears to be a fundamental rift in Forest Service compliance with NEPA regulations, which are primarily designed to provide disclosure, and FIFRA, which provides risk /benefit analyses. There is an explicit requirement in the use of registered herbicides that a beneficial use should be weighed against risks, a process that requires a quantified risk assessment completed by qualified individuals. Risk assessments and the valuable information they provide in quantifying harm, have been entirely lacking from recent Forest Service documents, even when risk assessments are already available.

Forest Service planning documents often make statements about herbicides that attempt to make health risks appear "unlikely" (Okanogan NF, 2000, p. 132). While it may be true that a minority of people would be affected, this is discriminatory to those who are affected.

The available literature for human toxicology is seldom accessed in Forest Service planning documents. Instead, gross generalizations are taken out of context and made to appear as if they are facts. For instance, in describing the human effects of the "most toxic surfactants" used with the herbicide glyphosate, the Okanogan NF (2000, p. 132), summarized a summary of an unpublished reference based on aquatic studies on a limited number of surfactants.

Had the Forest Service been genuinely committed to determining and disclosing effects, the Okanogan NF EA (2000) could have referenced numerous studies demonstrating harmful effects to wildlife, humans and the environment. But the Forest did not review toxicity tests of glyphosate, such as those which showed effects on salmonids (Mitchell et al., 1987; Wan et al., 1989), including sublethal effects of erratic swimming, labored breathing, altered feeding, migration and reproduction (Morgan et al., 1991; Liong et al., 1988), or those that found the combined effect of glyphosate and surfactants to be synergistic (Servizi et al., 1987) and involved pulmonary toxicity (Martinez and Brown, 1991). Despite their willingness to include unpublished anecdotes as references, the Forest Service rebuffs any efforts to provide published studies that show harm from herbicides (McDougle, 1999).

When available, it is certainly more appropriate to extrapolate human effects from studies on humans, rather than from animal toxicity models. While the EPA acknowledges that studies of glyphosate toxicity on humans are rare, those available portray this herbicide as far more toxic than the Forest Service reveals. Glyphosate exposures are associated with numerous deleterious effects including blurred vision, skin problems, heart palpitations, nausea, increased risk of miscarriages, premature birth, and non-Hodgkins lymphoma, or NHL (Cox, 1998). A case-controlled study linked NHL with exposures to pesticides including glyphosate (Hardell and Eriksson, 1999) and glyphosate has a death rate in humans of 10-20% during attempted suicides (Martinez and Brown, 1991).

Forest Service hand-waving that health risks are “unlikely” from some of their proposed herbicide treatments are not only lacking in credibility, but border on being false claims. When Monsanto Corporation was challenged by the New York State Attorney General for making for making false safety claims about their product glyphosate in 1996, Monsanto agreed out-of-court to stop advertising the product as “safe, non-toxic, harmless or free from risk.” (Cox, 1998).

Once Forest Service planning documents “determine” that health and environmental risks are “unlikely”, this becomes a handy excuse for sloppy implementation. Employees operate unaware of safeguards and shortcuts are emphasized over rules. Ad hoc variance from the planning documents are used whenever written procedures fail to anticipate real conditions, including unforeseen problems such as sudden changes in wind speed, public presence at a treatment site, lack of safety kits, vehicles in poor condition, etc.

During the use of chemical treatments, responsible personnel should always be available and preferably present at the treatment site. Managers need to anticipate the amount of staff time that will be necessary to implement projects. Staff need to be carefully chosen to maximize efficient use of personnel resources.

Case example: Okanogan NF spill risks go unstated

The Okanogan NF EA for noxious weeds (1999) included an Appendix purported to be a “Spill / Release Control Plan”, however the actual plan was only included there by reference. In its place was a set of measures designed to lessen, but not necessarily undo, the impacts of a major spill in the case of an accident. Lacking from the EA was an analysis of the potential likelihood of such a spill. The likelihood for the 1990s, it turns out, was 100%, because on October 3, 1994, an herbicide truck contracted by the Tonasket Ranger District to spray weeds on the Okanogan NF crashed and turned over, spilling five gallons of herbicide into Nicholson Creek.

Turning to the national risk analysis for conducted for glyphosate (Syracuse Environmental Research Associates, 1996), one finds that no such spill scenario was ever considered there either. Instead, the report only analyzes risks from relatively minute spills, such as applicators splashing the material on their hands, while completely dismissing the possibility that a major spill could occur:

> For this risk assessment, several very conservative scenarios are developed. As discussed below, most of these scenarios should be regarded as extreme, some to the point of limited plausibility.

Decision-makers and the public should have been made aware of these risks before serious harm occurs.

Case example: Okanogan NF estimates of risk are unwarranted

The Okanogan NF 1997 Integrated Weed Management Environmental Assessment (EA) (1997) found that the use of herbicides in their plan would pose,

> . . . minimal risks no greater than the risks predicted in the PNW Region FEIS for Competing and Unwanted Vegetation . . .

And that,

> It is unlikely that any members of the general public would receive sufficient exposure to develop any adverse effects from the treatment . . .

Based on this sweeping conclusion, there were few safety precautions incorporated into the plan, except to claim that Forest Service workers would receive training, adhere to label directions, and follow the Forest Service Pesticide Use Manual (FSM 2150). The Forest prepared another EA (Okanogan NF, 1999), in which the same statements were cut and pasted, verbatim, into the new text.

But in proclaiming health effects minimal and unlikely, the Okanogan NF was ignoring its own analyses prepared by the Washington Office explicitly for reference by the agency in planning documents (Syracuse Environmental Research Associates, 1996). The preparers of the EA were apparently unaware of the fact that the Forest Service Washington Office had contracted a thorough literature review of glyphosate that went far beyond the scope of the 1988 FEIS.

The Syracuse Environmental Research report listed numerous reasons for stringent precautionary measures to be taken with glyphosate:

> Glyphosate is a skin and eye irritant. This effect must be considered in the handling of commercial formulations. In addition, the toxicology of the combustion products of glyphosate has not been well characterized and this adds uncertainty to the risk assessment for brown-and-burn operations. . . .
>
> Incidental occupational exposure may occur from improper handling or use of the herbicide or from accidental contamination of the skin or clothing by a spill. All of these scenarios can be modeled using Fick's first law. . . . For this scenario, the estimated absorbed dose, using Fick's first law, is approximately 0.00012 mg/kg . . . If, however, the scenario involves contaminated clothing (e.g., the chemical spilled inside of gloves), which might be worn for a long time, absorbed doses could be much higher. For example, contaminated gloves worn for 1 hour would lead to an exposure 60 times greater than that described for the immersion scenario [i.e., 0.0069 mg/kg]. . . .

> The toxicity of glyphosate is relatively well characterized in humans and experimental mammals, although the mechanism of action is not clear. The acute toxicity of glyphosate is relatively low, with oral LD50 values ranging from approximately 1,000 to 4,000 mg/kg. Most of the data regarding human exposure to glyphosate involves the consumption of large quantities of glyphosate during attempted suicides. The signs of toxicity are generally consistent with massive mucosal irritation and tissue degeneration. In addition, glyphosate may interfere with normal metabolic biochemical functions. . . .
>
> Glyphosate contains small amounts of a nitrosamine, N-nitrosoglyphosate (NNG), and is metabolized, to a small extent, to aminomethylphosphonate (AMPA). The potential effects of these compounds are encompassed by the available toxicity data on glyphosate and glyphosate formulations.

During appeal of the 1999 EA for noxious weeds on the Okanogan and Colville National Forests, Gary Smith, Noxious Weed Coordinator of the Regional Office, went on record to deny requests to incorporate additional references to the toxicity of glyphosate made since the Syracuse Environmental Research Associates report, stating,

> I know that the peer review process used by SERA for Forest Service pesticide risk assessments includes qualified scientific experts outside of the Forest Service. Their comments would already be incorporated into the final document you have retrieved [the EA].

Besides being false, the statement indicates a disregard for concerns of public safety.

Solutions

- Stringent safety precautions should be followed for handling chemicals. See Appendix B for a recommended National Forest Chemical Safety Plan.
- Safety threshold for herbicide formulations should be specified in planning documents.
- All chemical handling and spill procedures must follow recognized safety procedures and prior documentation procedures for chemical spills and incidental and accidental exposures.
- Information to protect human safety must be available on the Districts and with applicators and field personnel working where chemicals are applied or stored. This information includes the following:
  1) Material Safety Data Sheets
  2) An approved plan of Forest safety precautions
  3) Exposure incident reporting forms
  4) Herbicide label directions
  5) Pesticide background sheets
- Applicators must have supplies and equipment for spill cleanup and hazardous materials cleanup on hand at all times.
- Supplies, equipment and safety and cleanup information must be kept in chemical storage areas in the case of chemical spills.
- Label directions must be strictly followed.
- Chemical applications will comply with planning documents. Variance from the described procedures will not be permitted.
- Responsible personnel should always be available during chemical applications, preferably at the treatment site.
- Managers need to anticipate the amount of staff time that will be necessary to implement projects.
- Staff need to be carefully chosen to maximize efficient use of personnel resources.

Section D. Treatments should receive adequate public notification.

NEPA (§1506.6 (ix)) specifies that notice of pending actions may include posting of notices on and off site in the area where the action is to be located. In light of the known and potential effects, public notification should accompany all herbicide treatments on public lands. Treatment locations should be available on request by visitors and treated areas should be posted with large, visible signs before, during and following the treatment for the remainder of the season. Workers in treated areas should be notified of chemical treatments and given opportunities for alternative assignments.

Signed areas should have large, readable signs to insure maximum protection of the public and workers in the area, particularly for sensitive individuals and children. Signs should include information indicating who to contact in case of injury, should be dated and should be checked for an entire season following treatment. To date, the Forest Service does not have an adequate procedure for signing areas treated with herbicides, using tiny, stapled pieces of paper located out of sight from most traffic.

The use of signs to protect workers and the public is a standard practice, which the Forest Service would do well to heed. The protection of worker and public safety should be part of everyone's responsibility. The Department of Pesticide Regulation of California (1999) cites a reasonable set of regulations that can protect worker safety:

> Under the reporting regulations, after every pesticide application pest control operators must give farmers a written notice that includes the date and time the application was completed and the restricted-entry and preharvest intervals. The restricted-entry interval is the period required between a pesticide application and when workers may re-enter the field. The preharvest interval is the time between an application and the earliest date the crop may be harvested. Farmers are required to post signs at fields treated with certain pesticides. The signs must include information on pesticide use including when it is safe for workers to re-enter the treated area. Farmers must also make records of pesticide use available to workers. Use reporting makes this information readily available.

Prior to treating areas with herbicides, public notification should also occur in local newspapers, on local public radio, Forest Service office bulletin boards, Forest Service web sites and any other readily available locations.

Despite the best efforts to protect workers and the public, injuries can occur. Even with the use of adequate warning signs, in some cases projects will result in unintended harm to sensitive members of the public. There should be an approved Forest Chemical Safety Plan to refer to in case of an accident or claim made by a member of the public. A recommended Chemical Safety Plan is included in Appendix B.

Solutions

- Public notification should accompany all herbicide treatments on public lands. Public notification should occur in local newspapers, on local public radio, Forest Service office bulletin boards, Forest Service web sites and any other readily available locations.
- Treatment locations and maps of treated areas should be available on request by visitors.
- Treated areas should be posted with large, visible signs before the treatment and signs should remain posted for the season. Signs should include date of application and contact information in case of accidental exposure.
- Workers in treated areas should be notified of chemical treatments and given opportunities for alternative assignments.

Chapter 4. Monitoring and reporting

Simply put, monitoring can be defined as education. Such education may reinforce what one already knows or provide new information, which encourages a change. In the context of natural resource management, high-quality monitoring programs can provide early-warning signs of unsustainable practices (Franklin et al., 1999).

Monitoring is imperative in order to determine if public land management decisions are being implemented as intended, if such decisions are effective in achieving goals and objectives, what types of impacts and effects such decisions may have, and to verify that the various assumptions that were made during planning were and are still valid. Monitoring analysis results are best used to evaluate actions taken and then determine whether activities should be changed, restricted, or stopped altogether.

Monitoring can make major contributions to ecological research programs if it produces research-quality data, and can also highlight important phenomena or spatial and temporal patterns that need scientific attention (Franklin et al., 1999).

To date, there is a lack of emphasis on monitoring public land management decisions that affect invasive species and a lack of emphasis on monitoring activities taken to "treat" invasive species. In the case of projects that involve commercial thinning or road reconstruction, for example, there is inadequate acknowledgment and disclosure of how such projects affect invasive species' spread.

Actions taken to "treat" invasive species, particularly those involving the use of chemicals, often result in a number of other indirect effects, such as soil and water quality, which are also rarely monitored.

Indeed, monitoring rarely occurs for projects that "treat" weeds, usually due to a lack of funding. Even when decisions specify monitoring as a required measure for likely impacts, treatment activities are likely to proceed to completion before monitoring is begun, at which point funds may well be exhausted, and monitoring requirements rendered moot. The end result is that there is no accountability to the public regarding whether Forest Service activities (particularly herbicide treatments) are spreading weeds and degrading public lands or whether they are even effective.

Solutions

- Project monitoring procedures should be funded separately from other project actions.
- Baseline monitoring must be performed prior to project implementation.
- Monitoring should include these critical components: (1) measurement of the extent of invasive species populations; (2) measurement of the effectiveness of treatments; and (3) assessment of the extent of non-target impacts resulting from treatments.

Section A. Monitoring should be included in all projects with invasive species impacts.

Quantitative information on the effects of forest management practices is ultimately essential to assess the long-term sustainability of a particular practice (Franklin et al., 1999).

With respect to activities involving the treatment of noxious weeds, the Mediated Agreement (1989) requires the Forest Service to monitor not only site-specific post-treatment conditions, but also to monitor the impacts to human health from using herbicides. Site-specific post-treatment information is to be used to aid in future project planning. The Agreement also included programmatic objectives to design a noxious weed monitoring plan for land management activities.

With respect to activities on public lands that do not involve the treatment of weeds, but may result in the spread of invasive species, it is important to recognize that the National Forest System is legally bound to monitor the effects of its activities. The National Forest System Land and Resource Management Planning Authority states in Sec. 219.7:

> (f) A program of monitoring and evaluation shall be conducted that includes consideration of the effects of National Forest management on land, resources, and communities adjacent to or near the National Forest being planned and the effects upon National Forest management of activities on nearby lands managed by other Federal or other government agencies or under the jurisdiction of local governments.

The National Forest Management Act (NFMA) requires that Forest Plans must contain “monitoring and evaluation requirements that will provide a basis for a periodic determination and evaluation of the effects of management practices” on forest resources. 36 CFR § 219.11(d). To effectively monitor the impacts of management actions, each Forest Supervisor is required to “obtain and keep current inventory data appropriate for planning and managing” forest resources (*ibid.* at § 219.12(d)).

Proposed NFMA regulation (Forest Service, 1999b) call for increased monitoring on public lands. In a statement of principles regarding the new regulations, the Committee of Scientists (1999) identified the four types of monitoring, and the circumstances for their application:

> Four types of monitoring can be considered:
>
> 1) Implementation monitoring asks the question, have the management standards and guidelines been used as anticipated to guide strategic and operational decisions?
> 2) Effectiveness monitoring asks, are the standards and guidelines producing the desired future conditions as anticipated at both the large-landscape and small-landscape planning levels?
> 3) Validation monitoring asks, are the basic assumptions about cause-and-effect relationships used to predict the outcomes of strategies and pathways of treatments valid?
> 4) Anticipatory monitoring asks, what factors (human induced or natural stressors) could compromise the attainment of sustainability in the near and long terms?

Monitoring is more than a technical tool. It provides the material for which projects may be viewed as successful or not, and why. Monitoring offers a shared viewpoint by which different interests can appreciate the relative merits (or lack thereof) of projects. It gives a measure of the success of a project, and provides the justification to continue or to change paths. Valid monitoring is crucial for successful projects when public acceptance is involved. Mack et al. (2000) describes the importance of public support,

> In all these instances, three key factors contributed to success. . . . particular aspects of the biology of the target species . . . sufficient resources . . . widespread support both from the relevant agencies and the public.

Monitoring can be used as an effective tool when the effects of a decision may be difficult to determine in advance because of uncertainty or costs. However, the Forest Service has failed to use monitoring in three important ways: (1) managers have historically given low priority to monitoring during the annual competition for scarce resources, (2) decision-makers continue to approve projects without an adequate monitoring component, and (3) Forest Service projects generally fail to monitor the implementation of its plans as required by regulations. The Forest Service's failure to monitor represents a lost opportunity to reduce the cost and time requirements of future decision-making.

Case Example: Colville NF lack of monitoring

A year 2000 FOIA request from Kettle Range Conservation Group, sent to the Colville NF, asked for "copies of any monitoring reports describing control effectiveness or environmental effects done, in conjunction with any herbicide application project (from 1998 to the present)".

The Colville NF response was, "Besides the water quality monitoring reports previously described, there are no other reports available. Field monitoring is occurring, however no written reports of effectiveness or other environmental effects reports besides water quality monitoring have been done".

It is important to recognize that a total of approximately 122 herbicide application records were supplied in response to the FOIA request for 1999 alone. Despite such a high number of treatments, the complete record for the Forest response to the FOIA returned only 1 water quality monitoring report and 4 vegetation monitoring transects, leaving the remaining treated areas without monitoring.

Every year, the Colville NF is obligated to report the results of their annual monitoring in order to assess whether their activities have complied with the Colville Forest Plan. These Reports are titled "Annual Monitoring and Evaluation Reports". As of the last Report published, which was for fiscal year 1997, there was no reporting of annual monitoring of noxious weeds on the Forest since the Forest Plan was signed in 1989. In fact, there is not even a monitoring item specific to noxious weeds in the Report, which would allow the Forest to gauge how their project activities are affecting the spread of invasive species on public lands. No one has any idea of how effective noxious weed treatment projects have been or whether funds were well spend.

One could legitimately question whether the Colville NF is in compliance with existing regulations, however, their performance is not exceptional. In response to a FOIA request from Kettle Range Conservation Group for monitoring results on the Methow Valley Ranger District, the response was that no monitoring occurred at all on this District, which is one of the largest and most heavily infested in region.

Solutions

- Invasive species treatments should monitor site-specific, post-treatment conditions for all affected resources.
- Monitoring should be used to determine the effectiveness of treatments and whether project implementation was performed as planned.
- Monitoring should be included in all projects with invasive species impacts, not just "weed" management projects. For example, monitoring of impacts to invasive species' spread should be occurring in projects involving road maintenance, fire fighting, livestock management, and timber sales.
- Monitoring invasive species needs to be periodically repeated on public lands.
- Monitoring must follow a consistent protocol, with written records maintained in a permanent archive.

Monitoring reports for vegetation management projects must be available to policy-makers, program managers and the public.

Monitoring of the effects of past management decisions is critical for managers to assess the need and direction of future programs. Verstraete and Schwartz (1991) identified the critical roles of monitoring:

> Monitoring the environment . . . plays a number of crucial roles and must be pursued to:
>
> 1) establish a baseline against which future observations can be compared;
> 2) document the spatial and temporal variability of the relevant environmental parameters;
> 3) identify the regions at risk of further degradation, and the nature of the processes at work;
> 4) provide the data needed to build and validate the mathematical models of the environment that are needed to understand and predict the evolution of these ecosystems;
> 5) support policy decision making in such tasks as prioritizing the target areas for relief and conducting cost-benefit analyses of various remedial actions or feasibility studies, as well as support field activities geared towards minimizing further degradation or reclaiming affected areas; and
> 6) evaluate the effectiveness of these policies, plans and remedial actions.

Within the Forest Service, the National Forest System Land and Resource Management Planning Authority (Sec. 219.11 (d)) specifies that Forest plan monitoring and evaluation requirements provide a basis for a periodic determination and evaluation of the effects of management practices. Sec. 219.12 (k) describes the process of monitoring and evaluation:

> At intervals established in the plan, implementation shall be evaluated on a sample basis to determine how well objectives have been met and how closely management standards and guidelines have been applied. Based upon this evaluation, the interdisciplinary team shall recommend to the Forest Supervisor such changes in management direction, revisions, or amendments to the forest plan as are deemed necessary. Monitoring requirements identified in the forest plan shall provide for:
>
> (1) A quantitative estimate of performance comparing outputs and services with those projected by the forest plan;
>
> (2) Documentation of the measured prescriptions and effects, including significant changes in productivity of the land; and
>
> (3) Documentation of costs associated with carrying out the planned management prescriptions as compared with costs estimated in the forest plan.
>
> (4) A description of the following monitoring activities:
>
> i. The actions, effects, or resources to be measured, and the frequency of measurements;
> ii. Expected precision and reliability of the monitoring process; and
> iii. The time when evaluation will be reported.
>
> (5) A determination of compliance with the following standards:
>
> i. Lands are adequately restocked as specified in the forest plan;
> ii. Lands identified as not suited for timber production are examined at least every 10 years to determine if they have become suited; and that, if determined suited, such lands are returned to timber production;
> iii. Maximum size limits for harvest areas are evaluated to determine whether such size limits should be continued; and

iv. Destructive insects and disease organisms do not increase to potentially damaging levels following management activities.

The language is good, but unless it is followed, it is useless.

Within the Bureau of Land Management, it is acknowledged that comprehensive monitoring programs are necessary to evaluate management activities, control noxious weeds, and demonstrate BLM compliance with applicable laws, regulations, and policies (BLM Weed Team, Asher et al. (http://www.blm.gov/nhp/main/WP7weedplan.html). The BLM report discusses the need for comprehensive monitoring programs:

> Monitoring and research are essential to provide information necessary for long-term planning and decision-making. For example, monitoring and research will help determine if: 1) BLM is achieving the management objectives established in land use and activity plans, 2) certain projects or management actions are having the desired effect, 3) species-specific control methods are effective, and 4) BLM should change its management. Monitoring and research also allows BLM to base its noxious weed management program on sound ecological knowledge of noxious weeds and their relationships to management actions.
>
> Monitoring information should be collected on treatment sites to determine effectiveness, the effects on nontarget species, and subsequent species that invade the treated site. Established infestation sites not currently being treated should be monitored for growth rates, rates of spread, population structure, and the environmental conditions that support the noxious weed invasion.

Such information, if it were being collected on a consistent basis across National Forest System lands, would result in the agency having a much better handle on the existing situation. Personnel would be able to assess what, if any, effects their present efforts have had and what actions need to be taken to reverse the existing trends. Without baseline data, it is difficult to garner public support for proposals to “treat” weeds using costly treatments with herbicides, when it cannot be demonstrated that these projects have an effect on controlling the spread of invasive species.
An important part of conducting a monitoring program and, specifically managing data, concerns making data available on a timely and comprehensive basis to a wide range of interested parties (Franklin et al., 1999). Unfortunately, insuring high-quality data management is a frequently unrecognized part of a monitoring program (*ibid*).

Solutions

- Monitoring information results should be periodically evaluated and the evaluation summaries transmitted to regional and national offices.
- A summarized account of monitoring results should be readily available for inspection at all supervisory offices and higher. Information gathered during the procedure is strategically important for future accounting needs and should be stored in a safe place, and kept on hand for many years, both on the districts as well as in regional offices, in both raw and summarized formats. The type of information contained on monitoring accounts should include:
  1) Date, site description and cross-reference number for mapping purposes
  2) Applicator name
  3) Application method
  4) Time of application
  5) Chemical used

6) Additives and carriers used
7) Mix concentration
8) Extent of area treated (as general descriptions and specific locations)
9) Rate of active chemical application (quantity per area)
10) Rate of mix formulation (quantity per area)
11) Total chemical amount applied (quantity per application)
12) Weeds present before and after treatment
13) Field notes
15) Efficacy of treatment
16) Experienced costs of the project (direct and indirect)
17) Residue analysis as appropriate (e.g., water quality, soil quality monitoring)
18) Analysis of unintended effects as appropriate (e.g., non-target vegetation effects)
19) Accidents, spills, drift encountered (reported and experienced)
20) Human health effects as appropriate (e.g., hazards and symptoms experienced)
21) Worker complaints

Section B. Monitoring procedures

Monitoring procedures should be carefully designed to provide useful information about project outcomes.

The outcome of monitoring is important enough that standardized procedures should be followed by all National Forest units when monitoring is performed. Monitoring is often complex and costly, however a wealth of source material is available to aid in design.

Franklin et al. (1999) assert that the development, operation, and interpretation of credible natural resource monitoring programs can only be achieved with extensive scientific involvement. The authors contend that results of scientific research and scientific expertise are needed in at least four major aspects of monitoring: (1) Design of monitoring programs, including the selection of parameters and development of the sampling design – where, when, and how to sample as well as details of the statistical design; (2) quality control; (3) interpretation of results; and (4) periodic assessments of the effectiveness of the monitoring program (“adaptive management”).

The type of monitoring required will to some extent dictate the range of available monitoring procedures. The need to design monitoring carefully is stated in the National Forest System Land and Resource Management Planning Authority. Sections 6 and 15, 90 Stat. 2949, 2952, 2958 (16 USC 1604, 1613); and 5 USC 301 (47 FR 43037, Sept. 30, 1982, Sec. 219.19 (6), Fish and wildlife resource):

> Population trends of the management indicator species will be monitored and relationships to habitat changes determined. This monitoring will be done in cooperation with State fish and wildlife agencies, to the extent practicable.

The design of monitoring procedures should account for expected difficulties in carrying out the procedures. Mockler et al. (1998) are circumspect about some of the pitfalls of monitoring in the real world:

> Monitoring forms had not been designed to note the following common ingredients of failure: inappropriate design, including insufficient hydrology as a result of design or construction oversights; slopes steeper than 20%, and plants specified for inappropriate habitat; compacted soil without organics; and lack of maintenance.

In any case, the Forest Service is certainly capable of designing good monitoring

procedures. For example, the Forest Service and BLM produced a set of guidelines for achieving riparian management objectives (Forest Service and BLM, 1995). These monitoring procedures were carefully defined to insure attainment of riparian management goals for maintaining healthy, functioning watersheds, riparian areas, and associated fish habitats, and they have been of great value in directing where management emphasis should occur. These monitoring procedures could easily be adapted to include monitoring information on impacts to soils and aquatic resources from chemical treatments and invasive species, however the Forest Service is apparently lacking in dedication to accomplishing this part of its mission.
If a project's scope, and hence monitoring needs, are extensive, then a rigorous, standardized approach to monitoring should be required as a prior condition of project approval and continued funding.

Case example: Boulder Creek on the Okanogan NF

In choosing Alternative C to use herbicides to treat over 5,000 acres of weeds with herbicides, the Okanogan NF (1997, p. 109) explained that with this alternative,

> Water quality and the sediment regime would not be affected by noxious weeds.

This statement naively implies that the treatment will be 100% effective and have no impacts to water quality at all. A monitoring program should have been used to show the actual effects on water quality and sediment regime, before making the claim, however the project was implemented without even performing baseline monitoring.

In an independent review of the project, photographs of areas treated in the project found that herbicides killed vegetation along riparian areas, resulting in decreased rain-intercept ability and likely increased erosion (Wooten, 1999d; Photo 4, p. 3).

Solutions

- Require a rigorous, standardized approach to monitoring as a prior condition of project approval and continued funding.
- For all projects with invasive species impacts, allocate a percentage of implementation funds toward monitoring.

Monitoring should provide useful answers to relevant questions.

Scoping for the National Invasive Species Council Research, Information Sharing, Documentation and Monitoring Working Group (2000) stated a need to, "Identify research and monitoring that address real needs, fill key information gaps, and address limitations."

Franklin et al. (1999) recommend that a monitoring program should include a definition of objectives, selection of the critical response variables, and design of a sampling scheme which will fulfill stated objectives. The following steps in developing a high-quality monitoring program are given:

1) Initially, it is important to identify which parameters are likely to be sensitive indicators of important ecological conditions, e.g., which are ecologically meaningful.

2) Once parameters have been selected, the next challenge is development of a sampling design – formalizing the answers to where, when, and how in

a statistically robust design. Temporal issues involve decisions about what sampling intervals will be used. For example, some monitoring is appropriate continuously, others components are sampled most efficiently at regular intervals or on an event basis. The design of the monitoring program needs to reflect the multiple temporal scales.

The lack of adequate monitoring by the Agencies lends weight to independent peer-reviewed studies which counteract foregone conclusions of the Forest Service that their treatments are "unlikely" to cause significant impacts (Okanogan NF, 1997, 1999, 2000). A recent report cited numerous studies and monitoring programs that implicated herbicides in harming aquatic species (Ewing, 1999). Monitoring these impacts as required would determine if Forest Service actions were resulting in the take of endangered species, as in an example cited in the Seattle Post-Intelligencer (Schreder, 1999):

> Our region has already seen dramatic fish kills due to pesticides. In 1996, a weed killer used in an irrigation canal made its way into Bear Creek of the Rogue River Basin, killing off thousands of steelhead trout and scores of coho salmon. When salmon are so near extinction, the loss of each one makes recovery efforts that much harder.

Under a recent District Court lawsuit (Bernton, 2001), the failure of the EPA to consult with the National Marine Fisheries Service (NMFS) could result in a federal court order to ban certain pesticides. These consultations are critically dependent on information from properly conducted monitoring procedures like those the Forest Service has neglected its duty to perform.

Solutions

- Determine what important questions need to be answered during projects with invasive species impacts on public lands.
- Include monitoring procedures in planning documents that will ask and answer important questions about proposed actions, both prior to and after project implementation.

Monitoring should be performed by qualified personnel.

Interpreting the ecological significance of a change in a monitored parameter is not a trivial issue and may in fact be the most challenging element of an operational monitoring program (Franklin et al., 1999). Substantial knowledge is often required to interpret the significance of observed changes in parameters.

Solutions

- Insure that personnel involved in a monitoring program have necessary technical qualifications, or receive training for such procedures.
- Monitoring reports must include the names of all participants involved and their qualifications for accomplishing the job.

Monitoring should use valid statistical and sampling procedures.

To be statistically valid, designs for treatment monitoring should attempt to either randomize the samples or assure that samples are representative of the entire treated area. Monitoring of treatments should include both treated and untreated samples, as experimental and control groups, respectively (Franklin et al., 1999). Samples should include enough observations to insure results are significant.

Monitoring procedures should use reproducible methods of measurement and replicate sampling to insure statistical validity. Consistent recording procedures and timing of visits should be part of the procedures. Monitoring should use quantitative measurements such as frequency, cover, density, etc., and plant identification should be carried to the level of the species.

Analyses should be performed that summarize the observations and should include a description of the implicit assumptions in the methods along with calculations of central tendency, data dispersion, and significance of results. Evaluations should be subject to independent professional reviews. Evaluations of monitoring results should be used as a series of approximations which will be modified periodically to adjust initial parameters toward fulfillment of objectives, or as new parameters are identified, or monitoring objectives change (Franklin et al., 1999). All stakeholders need to be a part of this process (*ibid.*).

When obstacles arise in the performance of monitoring procedures, alternate methods may be found in the literature. The use of indicator species as representative indicators of a wide array of environmental effects may be appropriate or necessary, as for example, surveys for spotted owls as indicators of prime old growth habitat. The use of bacterial or macroinvertebrate biosensors capable of detecting low concentrations of chemicals has been demonstrated to have wide applicability.

Hoof et al. (1992) were able to use the cyanobacterium *Synechoccus* to detect the herbicide atrazine rapidly at 50 micrograms/L concentrations, while Servizi (1987) used the microorganism *Daphnia* to demonstrate toxicity to the herbicide glyphosate.

Case example: Boulder Creek on the Okanogan NF in Washington

The Okanogan National Forest Environmental Assessment (EA) for noxious weeds (1997) failed to identify spotted knapweed (*Centaurea maculosa*) absinthe wormwood (*Artemisia absinthium*) on Boulder Creek. Both of which are new invaders in this area. Yet the EA stated that the highest priority for control of noxious weeds is stated in the EA as being new invaders.

Spotted knapweed in the area was originally found on Forest Service land near the mouth of Boulder Creek. One of the first herbicide treatment projects undertaken in the Pacific Northwest, following lifting of the Region 6 injunction against their use in Region 6, was at Eightmile Ranch, when the amount of spotted knapweed was still limited. In the approximately half dozen years since repeatedly treating Eightmile Ranch with herbicides, the infestation of spotted knapweed has now spread many miles in all directions onto adjacent private lands, and further into the National Forest, e.g., up Boulder Creek. Control of spotted knapweed by the Forest Service has been a failure.

Following the use of herbicides at Boulder Creek, the seeds in the soil will remain fertile and will require additional treatments again soon. It is unfortunate that an adequate monitoring program for spotted knapweed in this area does not exist, because it would have helped inform managers of the effectiveness (or lack thereof) of treatments.

Solutions

- Monitoring procedures should be performed for invasive species programs that incorporate valid statistical and sampling methods.
- Monitoring results should be evaluated for calculations of central tendency, data dispersion, and significance of results.
- Monitoring procedures should use reproducible methods of measurement and replicate sampling to insure statistical validity. Consistent recording procedures and timing of visits should be part of the procedures.
- Monitoring should use quantitative measurements such as frequency, cover and density; plant identification should be carried to the level of the species.
- Use of a map-based system such as a Geographic Information System (GIS) should be used to map invasive species locations.

Monitoring should include adequate baseline data and experimental controls.

An accurate inventory and map of existing populations of invasive species is critical to invasive species management. Land managers must inventory sites regularly in order to identify any small or outlier populations that could easily be eradicated (Moody and Mack, 1988). It would be foolish to try and control invasive species in a small area surrounded by uncontrolled weeds, yet this is presently what is happening on most National Forests.

National Forests should base their management on the measurement of damage, action and safety thresholds. A related part of monitoring includes recording incident reports involving harm to human safety. Baseline surveys used to determine the extent of weed populations are a requirement of adequate monitoring. The Okanogan NF has based a projected $1 million program primarily on outdated surveys made by personnel driving along Forest roads (George Wooten, personal observation while working as a botanist on the Okanogan NF). Botany surveys for TES species, which could be used to provide valuable location information for noxious weeds, do not include standardized procedures for assessing the extent of noxious weed populations, and these surveys are seldom used in invasive species projects anyway (*ibid.*)

Environmental Assessments can distort the scale of an infestation if not performed for a representative area. Quantitative measurements of invasive species require more than just road miles, but should also include estimates of the species, density, number of individuals, area, and control costs.
Many weeds can find a niche in secluded areas, where their presence is hidden from surveyors. For example, riparian habitats with annual flooding disturbance regimes are continual sources of reinfestation. Yet the practicality of surveying or treating these widely scattered satellite populations is exceedingly low. If the actual extent of noxious species was truly known to decision-makers, the futility of proceeding in the face of large-scale invasions without better planning and baseline monitoring might be more apparent.

Solutions

- Monitoring should include adequate baseline data and experimental controls.
- Monitoring of standards and guidelines for damage, action and safety thresholds should be performed prior to and during project implementation.
- Monitoring should include investigating and filing incident reports whenever human harm was reported or suspected.

- Monitoring should be performed over representative areas of a National Forest, using surveys that inventory more than roadsides.
- Quantitative measurements of invasive species should incorporate meaningful measures, including species identification, density, number of individuals, extent occupied, distance from roads, and potential control costs.
- Inventories should be performed periodically to confirm changes in the extent of target populations.

Section C. Mitigation procedures must include implementation monitoring.

Documentation must be provided for the accomplishment of all mitigation measures, conditional procedures and stipulated agreements. The satisfaction of such legally binding accomplishments should be a condition of project continuance.

The Mediated Agreement (1989), stipulates that the Forest Service interpret noxious weed survey data for use in determining environmental impacts, and then follow the established uniform method set forth in the vegetation management FEIS (Forest Service, 1988, IV, 77-78) to ask, "What changes can be made in the project design to mitigate potential and current weed problems?" Because some Forests are doing a poor job of monitoring, the Forest Service is in violation of the Mediated Agreement (1989), which stipulates that the Forest Service must interpret noxious weed survey data for use in determining environmental impacts.

Solutions

- Legally required mitigation measures, conditional procedures and stipulated agreements must be satisfied as a condition of continued project funding.
- Implementation monitoring should be incorporated into all mitigation measures, conditional procedures and stipulated agreements.

Chapter 5. Prevention of weed invasions.

Prevention of new invasions and the prevention of the spread of existing infestations should be the top priority of Forest Service invasive species programs. To date, this is not occurring. Pacific Northwest Forests that have been using herbicides during the 1990s are still not in compliance with the stipulation in the Mediated Agreement (1989), to "detect and ameliorate the conditions that cause or favor the presence of competing or unwanted vegetation," i.e., to use prevention.

Agency weed management plans and publications typically emphasize weed control and eradication using herbicides rather than prevention (Sheley et al., 1988; Sheley, 1994; BLM, 1996; Santa Fe NF, 2000; Deschutes NF, 1988; Okanogan NF, 1997, 1999; Colville NF, 1998). A large number of prevention measures are available for managers (see Appendix A), but these often go unheeded.

As an example, weed management plans such as the Integrated Weed Management Environmental Assessments (EAs) produced by the Okanogan NF (1997), called for herbicide spraying on approximately half of 10,000 infested acres as the main treatment method for noxious weeds. Although the EA stated that prevention is the most important method to stop the spread of noxious weeds, it gave little attention on how prevention would take place or what changes would have had to occur for prevention to work.

The Integrated Noxious Weed Treatment EA for the Colville NF (1998, p. II-13), states that "(p)revention is incorporated into the alternatives discussed in this document only to the extent that treatment activities would reduce or prevent the need for treatments in the future". Essentially, the agency is only willing to consider the concept of prevention within the scope of the current treatment plan, while ignoring the great majority of infestations spreading through other activities such as logging, road-construction, and livestock grazing.

These plans focus on the concepts of reduction, mitigation and continual treatment of infestations as their way of preventing further infestations; however, this fails to consider the underlying factors that cause invasive species to spread into new areas and fails to prevent further infestations. The treatment plans are merely symptomatic, and they lack prevention measures that could be a viable means to control the threat of plant invasions.

Section A. Preventive measures must receive high priority.

Prevention implies an impediment, hindrance, or preclusion. Compared to reduction, which implies a lessening or decline, or mitigation, which implies relief or alleviation; prevention calls for a barrier to the spread of invasive species, not a band-aid.

The Forest Service places a low priority on incorporating prevention measures into ongoing activities, including logging, livestock grazing and road maintenance and use. Little consideration is given to limiting or modifying the activities that cause weed invasions on public lands. This lack of responsibility must change if the agency is going to take their role in prevention seriously.

When the Forest Service conveys an intention to use prevention measures, it is usually given as a rationalization for a management action, e.g., thinning a forest to prevent stand-replacing fires, which are assumed to bring in more weeds. Rarely is the action itself examined for its role in the actual causes of weed spread and suitable prevention measures, e.g., reduction of soil disturbance.

As another example of this piecemeal approach to prevention, the Forest Service frequently acknowledges the presence of weeds along heavily traveled roads, while failing to connect that with the logical cause—motorized vehicles, ORVs and livestock, which all transport the seeds of damaging exotic species.

The willingness to allow and even encourage activities that spread weeds without tracking the consequences is the real culprit in the process of alien plant invasions. While it might be true that vehicles, logging equipment, or livestock actually transport weed seeds, it is the agency's refusal to act on this promotion of plant invasions that degrades public lands.

Solutions

- Prevention of further weed invasions should be given the highest priority in invasive species programs.
- Prevention measures must be incorporated into all ongoing activities that impact invasive species (see Appendix A).
- The scope of prevention and control measures should be determined by biological and ecological criteria that examines the causes of invasions, not just the symptoms.
- Prevention should be based on a desired future land condition.
- A comprehensive, map-based, baseline inventory of invasive species presence, by species, must be completed prior to initiating control efforts. The inventory should be updated through regular monitoring, and repeated at least every 5 years or before control actions are taken, whichever is shorter.

Section B. Programs need to incorporate comprehensive prevention strategies.

In order to reverse the invasion of public lands by aggressive and exotic species, plans and programs should incorporate comprehensive prevention strategies. A large number of prevention measures are given in Appendix A.

In addition to the specific requirement made in the Mediated Agreement (1989) that the Region 6 Forest Service use a prevention strategy prior to using herbicides, scientists and agencies widely agree that prevention is the least expensive and most effective way to manage plant invasions.

> Early detection and treatment of invasions before explosive spread occurs will prevent many future problems—Hobbs and Humphries (1995).

> Prevention and early detection are the best means of limiting weed problems—Youtie (1997).

> Effective prevention and control of biotic invasions require a long-term, large-scale strategy rather than a tactical approach focused on battling individual invaders—Mack et al. (2000).

> Goal 4 - Prevention and detection: develop a prevention and early detection program—Bureau of Land Management (1996).

The Invasive Species Council's Risk Analysis and Prevention Working Group (2000) explored issues related to developing a comprehensive, systematic strategy to prevent the introduction and spread of invasive species into United States ecosystems. The Working Group recognized that invasive species threaten our environment, agriculture, human health, economy, and quality of life, then outlined a prevention strategy:

> A successful prevention strategy assesses and mitigates risk of entry, establishment, and spread of invasive species by considering pathways for movement of invasive species, characteristics of individual invasive species organisms regardless of pathways, and inherent vulnerability of ecosystems.

The components of a successful prevention strategy that the Working Group came up with include:

1) Risk assessments of known pathways for intentional and unintentional introductions of invasive species;
2) Organism level risk assessments of known invasive species independent of pathways;
3) Ecosystem level risk assessments to rank ecosystem vulnerability;
4) Assessment of gaps in the safety net protecting U.S. ecosystems by arraying results of pathway, organism, and ecosystem risk analyses;
5) Evaluation and application of measures to close gaps in the safety net
6) Identification of research needs in the area of prevention of invasive species;
7) Recognition of the tendency for many introduced species to exhibit a long (> decades) lag phase between introduction, establishment and expansion and that this lag phase may offer "windows of opportunities" for risk management.

The first three of these components are concerned with prioritizing the likelihood of plant invasions through an analysis of the pathways (processes) that lead to invasion; the characteristics of species involved in an invasion; and the characteristics of the invaded ecosystem (site-specificity), respectively. The fourth and fifth components are concerned with developing legal and procedural measures that will minimize these risks. The sixth component seeks to insure that prevention measures remain up-to-date. The seventh component is a reminder that an understanding of the processes of invasion may lead to innovative measures to prevent future epidemics.

While these components offer some broad guidelines that may guide policy, they do not give enough specific details to be used in formulating prevention strategies. At the end of this section, some more specific directions are given for incorporating prevention measures into plans, however these are still general enough to allow a range of flexibility in designing Forest Service programs. While considering the full range of possible prevention measures for inclusion into invasive species programs, an Integrated Pest Management procedure was used to develop a list of all available prevention tools, and these procedures were then summarized into generalized strategies. A list of these prevention alternatives considered is given in the Appendix.

Prevention measures cannot be applied in a blind fashion. Prevention measures, like other treatments, require monitoring to insure they are effective. It is possible that weed inventories may fail to observe dormant seeds, and then incorrectly manage an area as weed-free when it is actually contaminated. This warning includes the case where restoration grasses may be used to revegetate a disturbed site without a follow-up survey. It is possible that weeds will subsequently re-emerge at the site, possibly through the use of contaminated seed mixes, or seed banks containing dormant weeds, or reintroduction by animals or vehicles. In these cases, prevention measures should be considered as ineffective.

Case example: Tansy ragwort along the Salmon River

At a March 29th, 2000, weed management meeting with the Forest Service in Bend, Oregon, Caroline Cox of the Northwest Coalition for Alternatives to Pesticides (NCAP) related some details about her study in a Research Natural Area in an old pasture along the Salmon River estuary north of Lincoln City, Oregon.

> When I first visited the site in 1980 the ragwort was literally a jungle. It was taller than I was, virtually a monoculture . . .
>
> . . . The combination of the ragwort flea beetle, the cinnabar moth, and the ragwort seed fly had a dramatic impact on my study site. By 1984 there was practically no live ragwort on the site—a density of zero.
>
> What are the important concepts that this story of mine illustrates? First, the ragwort decline occurred because the Forest Service addressed the causes of the ragwort "jungle". . . . prevention was the strategy used to deal with the ragwort problem. . . . on my site, competing grasses had been removed by the cattle that grazed on the site when it was being used as a pasture, allowing the ragwort to become a monoculture. That cause was addressed by ending the grazing. The other important cause of ragwort's success on this site was that ragwort had been introduced to the area without its natural enemies, and by introducing them this balance had been restored and ragwort could no longer predominate the way it had.
>
> It's also important to look at what would probably have happened had prevention not been the strategy of choice at this site and herbicide treatments used instead. During the 1980s the herbicide used would probably have been 2,4-D. The huge ragwort populations left a legacy of ragwort seeds in the soil—literally thousands of them per square meter, so it is unlikely that a single herbicide treatment would have been successful—more than likely repeated treatments would have been necessary. There would have been other consequences, too. The site as I mentioned is adjacent to the Salmon River estuary. Given that 2,4-D has been detected in 10 - 13% of the river and stream samples tested in the US Geological Survey's nationwide water monitoring program, there is at least a good chance that some of this 2,4-D would have ended up in the estuary. Concentrations of less than 1 ppm are toxic to a variety of aquatic organisms that serve as food for fish and other animals.
>
> One of the most interesting plants to reappear on the site following the ragwort decline was a *Sidalcea*—not an endangered species, but a pretty rare native species. Had 2,4-D been used on this site to deal with the ragwort, the *Sidalcea* would have been killed as well, and not had a chance to reappear.

Solutions

- Programs should consider all available prevention measures for control of invasive species (a list of prevention measures is given in Appendix A).
- Prevention measures should incorporate damage and action thresholds for invasive species abundance.
- Programs should consider the use of quarantine measures such as area and road closures for vehicles or cattle, and holding pastures for livestock herds.

- Programs should consider using procedures that eliminate weeds and their seeds from forest activities, including the use of weed-free animal feed, cleaning vehicles and fire equipment, and requirements for revegetation using only noxious-weed free seed.
- Programs should consider changing management activities known to increase the spread of weeds, including road building, road grading, vehicle use, ORV use, recreational use, livestock allotment use, timber sales, mining, etc.

Chapter 6. Education and research

The need for management of invading plants requires a serious commitment to education and increasing the awareness of the nature and extent of the problem. Obvious needs include plant and weed identification needs for land managers and information exchange between agencies and public and private groups. Signs, brochures, posters and news articles offer a chance for communication between groups. Workshops and classes can be held to bring interested people together in informative, problem-solving formats.

National Invasive Species Council (2000) backed up the need for research on invasive species:

> The Committee on Environment and Natural Resources Research (CENR) of the White House Office of Science and Technology Policy identified invasive species as a priority focus for integrated ecosystems research. It stressed the importance of sustained research programs that direct research based upon the needs determined by land and water managers and the need to strengthen core long-term resources essential for building basic understanding of invasion biology and predictive capacity for reducing invasive species impacts.

Wooten and Morrison (1995) described some of the research needs:

> There is an overwhelming need for more data on the ecology and biology of plant invasions. Agencies and educational institutions need to invest in research and methods that have the potential for solving the problems of invading species. Through cooperative agreements, cost-sharing and data-sharing, a better understanding of plant invasions will produce more effective prevention strategies and control techniques. Affected ecosystem components need to be studied, and at-risk ecosystems such as riparian areas should receive high priority. Specific topics that deserve attention include nutrient cycling, mycorrhizal connections, effects on wildlife, effects on biodiversity, biological controls, cultural (ecological) controls, research on target-specific or non-toxic herbicides, mechanisms of spread, genetics and reproductive biology of invading species, and the effects of varying the nature, severity and kind of causative disturbances.

There is a need for more comparative studies on the effectiveness of various control strategies. An example of a successful project to highlight research on invasive species occurred during the Reed Canarygrass Working Group Conference held on March 15, 2000, in Olympia Washington, sponsored by the Washington State Department of Transportation, Natural Resources Conservation Service, and Society for Ecological Restoration-Northwest Chapter. During the conference, over 20 different researchers were able to discuss their experiences in controlling and failing to control the invasive species, reed canary grass (*Phalaris arundinacea*). The conference was multidisciplinary, so that the entire spectrum of possible treatments was discussed, in addition to a number of related aspects about the biology of the species. Methods included disking, changing the hydrologic regime, grazing, herbicides, mowing, shade competition, and competition from nearby plants. Since the results of many different studies were all brought together, it was possible for the participants to get a better idea of how to deal with their own aspects of the problem.

Solutions

- Programs should provide additional funding for education and research efforts within the agencies.
- Programs should provide ongoing training in invasive species management.
- Programs should provide for data sharing and cost-sharing between cooperators and the agencies.
- Concerned groups should work with agencies to perform comparative studies on the effectiveness of various control strategies.

Acronyms used in this document

BE	Biological Evaluation.
LM	U.S. Bureau of Land Management.
BMP	Best Management Practices: U.S. Environmental Protection Agency and various States have approved management practices designed to meet the requirements of the Clean Water Act.
CEQ	Council on Environmental Quality.
CFR	Code of Federal Regulations.
DN	Decision Notice.
EA	Environmental Assessment.
EIS	Environmental Impact Statement.
EPA	U.S. Environmental Protection Agency.
ESA	Endangered Species Act.
FEMAT	Forest Ecosystem Management: An Ecological, Economic, and Social Assessment; Report of the Forest Ecosystem Management Assessment Team.
FIFRA	The Federal Insecticide, Fungicide, and Rodenticide Act.
FOIA	Freedom of Information Act requests and responses.
FONSI	Finding of No Significant Impact.
FS	U.S. Forest Service.
FSH	Forest Service Handbook.
FSM	Forest Service Manual.
GAO	U.S. General Accounting Office.
GIS	Geographic Information Systems; computerized mapping and land analysis tools.
ICBEMP	Interior Columbia Basin Ecosystem Management Project.
INFISH	Inland Native Fish Strategy Environmental Assessment: Interim direction for maintaining options for inland native fish species by reducing risk of loss of populations and reducing potential negative impacts to aquatic habitat.
IPM	Integrated Pest Management.
IWM	Integrated Weed Management.
LC50	The dose of a toxic substance that kills one-half the test animals.
LRMP	Land and Resource Management Plan.
Mediated Agreement	*Northwest Coalition for Alternatives to Pesticides et al. v. Clayton Yeutter, et al. 1989.* It specifies steps the Forest Service will take in implementing regional policy related to noxious weed management.
NCAP	Northwest Coalition for Alternatives to Pesticides.
NEPA	National Environmental Policy Act: An Act passed in 1969 to declare a national policy encouraging productive and enjoyable harmony between humankind and the environment. This Act promotes efforts that prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humanity, while enriching the understanding of ecological systems and natural resources important to the nation. The Act established the Council on Environmental Quality.
NF	National Forest.
NFMA	National Forest Management Act: The National Forest Management Act of 1976 amended the Resources Planning Act to direct the Secretary of Agriculture to develop direction and guidance for management of lands and resources of National Forest System lands.
NMFS	National Marine Fisheries Service.
NOEL	The "No-Observed-Effect Level/dose" of a toxic substance.

NPS	USDI National Park Service.
PACFISH	Interim Strategies for Managing Anadromous Fish: An interagency ecosystem management approach for maintaining and restoring healthy, functioning watersheds, riparian areas, and aquatic habitats within the range of Pacific anadromous fish on Federal lands managed by the USDI Bureau of Land Management and the USDA Forest Service.
PNW	Pacific Northwest.
PPM; ppm	Parts per million.
Region 6 Forest Service	The Pacific Northwest Region of the U.S. Forest Service: Includes all National Forests in the States of Washington and Oregon.
ROD	Record of Decision.
TES	Threatened, endangered, and/or sensitive species.
USC	U.S. Code.
USDA	U.S. Department of Agriculture.
USDI	U.S. Department of the Interior.
USFWS	U.S. Fish and Wildlife Service.
Vegetation Management FEIS	The FEIS for Managing Competing and Unwanted Vegetation, Pacific Northwest Region, U.S. Forest Service.
WO	Washington office of the U.S. Forest Service.

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Appendix A - Management strategies and paradigms

The following management strategies and frameworks have merit in invasive species management and are briefly described in this appendix.

1. Prevention strategies.
2. True Integrated Pest Management.
3. Ecosystem management.
4. Adaptive management.
5. Precautionary principles.

1. Prevention strategies

The following list compiles specific prevention measures that relate to invasive species which should be given consideration in public land management. Not all of these measures may be practical to every situation, however, when used together, they provide the foundation for a holistic invasive species management program where prevention is the primary goal. The following list has been compiled from a number of different sources, including some of the recommendations from the annual Mediated Agreement meeting held in Corvallis, Oregon on December 4-5, 2000.

Recommended prevention measures

- The scope of policies, plans and programs should be prevention and control of "aggressive exotic species" or “invasive species”, not "noxious weeds."
- The scope of policies, plans and programs should be determined by biological and ecological criteria, e.g., what invasive species are impairing biological diversity and ecological integrity?
- The stated purpose and goals of policies, plans, and programs should be to prevent further spread of invasive species, to prevent impacts from existing infestations, and to restore the land's resistance to exotic species.
- Policies, plans and programs should articulate a 100-year vision of how the public and the Forest Service wants National Forest lands to be, in terms of ecosystem health and invasive species, at a region-wide, landscape level. This vision should detail what steps need to be taken to get there in project-planning, and thus, should "back-cast" from the desired long-range future condition.
- Policies, plans and programs should examine the nature and causes of invasive species establishment and spread. Consideration should be given to all soil disturbing activities, which would include logging, road construction and reconstruction, regular and off-road motorized vehicle use, and livestock grazing. Such “root causes” should be clearly identified in policies, plans and programs with respect to their role in invasive species’ spread.
- Policies, plans and programs should analyze the proportional contributions of various human-caused or unnatural disturbances relative to natural weed vectors.
- Policies, plans and programs should take currently degraded lands, their existing conditions and the local abundance of invasive species’ seed pools into account during the analysis and planning of activities, regardless of whether they are 'weed treatment' projects.
- Policies, plans and programs should focus equally on prevention, treatment, and restoration.
- The focus on prevention should result in a reduction in the root causes of species invasions.
- Policies, plans and programs should identify damage thresholds for restricting and prohibiting particular activities at the site-specific level, which contribute to the spread of invasive species.
- Policies, plans and programs should direct National Forests to reduce their reliance on herbicides through prevention, reliance on natural processes and pre-project planning (e.g., not thinning beyond certain thresholds of canopy cover). Herbicides should be used only as a last resort and only in the

context of prevention and restoration such that a treadmill of chemical treatments and re-treatments will not occur.

- Restoration of degraded public lands should include passive restoration wherever possible in an effort to minimize soil disturbance.
- Policies, plans and programs should analyze current conditions and make project decisions using baseline data, including maps of known infestations, maps of treatment areas, monitoring results of treatment, monitoring of other project activities, etc. Policies, plans and programs should include the following data for all National Forest lands:
  - Describe and map remaining intact, uninvaded native plant communities, partially invaded areas, and areas that have lost their native plant components.
  - Analyze roadless, wilderness, and livestock-free areas for the presence of invasive species. Use analysis methods that can result in comparisons with areas that are actively managed.
- NEPA documents pertaining to new policies, plans and programs should have an alternative that focuses on prevention and restoration and involves restricting and prohibiting activities that are known to be causing weed invasions or are not being monitored.
- Off-road vehicle (ORV) trails should be closed unless posted open.
- Motorized travel should be limited to designated travel routes
- Cross-country motorized travel should not be allowed.
- If no monitoring or insufficient monitoring of invasive species infestations is occurring on ORV travel routes, then use should be curtailed.
- If enforcement of ORV travel is not occurring to insure that users are remaining on designated routes, then use should be curtailed.
- ORV use should not be allowed in Wilderness areas, wilderness study areas, or roadless areas.
- There should be no distinction made between cars, trucks and ORVs, because there is essentially no difference in their on-the-ground impacts with respect to invasive species spread.
- Ground disturbance should be limited in areas where there are invasive species vectors.
- There should be no logging on sites with extensive invasive species' infestations.
- There should be no logging on steep slopes or erosive sites.
- There should be no new construction of roads
- Minimum canopy closure requirements should be established for logging and thinning.
- Downed woody debris requirements should be established for logging and thinning.
- There should be consideration of the value in retiring livestock allotments as they become vacated to prevent the spread of invasive species.
- Livestock grazing should be restricted in areas infested with weeds, and prohibited in areas where prevention, control and restoration efforts have occurred.
- Livestock grazing should be prohibited in sensitive areas and rare species' habitat, such as, but not limited to, riparian areas, wetlands, TES habitat, and springs.
- Monitor livestock grazing using an increaser/decreaser species procedure (including microbiotic crusts, wildlife, and endemic/sensitive plant species) to track biodiversity and health.
- Livestock grazing should be excluded from burned (natural or prescribed) areas for at least five years.
- Establish site-specific monitoring to detect biological degradation on grazing allotments and establish procedures which would restrict renewal of allotment permits following unsatisfactory monitoring results.
- Identify thresholds of exotic plants that should trigger the restriction and/or prohibition of livestock grazing.
- Insure that implemented monitoring procedures include replicates and independent professional reviews.
- If no monitoring or insufficient monitoring of invasive species infestations is occurring on livestock allotments, then consider restricting use of those allotments.

- Use area closures and road closures in serious weed infestations.
- Require the use of certified weed-free animal feed that takes into account all invasive species, not just noxious weeds.
- Monitor disturbed areas for impacts to invasive species.
- Use warning signs at prominent infestation centers.
- Provide educational materials to the public and workers.
- Provide weed barrels for volunteers.
- Clean road equipment.
- Change the way in which the roads are graded to include consideration of impacts to invasive species' spread.

2. True Integrated Pest Management

Definitions of Integrated Pest Management (IPM) are not consistent. Wooten (1999b) used a synthesis of existing definitions to define a system of true IPM (including IWM), to differentiate it from invalid claims by agencies to be using IPM. He found,

> True IPM is an interdisciplinary system of techniques for controlling invasive plants that is both **practical** and **environmentally sensitive**.

Components of a true IPM program should include:
- monitoring
- integration of multiple objectives
- integrated strategies
- periodic re-evaluation

A wide variety of pest control options is considered in true IPM with preference for:
- Practicality -programs should be effective and cost-efficient.
- Environmental sensitivity -programs should reduce environmental risks.

A wealth of alternatives to chemical controls exist (Wooten, 1999c).

3. Ecosystem management

Some of the principles of ecosystem management have been spelled out by Noss (1999). Ecosystem management should consider the biology of invading species and their interactions within the affected environment, prior to implementing control actions. Preventive measures should be used to stop further spread and prioritize control measures on small populations of new invaders. For different invading species, different control methods should be considered.

Decisions made under the premise of ecosystem management need to be based on informed judgment as well as a system of principles that acknowledges the factors which are prohibiting successful restoration of ecosystem integrity. In the case of invasive species, these factors would include activities which create soil disturbances and aid in the transport of seeds.

Using the principles cited in Noss, Wooten (1999) listed a number of corollary principles for the use of true Integrated Pest Management within an ecosystem management framework:

Social and Cultural Objectives

- Education should be an integral part of weed management projects.
- Public involvement should be open and welcome during the planning, preparation, implementation, and if necessary, legal redress, of weed management projects.
- Weed management projects should be designed in the interests of the general public, without favor to special interests or chemical companies.
- Proposed projects should include integration of cultural values with resources.
- Proposed projects involving the use of pesticides or herbicides should include risk analyses for public health and safety. Thresholds for health and safety tolerance should be publicly available. Faulty analyses or risks exceeding thresholds should be cause for rejection of proposals and abandonment of projects.
- Proposed projects should describe and analyze the economics of manual control methods without bias.
- Proposed projects should describe and analyze costs/benefit ratios. Faulty analyses or net losses will be cause for rejection of proposals.
- Proposed projects should provide clear and concise definitions and terms.
- Goals of proposed projects should be realistic and objectives should be measurable.
- Monitoring should be incorporated in all weed management programs.

Ecosystem Management Objectives

- Managers should describe weed control measures within an ecosystem management framework involving an understanding of the biology, demographics and etiology of weed spread.
- Managers should describe weed control measures within an ecosystem management framework involving an understanding of the differences in ecology between native and introduced species' ecology.
- Damage thresholds should be established for invading species that activate a process of strategic weed management.
- Areas in which eradication of certain species may not be feasible should be identified and goals should be directed toward control strategies rather than eradication in these areas.
- Areas in which control or containment may not be feasible should be identified and management should not use funds in these situations until control mechanisms have been established.
- Use of native species for recovery should be required. The use of introduced forage grasses should be discouraged, as many introduced grasses are also ecosystem invaders and attract livestock into recovery zones.
- Monitoring should be incorporated in all weed management programs.

Preferred Alternative objectives

- Preferred alternatives should have clearly stated goals
- Preferred alternatives should substantially involve the public.
- Preferred alternatives should be long-term solutions.
- Preferred alternatives should be economically cost-effective
- Preferred alternatives should have clearly stated costs.
- Preferred alternatives should be specific about dates and times.
- Preferred alternatives should be site-specific.
- Preferred alternatives should be species-specific and should use scientific nomenclature for plant names.
- Preferred alternatives should incorporate effectiveness monitoring.

Herbicides use objectives

- Decision documents should provide analyses of health and safety risks associated with pesticides and should do so openly and without bias. Descriptions of potential hazards should be available to the public and should include discussion and analysis of potential effects on vulnerable groups of people.
- Decision documents should describe the effects of proposed treatments on the environment and should include discussion and analysis of potential and known effects of herbicides including, but not limited to, above- and below-ground transport, breakdown factors, food- web incorporation, nature of targets, synergistic effects, non-target effects and aquatic effects. If certain effects are completely unknown, herbicide use should be restricted to emergency cases in which eradication is imminently attainable and for which other documentation has been completed.
- Decision documents should include worst-case scenarios including a discussion of potential effects resulting from chemical spills, herbicide drift, off-target contamination and accidental over-application.
- Permits for use on public lands should be rejected for chemicals containing so-called "inert ingredients". Manufactured products containing trade secrets for ingredients have no place on public lands.
- All areas treated with herbicides should be posted for the duration of pesticide residuals on the site.
- Cumulative effects should be analyzed including the potential for development of herbicide tolerance, chemical buildup and selective changes in vegetation structure resulting in loss of resources.
- Only permitted applicators should be allowed to use herbicides.
- The use of herbicides should be a LAST resort.

Examples: As an example of how ecosystem management could improve the management of public lands, consider how plant invaders become established. Initial introductions often arise through the use of roads and trails in which seeds are brought in on cars, off-road vehicles, livestock, wildlife, hiker's boots, mountain bikes, contaminated feed or contaminated seed mixtures. Natural and man-made disturbances adjacent to those introductions then act as sites for further spread. It is ineffective to treat roads in an area where new road building will subsequently act as a vector for reinvasion of a treated species. It is also ineffective to use herbicide on a site where large populations of weeds are adjacent to the site for reinfection. And similarly, it is ineffective to treat grazed public lands through herbicide treatments when livestock will bring the seeds back to the site each year.

Treatments should be consistent with the management objectives for an area. Inappropriate seeding of forage grasses should not be combined with cattle grazing and invasive species management. Pasture grasses such as the wheatgrasses and the bromes have been commonly used in the Pacific Northwest with a number of undesirable ecosystem effects. Their high protein content acts as an attractant to livestock, resulting in increased soil disturbance and weed spread in recovery zones. Seed mixes are often contaminated with seeds of the very weeds that the grasses are supposed to replace. If successful, introduced perennial grasses often act as ecosystem invaders, spreading without control across the landscape, encouraging livestock and thus soil disturbance to new areas.

4. Adaptive management

Adaptive management is another emerging paradigm with promise for the Forest Service. It was defined in Everett (1994, p. 110, citing Baskerville, 1985):

> The formalized process of adaptive management allows restoration activities to be initiated based on current information, but efforts need to be constantly updated and redirected as new information becomes available.

The Interior Columbia Basin Ecosystem Management Project (ICBEMP) proposed decision (ICBEMP, 2000) chose to use adaptive management approach (ICBEMP, 2000, p. 19):

> . . . the ICBEMP decision will use an adaptive management approach to modify management plans and activities to incorporate new knowledge gained over time.

The process of adaptive management was described in more detail in ICBEMP (2000, Ch. 3, p. 7):

> . . . The intent of adaptive management is to incorporate and build on current knowledge, observation, experimentation, and experience to adjust management methods and policies, and to accelerate learning. The intent is for management direction to be modified if a site-specific situation is different than what was assumed during ICBEMP planning; if a flood, fire, or other event changes the characteristics of the environment; if new information gathered through monitoring indicates objectives are not being met; or if new science information indicates a need for change. . . . Monitoring and evaluation are an integral part of adaptive management and are key to achieving the short- and long-term goals and objectives of ICBEMP.

When used in the context as presented above, adaptive management can be a useful tool for restoring degraded areas and identifying successful methods. However, adaptive management is inherently dependent on the long-term commitment to ask questions and acquire information about the effectiveness and appropriateness of actions being taken. Monitoring is thus integral to a successful adaptive management approach which should be applied for invasive species management.

5. Precautionary principles

The risk assessment procedures that have been used by government EIS analysts are beginning to give way to precautionary principles, as described by Montague, 1999d):

> Science has no way to analyze the effects of multiple exposures, and almost all modern humans are routinely subjected to multiple exposures: pesticides; automobile exhaust; dioxins in meat, fish and dairy products; prescription drugs; tobacco smoke; food additives; ultraviolet sunlight passing through the earth's damaged ozone shield; and so on. Determining the cumulative effect of these insults is a scientific impossibility; so most risk assessors simply exclude these inconvenient realities. But the resulting risk assessment is bogus.
>
> Risk assessment is inherently an undemocratic process because most people cannot understand the data, the calculations, or the basis for the risk assessor's judgment.
>
> Now after 20 years, the public is catching on, that risk assessment has been a failure and in many cases a scam. Rather than allowing citizens to reach agreement on what's best, it has provided a patina of "scientific objectivity" that powerful corporations have used to justify continued contamination of the environment. With a few rare exceptions (sulfur dioxide emissions, for example) dangerous discharges have increased geometrically during the period when risk assessment has been the dominant mode of decision-making. It is now obvious to most people that risk assessment is a key part of the problem, not an important part of any solution.
>
> In place of risk assessment, a new paradigm is ripening: the principle of precautionary action. The precautionary principle acknowledges that we are ignorant about many

important aspects of the environment and human health. It acknowledges scientific uncertainty and guides our actions in response to it.

The precautionary principle says, ‘When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof. [See Rachel's Environmental and Health Weekly #586.] The process of applying the Precautionary Principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action.’

Certainly, this method of protecting public interests should be incorporated into invasive species management.

Appendix B - Chemical safety considerations

Forest Chemical Safety Plan

Personnel. Personnel should be knowledgeable about the handling of hazardous substances, and procedures for ordering and procurement of chemicals. Specifically:

1. The use of proper material handling equipment, protective apparel, and safety equipment;
2. Emergency procedures, including the cleanup of spills and the disposal of broken containers;
3. The dangers of contacting chemicals by skin absorption, inhalation, or ingestion;
4. The meaning of the various DOT labels on shipping packages;
5. The proper methods of material handling and storage, especially the incompatibility of some common substances, the dangers associated with alphabetical storage, and the sensitivity of some substances to heat, moisture, light, and other storage hazards;
6. The special requirements of heat-sensitive materials, including those shipped refrigerated or packed in dry ice;
7. The hazards associated with flammable liquids (especially the danger of their vapors catching fire some distance from the container) (e.g., alkali metals, burning magnesium, metal hydrides, acid chlorides, phosphides, and carbides);
8. The federal and state regulations governing controlled substance such as radioactive material, drugs, ethyl alcohol, explosives, and needles and syringes;
9. Chemicals that have offensive smells; and
10. Packages that exhibit evidence that the inside container has broken and leaked its contents.

Incidents and Accidents

1. Introduction: Reporting incidents and accidents is required by law. Relatively minor incidents without personal injury or only minor injury should be reported on the incident report form. Serious accidents (fatalities and multiple hospitalization injuries) must be reported directly to OSHA. Forms will be available from the Safety Officer.
2. Reportable Incidents Include:
   - A. Every accident (injurious or non-injurious).
   - B. Accidents resulting in damage to instruments or the building.
   - C. Situations or conditions, which have a potential for injury, hazard to health, or damage to the property.
   - D. Situations in which a member of the public claims to be harmed.
3. Serious Accidents Include:
   - A. Fatalities
   - B. Injuries requiring hospitalization
   - C. Injuries requiring medical treatment
   - D. Property damage
   - E. Chemical exposure resulting in lost time which may involve the public
4. Investigation:
   - A. Minor incidents reported to the supervisor will be investigated and a report filed in a 30-year archive file with an evaluation and recommendations.
   - B. Major accidents or serious incidents will be investigated by the supervisor and Safety Officer in conjunction with the safety committee and a full report given to the supervisor.
5. Reporting Accidents.

A. All accidents and injuries, no matter how minor, shall be reported PROMPTLY to the immediate supervisor, Office Director or person in charge of the work area. The agency's employee personal injury report form will be used to report all injuries or incidents.
B. The injured worker's immediate supervisor or the person in charge must conduct a thorough unbiased investigation to determine the cause(s) of the accident.
C. The injured employee and his/her supervisor shall handle and complete the Labor and Industries (L&I) Injury Claim Report, Form F242-130-111 if necessary.
D. The circumstances of any injury accident resulting in an immediate or suspected fatality shall be reported immediately to the local office of the Department of Labor and Industries and to the Safety and Benefits Section.
    (1) Except where removal is essential to prevent further injury, equipment involved in a fatal accident shall not be moved until the investigation is completed or the equipment is released by the L&I investigator.
    (2) All personnel shall cooperate fully with the L&I Industrial Safety and Health investigators and inspectors.
E. Cases involving injuries which are so severe that the employee may be off work for an extended period require the employee to be counseled with respect to benefits and various employment/compensation options available and how they may affect pay, retirement and leave provisions.

Accidents, Spills, and Releases. Spills of toxic substances or accidents involving any hazardous chemical shall be resolved immediately according to the State Public Health Laboratories' emergency procedure plan. Clean up of hazardous chemicals will be performed by qualified personnel from the area where the spill occurred. All accidents must be documented, and reported to the Safety Officer.

Emergency procedures for spills and accidents. All spills are different, and remediation requires judgement; below are some guidelines for reaction to spills.
1. Attend to any person who may have been contaminated or injured.
2. Notify your supervisor and appropriate emergency responders immediately.
3. If spilled chemical is flammable, extinguish all nearby sources of ignition.
4. Notify persons in the immediate area about the spill.
5. Evacuate all nonessential persons from the spill area.
6. If the spilled material is flammable turn off any heat source.
7. If a person has been splashed with a chemical, remove all contaminated clothing, flush the contaminated area with running water for at least 15 minutes, and GET MEDICAL ATTENTION, CALL 911.
8. If a person has been overexposed by inhalation, get victim to fresh air if it is safe to do so, begin rescue breathing if necessary, and GET MEDICAL ATTENTION, CALL 911.
9. Avoid breathing vapors of the spilled material; if necessary use a respirator.
10. Ingestion: GET MEDICAL ATTENTION, CALL 911and the local poison control center and follow their instructions.
11. Leave on or establish exhaust ventilation if it is safe to do so.
12. In other cases of overexposure, GET MEDICAL ATTENTION, CALL 911 and follow the instructions of the medical professional.
13. Secure supplies to effect cleanup. Promptly clean up spills using appropriate protective apparel and equipment and proper disposal.
14. Inform the safety officer if a regulated substance is involved.

Emergency procedures for spills and accidents. In handling emergencies:
1. DO NOT handle emergencies alone, GET HELP.
2. DO NOT linger at the accident scene if you are not one of the emergency responders.

3. DO NOT apply medical aid procedures without training in first aid. If you are not trained in first aid, get MEDICAL ATTENTION, CALL 911, or contact a medical professional as soon as possible.

Release of hazardous substances. The release of hazardous substances should minimize exposure of personnel and property. This preplanning should include consideration of the following factors:
1. potential location of the release;
2. the quantities of material that might be released and whether the substance is a piped material or a compressed state;
3. chemical and physical properties of the material (e.g., its physical state, vapor pressure, and air or water reactivity);
4. hazardous properties of the material (its toxicity, corrosivity, and flammability), and
5. the types of personal protective equipment that might be needed.

Commercial spill kits must be available with all applicators complete with instructions, absorbent, reactants, and protective equipment. These kits should also be strategically located in work areas where chemicals are stored, and with field personnel who will be travelling to treated areas.

Supplies and equipment must be on hand to deal with spills, consistent with the hazards and quantities of the spilled substance. These cleanup supplies should include neutralizing agents (such as vermiculite and sand). Paper towels and sponges may also be used as absorbent-type cleanup aids, although this should be done cautiously. Appropriate gloves should be worn when wiping up toxic materials with paper towels. Also, when a spilled flammable solvent is absorbed in vermiculite or sand, the resultant solid is highly flammable and gives off flammable vapors and, thus, must be properly contained or removed to a safe place.

Handling of Spilled Liquids:
1. Wear appropriate personal protective apparel; gloves, overcoat, mask, eyewear, or face shields as necessary.
2. Confine or contain the spill to a small area. Do not let it spread.
3. For small quantities of materials, absorb the spill with nonreactive material such as vermiculite, dry sand, or towels.
4. Carefully pick up and remove any cartons or bottles that have been splashed.
5. If the spilled material is extremely volatile, let it evaporate and be exhausted before attempting to clean it up without protective clothing and respiratory gear. Be sure that associated mechanical equipment in the area is spark-proof.
6. Dispose of residues according to safe disposal procedures (keep references manufacturer's references and material safety data sheets available to all personnel).

Exposure Evaluations and Medical Consultations

Suspected Exposures to Toxic Substances. When employees or supervisors suspect that an employee has been exposed to a hazardous chemical to a degree and in a manner that might have caused harm to the victim (circumstances suggest a reasonable suspicion of exposure), the affected employee shall be provided an opportunity for medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination. All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided at no cost to the employee, without loss of pay and a reasonable time and place.

Criteria of "Reasonable" Suspicion of Exposure. It is the policy of the Forest Service to promptly investigate all employee-reported incidents in which there is even a remote possibility of employee overexposure to a toxic substance. Regular medical surveillance should be established to the extent required by the regulations.

Circumstances That Constitute a Suspected Exposure:

1. Anyone whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable.
2. Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.
3. A hazardous chemical leaked, spilled or was otherwise rapidly released in an uncontrolled manner.
4. Odor was noticed, especially if person was working with any chemical, which has a lower TLV than odor threshold.
5. An employee had direct skin or eye contact with a hazardous chemical.
6. An employee manifests symptoms, such as headache, rash, nausea, coughing, tearing, irritation or redness of eyes, irritation of nose or throat, dizziness, loss of motor dexterity or judgement, etc.
7. Some or all of the symptoms disappear when the person is taken away from the exposure area and breathes fresh air.
8. The symptoms reappear soon after the employee returns to work with the same hazardous chemicals.
9. Two or more persons in the work area have similar complaints.
10. All complaints will be promptly investigated to determine risk of employee overexposure to the toxic substances in their work place.

Exposure Evaluation. All complaints and their disposition, no matter what the ultimate disposition may be, are to be documented. If no further assessment of the event is deemed necessary, the reason for that decision should be included in the documentation. If the decision is to investigate, a formal exposure assessment will be initiated.

Exposure Assessment. In cases of emergency, exposure assessments are to be conducted by a Chemical Hygienist after the victim has been treated.

It is not the purpose of an exposure assessment to determine that a failure on the part of the victim, or others, to follow proper procedures was the cause of an exposure. The purpose of an exposure assessment is to determine that there was, or was not, an exposure that might have caused harm to one or more employees or members of the public, and, if so, to identify the hazardous chemical or chemicals involved. Exposure assessments determine facts; they do not make recommendations.

Unless circumstances suggest other or additional steps, these actions constitute an exposure assessment:

1. Interview the complainant and also the victim, if not the same person.
2. List the essential information about the circumstances of the complaint, including:
   A. The chemical and physical properties involved and the quantity in use; the potential for overexposure associated with the operation involved and an estimation of the duration of exposure;
   B. Other chemicals used by victim;
   C. All chemicals being used by others in the immediate area;
   D. Other chemicals stored in that area;
   E. Symptoms exhibited or claimed by the victim;
   F. How these symptoms compare to symptoms stated in the materials safety data sheets for each of the identified chemicals;

G. Were control measures, such as personal protective equipment and clothing, being used properly?;
H. Were any air sampling or monitoring devices in place? If so, are the measurements obtained from these devices consistent with other information?;
I. Monitor or sample the air in the area for suspect chemicals;
J. Determine whether the present control measures and safety procedures are adequate.

Physician Written Opinion. For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician (WAC 296-62-40013) which shall include the following:

1. Any recommendations for further medical follow-up.
2. The results of the medical examination and any associated tests.
3. Any medical condition, which may be revealed in the course of the examination, which may place the employee at increased risk as a result of exposure to a hazardous chemical, found in the workplace.
4. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.
5. The written opinion shall not reveal specific finding of diagnoses unrelated to occupational exposure.

Notification of Monitoring Results. Within 15 working days of receipt of the results of any monitoring, employees will be notified of those results either individually or by posting results in an appropriate location that is accessible to employees.

Medical Consultation. When employees are suspected or known to be overexposed to toxic chemicals, they should receive prompt medical attention. To ensure that they do receive proper and informed medical attention, the Forest Service will designate preferred medical facilities for consultation and diagnosis.

Medical Consultation Authority. It is the authority of the Safety Officer, to authorize medical consultation in Non-Emergency cases.

The employee to be examined will consult with or visit previously designated medical facility. It is the responsibility of supervisory staff or designee to arrange transportation to and from the medical facility. (Note; if chemical exposure is confirmed or suspected, a supervisor cannot assure the victim can properly operate a motor vehicle). The medical report will be sent directly to the Safety Officer, who will pass the appropriate information along to those involved.

Documentation. All memos, notes, and reports related to a complaint of actual or possible exposure to hazardous chemicals are to be maintained as part of the record.

Notification. Employees shall be notified of the results of any medical consultation or examination with regard to any medical condition that exists or might exist as a result of overexposure to a hazardous chemical.

Pesticides. A pesticide label containing information on use and safety must be attached to all pesticide containers. The label includes the product name, name and amount of active ingredients, EPA registration number and establishment number, name and address of the manufacturer, and net contents.

The use classification (general use or restricted use) is noted on the label. The signal word (danger, warning, or caution) provides information about hazard classification. Precautionary statements inform users of handling requirements, procedures, and special concerns. Directions for use specify legal application sites, rates, and mixing and handling instructions. The pesticide label is a binding legal agreement between the EPA, the registrant, and the user. It is illegal to use a pesticide in a way or place not specified on the label.

Procedures for Carcinogens, Reproductive Toxins, Substances with a High Degree of Acute Toxicity and Chemicals of Unknown Toxicity. Follow the procedures described in this section when performing work with any carcinogen, reproductive toxin, substance that has a high degree of acute toxicity, or a chemical whose toxic properties are unknown. This includes pesticides with "inert ingredients" that have not been profiled by the EPA.

The following definitions will apply:

1. Select carcinogen: Any substance defined as such in 29 CFR 1910.1450 and any other substance described as such in the applicable MSDS. "Select carcinogen" means any substance, which meets one of the following criteria:
    - A) It is regulated by OSHA as a carcinogen;
    - B) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
    - C) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest edition); or 7.4Procedures for Carcinogens, Reproductive Toxins, Substances with a High Degree of Acute Toxicity and Chemicals of Unknown Toxicity
    - D) It is listed in either Group 2A or 2B by IARC or under the category, "reasonable anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: a) After inhalation exposure of 6-7 hours per day, 5 days per week for a significant portion of a lifetime to dosages of less than 10 mg/m3; b) After repeated skin application of less than 300 (mg/kg of body weight) per week; or c) After oral dosages of less than 50 mg/kg of body weight per day.

2) Reproductive toxin: Any substance described as such in the applicable MSDS, or any substance identified as a reproductive toxin by the Oak Ridge Toxicology Information Resource Center (TIRC), (615)576-1746; or for teratogen only: Any substance identified as such in Thomas H. Shepard, "Catalog of Teratogenic Agents", 6th ed., John Hopkins Press, 1989.
3) Substance with a high degree of acute toxicity: any substance for which the LD50 data described in the applicable MSDS cause the substance to be classified as a "highly toxic chemical" as defined in ANSI Z129.1
4) Chemical whose toxic properties are unknown: A chemical for which there is no known statistically significant study conducted in accordance with established scientific principles that establishes its toxicity.

All work involving carcinogens must be done using barrier clothing out of doors to reduce the risks of employee exposure to the vapors.

Records. This section reviews the value of documenting compliance with this safety standard for general liability and the ability to periodically assess the safe conduct of employees.

1) Accident records should be written and retained.
2) Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations.
3) Inventory and usage records for high-risk substances should be kept as specified. Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved.
4) Medical records should be retained by the institution in accordance with the requirements of state and federal regulations.
5) Specific records may be required in the event of time loss resulting from an exposure by accident on the job. The standard form OSHA 200 is used to document lost workdays from incidents that occur at work.

6) In addition to records required by OSHA, it will be desirable to keep special records developed internally which document suspected exposures and employee exposure complaints regardless of the outcome of the Exposure Evaluation. Other incidents and activities could be documented for future reference. These include:
   A. COMPLAINTS FROM EMPLOYEES - Even if the complaint is found to be unjustified, it is desirable to keep a record of the complaint, the investigation, and the outcome. The complaint might be about chemical exposure, but could include complaints about inoperative-engineered controls or defective personal protective equipment.
   B. REPAIR AND MAINTENANCE RECORDS FOR CONTROL SYSTEMS - Demonstrate that equipment such as protective clothing and gear is well maintained and kept in clean, proper operating order. These are useful; they suggest corrective actions and indicate that equipment was or was not well maintained and kept in working order.
   C. MAJOR SAFETY SUGGESTION FROM EMPLOYEES - Can be valuable to improve workplace safety. Even if the issue is decided to be non-workable, the fact that the suggestion was take seriously and examined is valuable.
   D. NEAR-MISS REPORTS - Employees who participate in or witness events that could have caused harm, but fortunately did not, should prepare reports of the incidents. These reports are used to develop changes in procedures that will prevent a future more serious occurrence.
   E. RECORDS TO BE KEPT - The Forest Chemical Safety Plan requires that records of air concentration monitoring results, exposure assessments, medical consultation, and examinations be maintained for at least 30 years and that they be accessible to employees or their representatives. A system will be developed to retain documents related to distribution and maintenance of Material Safety Data Sheets and to the safety training of employees. Specific records may be required in the event of lost work time resulting from injury on the job.

Record keeping. All records should be kept for at least as long as the employees affected are employed with the Government. Require medical records to be kept for 30 years beyond the employee's time of employment. It is prudent to set up an archiving system to keep all-important documents related to safety employee training and distribution of Material Safety Data Sheets for the lifetime of the company. Medical records of employees who have worked less than one year need not be retained after employment, but the employer must provide these records to the employee upon termination of employment.

Storage of Records and Documents. All records pertaining to personnel training, and safety concerns or actions will be kept in a locked fireproof container. These records will be accessible to the employee to whom they pertain.